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No. 42

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

MUNICIPAL WATER SUPPLY PUBLIC CORPORATION(EMPAGUA)
THE REPUBLIC OF GUATEMALA

THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA

FINAL REPORT

VOLUME II
MAIN REPORT

AUGUST 1996

NIHON SUIDO CONSULTANTS CO., LTD.
PACIFIC CONSULTANTS INTERNATIONAL

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EXCHANGE RATES USED IN THIS STUDY

1. Selection of Priority Regions (Master Plan)
   1US$ = Q5.71 = Yen 100.75(average of May '94 ~ April '95)
2. First Stage Project
   1US$ = Q5.88 = Yen 99.12(average of July '95 ~ December '95)

LOCATION OF THE REPUBLIC OF GUATEMALA

THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE LOCATION MAP OF THE STUDY AREA

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ABBREVIATIONS

ABBREVIATIONS OF ORGANIZATION / SIGLAS DE ORGANIZACION

AID	=	Agency for International Development Agencia Internacional para el desarrollo
ANAM	=	National Association of Municipalities Asociacion Nacional de Municipalidades
BANVI	=	National Housing Bank Banco Nacional de Vivienda
BANGUAT	=	Central Bank of Guatmala Banco de Guatemala
BCIE	=	Central American Economic Integration Bank Banco Centroamericano de Integracion Economica
CIDA	=	Canadian International Development Agency = Agencia Canadiense de Desarrollo Internacional
CACIF	=	Coordinator Committee of Agricultural, Industrial and Financial Associations Comite Coordinador de Asociaciones Agricolas, Industriales y Financieras
CAPRE	=	Regional Coorinating Committee of Drinking Water and Sanitation of Central America, Panama and Dominican Republic Comite Coordinador Regional de Instituciones de Agua Potable y Saneamiento de Cetroamerica, Panama y Rupublica Dominicana
CIEN	=	National Economic Research Center Centro de Investigaciones Economicas Nacionales
CNPE	=	National Council of Economic Planning Consejo Nacional de Planificacion Economica
CONAMA	=	National Environmental Commission Comision Nacional del Medio Ambiente
CONAP	=	National Council of Protected Area Consejo Nacional de Areas Protegidas
COPECAS	=	Permanent Committee of Coordination of Water and Sanitation *Comite Permanente de Coordinacion de Agua y Saneamiento*
EDOM	=	Study of Metropolitan Orderliness Estudio de Ordenamiento Metropolitana
DGSS	=	General Bureau of Health Services Direction General de Servicios de Salud
DST	=	Environmental Sanitation Department Division de Saneamiento del Medio
EMPAGUA	=	Guatemala Municipal Water Supply Corporation Empresa Municipal de Agua de la Ciudad de Guatemala
ERIS	=	Regional School of Sanitary Engineering Escuela Regional de Ingeneria Sanitaria
FAO	=	Food and Agricultural Organization Organizacion de Comidas y Agricultura
GOG	=	Government of Guatemala Gobierno de Guatemala
GOJ	=	Government of Japan Gobierno de Japon
GTZ	=	German Cooperation Agency Sociedad Alemana de Cooperacion
IBRD	=	See "WB" Vease "WB"
IDA	=	International Development Association Asociacion Internacional de Desarrollo
IDB	=	Inter-American Development Bank Banco Interamericano de Desarrollo
IGM	=	Military Geographic Institute Instituto Geografico Militar

IGSS	=	Guatemalan Institute of Social Security
		Instituto Guatemala de Seguridad Social
INAFOR	=	National Institute of Forestation
		Instituto Nacional de Forestacion
INDE	=	National Institute of Electrification
		Instituto Nacional de Electrificacion
INE	=	National Institute of Statistics
		Instituto Nacional de Estadistica
INFOM	=	National Institute of Municipal Development
		Instituto Nacional de Fomento Municipal
INSIVUMEH	=	National Institute of Seismology, Vulcanology, Meteorology and Hydrology
		Instituto Nacional de Sismologia, Vulcanologia, Meteorologia e Hidrologia
INTECAP	=	Technical Institute of Training and Productivity
		Instituto Tecnico de Capacitacion y Productividad
JICA	=	Japan International Cooperation Agency
	=	Agencia de Cooperacion Internacional del Japon
MCTyOP	=	Ministry of Communications, Transportation and Public Works
	=	Ministerio de Comunicacion, Transportacion y Obras Publicas
MINFIN	=	Misnistry of Public Finance
		Ministerio de Finanzas Publicas
MSPyAS	=	Ministry of Public Health and Social Assistance
		Ministerio de Salud Publica y Asistencia Social
MUNI	=	Municipality of Guatemala
		Municipalidad de Guatemala
OECF	=	Overseas Economic Cooperation Fund of Japan
		Fondo Japones de Cooperacion Economica Ultramar
PAHO	=	Panamerican Health Organization
		Organizacion Panamericana de Salud
PLAMABAG	=	Guatemala City Water Supply Master Plan
		Plan Maestro de Abastecimiento de Agua a la Ciudad de Guatemala
SEGEPLAN	=	General Secretariat of Economic Planning
		Secretaria General de Planificacion Economica
SRH	=	Secretariat of Hydraulic Resources
		Secretaria de Recursos Hidraulicos
UEA	=	Emergency Water Unit
		Unidad de Emergencia de Agua
UENIA	=	Study Unit of New Water Introduction
		Unidad de Estudios de Nuevas Introducciones de Agua
UN	=	United Nations
		Organicacion de Naciones Unidas
UNDP	=	United Nations Development Program
		Programa de Naciones Unidas para el Desarrollo
UNEHIVAGUA	=	Executant Unit of Hydrological Study of Guatemalan Valley
		Unidad Ejecutora del Estudio Hidrologico del Valle de Guatemala
UNEPAR	=	Executant Unit of Rural Aqueduct Program
		Unidad Ejecutora del Programa de Acueductos Rurales
UNESCO	=	United Nations Educational Scientific and Cultural Organization
		Organizacion Educacional, Sientifica y Cultural de Naciones Unidas
UNICEF	=	United Nations International Children's Emergency Fund
		Fondo de Nacioned Unidas para la Infancia
USAC	=	University of San Carlos of Guatemala
		Universidad San Carlos de Guatemala
USAID	=	United States Agency for International Development
		Agencia Internacional de Desarrollo de Estados Unidos
WB	=	World Bank
		Banco Mundial
WHO	=	World Health Organization
		Organizacion Mundial de Salud

ABBREVIATIONS OF TERMS USED IN THIS REPORT

B/C	-	Benefit Cost Ratio
BOD	-	Biochemical Oxygen Demand
CCTV	-	Closed Circuit Television
COD	-	Chemical Oxygen Demand
DSR	-	Debt Service Ratio
EIA	-	Environmental Impact Assessment
EIRR	-	Economic Internal Rate of Return
FIRR	-	Financial Internal Rate of Return
GDP	-	Gross Domestic Product
GDE	-	Gross Domestic Expenditure
GFCF	-	Gross Fixed Capital Formation
HWL	-	High Water Level
IC	-	Intermediate Clarifier
IEE	-	Initial Environmental Examination
MSL	-	Above Mean Sea Level
NPV	-	Net Present Value
O/M	-	Operation and Management
PDWF	-	Peak Dry Weather Flow
PST	-	Primary Sedimentation Tank
RCP	-	Reinforced Concrete Pipe
SCF	-	Standard Conversion Factor
SDB	-	Sludge Drying Bed
SDT	-	Sludge Digester Tank
SGC	-	Screen · Grit Chamber
SS	-	Suspended Solids
TF	-	Trickling Filter
T-N	-	Total Nitrogen
TOR	-	Terms of Reference
T-P	-	Total Phosphorous
TS	-	Total Solids
VA	-	Value Added
VAT	-	Value Added Tax
WWTP	-	Wastewater Treatment Plant

ABBREVIATIONS OF MEASURES

1 Length

mm	=	millimeter
cm	=	centimeter
m	=	meter
km	=	kilometer
"	=	inch

2 Area

m2, sq.m	=	square meter
ha	=	hectare
km2, sq.km	=	square kilometer

3 Volume

cc	=	cubic centimeter
lit, l,L	=	liter
lcd	=	liter per capita per day
m3, cu.m	=	cubic meter
Gal, Gallon (US)	=	3.785 liter

4 Weight

mg	=	milligram
g	=	gram
kg	=	kilogram
t	=	ton

5 Time

s, sec	=	second
mim	=	minute
h, hr	=	hour
d	=	day
yr	=	year

6 Money

Q	=	Quetzales (unit of Guatemalan currency)
US$, $	=	US Dollar
¥	=	Japanese Yen

7 Electric Measures

A	=	ampere
V	=	volt
kV	=	kilovolt
kW	=	kilowatt

	kWh	=	kilowatt hour
	kVA	=	kilovolt ampere
	Hz	=	hertz

8 Other Measures

mS	=	milli Siemens
μmho	=	micromho = conductivity
ppb	=	parts per billion
ppm	=	parts per million
MPN	=	most probable number
‰	=	per thousand
%	=	percent
PS	=	0.736 kW
°	=	degree
'	=	minute
"	=	second
°C	=	degree centigrade

9 Derived Measures Based on the Same Symbols

cm/sec	=	centimeter per second
m/s, m/sec	=	meter per second
cm3/min	=	cubic centimeter per minute
m3/sec, cu.m/sec	=	cubic meter per second
m3/s, cu.m/s	=	cubic meter per second
m3/min, cu.m/min	=	cubic meter per minute
m3/h, cu.m/h	=	cubic meter per hour
m3/day, cu.m/day	=	cubic meter per day
m3/d, cu.m/d	=	cubic meter per day
lpcd	=	liter per capita per day
m3/m2/day	=	cubic meter per square meter per day
m3/sec/km2	=	specific discharge
kg/day	=	pollutant load
ton/m2	=	ton per square meter
kg/day/km2	=	unit areal pollutant load
kg/(ha•mm)	=	areal pollutant load per unit rainfall
mg/kg	=	milligram per kilogram
mS/cm	=	milli Siemens per centimeter
mg/L	=	milligram per litre
g/cm3	=	gram per cubic centimeter
GPM	=	Gallon per minute

CHAPTER 1

INTRODUCTION

1 INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Government of Guatemala (GOG) has placed much importance on the improvement of urban infrastructure and living conditions of Guatemala Metropolitan Area. In this respect, to improve the wastewater management in the Guatemala Metropolitan Area, the GOG has requested Government of Japan (GOJ) for technical assistance.

In response to the request of the GOG, Japan International Cooperation Agency (JICA) has dispatched the Preparatory Study Team headed by Mr. Katsuhiko Kitai, to Guatemala from December 4 to 13, 1994 to decide the Scope of Work for the Study on the Improvement of Wastewater Management in the Guatemala Metropolitan Area with the GOG.

The Study on the Improvement of Wastewater Management in the Guatemala Metropolitan Area has bee conducted according to the Scope of Work.

1.2 OBJECTIVES OF THE STUDY

The Objectives of the Study are as follows:

a) to formulate a master plan for the improvement of wastewater management that contributes to the upgrading of sanitary and environmental conditions in the Guatemala Metropolitan Area to the year 2015; and

b) to conduct a feasibility study to select the first stage project from the master plan; and

c) to transfer technology in planning skills to the Guatemala counterpart personnel through the Study.

1.3 PURPOSE AND STRUCTURE OF THIS REPORT

This Final Report has been prepared to present the Sewerage/Sanitation Master Plan and Priority Regions up to the target year of 2015 and Feasibility Study on the First Stage Project, which have been prepared from cooperative work with counterpart personnel during the period from the end of March 1995 to the beginning of June 1996.

The Final Report consists of the following nine volumes :

Volume I : Executive Summary (English)
Volume II : Main Report (English)

Volume III	:	Supporting Reports I (English)
Volume IV	:	Supporting Reports II (English)
Volume V	:	Supporting Reports III (English)
Volume VI	:	Drawings
Volume VII	:	Executive Summary (Spanish)
Volume VIII	:	Main Report (Spanish)
Volume IX	:	Data Book (English)

Fig. 1-1 shows the structure of Main Report which mainly consists of a) existing conditions, b) Wastewater Management Plan and Priority Regions, c) Feasibility Study on the First Stage Project, and d) environmental impact assessment.

1.4 STUDY AREA

The Study Area is limited to Guatemala City and part of seven municipal areas which are: Chinautla, Mixco, Villa Nueva, San Miguel Petapa, Santa Catarina Pinula, Villa Canales and San Pedro Ayampuc, as specified in the Scope Work agreed by EMPAGUA and JICA on December 13, 1994.

The Study Area, specified on a 1:50,000 scale topographical map, agreed in the Minutes of the Meeting on the Inception Report held on April 6 , 1995, was modified and confirmed as shown in Fig. 1-2. This modification was agreed upon between EMPAGUA and the Study Team as per the letter dated May 19, 1995. The modification was based on information stating boundaries of the municipalities to fulfill the Study Area specified in the Scope of Work. Total area of the Study Area is 34,500 ha.

Fig. 1 - 1

EXISTING CONDITIONS

Chapter 2 Natural Conditions
Chapter 3 Socio-economic Conditions
Chapter 4 Environmental Conditions
Chapter 5 Administrative and Financial Situation
Chapter 6 Existing Wastewater Management

WASTEWATER MANAGEMENT MASTER PLAN

Chapter 7 Fundamentals of Planning Framework
Chapter 8 Study on Wastewater Management Facilities
Chapter 9 Proposed Sewerage System
Chapter 10 Proposed Sanitation System
Chapter 11 Selection of Priority Regions

PRIORITY REGIONS : **CENTRAL REGION AND SOUTH 3 REGION**

FEASIBILITY STUDY ON THE FIRST STAGE PROJECT

Chapter 12 Alternative Study on the First Stage Project
Chapter 13 Implementation Program of the First Stage Project

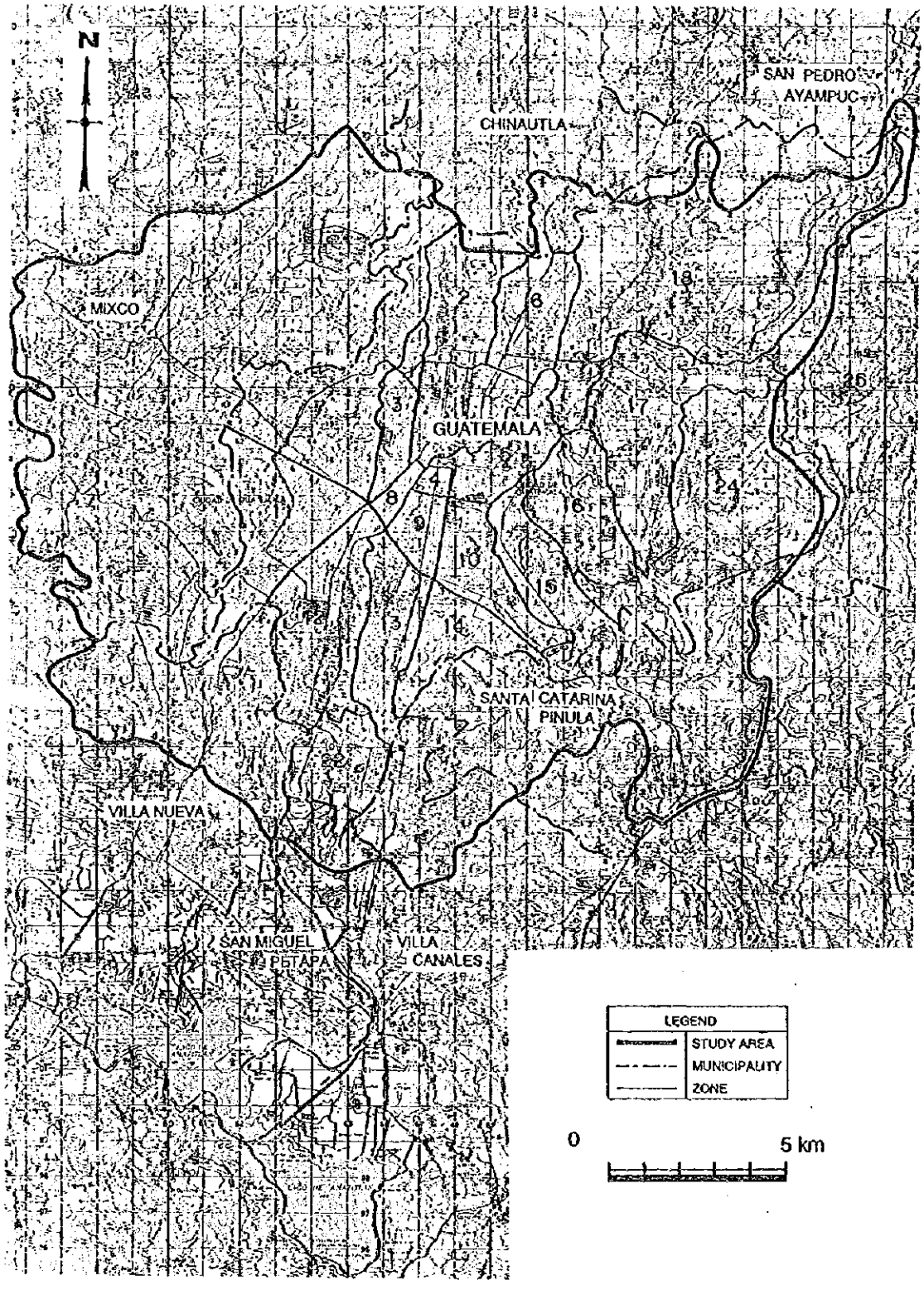
FIRST STAGE PROJECT : **SOUTH 3 REGION**

ENVIRONMENTAL IMPACT ASSESSMENT

Chapter 14 Environmental Impact Assessment
Chapter 15 Conclusion and Recommendation

THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE STRUCTURE OF MAIN REPORT

Fig. 1 - 2



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1.5 STUDY ORGANIZATION

The organization for execution of the Study is as shown in Fig. 1-3. The details of components of the organization are described in the following:

1.5.1 Steering Committee

The Steering Committee comprises the following personnel:

1) Mr. Carols Francisco Quezada Vega	Chairman	General Manager, EMPAGUA
2) Mr. Pedro Obando	Member	Advisor, SEGEPLAN
3) Mr. Luis Hugo Solares	Member	Director, Hydraulic Planning Department, SRH
4) Dr. Juan de Dios Calle	Member	Sub Coordinator, CONAMA
5) Mr. Victor Arias Milian	Member	Environmental Control Department, CONAMA
6) Mr. Julio Cesar Giron Diaz	Member	Executive Secretary , ANAM (up to December 1995)
7) Mr. Rolando Argueta	Member	Advisor, ANAM (from February 1996)

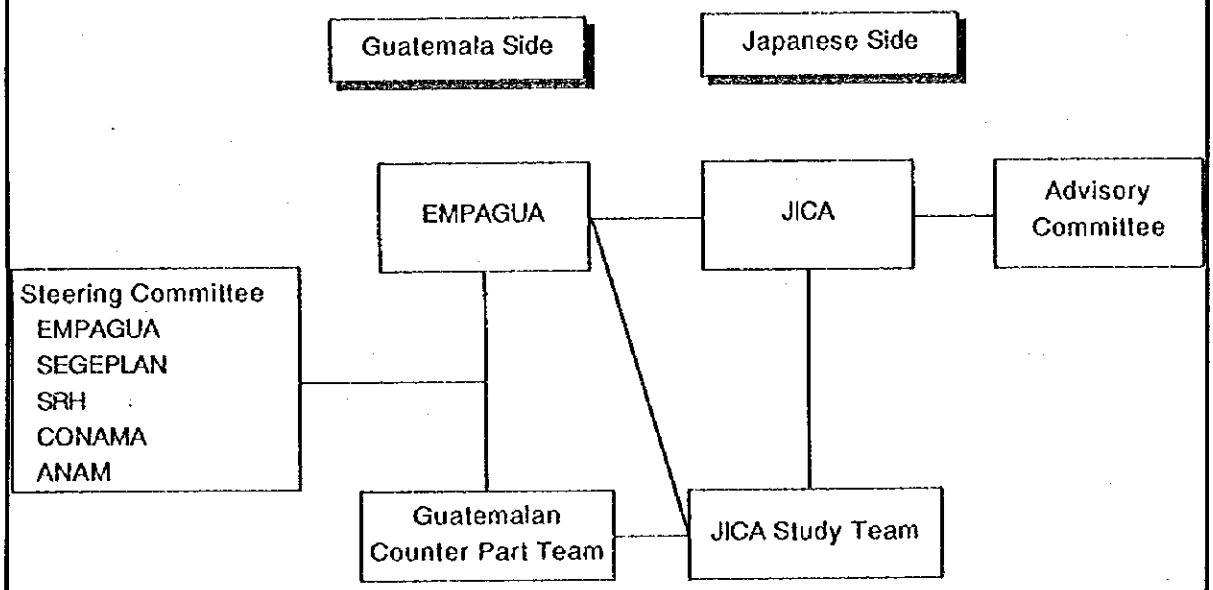
1.5.2 EMPAGUA Counterparts

EMPAGUA has provided the necessary counterpart personnel to the JICA Study Team throughout the study period. The following personnel were attached to the Study:

1) Mr. Ricardo Rodas Romero	Project Coordinator
2) Mr. Sigfrido Castillo	Sewerage Engineer
3) Mr. Roy Osorio	Sewerage Engineer
4) Mr. Carlos Cesar Barrios	Sewerage Engineer
5) Mr. Manuel de Jesus Ramirez	Institutional/Financial Specialist (up to July 1995)
6) Mr. Jorge Mauricio Lau Menendez	Institutional/Financial Specialist (from November 1995)
7) Mr. Rodolfo Gonzales	Water Quality Specialist
8) Mr. Mario Rojas	Water Quality/Environmental Specialist
9) Dr. Carlos Humberto Rivera Pomes	Environmental Specialist (up to July 1995)

In addition to the above personnel, other supporting staff from EMPAGUA, including a secretary and drivers, have participated in the Study and assisted the Study Team throughout the Study period.

Fig. 1 - 3



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1.5.3 JICA Advisory Committee

The Advisory Committee comprises the following personnel:

1) Mr. Katsuhiko Kitai	Chairman	Executive Director, Japan Sewage Works Agency
2) Mr. Hideichiro Nakajima	Member	Deputy Director, Wide Area Planning Division, Japan Sewage Works Agency

1.5.4 JICA Study Team

The JICA Study Team members comprises the following personnel:

1) Dr. Harutoshi Uchida	Team Leader/Work Planner
2) Mr. Kazuji Sasaki	Sewerage System Planner
3) Mr. Noboru Takahashi	Sewerage Facility Planner
4) Dr. Sanjay Arora	Sanitation Facility Planner
5) Mr. Shohei Sata	Urban/Regional Planner
6) Mr. Mitsuhiro Doya	Management/Institutional Specialist
7) Mr. Tatsuo Tashino	Financial Specialist
8) Mr. Hiroaki Miyakoshi	Construction Planner/Cost Estimator
9) Dr. S. Kugaprasatham	Water Quality/Environmental Specialist
10) Mr. Hajime Sakurai	Study Team Coordinator

CHAPTER 2

NATURAL CONDITIONS

2 NATURAL CONDITIONS

2.1 TOPOGRAPHY

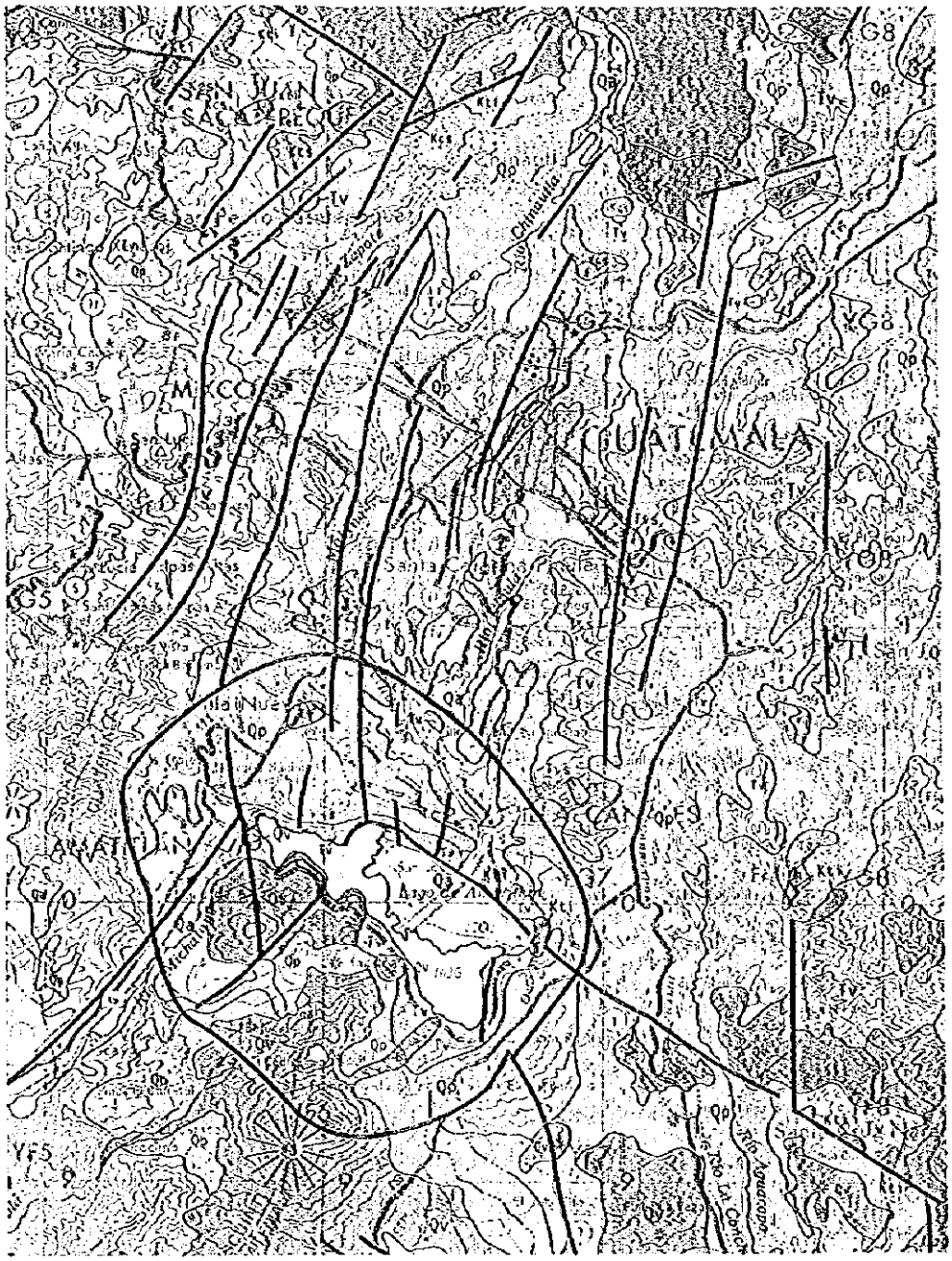
The western highlands are the continuation of Mexico's Sierra Madre range, volcanic formations reaching heights of 3,800 m in the Cuchumatanes range north-west of Huehuetenango. Land that has not been cleared for Maya milpas (cornfields) is covered in pine forests. Many of the volcanoes are active or dormant, and the red glow of volcanic activity is sometimes visible above a distant mountain top. This volcanic activity means that the area is prone to earthquakes. Major quakes struck in 1773, 1917 and 1976, and there are more to come.

The Study Area lies on a sierra which is formed by the Sierra Madre mountain range running in parallel with the Pacific Ocean and declining gradually from west to east. To the west and southeast of the Area are several volcanoes; Acatenango (3,976 m), Fuego (3,835 m), Agua (3,766 m) and Pacaya (2,552 m), which belong to the volcanic range stretching from the west towards the southeast. To the north and south of the Area, the Montagua- San Augustin Faults run in parallel from west to east. In the south eastern part of the Area, Jalpatagua Fault runs from west to south. The Study Area, is bounded by these two great faults to the north and south. Several faults run north-south between these two; namely, Mixco, Santa Catarina Pinula, San Jose Pinula, Teocinte/Palencia, etc., thus forming complex geological features. The local difference of ground elevations is as large as 200 m in some places. Figure 2 - 1 shows the location of main faults and Figures 2 - 2 and 2 - 3, sections through the Study Area, indicate the extensive geological disturbance and hilly terrain.

The Guatemala Valley extends 20.5 km from east to west and 40.0 km from north to south with a total area of about 800 km^2 area. The Valley is surrounded by Santa Catarina Pinula and Mixco Faults to the east and west, and by Volcano Agua and Pacaya Volcano to the south, and extends to the confluence of the El Zapote and Las Vacas Rivers in the north.

The Study Area consists of most of the Guatemala Valley and the eastern part of the area surrounded by the Catarina and Teocinte/Palencia Faults; the principal contours in the Study Area are shown in Figure 2 - 4. South and east along the Inter-American Highway the altitude decreases to about 1,500 m at Guatemala City. North of Guatemala City the highlands of Alta Verapaz gradually decline to the lowlands of El Peten. The altitude ranges between 1,500 and 1,600 m in the central part of the Study Area but to the east and west, in the hilly areas, the range is between 1,900 m and 2,000 m. The ground surface south of the

Fig. 2 - 1



0 10km

Scale 1 : 250,000

THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE LOCATION OF MAIN FAULTS IN THE PROXIMITY OF STUDY AREA

Fig. 2 - 2

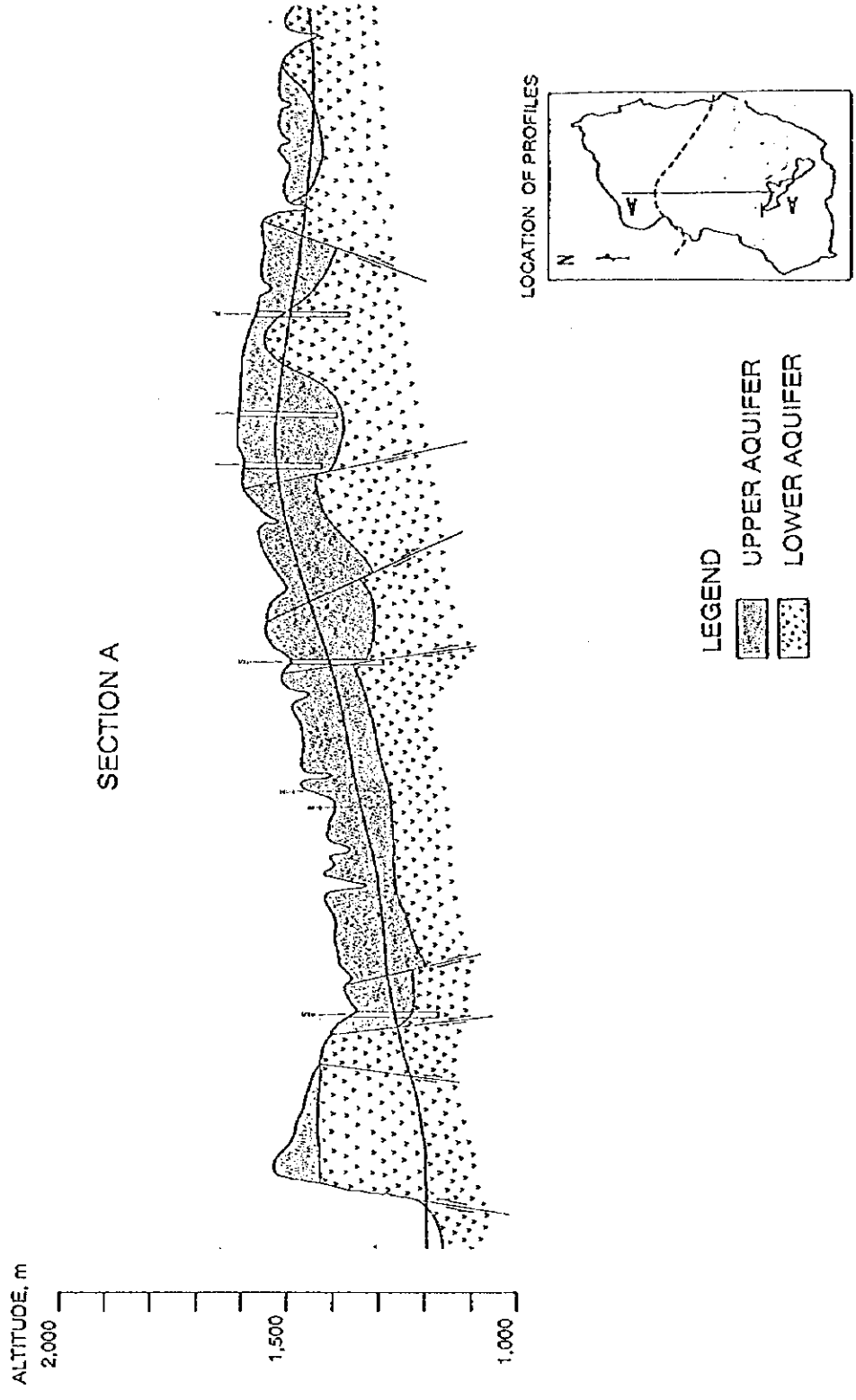


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Fig. 2 - 3

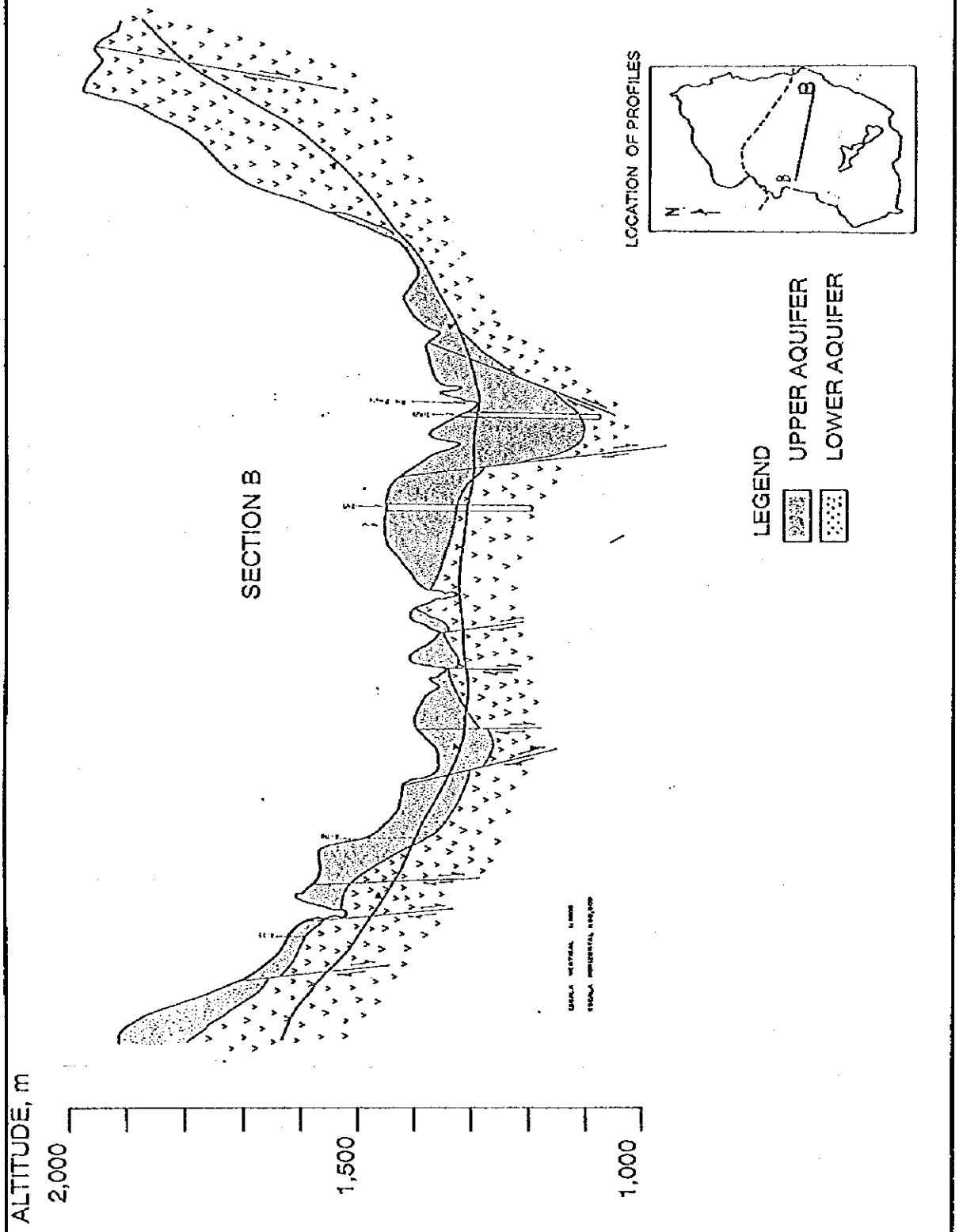

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Fig. 2 - 4

LEGEND

CONTOUR

1,600m

1,500m

1,400m

1,300m

STUDY AREA

THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE PRINCIPAL CONTOURS IN STUDY AREA

Continental Divide slopes at 1/50 to 1/60 towards Lake Amatitlan, whereas the terrain north of the Divide declines slowly.

2.2 GEOLOGY

Most of the ground surface is of the Quaternary period and consists of alluvial sediment, solidified pumice sediment, ash flow and pyroclastics, with an average depth of about 250m. These volcanic sediments form deep V-shaped valleys and separate the Area. The depth of valleys ranges between 150 m and 250 m. Below the surface layer is Pliomiocene, consisting of andesite, tuff, basalt mud flow, vesicular rhyolite, glassy quartz, welded tuff, latite-dacite tuff, welded glassy tuff, etc. Rivers in the Study Area have formed following the faults, and each river has a relatively small catchment area. The gradient of river beds ranges from 0.9 % in the south to 1.5 % in the north of the Area.

2.3 CLIMATE

2.3.1 Air Temperature and Humidity

Table 2-1 shows air temperature and relative humidity data for Guatemala City for a station situated at an altitude of 1,489 m. The data is also shown graphically in Figure 2 - 5. The average daily temperature variation is between 16°C and 20°C throughout the year. The average monthly temperature is 18.4°C with a record high of 38.1°C on July 24, 1946. Temperatures are generally low during the winter months and higher during the summer months, with the seasonal temperature transition being smooth and uniform and following the regular progression of the seasons in the northern hemisphere. The maximum monthly mean temperature of 19.9°C occurs in July, while the minimum monthly mean temperature of 16.7°C occurs in January.

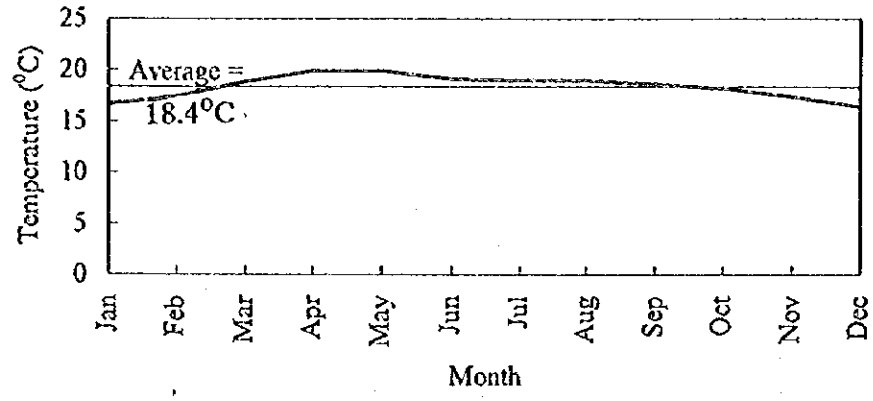
Table 2-1 Average Monthly Temperature and Relative Humidity in Guatemala City

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Temp (°C)	16.7	17.4	18.9	19.9	19.9	19.1	19.0	19.0	18.6	18.2	17.4	16.5	18.4
Humidity (%)	68	68	68	70	74	79	75	75	80	77	75	70	73

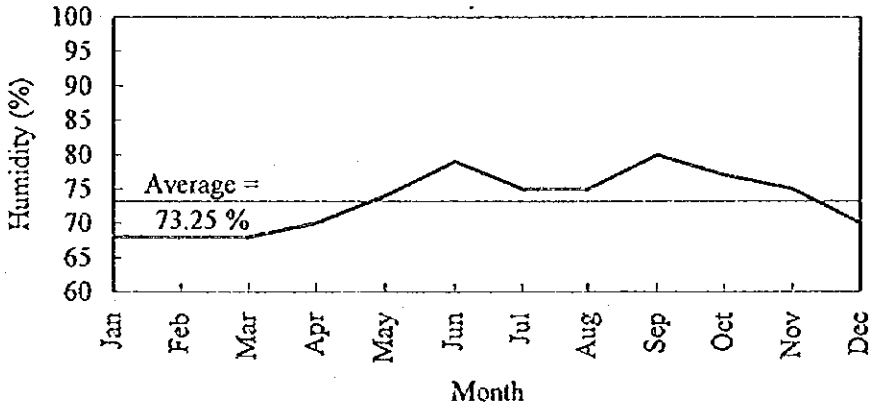
Note: Altitude 1,498 m. Data observed over 30 years from 1951 through 1980
Source: INSUVIMEH

Fig. 2 - 5

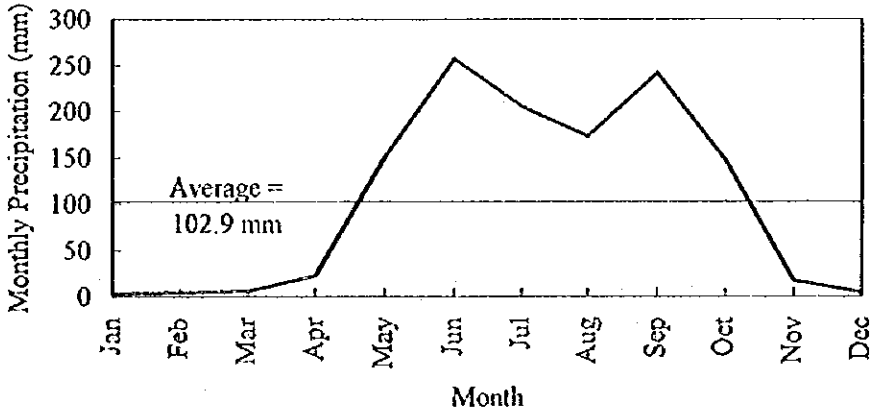
Average Monthly Variation of Temperature in Guatemala City



Average Monthly Variation of Humidity in Guatemala City



Average Monthly Variation of Precipitation in Guatemala City



Note: Altitude (m) 1,498. Data observed over 30 years from 1951 through 1980

Source: INSUVIMEH

THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE VARIATION OF AVERAGE MONTHLY TEMPERATURE, HUMIDITY AND PRECIPITATION IN GUATEMALA CITY

The monthly average relative humidity observed over the seven year period from 1961 through 1976 varied between a maximum of 80% in September and a minimum of 68% in January, February and March. The annual average relative humidity is 73 %.

2.3.2 Precipitation

Table 2-2 and Figure 2 - 5 show the monthly average amounts of precipitation which occurred over 30 years from 1950 through 1980 in Guatemala City. The average annual rainfall for Guatemala City is 1,234.4 mm.

The driest month of the year is January with an average precipitation of 3.6 mm. The wettest month is June with an average precipitation of 257.2 mm. There are two well defined seasons, the wet season from May to October and the dry season from November to April.

Table 2-2 Average Monthly Precipitation in Guatemala City

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average Annual Total
Precipitation (mm)	3.6	4.6	5.9	22.2	150.1	257.2	205.3	173.3	241.9	148.1	17.3	4.9	1,234.4

Note: Altitude 1,498.m - Data observed over 30 years from 1951 through 1980.
Source : INSUVIMEH

2.3.3 Wind

The average wind velocity is 15.2 km/hr, with a maximum recorded velocity of 75 km/hr.

2.3.4 Evaporation

The annual average evaporation is about 80% of the precipitation. The evaporation rates are generally higher when the temperatures are at a maximum and lower when the temperature is lower.

2.4 RIVERS AND LAKE AMATITLAN

2.4.1 Rivers

The Study Area is separated into north, east and south catchments by three major watersheds as shown in Fig. 2 - 6.

South of the Continental Divide is the Michatoya River Basin, and the water within the basin flows into several major rivers and their tributaries; namely the El Molino, Mariscae, Parrameno, Villalobos, Pinula, Las Minas and Platanitos Rivers which finally flow into Lake Amatitlan. Then, water is discharged from the southern end of the lake down the Michatoya River.

The river basin in the north of the Area, which encompasses the northern part of Guatemala City, consists of about 20 small and large rivers in the Las Vacas river basins which belong to the Motagua Basin. The major rivers which flow across the Area are; the Lapole, El Zapote and Las Vacas Rivers which finally flow out of the Area towards the north. The flow in each river is relatively low and they sometimes dry up during dry seasons.

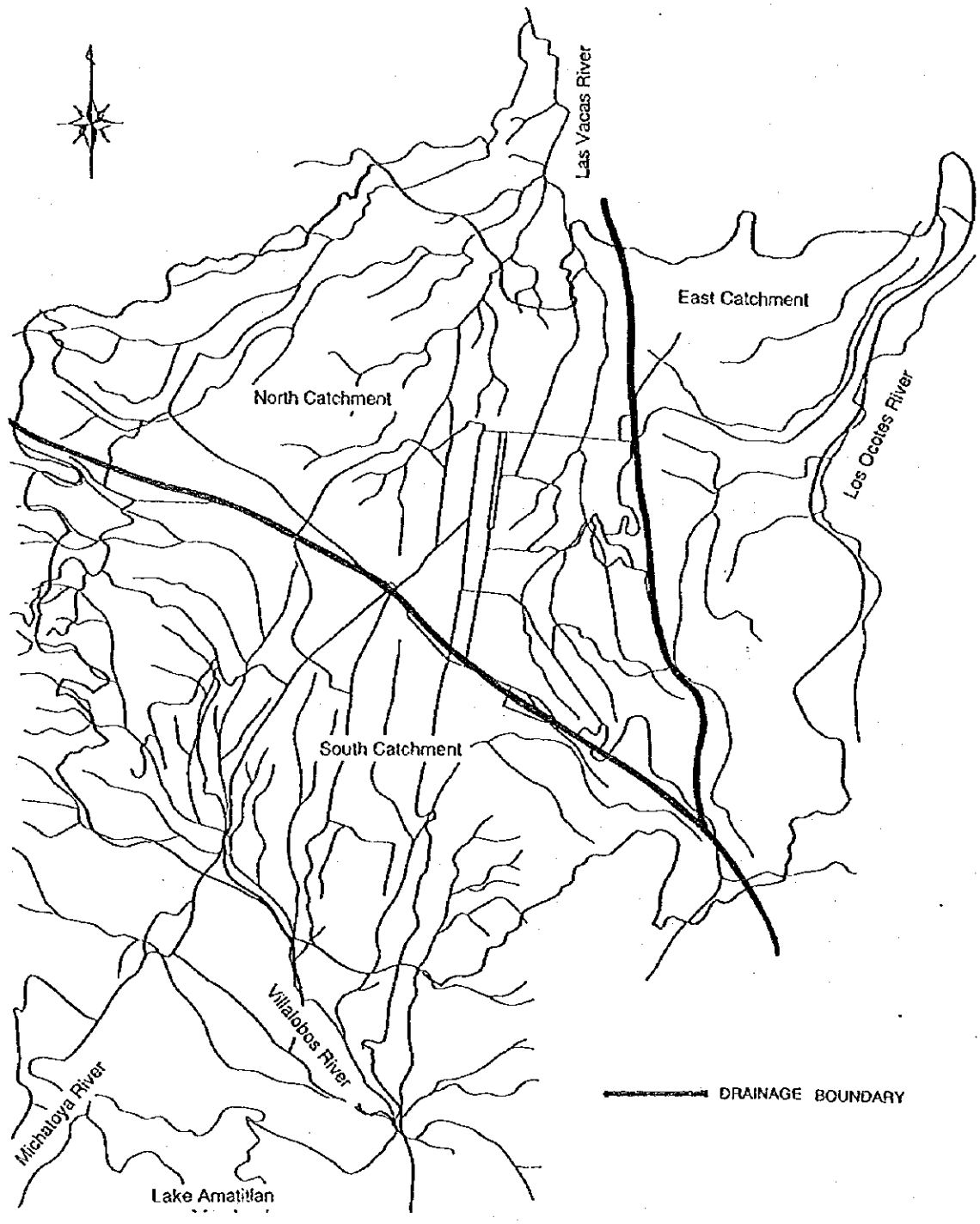
In the eastern part of the Area surface water is collected through several major rivers such as the Teocinte, Bijague, Los Ocotes, Monjitas and Canalitos Rivers, which flow out of the Area towards the northeast.

The river water, together with groundwater, springs and lake water, is a major water source for the residents in and around Guatemala Metropolitan Area. About 1.65 m^3/sec or 55% of EMPAGUA's potable water production relies on river water, including a watershed outside of the Study Area. The water is used not only for public water supply but is also used by the nearby residents for washing, bathing and for various other purposes. However, due to recent river water contamination, direct use of river water has become more limited.

2.4.2 Lake Amatitlan

Lake Amatitlan is situated at the southern end of the Study Area, about 20 km from the center of Guatemala City. The lake has a surface area of 15.35 km^2 and a storage capacity of 286 x 10^6 m^3 with a depth ranging from 24 to 33m. Because of its location near the populated area, the lake is used in various ways by the population in the Area, including for recreational and associated activities, as cooling water for a thermal electric generating plant, as a drinking water source, and for controlling the flow to a hydraulic power plant.

Fig. 2 - 6



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE MAJOR WATERSHEDS AND RIVERS IN STUDY AREA

About 0.75 m^3/s (Data of year 1976 measured at El Cementerio, source: INSUVIMEH) of water flows into the lake through the Villalobos a River, while 3.03 m^3/s (Average of 1953~1994, source:INDE) of water is out flowing through the Michatoya River. The balance of the inflow is considered to be supplemented with groundwater flowing into the lake. Even though the wastewater discharges to rivers increased significantly compared to 1976, due to porous nature of river beds surface flow to Lake Amatitlan seems to have not changed much.

Substantial amounts of wastewater from residences, commercial properties, industry and agricultural land in the catchment, including Guatemala City and the southern neighboring communities, flows into the lake, mainly through the Villalobos and Pinula Rivers. Furthermore, soil and sand washed from the land, which is predominantly of composed of volcanic ash and rock, has been gradually transported and deposited in the lake. Torrential storm-water flows in the tributary easily erode the soil, and a considerable amount of topsoil is carried into the rivers and other waterways and finally finds its way into the lake. These conditions have degraded water quality in the lake and the existing water quality conditions are approaching unacceptable levels.

CHAPTER 3

SOCIO-ECONOMIC CONDITIONS

3 SOCIO-ECONOMIC CONDITIONS

3.1 POPULATION

According to the latest census data as of 1994, as shown in Table 3-1, the population of the Republic of Guatemala is about 8.3 million of which the Department of Guatemala and Guatemala City represent about 1.8 million and 0.82 million, respectively.

From a comparison of the census data of 1981 and 1994, the population of the Department of Guatemala increased from 1.31 to 1.81 million during thirteen years at an annual rate of 2.9%, which coincides with the national rate of increase.

Guatemala City's population of 0.82 million, as of 1994, accounted for 45% of the total population of the Department of Guatemala and its share decreased. Its growth rate of 0.7% was lower than those of surrounding municipalities and was also lower than those of the Department of Guatemala and the Republic of Guatemala while the municipalities of Villa Nueva and Santa Catarina Pinula showed a particularly sharp increase at annual rates of 13% and 9%, respectively.

Table 3 - 1 Population and Annual Growth Rate based on Census Data

Area	1981 *1)		1994 *2)		Annual
	Population	Share (%)	Population	Share (%)	Growth Rate (%)
Republic of Guatemala	6,054,227	-	8,322,051	-	2.9
Guatemala Department	1,311,192	100.0	1,812,411	100.0	2.9
Guatemala City	754,243	57.5	822,587	45.40	0.7
Mixco	197,741	15.1	304,954	16.83	4.2
Villa Nueva	71,069	5.4	191,985	10.59	13.1
Villa Canales	39,309	3.0	62,284	3.44	4.5
Santa Catarina Pinula	17,387	1.3	38,609	2.13	9.4
Chinautla	41,682	3.2	63,431	3.50	4.0
Other Municipalities	189,761	14.5	328,561	18.13	5.6

Source: *1) INE, 1985, Censos nacionales de 1981
*2) INE, 1995, Censos nacionales de 1994
Note: The census data has some omissions.

3.2 ECONOMIC CONDITIONS

a) National Accounts

As can be seen in Table 3-2, the gross domestic product (GDP) of 1993 and 1994 recorded an annual growth of about 4 percent, which was a slight decrease from 1992. Since the GDP growth has been exceeded by the annual rise in population, the GDP per capita has not grown at a same pace as the GDP itself. The highest growth rate over the shown period was 1.85 percent of 1992.

There has been little change in the sectorial composition of GDP since 1988, as shown in the table. The share of major economic sectors have declined somewhat as follows: the agriculture sector from Q5,311 million (or 26% of GDP) in 1988 to Q18,268 million (or 25%) in 1994; manufacturing from 15% to 14%; and trading from 25% to 24%. On the other hand, the transportation and communication sector increased from 7% in 1988 to 9% in 1994. The electricity and water sector also increased slightly from 2% to 3%.

Agriculture is still the most important sector in the national economy. Traditional agricultural commodities such as coffee, sugar, banana and cardamom continue to be leading export products, accounting for over 40% of total export earnings in 1994 (Table 3-3). Although manufacturing is expected to become stronger, its performance still seems to be weak. Construction, a sensitive barometer of the overall level of economic activity, fluctuated between 1988 and 1994 as shown by the 1958 constant values in Table 3-2.

The share of gross fixed capital formation (GFCF) in overall gross domestic expenditure (GDE) increased from Q2,747 (or 13% of GDE) in 1988 to Q10,572 (or 14%) in 1994, as shown in Table 3-4. In particular, the share of the private sector in GFCF grew from Q2,157 (or 10% of GDE) to 12%. On the other hand, the public sector remained small at less than 3%, and recorded negative growth except in 1989 and 1992 as seen from the 1958 constant values. Government consumption is still low in Guatemala, as compared with the modest standards of Central America. Over the period of 1988 through 1994, its share in current prices fell from 8% to 6%.

Table 3-2 Gross Domestic Product by Economic Sector: 1988 - 1994

(Unit: Million Quetzals)

Item	1988	1989	1990	1991	1992	1993	1994
GDP at Current Prices							
1 Agriculture	5,311	6,071	8,881	12,135	13,651	15,975	18,268
2 Mining & Quarrying	56	65	86	124	175	223	259
3 Manufacturing	3,169	3,596	5,165	7,031	7,905	9,313	10,703
4 Construction	441	527	682	921	1,257	1,396	1,482
5 Electricity & Water	482	576	857	1,184	1,465	1,839	2,170
6 Transportation & Comm.	1,497	1,832	2,733	3,849	4,504	5,408	6,353
7 Trading	5,042	5,788	8,263	11,446	13,020	15,514	18,229
8 Finance & Insurance	789	930	1,408	2,005	2,323	2,862	3,451
9 Real Estate	1,066	1,208	1,736	2,363	2,635	3,101	3,540
10 Public Services	1,420	1,647	2,404	3,344	3,844	4,825	5,725
11 Other Services	1,273	1,446	2,101	2,901	3,206	3,787	4,392
GDP at Current Prices	20,545	23,685	34,317	47,302	53,985	64,243	74,572
GDP at 1958 Constant Prices							
1 Agriculture	818	843	877	901	931	952	975
2 Mining & Quarrying	9	9	9	9	12	13	14
3 Manufacturing	488	499	510	522	539	555	571
4 Construction	68	73	67	68	86	83	79
5 Electricity & Water	74	80	85	88	100	110	116
6 Transportation &	230	254	270	286	307	322	339
7 Trading	776	803	816	850	888	924	973
8 Finance & Insurance	121	129	139	149	159	171	184
9 Real Estate	164	168	172	176	180	185	189
10 Public Services	219	229	238	248	262	288	306
11 Other Services	196	201	208	216	219	226	234
GDP at Constant Prices	3,163	3,288	3,390	3,514	3,684	3,828	3,981
Real Growth Rate (%)	3.90	3.94	3.10	3.66	4.84	3.93	3.99
GDP per Capita							
Population in 1,000	8,681	8,935	9,197	9,467	9,745	10,030	10,322
GDP per Capita							
in Quetzals at Current Prices	2,367	2,651	3,731	4,997	5,540	6,405	7,225
Exchange Rate (Q/US$)	2.620	2.816	4.486	5.029	5.171	5.635	5.751
in US$	903	941	832	994	1,071	1,137	1,256
in Quetzals at 1958 Constant	364	368	369	371	378	382	386
Real Growth Rate (%)	0.90	0.98	0.17	0.71	1.85	0.97	1.05

Source:
Principales Indicadores Economicos y Sociales Periodo 1990-1994, January 1995, SEGEPLAN
Boletin Estadistico, Octubre-Noviembre-Diciembre 1994, Banco de Guatemala
Estudio Economico y Memoria de Labores 1994, Banco de Guatemala
Indicadores Economicos de la Evolucion de Precios, Salarios, Poblacion y Otras Variables 1995, Banco de Guatemala
International Financial Statistics, March 1995,

Table 3-3 Principal Export/Import Products

FOB Value of Export Products (Unit: US$Million)

Year	1990	1991	1992	1993	1994
Traditional Products					
Coffee	323	286	249	276	346
Sugar	120	138	158	156	172
Bananas	68	66	102	102	120
Cardamom	35	29	32	39	42
Meat	27	29	16	15	8
Cotton	24	10	1	0	0
Petroleum	21	19	20	25	22
Total	618	578	579	614	711
Non-traditional products					
Sesame	28	22	19	18	23
Vegetables and Legumes	27	31	34	36	39
Chemical products	27	32	32	33	42
Tobacco	21	18	36	40	22
Fruits and Preserves	18	32	30	25	28
Fabric, Yarn and Thread	18	18	14	19	13
Shrimp and Fish	15	19	21	27	31
Flowers and Plants	15	17	21	20	26
Others	377	435	510	531	615
Total	545	624	717	750	840
Total	1,163	1,202	1,295	1,363	1,550
Exports to Central America	316	324	395	418	475
Exports to Other countries	847	878	900	945	1,075
Total	1,163	1,202	1,295	1,363	1,550

CIF Value of Import Products (Unit: US$ Million)

Year	1990	1991	1992	1993	1994
Total	1,649	1,851	2,463	2,599	2,781
Consumer goods	317	364	542	709	828
Raw materials and intermediary	736	850	1,023	940	1,047
Petroleum and Petroleum products	186	205	224	217	201
Construction materials	87	79	117	81	78
Machinery, Equipment and Tools	319	351	552	644	624
Others	4	2	5	8	4
As a percent of total imports					
Consumer goods	19.2%	19.7%	22.0%	27.3%	29.8%
Raw material and intermediary	44.6%	45.9%	41.5%	36.2%	37.6%
Fuel and lubricant	11.3%	11.1%	9.1%	8.3%	7.2%
Construction material	5.3%	4.3%	4.8%	3.1%	2.8%
Machine, equipment and tool	19.3%	19.0%	22.4%	24.8%	22.4%
Miscellaneous	0.2%	0.1%	0.2%	0.3%	0.2%

Source: SEGEPLAN, Bank of Guatemala

Table 3-4 Gross Domestic Expenditure: 1988 - 1994

(unit: million quetzals)

	1988	1989	1990	1991	1992	1993	1994
GDE at Current Prices							
Private Consumption	17,289	19,837	28,692	39,693	45,899	54,164	63,893
Government Consumption	1,640	1,870	2,324	2,714	3,482	4,151	4,508
Gross Fixed Capital Formation	2,747	3,255	4,455	5,760	8,445	10,334	10,572
- Public	590	755	932	1,024	1,622	1,745	1,860
- Private	2,157	2,500	3,523	4,736	6,823	8,589	8,712
Change of Stocks	67	-54	213	1,002	1,448	745	998
Exports of Goods & Services	3,309	4,099	6,776	8,349	9,483	11,613	13,173
(less) Imports of Goods & Services	4,507	5,323	8,143	10,216	14,771	16,765	18,571
Total	20,545	23,685	34,317	47,302	53,985	64,243	74,572
GDE at 1958 Constant Prices							
Private Consumption	2,470	2,544	2,606	2,706	2,843	2,959	3,103
Government Consumption	273	283	293	298	314	339	353
Gross Fixed Capital Formation	300	319	286	297	385	412	397
- Public	89	96	88	85	115	111	106
- Private	211	223	198	212	270	301	290
Change of Stocks	10	-8	21	80	103	49	63
Exports of Goods & Services	437	495	528	502	544	596	625
(less) Imports of Goods & Services	328	347	344	369	506	527	559
Total	3,163	3,288	3,390	3,514	3,684	3,828	3,981

Source: Boletin Estadistico, Octubre-Noviembre-Diciembre 1994, Banco de Guatemala
Estudio Economico y Memoria de Labores 1994, Banco de Guatemala
International Financial Statistics, March 1995, IMF

b) Balance of Payment

As shown in Table 3-5, Guatemala has continued running a current account deficit. Soaring merchandise imports starting from 1992 increased the deficits to over US$700 million. The current account deficit slightly widened to US$713 million in 1994. It is improving however, in comparison with the GDP scale, which is about 5.5 percent of GDP in 1994, down from 6.2 percent in 1993. These current account deficits have been financed by the capital account surplus. Capital inflows remained strong in 1994, with the capital account surplus of US$742 million.

Table 3-5 Balance of Payments: 1989-1994

(Unit: US$ Million)

	1989	1990	1991	1992	1993	1994
Current Account	-370	-243	-214	-713	-702	-713
Merchandise	-358	-217	-443	-1,044	-1,021	-997
Export (F.O.B.)	1,126	1,211	1,230	1,284	1,363	1,550
Import (F.O.B.)	-1,484	-1,428	-1,673	-2,328	-2,384	-2,547
Services	-262	-258	-31	-59	-44	-165
Export	327	410	522	669	721	1,084
Import	-589	-667	-553	-727	-766	-1,250
Net Transfers	250	231	260	391	363	448
Private	147	174	218	290	309	386
Official	103	57	42	101	54	62
Capital Account	452	256	755	546	705	742
Long Term Capital Inflow	221	67	227	294	341	399
Direct Investment	60	59	90	90	138	28
Official and Bank Capital	121	-2	-78	76	-78	75
Other Long Term Capital	39	10	214	128	280	297
Short Term Capital Inflow	231	189	528	251	364	343
Commercial Bonds	140	23	524	321	334	263
Other Short Term Capital	91	166	4	-70	30	80
Errors and Omissions	-22	-83	19	114	110	-30
Reserves	59	-69	559	-53	113	-2

Source: Boletin Estadistico, Banco de Guatemala

c) Foreign Assistance and Debt

As can be seen in Table 3-6, over the period of 1988 through 1994, Guatemala received US$1,537 million in development aid, whose annual average is calculated as about US$220 million. The primary source of bilateral aid to Guatemala is the US Agency for International Development, (USAID). Bilateral aid from USAID accounted for almost half of the total figure.

As shown in Table 3-6, Guatemala's external debt gradually increased from some US$2,600 million to US$3,000 million over the period of 1988 through 1994. Although it still stayed at a low level compared with other Central American countries such as Honduras and El Salvador, the debt outstanding was not small compared with the current-account balance in the balance of payment. Most of Guatemala's debt is owned by the Government. In 1994, total debt service decreased from 1992's US$517 million to US$283 million, thus, the debt-

service ratio (DSR) was lowered to 10.9% in 1994 which is almost the level of the early 80s and safely below the critical 20%.

Table 3-6 Foreign Development Assistance and External Debt: 1988-1994

(Unit: US$ Million)

Item	1988	1989	1990	1991	1992	1993	1994
Foreign Assistance	235	262	204	199	198	215	224
Bilateral	193	211	150	155	177	180	157
Multilateral	42	51	54	44	21	35	67
External Debt							
External Debt	2,639	2,637	2,840	2,825	2,753	2,891	3,017
Long-term Debt	2,255	2,243	2,368	2,362	2,250	2,420	2,529
Short-term-Debt	296	321	406	399	473	471	488
Use of IMF Credit	88	73	67	64	31	0	0
Total Debt Service	374	304	212	289	517	302	283
Principal	247	172	102	157	346	190	166
Interest	126	132	111	132	171	112	117
Debt-Service Ratio (%)	27.5	19.6	12.3	15.3	24.2	14.5	10.9

Source: Geographical Distribution of Financial Flows to Aid Recipient, OECD
World Debt Tables, World Bank

d) Inflation

Table 3-7 shows the annual change of consumer price index and the inflation. The high inflation in 1990 and 1991 was caused by the progressive exchange depreciation and fiscal deficits under the government. The fiscal retrenchment countermeasure was taken by the succeeding administration. In 1995, the average yearly inflation was curbed down to 8.41%. However, The value added tax was raised from 7% to 10 % at the beginning of 1996, which is likely to have an inflationary effect in this year.

Table 3-7 Inflation : 1988-1995

	1988	1989	1990	1991	1992	1993	1994	1995
Consumer Price Index *	207.73	234.73	331.00	447.23	493.03	558.91	628.81	681.70
Inflation	10.28%	13.00%	41.01%	35.11%	10.24%	13.36%	12.51%	8.41%

Source: Indicadores Economicos de la Evolucion de Precios, Salarios, Poblacion y Otras Variables 1995
Note: * Yearly average of general consumer price index

e) Employment

The labor force represents about 30% of the total population. As shown in Table 3-8, the number of labor force has been increasing and in 1995 reached 3.3 million. Unemployment rate stayed at as much as 35.8% in 1995, although ratewise, both total unemployment and semi-unemployment have been decreasing.

Table 3-8 Labor Force and Unemployment : 1988-1995

	1988	1989	1990	1991	1992	1993	1994	1995
Labor Force (thousand persons)	2,722	2,799	2,877	2,958	3,040	3,126	3,213	3,303
Ratio of Totally Unemployed (a)	8.8%	6.1%	6.5%	6.4%	5.7%	5.5%	5.2%	4.3%
Ratio of Semi-unemployed (b)	33.6%	35.4%	34.7%	34.0%	33.3%	32.7%	32.1%	31.5%
Unemployment Rate (a) + (b)	42.3%	41.5%	41.1%	40.4%	39.1%	38.2%	37.3%	35.8%

Source: Indicadores Economicos de la Evolucion de Precios, Salarios, Poblacion y Otras Variables 1995, Banco de Guatemala

3.3 LAND USE

3.3.1 Present Land Use

The Guatemala Metropolitan Area is undergoing a remarkable rate of growth. Between 1964 and 1994 the population of Guatemala City almost tripled. Economic and construction indicators reflected this trend of high growth rate. The rapid urbanization has brought problems to the area. Urban utility systems have failed to develop to serve the expanding metropolis. Migration in to urbanized area has exceeded available jobs, resulting in unemployment and lower real wages.

Nonetheless, the Metropolitan Area is expected to continue to grow, chiefly because of its key position in a rapidly growing region. The pattern of growth, characterized by relatively uncontrolled suburban expansion, appears to have generally been concentrated within the Study Area, and areas of industrial, residential, and commercial expansion are apparent.

An intensive land use and urban development study is being carried out by the Urban Development Department of Guatemala Municipality to analyze present land use and urbanization patterns in the City and to develop the future land use patterns for the year 2010. This study is in its initial stages.

The land use pattern established and authorized for the "Comprehensive Urban Transportation System in Guatemala Metropolitan Area" and summarized in Table 3-9, which was prepared in March 1992 by JICA is therefore used for this Study. The Transportation Study showed that the total urban area was 24,916.2 ha made up as shown in Table 3-10.

Table 3-9 Land Use Composition

Classification	Area Within Study Area		Overall
	Area (ha)	Percentage with slope less than 30° (%)	Percentage(%)
Area with less than 30° slope			
Urban Area	24,916.2	52.2	
Farm	17,760.3	37.2	
Forest	3,530.5	7.4	
Water Area	1,352.5	2.8	
Others	192.5	0.4	
Total	47,752.0	100.0	50.9
Area with more than 30° slope (Forest)	45,973.5		49.1
Grand Total	93,725.5		100.0

Source: "The Comprehensive Urban Transportation System in Guatemala Metropolitan Area," March 1992 by JICA.

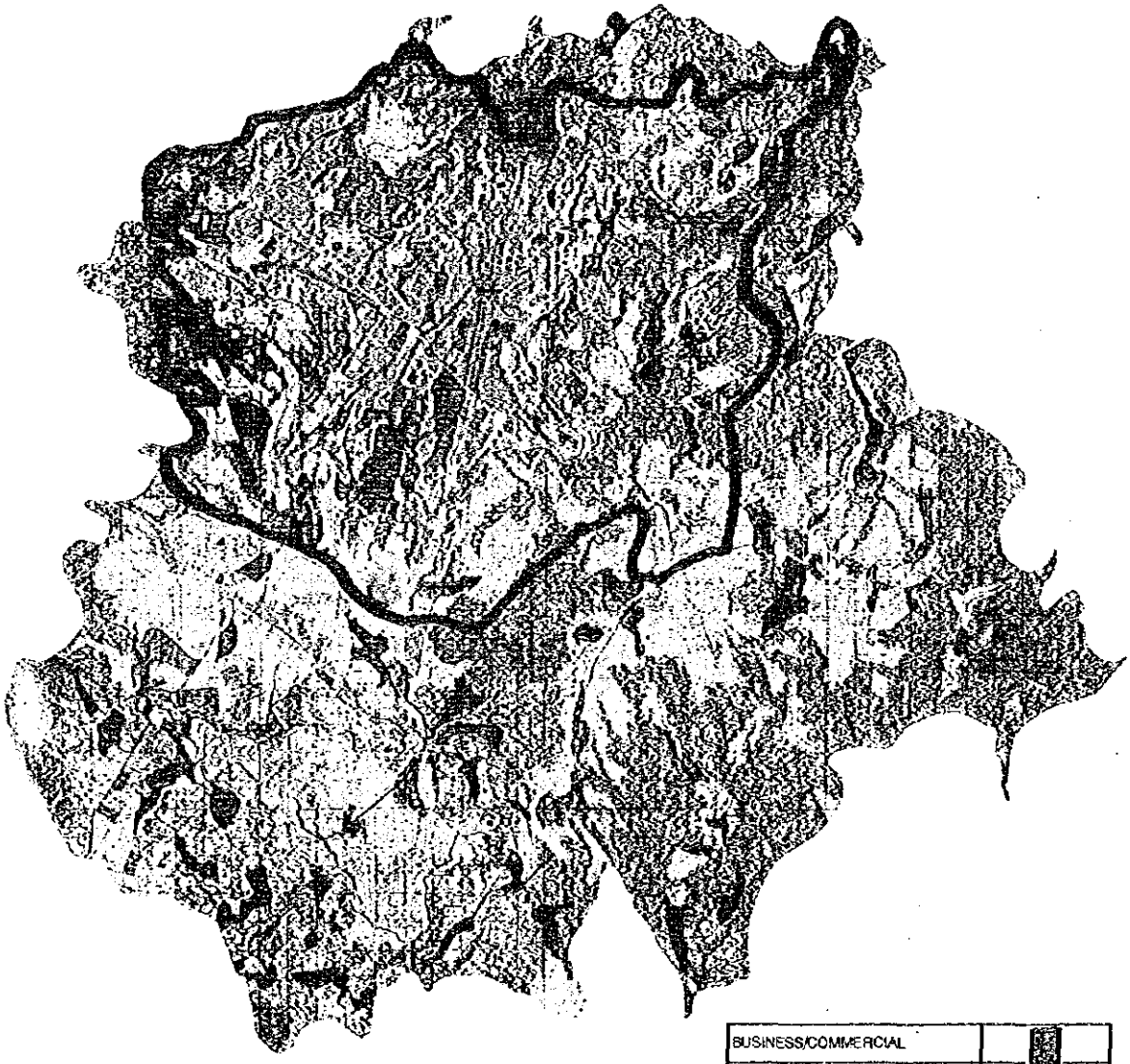
Table 3-10 Composition of Urban Area Classification

Category	Area, (ha)	Percentage, (%)
Residential	13,279.3	53.3
Business/Commercial	538.2	2.2
Industrial	1,134.2	4.6
Public	998.7	4.0
Mixed	631.4	2.5
Green Area	394.8	1.6
Semi-Urban	7,939.5	31.8
Total	24,916.2	100.0

Source : "The Comprehensive Urban Transportation System in Guatemala Metropolitan Area,"March 1992 by JICA

Figure 3-1 shows the land use pattern in the Transportation Study in 1992 with the present wastewater Study Area imposed on it.

Fig. 3 - 1



STUDY AREA

BUSINESS/COMMERCIAL
INDUSTRIAL
RESIDENTIAL
SEMI-URBAN
PUBLIC
MIXED
FARM
RECREATION
FOREST
WATER AREA
OTHERS
SLOPE OF MORE THAN 30%

SOURCE : MASTER PLAN STUDY ON THE COMPREHENSIVE URBAN TRANSPORTATION SYSTEM IN GUATEMALA METROPOLITAN AREA, MARCH 1992, JICA

THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE PRESENT LAND USE IN THE STUDY AREA

The projections made above appear to be reasonable within the central urbanized area but are conjectural in the periphery. However, the peripheral areas will be the last to be sewered and variations from the forecast may be taken into account prior to final design.

3.3.2 Future Land Use Pattern

Fig. 3-2 shows the proposed land use pattern in 2015, which is based on the Transportation Master Plan.

a) Purpose of the Land Use Study

Various conditions influence the estimation of wastewater flows including water supply, the pattern of water use, plumbing and sewerage facilities, and other criteria. However, the actual area of land occupied by residences, factories, and shops was the basis upon which the other criteria were later applied.

Therefore, within the Master Plan Area, the area and location of existing residential, commercial, industrial and public land use was assessed and this assessment formed the basis for projecting land use and hence wastewater flows, throughout the design period.

b) Types of Land Use

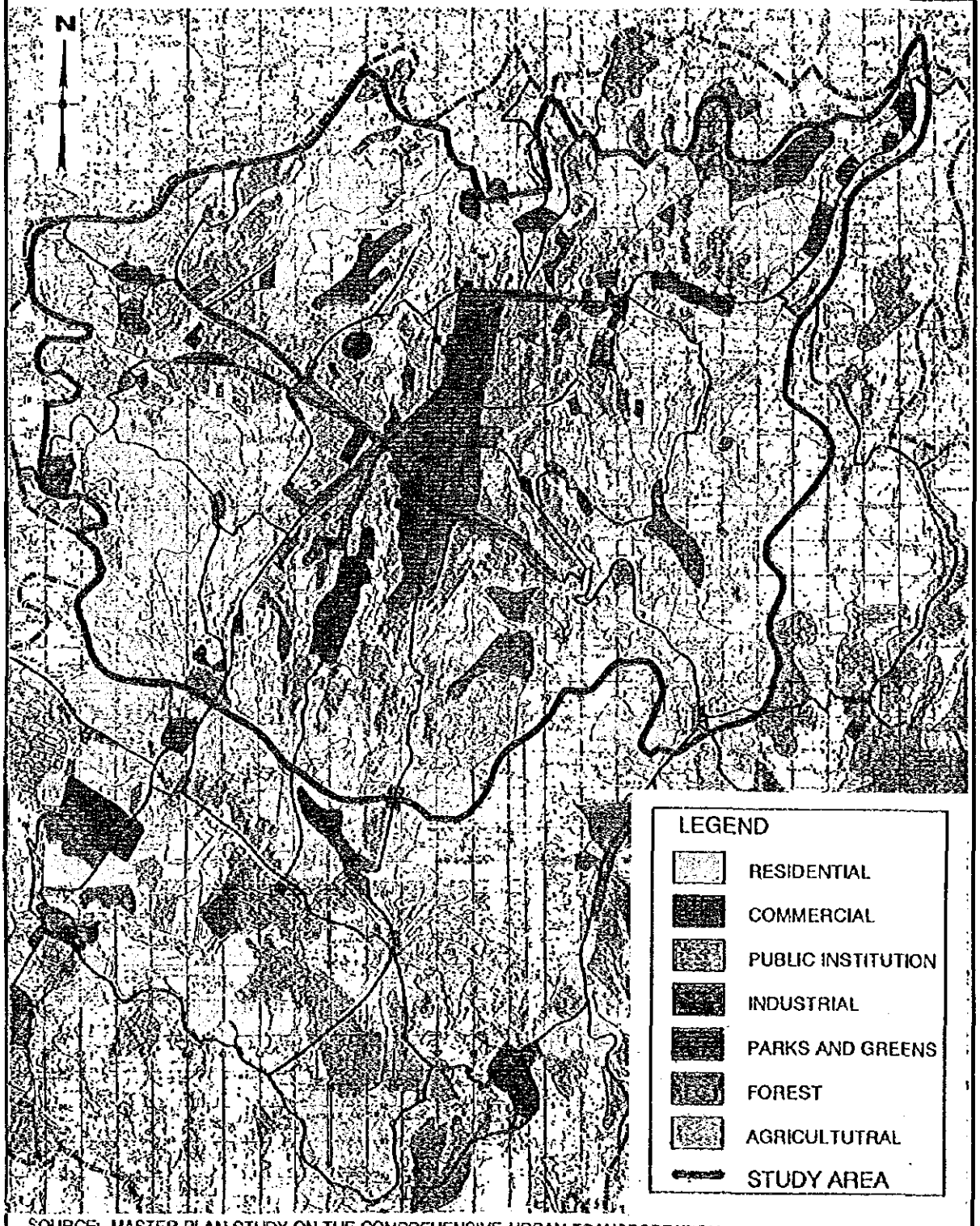
The various types of land use planned for the year 2010 are listed here under:

Residential: Residential areas include single and multiple family dwellings of all types, squats, buildings of mixed use, (in which the non-residential use is limited to a store or shop), and all other types of inhabited structures. new residential areas totaling 6,370 ha are planned to accommodate the 639,000 increase in population which cannot be absorbed into existing urban areas. The average population densities of the areas are assumed to be as follows:

Central Guatemala and Zone 18	150 persons/ha
General urban zones	100 persons/ha
Higher class residential zones	70 persons/ha

The location of new residential areas are show in Table 3-11:

Fig. 3 - 2



SOURCE: MASTER PLAN STUDY ON THE COMPREHENSIVE URBAN TRANSPORTATION SYSTEM IN GUATEMALA METROPOLITAN AREA, MARCH 1992, JICA

THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE LAND USE IN THE STUDY AREA (2015)

Table 3-11 Location of New Residential Areas

Municipality	Area (ha)	Percentage	Average Population Density (persons/ha)
Central Guatemala	417.3	6.5	150.0
East Guatemala	1,000.0	15.7	120.0
Mixco	850.0	13.0	92.9
Villa Nueva	1,952.5	30.7	94.5
San Miguel Petapa	1,000.0	15.7	100.0
Santa Catarina Pinula	1,150.0	18.1	80.4
Total	6,369.8	100.0	100.2

Source: "The Comprehensive Urban Transportation System," March 1992, by JICA

Industrial: Industrial land use includes all heavy industry and that light industry to which a significant water use can be attributed. Cottage industries and ground floor family type shops within a residential building were listed as Residential. New industrial areas are to be located in habitable land along the regional trunk roads. Of the total 1,400 ha new industrial areas 500 ha will be along CA-9 and Department Route 10, and 250 ha along CA-1 in Fraijanes. In Mixco, 50 ha industrial developments are planned along both CA-1 and Calzada San Juan Sacatepequez. The locations of new industrial areas are shown in Table 3-12 below:

Table 3-12 Location of New Industrial Areas

Municipality	Area (ha)	Percentage
Central Guatemala	-	-
East Guatemala	250.0	17.9
Mixco	100.0	7.1
Villa Nueva	500.0	35.7
San Miguel Petapa	300.0	21.4
Santa Catarina Pinula	250.0	17.9
Total	6,369.8	100.0

Source: "The Comprehensive Urban Transportation System," March 1992, by JICA

Commercial/Institutional: Included in the commercial districts are buildings which are used as markets, shopping centers, office buildings, warehouses, retail establishments, theaters, and the like, whereas institutional land use includes schools and colleges, most public offices, hospitals, sports stadiums, and military bases.

The new commercial/institutional cores which total 390 ha as shown in Table 3-13 are to be located throughout the Area, particularly in Santa Catarina Pinula/Frojanes, where the number of high income residents may increase and where there are currently no commercial facilities.

Table 3-13 Location of New Commercial/Institutional Cores

Municipality	Area (ha)	Percentage
Central Guatemala	40.0	10.3
East Guatemala	70.0	17.9
Mixco	60.0	15.4
Villa Nueva	80.0	20.5
San Miguel Petapa	50.0	12.8
Santa Catarina Pinula	90.0	23.1
Total	390.0	100.0

Source: " The Comprehensive Urban Transportation System," March 1992, by JICA.

The urban areas planned for 2010 total 33,400 ha, of which 8,200 ha will be newly developed. The urban area will occupy about 72% of the habitable land. About one third of the new urban areas will be formed in Villa Nueva, where the residential and industrial areas will increase remarkably. The remainder will be distributed almost evenly between East Guatemala, Mixco, Petapa and Santa Catarina Pinula. Non-urban districts will comprise approximately 13,000 ha, of which 10,700 ha will be farmland and 2,263 ha forest. The overall land use plan is summarized in Table 3-14.

c) Land Use Plan for 2015

In planning the sewerage system such basic elements as the land use pattern, population distribution, development trends, etc. are essential to estimate the present and future wastewater characteristics and quantities. For this purpose, the land use pattern in the year 2015 has been elaborated in principle based on the 2010 land use plan established in the Transportation System Study, as summarized in Table 3-15.

Table 3-14 Summary of Land Use Plan for 2010

Municipality	Urban Area (ha)			Non-Urban Area (ha)			Total Habitable Land (ha)
	Existing	New	Subtotal	Farmland	Forest	Subtotal	
Central Guatemala	7,461.1	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	4,539.8	1,010.0	5,549.8	122.5	625.5	748.0	6,297.8
Villa Nueva	4,632.5	2,532.5	7,165.0	1,297.5	302.5	1,600.0	8,765.0
Petapa	3,437.5	1,350.0	4,787.5	2,920.0	440.0	3,360.0	8,147.5
Santa Catarina Pinula	2,655.0	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

Source: "The Comprehensive Urban Transportation System,"March 1992, by JICA

Table 3-15 Land Use Distribution by Municipality in 2015

(unit * ha)

Municipality	Residential and Commercial	Industrial	Public	Green Areas	Valleys and Others	Total
Central Guatemala	9,257	722	404	345	7,622	18,350
Mixco	4,2396	116	52	220	3,596	8,280
Villa Nueva	1,146	28	56	55	1,015	2,300
San Miguel Petapa	370	-	-	-	30	400
Villa Canales	960	-	-	-	80	1,040
Santa Catarina Pinula	1,375	-	-	274	1,911	3,560
Chinautla	215	-	-	-	305	520
San Pedro Ayampuc	-	-	-	-	50	50
Total	17,619	866	512	894	14,609	34,500

Source: Elaborated by the JICA Study Team

CHAPTER 4

ENVIRONMENTAL CONDITIONS

4 ENVIRONMENTAL CONDITIONS

4.1 WATER ENVIRONMENTAL CONDITIONS

4.1.1 Water Quality

As described in Section 2.4, the Motagua River Basin drained by Las Vacas River in the north and the Michatoya River Basin drained by Villalobos River in the south, are the main river systems in the Study Area.

Rivers and ground water are exploited for water supply, details of which are described in Supporting Report B on Water Supply Sources and Effect of Wastewater Discharges. Fecal contamination is evident for all of the surface water intakes and most notably in the Pinula River which has two intakes.

Except for small-scale sewage treatment plants and on-site treatment by septic tanks for individuals/communities, wastewater treatment is practically absent, resulting in the discharge of untreated wastewater. These discharges are eventually drained by rivers in the Study Area most notably the Las Vacas River and the Villalobos River. Gran Collector North which drains most parts of Guatemala City discharges into the Las Vacas River without any treatment and finally ends up in the Motagua River affecting downstream users. Wastewater discharged from Gran Collector North makes up most of the flow in Las Vacas River.

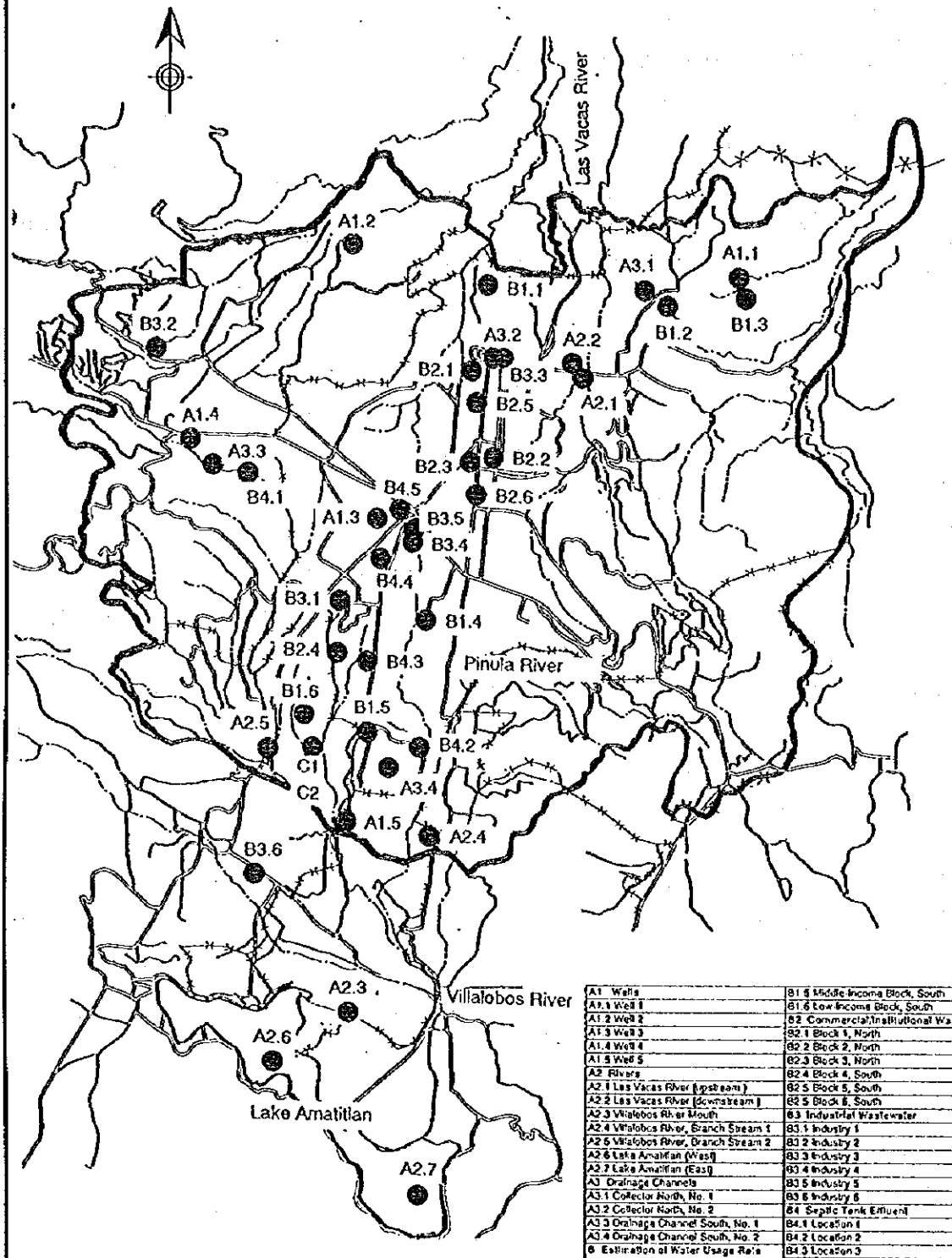
In the South, there are no large individual wastewater discharges like Gran Collector in the North and the wastewater discharges ends up in the Villalobos River which drains to Lake Amatitlan.

Water quality surveys were conducted to investigate the pollution levels in public water bodies and to estimate unit pollutant load generation, details for which can be found in Supporting Report E on Water Quality Surveys. Surveys were conducted during the period of April to June 1995. Water quality analysis was entrusted to the Radiochemical Laboratory of the Ministry of Energy and Mines (ALGEN). Fig. 4-1 shows the location of water quality sampling locations.

a) Rivers and Channels

Table 4-1 shows water quality of the Villalobos River and Gran Collector North for January and February 1995. BOD concentrations were in the range 130~345 mg/L and 70~240 mg/L

Fig. 4 - 1



A1 Wells	B1 5 Middle-Income Block, South
A1.1 Well 1	B1.6 Low-Income Block, South
A1.2 Well 2	B2 Commercial/Institutional Wastewater
A1.3 Well 3	B2.1 Block 1, North
A1.4 Well 4	B2.2 Block 2, North
A1.5 Well 5	B2.3 Block 3, North
A2 Rivers	B2.4 Block 4, South
A2.1 Las Vacas River (upstream)	B2.5 Block 5, South
A2.2 Las Vacas River (downstream)	B2.5 Block 6, South
A2.3 Villalobos River Mouth	B3 Industrial Wastewater
A2.4 Villalobos River, Branch Stream 1	B3.1 Industry 1
A2.5 Villalobos River, Branch Stream 2	B3.2 Industry 2
A2.6 Lake Amatitlan (West)	B3.3 Industry 3
A2.7 Lake Amatitlan (East)	B3.4 Industry 4
A3 Drainage Channels	B3.5 Industry 5
A3.1 Collector North, No. 1	B3.6 Industry 6
A3.2 Collector North, No. 2	B4 Septic Tank Effluent
A3.3 Drainage Channel South, No. 1	B4.1 Location 1
A3.4 Drainage Channel South, No. 2	B4.2 Location 2
B Estimation of Water Usage Rate and Unit Pollutant Load Generation	B4.3 Location 3
	B4.4 Location 4
B1 Domestic Wastewater	B4.5 Location 5
B1.1 High-Income Block, North	C Sewage Treatment Plant
B1.2 Middle-Income Block, North	C1 Raw Sewage and Effluents
B1.3 Low-Income Block, North	C2 Sludge
B1.4 High-Income Block, South	

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	JAPAN INTERNATIONAL COOPERATION AGENCY	

Table 4-1 Water Quality of Gran Collector North and Villalobos River

Parameter	Units	Rio Villalobos (at bridge connecting Villa Canales and San Miguel Petapa).				Gran Collector North				
		06-02-95	02-02-95	30-01-95	25-01-95	23-01-95	26-01-95	02-02-95	06-02-95	30-01-95
					8:20	9:35	10:35	9:35	14:10	13:25
Temperature	°C	24	22	23	20.	20				
pH		7.10	7.30	7.10	7.20	7.20	7.20	7.40	7.40	7.30
Total Solids	mg/L	870	3681	917	576	477	498	873	514	364
Dissolved Solids	mg/L	410	450	490	390	325	380	515	295	250
Settleable Solids	mL/L	4.7	11.0	4.0	3.7	0.5	0.7	0.7	0.6	0.7
BOD5	mg/L	250	345	290	130	150	200	240	150	70
COD	mg/L	320	585	425	225	188	350	370	190	90
T-P	mg/L	14.25	10.25	12.0	6.5	12.0	23.5	12.75	9.75	10.50
NO3-N	mg/L	33.44	31.24	29.60	27.26	14.98	58.96	24.64	11.88	12.44
NH4-N	mg/L	12.0	2.5	11.75	10.0	19.5	16.75	17.00	10.0	7.0
PO4-P	mg/L	4.25	5.25	3.55	3.10	4.0	9.25	4.75	3.0	3.8
NO2-N	mg/L	0.14	0.066	0.155	0.049	0.02	0.587	0.033	0.37	0.40
Total Coliform	MPN/100mL	>24E+14	>24E+14	>24E+14	>24E+11	>24E+11	>24E+11	>24E+14	>24E+14	>24E+14
Fecal Coliform	MPN/100mL	>24E+14	>24E+14	>24E+14	>24E+11	>24E+11	>24E+11	>24E+14	>24E+14	>24E+14

Source: EMPAGUA

in the Villalobos River and Gran Collector, respectively. Nitrate nitrogen levels were 27.26~33.44 mg/L and 11.88~58.96 mg/L, respectively.

Table 4-2 shows the flowrates and water quality of Las Vacas River near Gran Collector, Villalobos River, Pinula River and Molino River, measured in this Study.

Water quality of the rivers was almost similar to that of sewage. BOD concentrations varied in the range 11~292 mg/L. Due to sewage flow into the rivers, the river flow varied during the daytime. Rivers function as open sewage channels.

Based on the measurements upstream and downstream of the Las Vacas River near Gran Collector, wastewater quality (BOD) and flow rate of Gran Collector were estimated and are shown in Table 4-3. Average daytime BOD concentrations were 277 and 242 mg/L, and SS concentrations were 264 and 318 mg/L, for the first and second samplings respectively.

For the Villalobos River, the average T-N (total nitrogen) concentration was 0.51 mg/L (0.20~1.88) in 1969~1970, compared to 10~32.9 mg/L in 1995, indicating a drastic increase in pollution of Lake Amatitlan. The average nitrate nitrogen concentration in the Villalobos River in 1970 was 0.1 mg/L, (Guatemalan Rivers, 1969~1970, Charles Weiss), compared to 27.26~33.44 mg/L (Table 4-1) in January and February 1995, again indicating a drastic increase in pollutant load to the lake.

Since no treatment is provided, it is obvious that the concentration of pollutants in collector sewer and drainage channel discharges are similar to those for raw sewage and represent the wastewater concentrations that would be expected. For example, BOD concentrations were in the range of 74~442 mg/L, with an average concentration of 172 mg/L and a standard deviation of 104 mg/L during daytime. Compared to the rivers, SS concentrations were lower indicating the effect of eroded soil in the river water.

Table 4-2 Water Quality of Rivers (1/2)

Parameter		Las Vacas River (near Grand Collector Outfall)						Villalobos River and Its Tributaries								
		Upstream of Outfall			Downstream of Outfall			Villalobos River Mouth (near Maya Crops)			Pinula River (Puente Villa Hermosa			Molino River (Puente Villalobos)		
		A2.1			A2.2			A2.3			A2.4			A2.5		
		3-05-95			3-05-95			27-04-95			27-04-95			27-04-95		
		7:45	12:30	15:10	8:30	13:15	16:30	8:30	13:25	15:15	9:00	12:45	16:00	11:30	14:00	15:30
Flowrate, m3/s		0.525	0.729	0.633	1.646	1.547	1.448	1.119	0.792		0.313	0.276		0.114		0.148
Temperature, °C	Ambient	18	24	21	22	23	22	18	23	22	19	22	21	20	21	22
	Sample	19	26	26	24	25	24	20	26	26	22	24	25	22	25	25
pH		7.7	7.7	7.7	7.9	7.7	7.7	8.1	7.7	7.7	9.3	8.6	7.3	7.9	8.0	8.0
DO, mg/L		4.86	_	_	3.80	_	_	0.49	_	_	3.11	_	_	3.30	_	_
BOD5, mg/L		11	25	40	213	111	200	214	49	112	292	122	117	177	190	168
COD, mg/L		12	36	42	219	192	208	222	257	230	332	202	161	280	264	188
SS, mg/L		148	6	80	128	274	156	2,176	496	1,252	536	996	292	388	444	416
T-N, mg/L		0.55	1.95	0.61	62.4	20.4	27.1	32.9	30.3	10.0	62.9	24.0	19.4	37.1	39.1	9.9
T-P (Total Phosphorous), mg/L		0.90	1.52	1.93	5.45	4.86	4.48	8.87	5.82	4.04	2.64	2.46	2.59	5.83	3.94	3.34
Fecal Coliform, MPN/100 mL		4.6E06	>24E06	40E+02	11E+06	2.1E06	>24E06	>24E06	>24E06	>24E06	1.5E05	1.1E06	>24E06	>24E06	>24E06	>24E06
SO4-2, mg/L		12.1	6.1	3.4	78.4	24.0	27.8	16.1	4.0	12.0	6.0	4.8	0.7	267	329	29
Chloride (Cl-), mg/L		13.8	18.3	20.3	30.6	56.8	41.0	28.2	22.7	27.2	88.5	21.3	20.3	34.6	18.3	18.8

Source : Study Team

Table 4-2 Water Quality of Rivers (2/ 2)

Parameter		Las Vacas River (near Collector outfall)						Villalobos River and Its Tributaries								
		Upstream of Outfall			Downstream of Outfall			Villalobos River Mouth (near Maya Crops)			Pinula River (Puente Villa Hermosa			Molino River (Puente Villalobos)		
		A2.1			A2.2			A2.3			A2.4			A2.5		
		7-06-95			7-06-95			18-05-95			18-05-95			18-05-95		
		7:15	12:30	15:30	7:45	13:15	16:00	9:30	13:30	15:30	8:30	12:30	16:00	7:30	12:30	15:30
Flowrate, m3/s		0.443	0.511	0.365	1.512	1.149	1.483	0.140	0.468	0.397	0.234	0.350	0.099	0.226	0.022	0.036
Temperature, °C	Ambient	20	25	20	22	25	21	21	24	22	20	23	22	24	26	24
	Sample	21	27	26	25	27	26	22	27	26	22	25	26	19	21	20
pH		7.5	7.5	7.5	7.6	7.4	7.5	7.7	7.7	7.7	8.4	7.5	7.5	8.1	8.7	9.1
DO, mg/L		3.6	-	-	1.85	-	-	2.3	-	-	2.00	-	-	1.79	-	-
BOD5, mg/L		42	47	107	205	209	146	135	112	192	110	175	117	74	110	96
COD, mg/L		44	86	117	222	272	222	167	177	203	142	299	172	175	271	98
SS, mg/L		36	40	660	264	156	1,436	24	636	876	252	768	24	88	4	12
T-N, mg/L		4.9	0.17	6.3	31.5	9.8	9.0	16.7	47.7	26.7	27.2	47.2	15.3	58.6	47.5	52.8
T-P (Total Phosphorous), mg/L		2.0	3.3	2.3	6.1	5.1	5.1	4.3	7.2	6.5	5.6	3.9	1.8	4.9	4.4	3.6
Fecal Coliform, MPN/100 mL		28E+04	30E+04	20E+04	20E+04	11E+04	15E+04	>11E+06	21E+05	15E+05	40E+03	20E+04	30E+04	28E+04	70E+03	21E+02
SO4-2, mg/L		0.6	6.7	4.9	3.4	7.3	11.2	13.2	11.9	12.9	7.9	24.4	9.9	22.0	17.4	20.0
Chloride (Cl-), mg/L		14.8	9.4	23.2	30.2	57.8	42.0	51.9	60.3	43.5	26.2	58.3	19.3	38.6	39.0	34.6

Source : Study Team

Table 4-3 Calculated Water Quality and Flowrate of Gran Collector North

Date	Time	Flowrate, m^3/s	BOD5, mg/L	SS mg/L	COD mg/L	T-N mg/L	T-P mg/L
03-05-95	7:45~	1.121	308	119	316	91	7.6
	12:30~	0.818	188	513	331	37	7.8
	15:10~	0.815	324	215	337	43	6.5
	Day-time Average	0.912	277	264	327	61	7.3
07-06-95	7:15~	1.069	271	358	296	43	7.8
	12:30~	0.638	339	249	421	18	6.5
	15:30~	1.118	159	1689	256	10	6.1
	Day-time Average	0.863	242	860 (318)	308	24	6.8

Note : Daytime average SS concentration shown in brackets (318) excludes the SS concentration of 1,689 mg/L on 7 June 95.

Source : Study Team

b) **Lake Amatitlan**

The water quality of Lake Amatitlan shows a difference between east and west parts of the lake, especially in terms of chloride concentrations. Chloride concentrations were 99.3~165.1 mg/L in the western part while those in the eastern part were 23.2~25.2 mg/L. However, the range of concentrations is similar to the values measured in 1970 for west and east stations which were in the range 147~170 mg/L for west and 83~90 mg/L in the east. Sulfate concentrations did not show much variation and are also similar to the values measured in 1970.

Probably the most important characteristic of Lake Amatitlan is its low concentration of T-P which has not varied much during the last forty years. It was 0.0455~0.053 mg/L in 1950, 0.035~0.046 mg/L in 1970 and 0.028~0.042 mg/L in this survey (excluding 0.391 mg/L for A2.7, which needs to be confirmed refer Supporting Report E for details). A previous study by Charles Weiss, (1970), pointed out this characteristic, noting that this may be the limiting factor preventing large-scale eutrophication from taking place even though the pollutant load to the lake is increasing.

COD concentrations for the west part did not show much variation (59~24 mg/L) while those for the east showed extreme variation (67~7.5 mg/L). Unfortunately, COD (or BOD)

values, which indicate direct contamination, are not available for 1970 or thereafter so comparisons could not be made.

c) Ground Water

Ground water is exploited for water supply while wastewater disposal by infiltration is also widely practiced for domestic and industrial wastewater disposal. As described in the preceding sections, raw wastewater flows in the rivers and channels. As described in Supporting Report B (Table B-10) wells closer to Villalobos River near Ojo de Agua (Pozo Anexo and Pozo Diamante) are gradually becoming polluted by infiltration of raw wastewater flowing in the river.

Except for groundwater wells for water supply, no systematic monitoring is in place and there are no controls over the underground disposal of wastewater.

4.1.2 Pollutant Load Generation

a) Domestic Sources

Surveys of domestic sources were conducted during the daytime and thus it is necessary to make assumptions in order to estimate the unit pollutant load. Domestic wastewater sources were selected mainly at the existing small-scale treatment plants and based on user income level. Water consumption will be estimated from water supply data. Except for La Cañada, BOD concentrations during day-time varied between 120~503 mg/L with an average of 297 mg/L (Table 4-4). La Cañada is a very high-income area with high water consumption. Average daytime SS concentrations were 183 mg/L (172~380 mg/L). Similarly, T-N and T-P concentrations were 36.3 and 6.22 mg/L, respectively.

Water consumption of the households in the colonies surveyed were estimated using the meter reading data of EMPAGUA for January 1994~May 1995, except for Cañada De San Angel and Pinares Del Norte. Only actual readings, excluding estimated readings, were used and meter readings below 3 m^3 and above 90 m^3 were also excluded. Water consumption for Cañada De San Angel was obtained from the water meter reading for the whole colony for the months of February to April 1995 and that for Pinares Del Norte was estimated from pump capacity and operating time. Average per capita water consumption was calculated assuming 5.5 persons per household and is between 136~97 lpcd.

Table 4-5 shows the results of unit per capita load estimated assuming that the ratio of daytime load to total load is 0.6. Per capita BOD load for medium and low-income colonies

Table 4-4 Water Quality of Domestic Wastewater Sources

Parameter	Northern Region						Southern Region					
	Cañada de San Angel (High-Income)		Pinares Del Norte (Middle-Income)		Santa Elena II (Low-Income)		La Cañada (High-Income)		Bello Horizonte (Middle-Income)		Villalobos II (Low-Income)	
	B1.1		B1.2		B1.3		B1.4		B1.5		B1.6	
	10-05-95	24-05-95	11-05-95	24-05-95	11-05-95	24-05-95	10-05-95	25-05-95	11-05-95	25-05-95	10-05-95	25-05-95
pH	7.6	7.4	7.3	7.6	7.2	7.2	7.6	7.4	7.1	7.4	7.1	7.1
BOD5, mg/L	351	407	342	120	360	138	37	32	280	236	229	503
COD, mg/L	389	461	360	260	426	354	69	121	308	245	418	797
SS, mg/L	172	68	208	244	204	208	208	32	380	216	228	276
T-N, mg/L	42.5	27.5	37.8	26.6	38.8	20.9	27.5	42.7	67.2	38.8	67.2	68.6
T-P (Total Phosphorous), mg/L	8.30	9.11	10.12	5.70	6.00	5.52	2.83	3.47	6.86	6.86	7.08	9.08
Fecal Coliform, MPN/100 mL	> 24E+06	> 24E+06	> 24E+06	11E+06	46E+04	28E+04	> 24E+06	28E+04	> 24E+06	> 24E+06	> 24E+06	> 24E+06
SO4-2, mg/L	15.6	13.5	20.4	11.9	15.4	10.8	7.2	9.3	22.4	10.6	29.6	13.5
Chloride (Cl-)	28.7	29.2	20.2	25.2	47.0	23.7	26.2	7.4	35.6	17.8	38.1	31.6

Source : Study Team

Table 4-5 Unit Per Capita Load Generation for Domestic Sources

Colony	Water Consumption lcpd	Wastewater Generation ** lcpd	Per Capita Load, g/(person.day)				
			BOD	COD	SS	T - N	T - P
Cañada De San Angel	136 #	167	53	60	15	4.7	1.2
Pinares Del Norte	108 *	122	23	31	23	3.2	0.8
Santa Elena II	115	63	15	21	11	1.7	0.3
La Cañada	333	-	-	-	-	-	-
Bello Horizonte	133	121	27	29	33	5.8	0.7
Villalobos II	97	86	24	41	18	4.9	0.6

Note:

Estimated from water meter readings of Colonia Canada and la Floresta for the months of February~April 1995.

* Estimated from pump capacity and pump operation time.

** Wastewater generation is estimated from the wastewater flow rate measured during daytime with the following assumptions : 1) ratio of day time flow to total flow is 0.5, 2) ratio of daytime load to total load is 0.6 and 3) average number of persons per household is 5.5.

Source : Study Team

is between 15~27 gpcd, while that for Cañada De San Angel, which is a high income area, is 53 gpcd.

b) Institutional and Commercial Sources

Compared to domestic wastewater, concentration of institutional / commercial wastewater is low, especially in terms of SS. BOD concentrations were in the range 65~354 mg/L; the highest was from a school and the lowest from the municipality building.

c) Industrial Sources

Of the six industries surveyed only four of the industries could be sampled within the industry's compound so the rest were sampled at the street manhole. Meat processing, brewery and textile industries used the most water.

High BOD concentrations were found for the brewery and tannery at 3,544 and 3,028 mg/L respectively. The BOD concentration for the brewery was unexpectedly low, possibly due to dilution by bottle cleaning wastewater.

SS concentrations were higher for all industries, most probably exceeding settleable solids standards.

The ratio of BOD/COD for pharmaceutical, textile dyeing and meat processing wastewaters were in the range of 0.54~0.93 indicating the possibility of biological treatment. For wastewater from milk products, the BOD/COD ratio for the first sample was very low (556/3544=0.16) while that for second sample was 0.71. The presence of detergents or fat may have caused the low BOD/COD ratio. Brewery wastewater also showed much difference of BOD/COD ratio between the first and second sampling (0.26 and 0.74).

d) Septic Tank Effluents

The BOD concentrations of septic tank effluents were in the range 108~231 mg/L. Three of the septic tanks showed SS concentrations in the range 76~152 mg/L indicating poor sedimentation while the other two showed very low SS concentrations.

e) Rivers

Table 4-6 shows daytime pollutant loads calculated from the water quality survey results for the Las Vacas River, the Villalobos River, the Pinula River and the Molino River. The latter

Table 4-6 Pollutant Loads Estimated for Las Vacas River near Gran Collector Outfall, and Villalobos River and its Tributaries

Parameter	Las Vacas River (near Gran Collector Outfall)				Villalobos River and Tributaries					
	Upstream of Outfall		Downstream of Outfall		Villalobos River Mouth (near Maya Crops)		Pinula River (Puente Villa Hermosa)		Molino River (Puente Villalobos)	
Day-time Load.(approximate 7:30–16:00)										
BOD, kg	468.7	742.6	7,137.0	7,332.8	3,057.3	1,388.1	1,428.6	1,163.5	632.0	192.1
COD, kg	596.4	1,057.6	9,094.4	9,293.4	6,090.8	1,889.9	1,924.5	1,883.4	867.2	428.4
SS, kg	1,011.4	1,941.2	9,233.5	19,230.8	31,626.8	6,504.3	5,825.2	4,363.3	1,475.0	165.1
T-N, kg	25.23	33.32	1,533.62	632.02	693.66	407.18	288.59	298.99	107.68	134.30
T-P, kg	27.48	36.64	221.80	206.74	166.93	69.66	20.97	31.39	14.97	11.18
Daily Load(Day-time Load/Total Load = 0.5)										
BOD, kg/d	938	1,485	14,274	14,666	6,115	2,776	2,857	2,327	1,264	384
COD, kg/d	1,193	2,115	18,189	18,587	12,182	3,780	3,849	3,767	1,734	857
SS, kg/d	2,023	3,882	18,467	38,462	63,254	13,009	11,650	8,727	2,950	330
T-N, kg/d	50.5	66.6	3,067.2	1,264.0	1,387.3	814.4	577.2	598.0	215.4	268.6
T-P, kg/d	55.0	73.3	443.6	413.5	333.9	139.3	41.9	62.8	29.9	22.4
Daily Load(Day-time Load/Total Load = 0.6)										
BOD, kg/d	781	1,238	11,895	12,221	5,096	2,313	2,381	1,939	1,053	320
COD, kg/d	994	1,763	15,157	15,489	10,151	3,150	3,207	3,139	1,445	714
SS, kg/d	1,686	3,235	15,389	32,051	52,711	10,841	9,709	7,272	2,458	275
T-N, kg/d	42.1	55.5	2,556.0	1,053.4	1,156.1	678.6	481.0	498.3	179.5	223.83
T-P, kg/d	45.8	61.1	369.7	344.6	278.2	116.1	35.0	52.3	24.9	18.63

Source : Study Team

two are major tributaries of the Villalobos River. Since, the rivers function as wastewater drainage channels, it is assumed that the ratio of daytime load to the total load is between 0.5 and 0.6 and that the daily load is estimated for both cases to be as shown in Table 4-6. BOD loads for the Las Vacas River, immediately downstream of Gran Collector, are similar for the first and second sampling, whereas those for the other sampling points were very different between the first and second sampling. The river flow downstream of Gran Collector North is mostly made up of wastewater and the measurements were made close to the Gran Collector discharge. For the other rivers, wastewater discharges are spaced out along the rivers and have smaller individual flowrates, and the pollutant load showed seasonal variation.

4.1.3 Pollutant Sources Other Than Domestic Wastewater

The main pollutant source, other than from domestic wastewater, is from industries. In addition to the water quality survey, an industrial questionnaire survey of twenty-one industries was conducted and the results are discussed in Supporting Report F. Food and textile industries account for more than 50% of the large industries in the Study Area and its vicinity, and water usage is high in these types of industries.

Only one industry has a water consumption in excess of 1,000 m^3/day and five industries use more than 100 m^3/day. Industries using more than 50 m^3/day have their own ground water wells for water supply.

Wastewater disposal is mainly by public sewer or private absorption wells. Almost two thirds of the industries provide treatment for process wastewater and the remaining one third have only treatment for domestic wastewater. Generally, treatment is by septic tank and absorption wells. Monitoring of the treatment process is totally absent and generally only done visually.

A survey of ten farms selected in the Study Area was also conducted to investigate the fertilizer and biocides usage. Fertilizer usage is in the range 180~650 kg/(ha.year) and generally applied twice a year.

4.2 PUBLIC HEALTH CONDITIONS

Cholera epidemic's occur in Guatemala and there was such an epidemic in June 1995 at El Progreso. In 1991, 1992 and 1993 there were 28,084 cases resulting in 379 deaths. The fact that there is practically no treatment of wastewater has an adverse effect on public health. Table 4-7 shows incidences of water-related diseases (number of cases per thousand). The number of incidences of typhoid fever has remained almost constant during the period 1988~1993.

Infant mortality in Guatemala was 46.6 per thousand live births in 1988 (INE), which is also high. The major cause of infant mortality is intestinal infection related to contaminated water and food.

Table 4 - 7 Incidence of Water Related Diseases in Guatemala

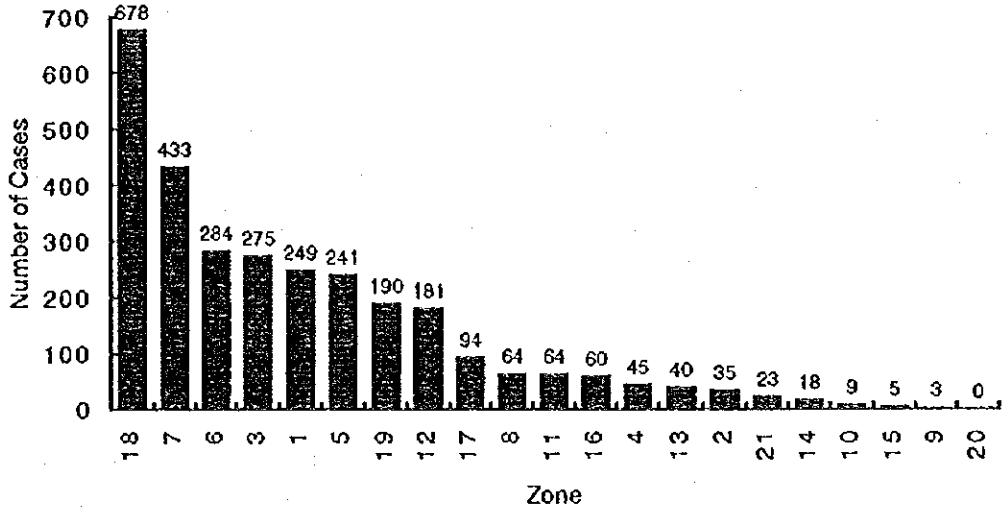
	Number of cases per thousand					
	1986	1987	1988	1989	1990	1993
Diarrhea	6.42	11.99	13.62	14.34	11.91	11.43
Typhoid Fever	0.08	0.03	0.13	0.07	0.02	
Hepatitis	0.24	0.30	0.23	0.17	0.02	
Malaria	5.20	6.84	6.05	5.30	6.10	0.04
Dengue	-	0.22	0.60	0.61	0.31	0.24

Source : EMPAGUA & Unidad de Informatica DGSS, 1992

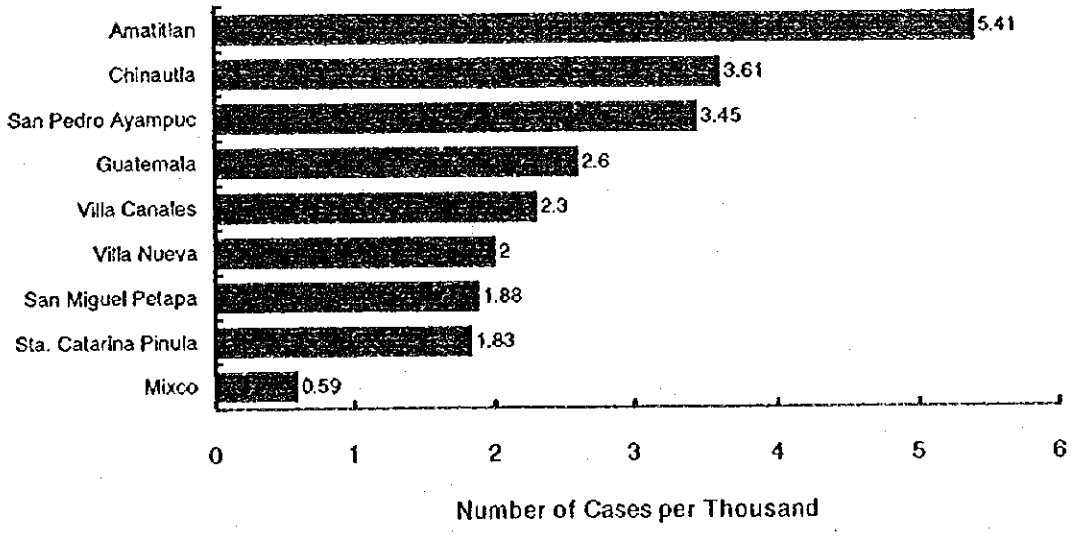
Fig. 4-2 shows the incidence of cholera in Guatemala Metropolitan Area according to zones and municipalities in the year 1993. Zone 18 had the highest incidence followed by Zone 7. The average per capita consumption in Zone 18 is also the lowest among the zones (103 lpcd while the average per capita consumption is 237 lpcd, refer Table K-2 of Supporting Report K) and the sanitary conditions are bad. Out of the municipalities, Amatitlan had the high incidence per population followed by Chinautla. Both are at the downstream of Guatemala City affected by raw wastewater discharge to Villalobos River and Las Vacas River.

Fig. 4 - 2

Reported Cases of Cholera by Zones in 1993 (both confirmed and unconfirmed cases)



Reported Cases of Cholera by Municipality in 1993 (both confirmed and unconfirmed)



Source : Centro de Salud, Area Norte, Guatemala

THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE INCIDENCE OF CHOLERA IN GUATEMALA METROPOLITAN AREA IN 1993 (CONFIRMED AND UNCONFIRMED CASES)

4.3 LAWS, REGULATIONS AND STANDARDS ON WATER POLLUTION CONTROL

4.3.1 Introduction

Table 4-8 shows the laws, regulations and standards on water pollution control and the respective implementing authorities. Descriptions of each can be found in Supporting Report C. Most important among them is the 'Health Code', the Law for the Protection and Improvement of the Environment (68-86), and Regulations on the Minimum Requirements and Maximum Permissible Values for Wastewater Discharges (60-89) which are discussed here.

4.3.2 Health Code (1979)

Articles 31, 32, 33, 34, 35, 36 and 37 of the Health Code entrust the Minister of Public Health and Social Welfare with a responsibility to protect the citizens health from water pollution arising from domestic and industrial wastewater discharges.

4.3.3 Law for the Protection and Improvement of the Environment (68-86)

Major aspects of this law are;

a) Formation of a committee for environmental policy making, implementation and supervision.
b) Requirement for Environmental Impact Assessment.
c) Introduction of fines from Q. 5,000.00 up to Q. 100,000.00 and powers of closure of the business/activity for non-compliance after six months.
d) Vested powers with the government to protect the environment .

4.3.4 Regulations on the Minimum Requirements and Maximum Permissible Pollution Values for Wastewater Discharges (60-89)

This is the only regulation concerning municipal and industrial wastewater discharges in Guatemala (Table 4-9 through 4-14). Though it is not very stringent, it proposed the first steps in water pollution control in Guatemala. In most of the standards, complying with settleable solids concentrations is critical and could generally be satisfied by primary treatment.

Table 4 - 8 Laws, Regulations and Standards on Water Pollution Control and Respective Implementing Institutions

Name of the Laws, Regualtions and Ordinance	Year Enacted	Implementing Institution	Remarks
Codigo de Salud , Decreto del Congreso de la Republica 45-79 Capitulo I, Articulo 31,32,33,34,35,36, y 37 (Health Code)	1979	MSPyAS	Regarding wastewater discharges, implemented only when serious problems are reported by the public to Health Centers (Centro de Salud).
Ley de Protección y Mejoramiento del Medio Ambiente, Decreto del Congreso de la Republica 68-86, (Law of the Protection and Improvement of the Environment).	1986	CONAMA	Requires EIA for new activities affecting the environment.
Reglamento de Requisitos Minimos y Sus Limites Maximos Permisibles de Contaminación Para la Descarga de Aguas Servidas Acuerdo Gubernativo, Numero 60-89 (Regulations on the Minimum Requirements and Maximum Permissible Pollution Values for Wastewater Discharges)	1989	MSPyAS CONAMA	Not being implemented due to lack of manpower, intitutional capacity and other factors.
Reglamento de Localizacion e Instalacion Industrial (Regulation on Location and Installation of Industries in Municipality of Guatemala)	1971	MUNI	
Instructivo de Procedimientos para las Evaluaciones de Impacto Ambiental (Instructions and Procedures for the Environmental Impact Assessment)	1990	CONAMA	Implemented by CONAMA, but lacks monitoring after installation of facilities.
Crease Como Organismo Al Mas Alto Nivel, la Authoridad Para el Rescate y reguardo del Lago de Amatitlan Acuerdo Gubernativo Numero 204-93 (Law on Creation of Lake Amatitlan authority and Conservation of Lake Amatitlan)	1993	Lake Amatitlan Authority	
Creada Segun Acuerdo Gubernativo No. 238-92	1992	SRH	Regulation to create Secretariat of Water Resources

Source : Study Team

Table 4 - 9 Maximum Permissible Pollution Values for Municipal Wastewater Discharges

Sample	Settleable Solids, mL/L	BOD_5, mg/L	COD, mg/L
Random Sample	1.0	-	-
Composite Sample, 2 hours	1.0	250	500
Composite Sample, 24 hours	1.0	200	450

Source : Reglamento 60-89

Table 4 -10 Maximum Permissible Pollution Values for Coffee Mill Wastewater Discharges

Type of Industry	Sample	Settleable Solids, mL/L	BOD_5, mg/L	COD, mg/L
Coffee Mill	Random Sample	no pulp	-	3,000
	Composite Sample, 2 hours	no pulp	-	2,500
	Composite Sample, 24 hours	no pulp	-	2,500

Source : Reglamento 60-89

Table 4 - 11 Maximum Permissible Pollution Values for Sugarcane Industry Wastewater Discharges

Type of Industry	Sample	Settleable Solids, mL/L	BOD_5, mg/L	COD, mg/L
Sugarcane Industry	Random Sample	0.5	-	-
	Composite Sample, 2 hours	-	40,000	45,000
	Composite Sample, 24 hours	-	30,000	40,000

Source : Reglamento 60-89

Table 4 - 12 Maximum Permissible Pollution Values for Tannery Wastewater Discharges

Type of Industry	Sample	Settleable Solids, mL/L	pH	COD, mg/L
Tannery	Random Sample	1.0	5 ~ 8	-
	Composite Sample, 2 hours	-	6 ~ 8	-
	Composite Sample, 24 hours	-	-	-

Source : Reglamento 60-89

Table 4-13 Permissible Maximum Pollution Levels for Wastewater Discharges from Food Industries

Type of Industry	Samples	Settleable Solids mL/L	Chemical Oxygen Demand, COD, mg/L	Biochemical Oxygen Demand at 5 days, BOD5, mg/L
1.1 Beer Brewery	Random sample: maximum	5.0		
	Sample, 2 hour average: maximum		1,800	1,000
	Sample, 24 hour average: maximum		1,600	900
1.2 Dairy Products	Random sample: maximum	1.0		
	Sample, 2 hour average: maximum		2,000	1,000
	Sample, 24 hour average: maximum			
1.3 Oil and Fat Production	Random sample: maximum	0.5		
	Sample, 2 hour average: maximum		500	
	Sample, 24 hour average: maximum		4,500	
1.4 Fruit and vegetable Processing	Random sample: maximum	0.5		
	Sample, 2 hour average: maximum		800	500
	Sample, 24 hour average: maximum			
1.5 Potato Processing	Random sample: maximum		700	450
	Sample, 2 hour average: maximum	1.0		
	Sample, 24 hour average: maximum		8,000	5,000
1.6 Juice Factory	Random sample: maximum		7,000	4,000
	Sample, 2 hour average: maximum	0.5		
	Sample, 24 hour average: maximum		800	500
1.7 Sea Food Industries	Random sample: maximum		700	450
	Sample, 2 hour average: maximum	1.0		
	Sample, 24 hour average: maximum		900	600
1.8 Meat Industry	Random sample: maximum		750	500
	Sample, 2 hour average: maximum	0.5		
	Sample, 24 hour average: maximum		900	600
1.9 Liquor Distillery	Random Sample: maximum	0.5		
	Sample, 2 hour average: maximum		45,000	40,000
	Sample, 24 hour average: maximum		40,000	30,000

Source : Reglamento 60-89

Table 4 -14 Permissible Maximum Pollution Values for the Discharge of Metal and Other Metal Processing Industries

Parameter		1.1 Galvanizing	1.2 Surface Cleaning with Acids	1.3 Plastic Coating	1.4 Bronze Plating	1.5 Zinc Plating	1.6 tempered	1.7 Batteries and Charging	1.8 Enamelling	1.9 Forging	1.10 Paints
		Random Samples									
Settleable Solids	mL/L	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
		Composite Sample for 2 hours									
Chemical Oxygen Demand	mg/L	1200	200	200	400	400	1500	500	200	1500	1500
Cadmium as Cd	mg/L	1.0				0.2		0.4	0.1		1.0
Mercury as Hg	mg/L							0.1			
Aluminum as Al	mg/L	6	6	6					4	6	6
Ammonium Nitrogen	mg/L	200				8.0		300	40	600	
Barium as Ba	mg/L						4				
Lead as Pb	mg/L	2						4	2	2	2
Chlorine as Cl	mg/L	1.0	1.0	1.0	1.0		1.0				
Total Chromium as Cr	mg/L	4	2	2	2				4	2	2
Heaxavalent Chromium	mg/L	1.0	1.0	1.0	1.0				1.0	1.0	1.0
Cyanide as CN	mg/L	0.4					2			0.4	
Iron as Fe	mg/L	6	6		6	6		6	6	6	6
Flouride as F	mg/L	100	40	100		100			100	60	
Copper as Cu	mg/L	4	4					4	4	2	4
Nickel as Ni	mg/L	6	4		4			6	4	2	2
Nitrate Nitrogen	mg/L		20	10	20		10		10	20	
Sulfites	mg/L										
Zinc as Zn	mg/L	10	10	6		10		10	4	6	6
Hydrocarbons	mg/L	20	20	20	20	20	20	20	20	20	20
Silver as Ag	mg/L	0.2						0.2			
Cobalt as Co	mg/L								2		

Source : Reglamento 60-89

Major aspects of this regulation are;

a) Effluent standards for municipal wastewater discharges and industrial wastewater discharges.
b) Requires compliance within two years after its enactment and in the case of non-compliance, requires at least a sedimentation tank with a retention time of two hours.

However, the regulation has shortcomings as follows,

a) Direct and indirect (e.g. through public sewers or drainage) discharges are not differentiated,
b) Only a few parameters are specified, namely settleable solids, BOD and COD,
c) Does not specify any specific authority for carrying out monitoring,
d) Does not specify any punitive measures for non-compliance.

4.3.5 Observations on the Existing Enforcement Framework

The following are observations on the existing enforcement framework of water pollution control:

a) Unclear roles among institutions
b) Deficiency of personnel and equipment
c) Absence of a monitoring system

CHAPTER 5

ADMINISTRATIVE AND FINANCIAL SITUATION

5 ADMINISTRATIVE AND FINANCIAL SITUATION

5.1 INSTITUTION

5.1.1 Laws and Regulations

Having a complete set of laws and regulations pertinent to control, operation and maintenance of the wastewater management system is essential for EMPAGUA to undertake the proposed project. The laws, regulations and standards pertinent to water pollution control have been discussed in the Section 4.3. The other laws and regulations related to the wastewater management are reviewed in succeeding paragraphs. However, it found difficult to judge, due to lack of information, whether or not existing laws and regulations related to wastewater management can cover necessary judicial actions required to undertake wastewater management activities.

Although further legal analysis is beyond the scope of this study, the general opinion about juridical situation in Guatemala is worth mentioning. It is said that: already sufficient number of laws and regulations have been enacted; after duplication and complication, some laws even contradict each other; and actual executing power of laws is considerably weakened due to the lack of legal sense or laboriousness to observe laws.

a) Executive Power to Undertake Wastewater Management Activity

The Article 19 of Health Code (Decree 45-79, 1979) prescribes that MSPySA is charged with the environmental sanitation by enforcing general actions oriented toward (i) the disposal of excrementitious matters and wastewater, (ii) the elimination of garbage and other refuse and (iii) the control of water contamination. At municipal level, as indicated by the Articles 30 and 31 of Municipal Code (Decree 58-88, 1988), municipalities have the power to provide the residents in each jurisdictional area with wastewater management services. In Guatemala City, this responsibility was transferred to EMPAGUA in 1984 by the Agreement No. AA-100-84 issued by the municipality. Existing laws and regulations however, do not stipulate responsibility of a municipality to offer public services outside the municipal boundary. On the other hand, according to the Article 2 of the General Rule of EMPAGUA's Management, its service area is defined as Guatemala City and its associated urban area. The same article also states that any other municipalities can be served by EMPAGUA if the necessary agreements are concluded. It is, thus, understood that

Guatemala Municipality and other municipalities will have to reach an agreement if the service area of EMPAGUA is to expand beyond Guatemala Municipality.

b) Mandatory Use of Public Sewers and Control of Private Wastewater Disposal System

The Article 1 of Decree 1004, 1953 prohibits the discharge of vegetable or chemical substances, agricultural or industrial wastes or refuse, into rivers, rivulets, fountains and lakes. The Article also prohibits the use of privy without sewage treatment facility in places nearby rivers, rills, fountains and lakes. Any person who violates this Ordinance shall be subject to penalties regulated by Penal Code (Decree 17-73, 1973).

c) Penalty and Punishment

Health Code (Decree 45-79, 1979) provides prohibitions against the water contamination, and the agricultural use of contaminated water. However, the sanction on the violation is not enough due to the lack of regulation defining such materials. Penal Code (Decree 17-73, 1973) stipulates that those who deliberately poison, contaminate, adulterate the water, foods, or medicines shall be punished with imprisonment of two to eight years. The same sanction shall be applied to those who knowingly give or place for distribution, the adulterated or contaminated water, foods, or medicines.

d) Power to Impose Property Tax

Single Real Estate Tax Law (Decree 62-87, 1987) empowers the Central Government to impose the annual rate of 0.9 percent of property assessment value exceeding Q70,000, 0.6 percent between Q20,000 and Q70,000, and 0.2 percent between Q2,000 and Q20,000. Taxable properties include lands and buildings, attached installation, and permanent farming. According to the Article 86 of Municipal Code (Decree 58-88, 1988), municipalities may charge full construction cost to the residents of the communities directly benefiting from the infrastructure.

e) Power to Apply for Loan or Subsidy

Each municipality can request loans through INFOM. This borrowing power is prescribed by the Articles 4 and 9 of the Chapter 2 of the Municipal Development Institute Law 1132 , and the Articles 2, 89 and 90 of the Municipal Code (Decree 58-88, 1988).

f) Power to Obtain Easement for Project and Purchase Land

Each municipality is empowered to obtain the easement or right-of-way for the purpose of wastewater management works, expropriate and purchase the land. This power is prescribed by the Article 794 of the Civil Code (Decree 106) and the Article 19 of the Expropriation Law (Decree 529).

g) Inspection of User's Premises

The Articles 200-a and 200-b of the Regulation for Design and Construction of Drainage prescribe for EMPAGUA to inspect the premises of business and commercial enterprises and households to examine the compliance with sewerage regulations.

h) Wastewater Quality Check

EMPAGUA is not empowered to sample, test, and analyze wastewater in order to check the quality of wastewater being discharged into the public sewers.

i) Takeover of Private Sewage Disposal System

There is no regulation empowering each municipality or EMPAGUA to take over the control, supervision, maintenance and repair of private septic tanks or other sewage treatment plants in improper or no operation.

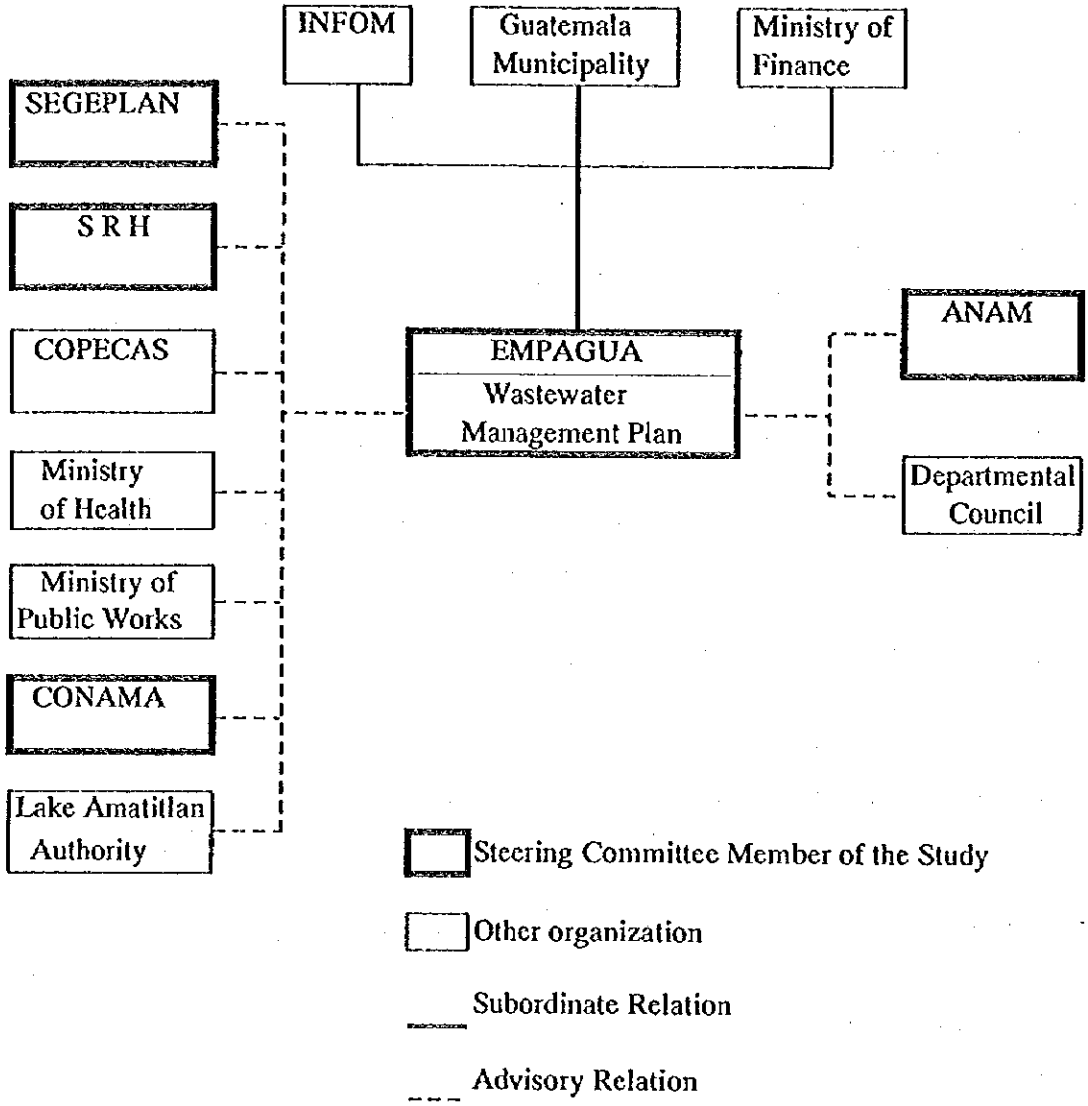
5.1.2 Organizations Related to Wastewater Management

Numerous organizations are involved in one way or another in wastewater management in the Guatemala Metropolitan Area. Fig. 5-1 illustrates those which are principally involved. The functions of each participant are described below. Apparently there are many organizations which are capacitated as coordinator but at present there seems to be no single organization which can strongly manage a large scale wastewater project. In order for the project to be successful, a leading coordinator should be singled out. It is not necessary to create a new entity, rather it will be more convenient to reactivate one of the existing organizations which is best positioned to carry out the coordinator's role.

a) Guatemala Municipality

Regarding Guatemala Municipality's competence to offer public services, Articles 30 and 31 of the Decree No. 58-88, 1988 (Municipal Code) stipulate as follows:

Fig. 5 - 1



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE RELATIONSHIP OF OGRANIZATIONS RELATED TO WASTEWATER MANAGEMENT

"Municipality's primordial objective is to supply and administer public services in its jurisdictional territory on a non-profit making basis, therefore a municipality has a responsibility to establish, maintain, improve and regulate its services while guaranteeing an efficient, secure, continuous, pleasant and hygienic function to the residents and beneficiaries of the territory. Determination and collection of a charge based on a fair contribution is also the municipality's responsibility".

"Municipal public services will be provided and administered by municipalities and their administrative dependencies, service units and companies under their supervision."

Thus, Guatemala Municipality has the power to provide its residents in the jurisdictional area with wastewater management services. This responsibility was transferred to EMPAGUA in 1984 by the Agreement No. AA-100-84 issued by Guatemala Municipality. But existing laws and regulations do not stipulate responsibility of a municipality to offer public services outside the municipal boundary. It is, thus, understood that Guatemala Municipality and other municipalities will have to reach an agreement if the service territory of EMPAGUA is to expand beyond Guatemala Municipality.

b) Institute of Municipal Development

Institute of Municipal Development (INFOM) was created by Decree No. 1132, as an autonomous entity which is decentralized from the Central Government and functions as a link between the government and 329 municipalities, excluding the Guatemala Municipality. Furthermore INFOM nominates one member of EMPAGUA's managing board. According to the Article 4 of the aforementioned Decree, its principal functions are to give municipalities (i) technical assistance; (ii) financial assistance; (iii) administrative assistance; (iv) to guarantee loan repayment; (v) supervision, or administration of the municipality's works and services; (vi) commercial agency assistance; and (vii) legal advice.

c) Ministry of Public Finance

This ministry participates in EMPAGUA's management by delegating one member to the Managing Board. Also it is the competent ministry for financing public works including wastewater management.

d) General Secretariat of the National Council of Economic Planning

General Secretariat of the National Council of Economic Planning (SEGEPLAN) is directly dependent on the Presidential Office and pursuant to Article 11 of Decree No. 157, this

secretariat has attributed powers to define the policies for development and investment for different areas at a national level. Therefore, due to the lack of a national entity in charge of planning wastewater management and sanitation, SEGEPLAN assumes responsibility for coordinating the organizations involved in this sector.

e) Secretariat of Hydraulic Resources

The Secretariat of Hydraulic Resources is abbreviated as SRH. The Article 2 of the Governmental Agreement No. 238-92 stipulates SRH's attributions and functions, of which major items are (i) to formulate and develop the national water policy, giving priority to the usage and development of the water resources in this country; (ii) to formulate and develop the national water plan; (iii) to set up and maintain the registry of national water resources; (iv) to manage the national water resources; (v) to watch over for the conservation, good use and development of water quality and quantity; (vi) to coordinate the planning and construction of public projects related to use of national water resources; (vii) to evaluate technically and approve all plans, programs and projects related to the development and usage of national water resources; (viii) to establish and maintain a program of compilation and evaluation of water resources data; and (ix) to plan and investigate through coordination with the National Environmental Committee (CONAMA) and the National Council of Protected Areas (CONAP), the interaction between water resources, other natural resources and social and economic sectors.

f) Permanent Committee of Coordination of Water and Sanitation

The Permanent Committee of Coordination of Water and Sanitation (COPECAS) was officially created by the Governmental Agreement No. 1036-85 and presently comprises the Institute of Municipal Development (INFOM), the Executant Unit of Rural Aqueducts Program (UNEPAR), Environmental Sanitation Division of the Ministry of Public Health and Social Assistance (DSM), General Secretariat of the National Council of Economic Planning (SEGEPLAN) and EMPAGUA. Furthermore, the Secretariat of Hydraulic Resources (SRH), Regional School of Sanitary Engineering of the University of San Carlos and Pan-American Health Organization (OPS) are participating in the Committee as observers. Its principal function is coordination of those public institutions whose activities are related to water supply and sanitation.

g) Ministry of Public Health and Social Assistance

As defined in Article 22 of the Executive Organization Law, the Ministry of Public Health and Social Assistance (MSPySA) has jurisdiction over the management, organization,

centralization and coordination of all activities related to public health at individual, municipal and national levels. The Environmental Sanitation Division (DSM) exists under the General Bureau of Health Services (DGSS) and has functions including to study sanitation problems in Guatemala and propose priorities for their solution; to define existing and necessary resources to confront the sanitation problems; to elaborate the national environmental sanitation program which will be the basis for operative level programs; to elaborate the norms and procedures to control and avoid the environment contamination; to supervise environmental sanitation programs at operative level; to monitor if the sanitary legislation is being observed; and to comply with international agreements and commitments which are assigned to its remit.

h) Ministry of Communication, Transportation and Public Works

The Article 14 of the Executive Organization Law capacitates the Ministry of Communication, Transportation and Public Works (MCTyOP) for the study, realization and technical administration of various infrastructure plans at national level. The unit most relevant to wastewater management is the Aqueduct and Sewerage Division (DAA) under the General Bureau of Public Works (GOP). DAA carries out various studies of water supply and sanitation.

i) National Environmental Committee

The National Environmental Committee (CONAMA) was created by the Decree No. 68-86 or the Law for Protection and Improvement of the Environment. Article 20 of the Decree defines the function of CONAMA as adviser and coordinator of all of the actions regarding formulation and application of the national policy in order to protect and improve the environment. CONAMA has the Technical Advisory board which comprises the representatives from the General Secretariat of the National Council of Economic Planning (SEGEPLAN), Ministry of Urban and Rural Development, Ministry of Education, the Ministry of Public Health and Social Assistance (MSPySA), the Ministry of National Defense, the Coordinator Committee of Agriculture, Industrial and Financial Associations (CACIF), the University of San Carlos, the Guatemala Journalists Association, and the Private University League.

j) Lake Amatitlan Authority

This authority was created by the Governmental Agreement No. 204-93, and its function is to rescue and protect the Lake Amatitlan by planning, coordination and execution of all of the

actions of both public and private sectors necessary to preserve the Lake Amatitlan and its tributary basins.

k) National Association of Municipalities

The National Association of Municipalities (ANAM) was created by Governmental Agreement No. 899-92 and its members are all municipalities in Guatemala. The Article 3 of the above Agreement defines its principal functions as to defend the development of municipal autonomy established in the Constitution; to coordinate national and regional actions in social and economic development programs of municipalities; to give technical, administrative and legal assistance to municipalities with certain problems; to promote and negotiate governmental action for municipal development; and to promote and negotiate the participation of national and international agencies in providing technical and financial assistance, in order to improve municipal governments.

l) Departmental Council

Pursuant to Decree No. 52-87, the National System of Urban and Rural Development Councils was created. This system is composed of the National Council, Regional Councils, Departmental Councils, Municipal Councils and Local Councils. This group of councils has the objectives of organizing and coordinating public administrations in order to promote urban and rural development. In the Guatemala Metropolitan Wastewater Management Plan, the Council of Guatemala Department is to be served for coordination of public entities involved in the plan.

m) EMPAGUA

EMPAGUA was created by the Guatemala City Council Agreement dated November 28, 1972 as a semi-autonomous entity under the Guatemala Municipality. Its principal functions were to offer drinking water supply services. Subsequently in 1984, sewerage services were also handed over to EMPAGUA. According to Article 2 of the General Rule of EMPAGUA's Management, its service area is defined as Guatemala City and its associated urban area. The same article also states that any other municipalities can be served by EMPAGUA if the necessary agreements are concluded. EMPAGUA's organization and management are further analyzed in Section 5.3.