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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF PUBLIC HEALTH AND SOCIAL WELFARE

THE REPUBLIC OF PARAGUAY

THE STUDY
ON
THE SOLID WASTE MANAGEMENT
FOR
METROPOLITAN AREA OF ASUNCION

FINAL REPORT
VOLUME II
MAIN REPORT

AUGUST 1994

KOKUSAI KOGYO Co., Ltd.

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In this report, project cost is estimated at February 1994 price and at an exchange rate of 1 US$ = ¥ 106.41 = 1,880.50 Gs.

THE STUDY
ON
THE SOLID WASTE MANAGEMENT
FOR
METROPOLITAN AREA OF ASUNCION

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VOLUME I	**EXECUTIVE SUMMARY**
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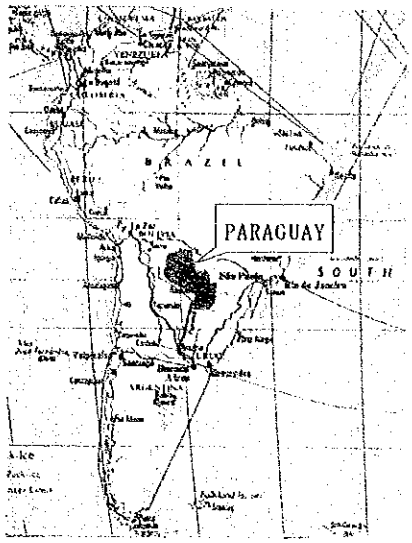
I The Master Plan
J Feasibility Study of the First Priority Project
K General Recommendation for the Improvement of ISWM and MSWM

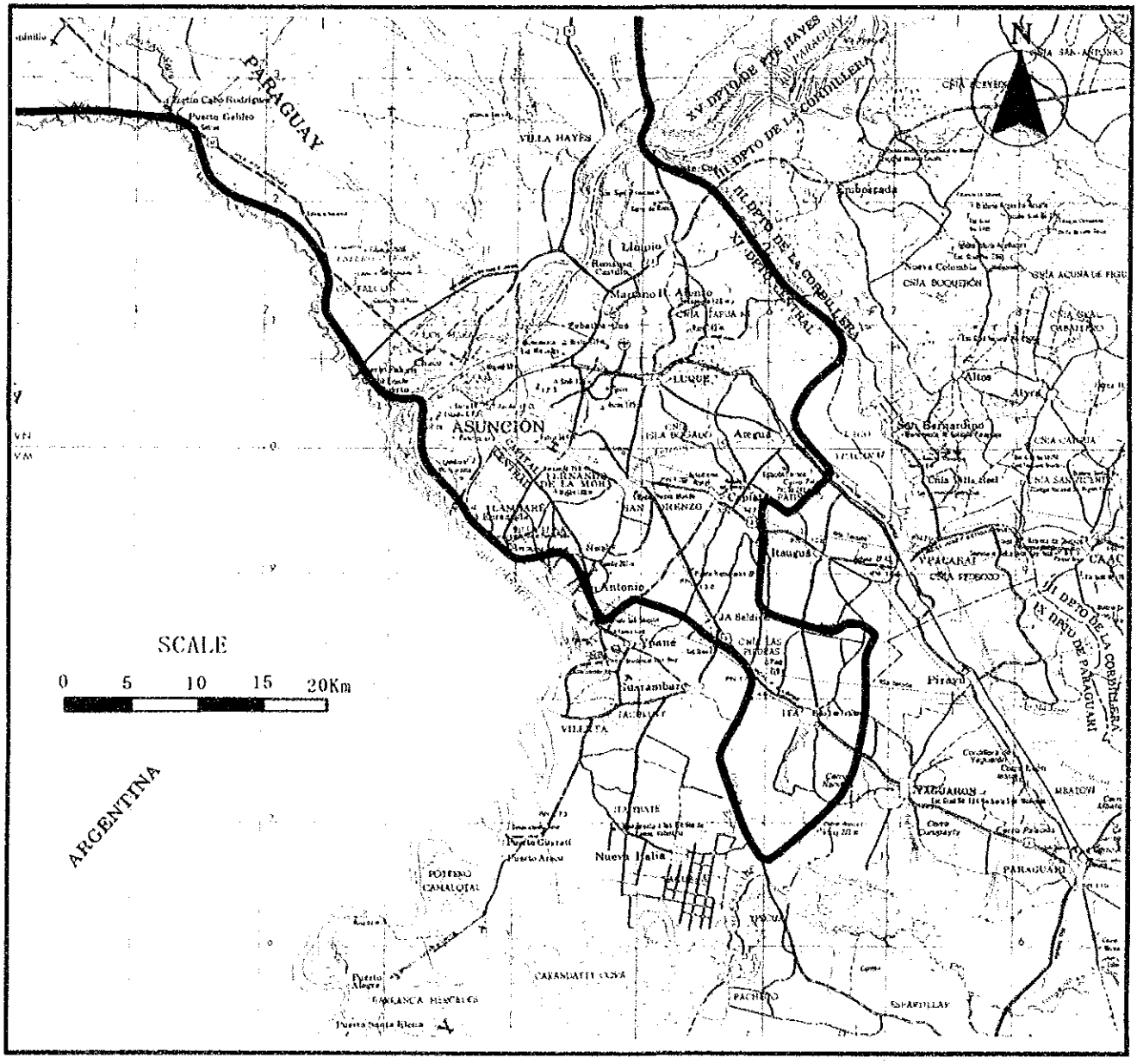
VOLUME IV **DATA BOOK**

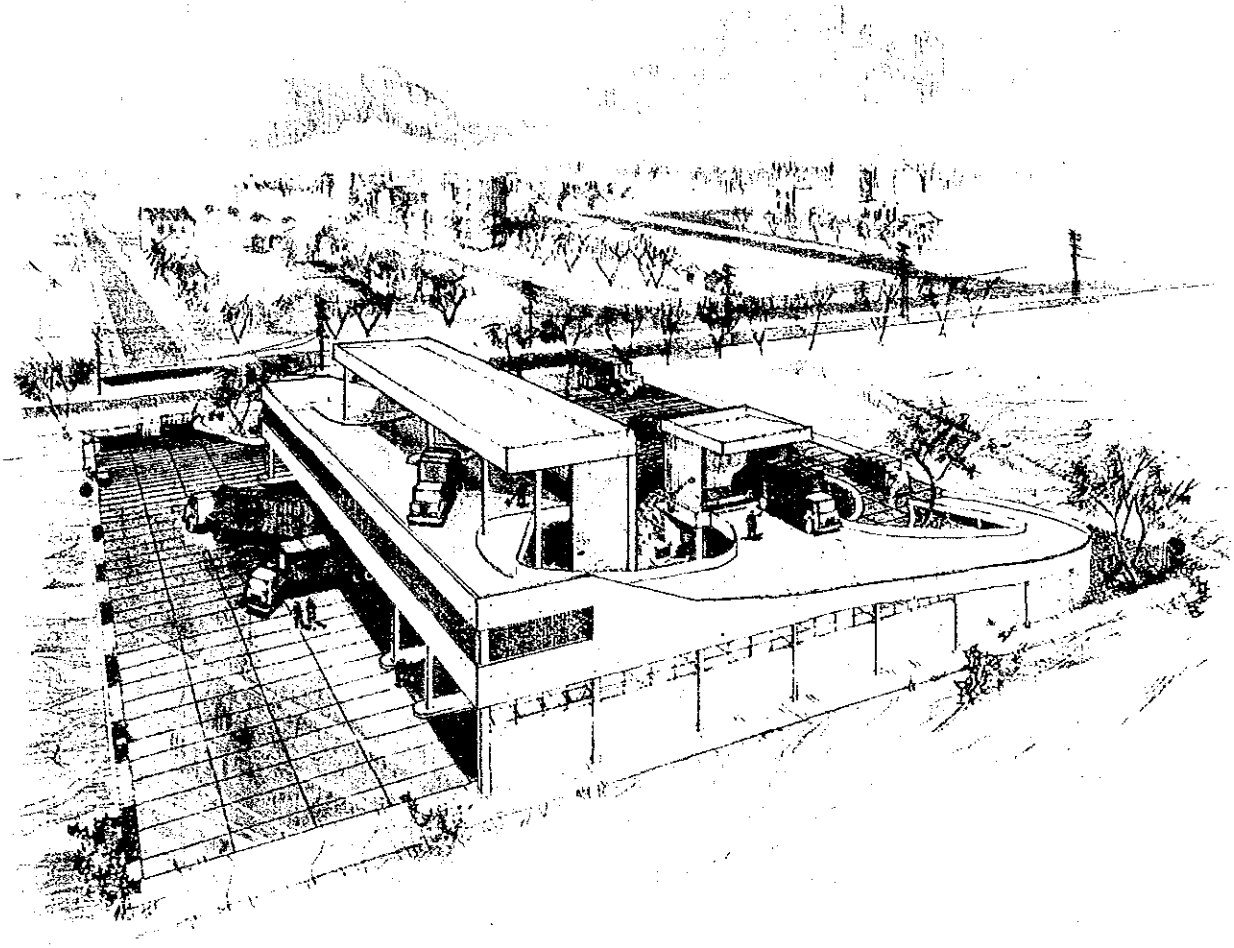
This is the MAIN REPORT.

Location Map of

The Study Area







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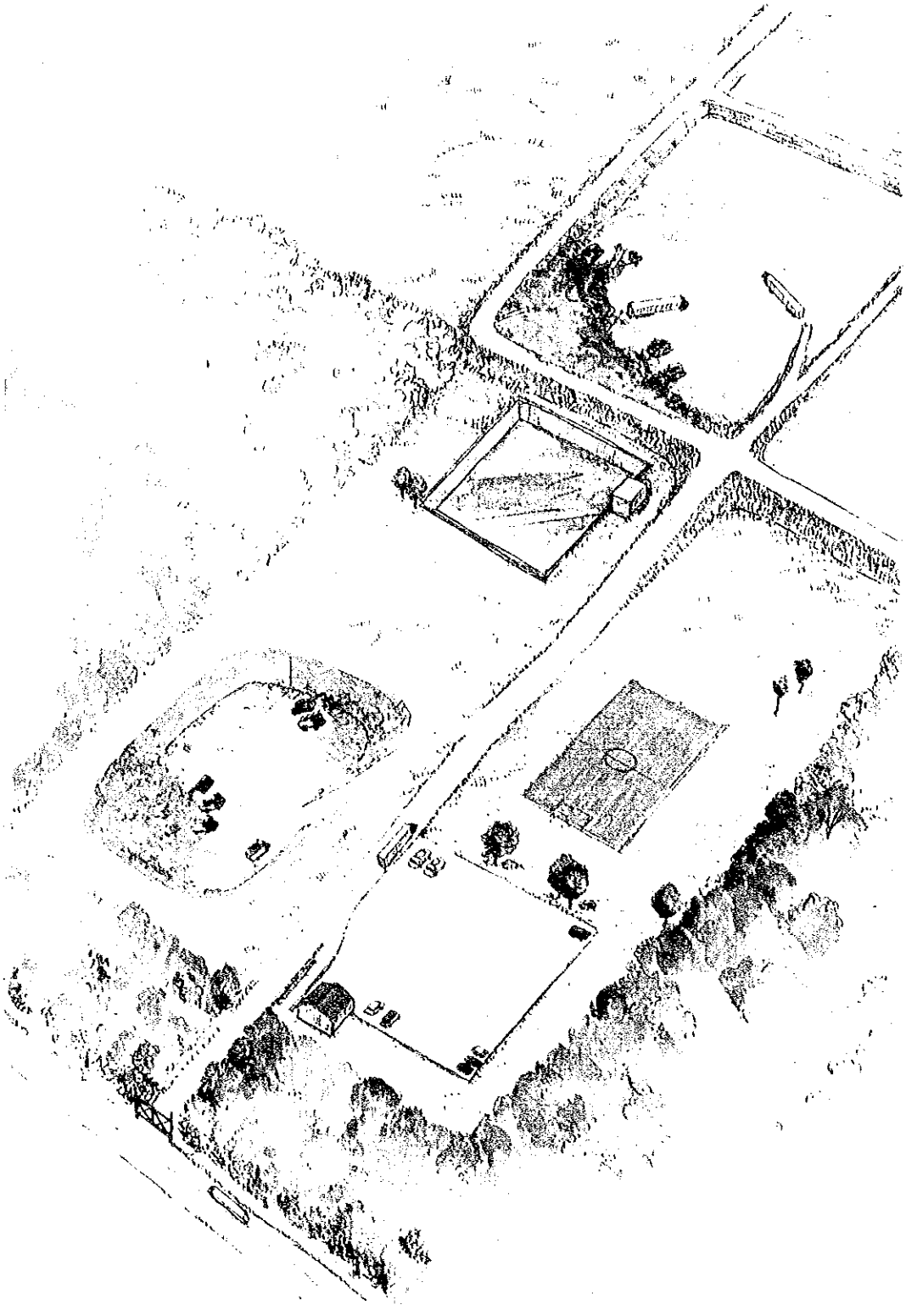
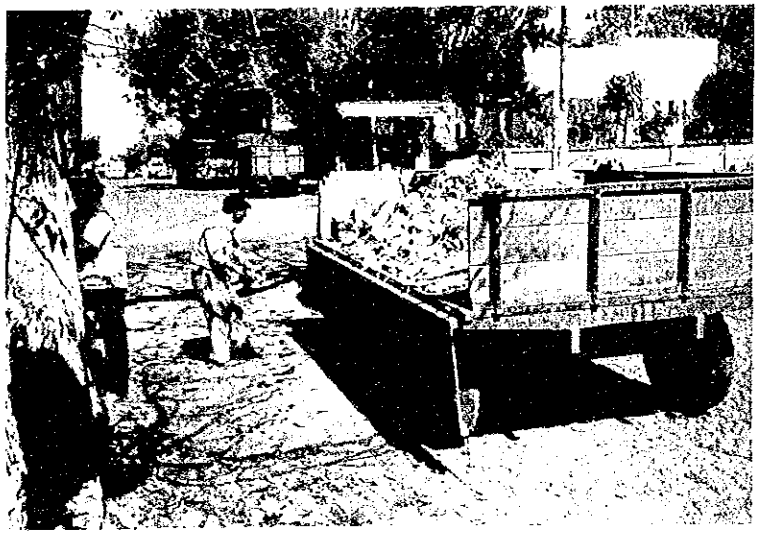


Plate 2: Image of Final Disposal Site

Cateura Final Disposal Site

Workshop of Asuncion Municipality



Street Sweeping Work in San Lorenzo

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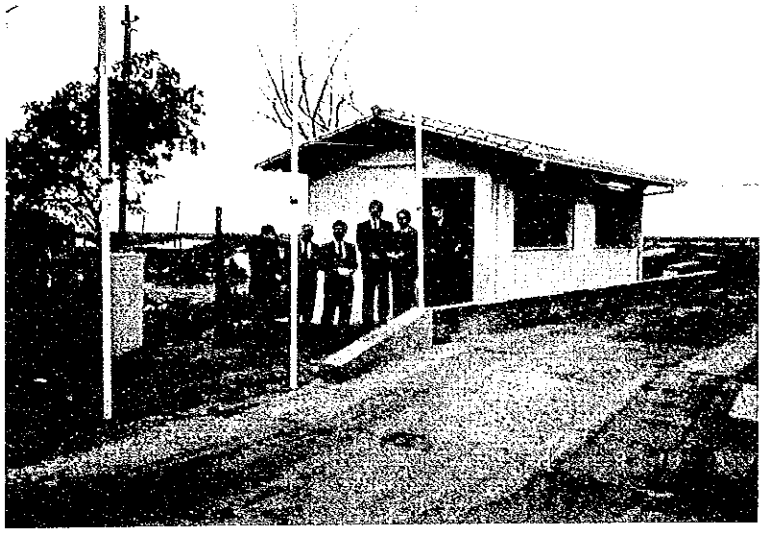
Weighing waste amount discharged by houses

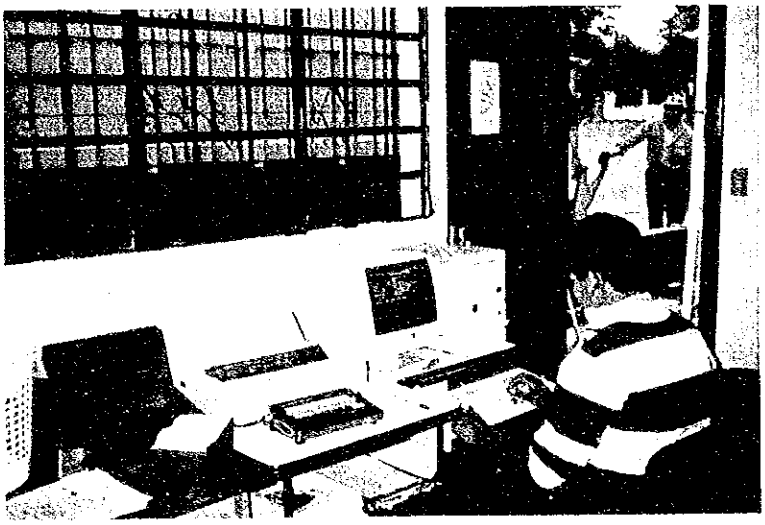
Mixing and reducing waste sample collected for waste composition analysis

Sorting waste sample by waste categories

Plate 4: Joint Survey (1), Waste Amount and Composition



Truck Scale Inspection Building constructed by Asuncion Municipality and JICA in Cateura Landfill Site



Inside View of the Inspection Building of Truck Scale. One set of Computer is installed

Water Sampling for Water Quality Analysis at Lambare Landfill Site

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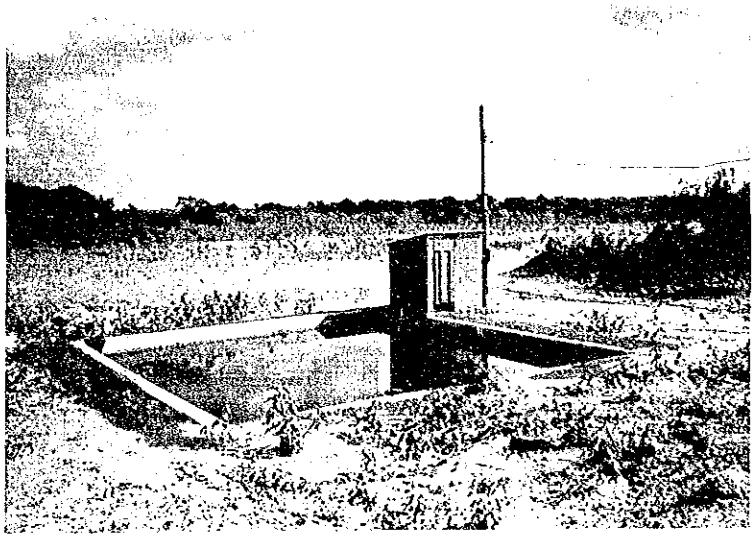
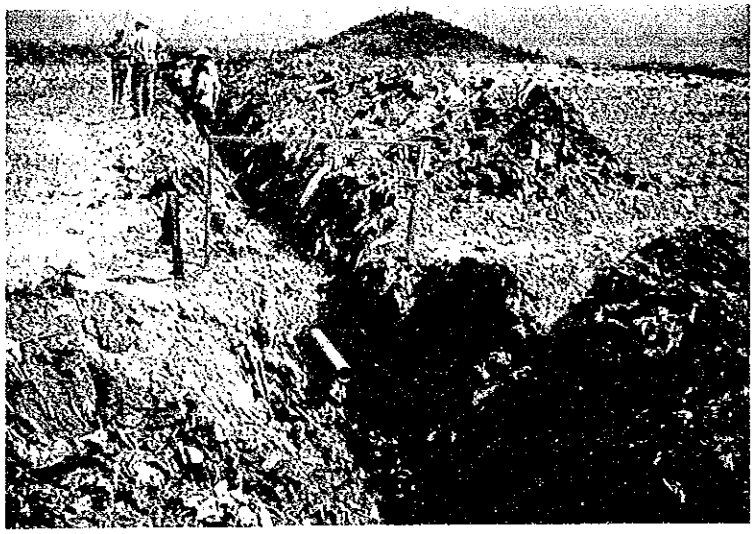
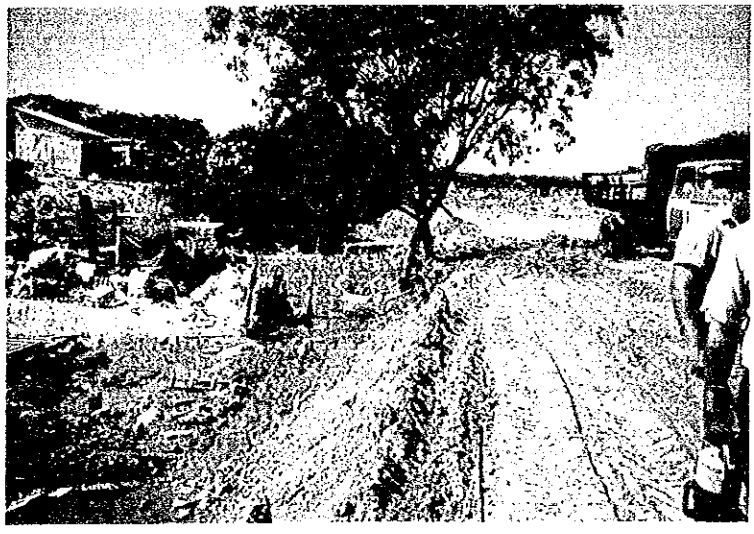
Plate 5: Joint Survey (2)



View of the leachate circulation pond

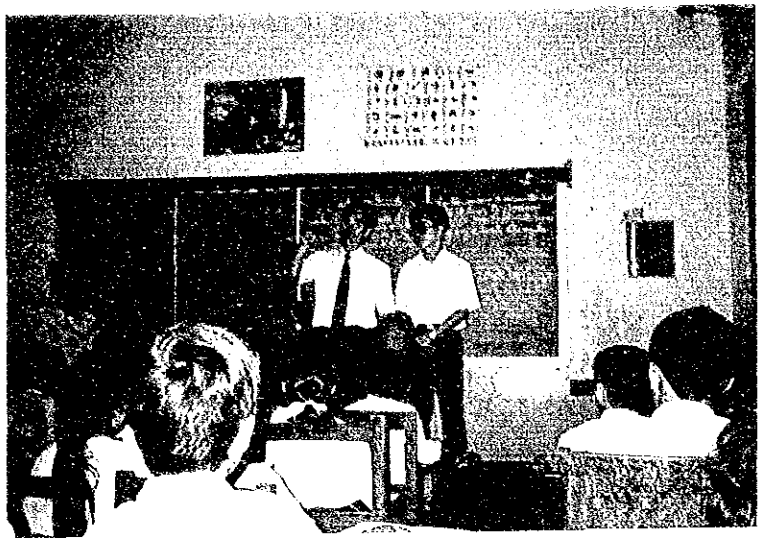


Installing horizontal gas removal facility

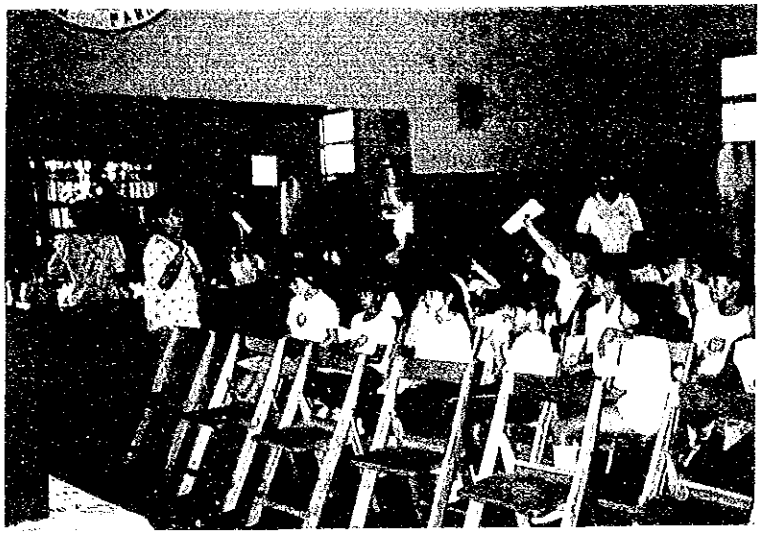


Constructing drain by banking soil to intercept sewage and rain water to the disposal area

Plate 6: Experiment of Sanitary Landfill Operation



Lecture on solid waste given to the primary school students by the Study Team



Lecture on solid waste given by SENASA staff

Pupils are watching solid waste educational video made by the Study Team

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for
Metroplitan Area of Asuncion

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ABBREVIATIONS

ORGANIZATIONS

AMUAM	Association of Municipalities of the Metropolitan Area
CORPOSANA	Corporation for Sanitary Work
IDB	Inter-American Development Bank
IDM	Institute of Municipal Development
JICA	Japan International Cooperation Agency
MEC	Ministry of Education
MIC	Ministry of Industry & Trade
MOPC	Ministry of Public Works and Communication
MSPBS	Ministry of Public Health and Social Welfare
OECF	Overseas Economic Cooperation Fund
SENASA	National Service of Environmental Sanitation
STP	Technical Planning Secretariat

REPORT and STUDY

AML	Madame Lynch Avenue
ASG	Apparent Specific Gravity
CRF	Capital Recovery Factor
CV	Calorific Value
DF/R	Draft Final Report
F/R	Final Report
HCV	Higher Calorific Value
HUM	Highly Urbanized Municipalities
IC/R	Inception Report
ISW	Industrial Solid Waste
ISWM	Industrial Solid Waste Management
IT/R	Interim Report
LCV	Lower Calorific Value
LUM	Less Urbanized Municipalities
MAA	Metropolitan Area of Asuncion
M/M	Minutes of Meeting
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
N.A.	Not Available
O & M	Operation and Maintenance
PR/R	Progress Report
SCF	Standard Conversion Factor
S/W	Scope of Work

SWM	Solid Waste Management
UM	Urbanized Municipalities
VC	Vinas Cue
WACS	Waste Amount and Composition Survey

SOCIO-ECONOMY

EIRR	Economic Internal Rate of Return
FIRR	Financial Rate of Return
GDP	Gross Domestic Product
GNP	Gross National Product
GRDP	Gross Regional Domestic Product
US$	U.S.dollar
Gs	Guaranis
p.a.	per annum
mill.	million
bill.	billion

UNIT

mm	millimeter
cm	centimeter
m	meter
km	kilometer
m^2	square meter
km^2	square kilometer
ha	hectare
m^3	cubic meter
mg	milligram
lit.	litre
kg	kilogram
ton	ton
sec.	second
min.	minutes
hr	hour
d	day
%	percent
no.	number
nos.	numbers
kw	kilowatt
kj	kilojoule
kcal	kilocalorie

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

This chapter describes the outline of the Study, i.e. background, objective, policy, key assumptions, work process and organization of the study. The readers may understand the general feature of the study by the chapter.

1.1 Background

The rapid pace of the socio-economic development in Paraguay has brought about an increasing complexity in the generation of solid waste. Solid waste collection and disposal has become a social and public health problem of great magnitude. The Paraguayan Government is firm in its policy of maintaining clean urban centers, and its importance is stressed in the National Economic and Social Development Plan prepared by STP (Technical Planning Secretariat). However, due to limited resources for municipal solid waste management (MSWM) of Local Authorities nationwide, the policy of maintaining clean urban centers has not yet been realized.

The 1992 population of the metropolitan area, composed of municipalities of Asuncion, F.Mora, Lambare, San Lorenzo, Capiata, Luque, M.R.Alonso, Villa Elisa, Nemby, J.A.Saldivar, Ita, Aregua, Limpio, Villa Hayes and B.Aceval, was approximately 1,164,000 inhabitants, representing 20% of the country's total population and 65% of the urban population of Paraguay. As in the case of many cities with large populations, the management of solid waste in the metropolitan area has become a critical problem. For example:

- A portion of the waste is not routinely collected.
- Enforcement of regulation concerning solid waste is inadequate.
- Collection routine is inefficient.
- Collection vehicle fleet is old and subject to breakdowns.
- Environmental conditions of present disposal sites contribute to health problems.
- The institutional and administrative structure is not well established and not suited for the required cleansing services.
- Finance and auditing procedures are in need of revision.
- Public education system and participation programs are not developed.

To overcome the above problems and to improve the situation in a systematic manner, the preparation of an MSWM Master Plan for the metropolitan area is a

very effective approach, technically as well as financially. However, this approach has not been practiced in the metropolitan area and not a single MSWM Plan has been prepared in the country.

It is with the above objective and consideration that the National Service of Environmental Sanitation (SENASA) in cooperation with the Asuncion Municipal Government and the other 14 municipalities in the Metropolitan Area wished to carry out the "Solid Waste Management Study in the Metropolitan Area".

In response to the request of the Government of Paraguay, the Government of Japan decided to conduct the Study on the SWM for the Metropolitan Area of Asuncion in accordance with the relevant laws and regulations in force in Japan. Accordingly, the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, undertook the Study in close cooperation with the concerned authorities of the Government of Paraguay. Kokusai Kogyo Co., Ltd. was the consultant selected by JICA to carry out the Study.

1.2 Scope of the Study

a. Objective of the Study

The objectives of the Study are:

- to formulate a master plan for the improvement of the Solid Waste Management of the Asuncion Metropolitan Area up to the target year of 2006; and
- to conduct a feasibility study for the First Priority Project based on the master plan.

b. Study Area

The study area was the whole area under the jurisdiction of the Metropolitan Area of Asuncion, and was limited to the urbanized areas of the municipalities. This Study area is shown in Figure 1.2a.

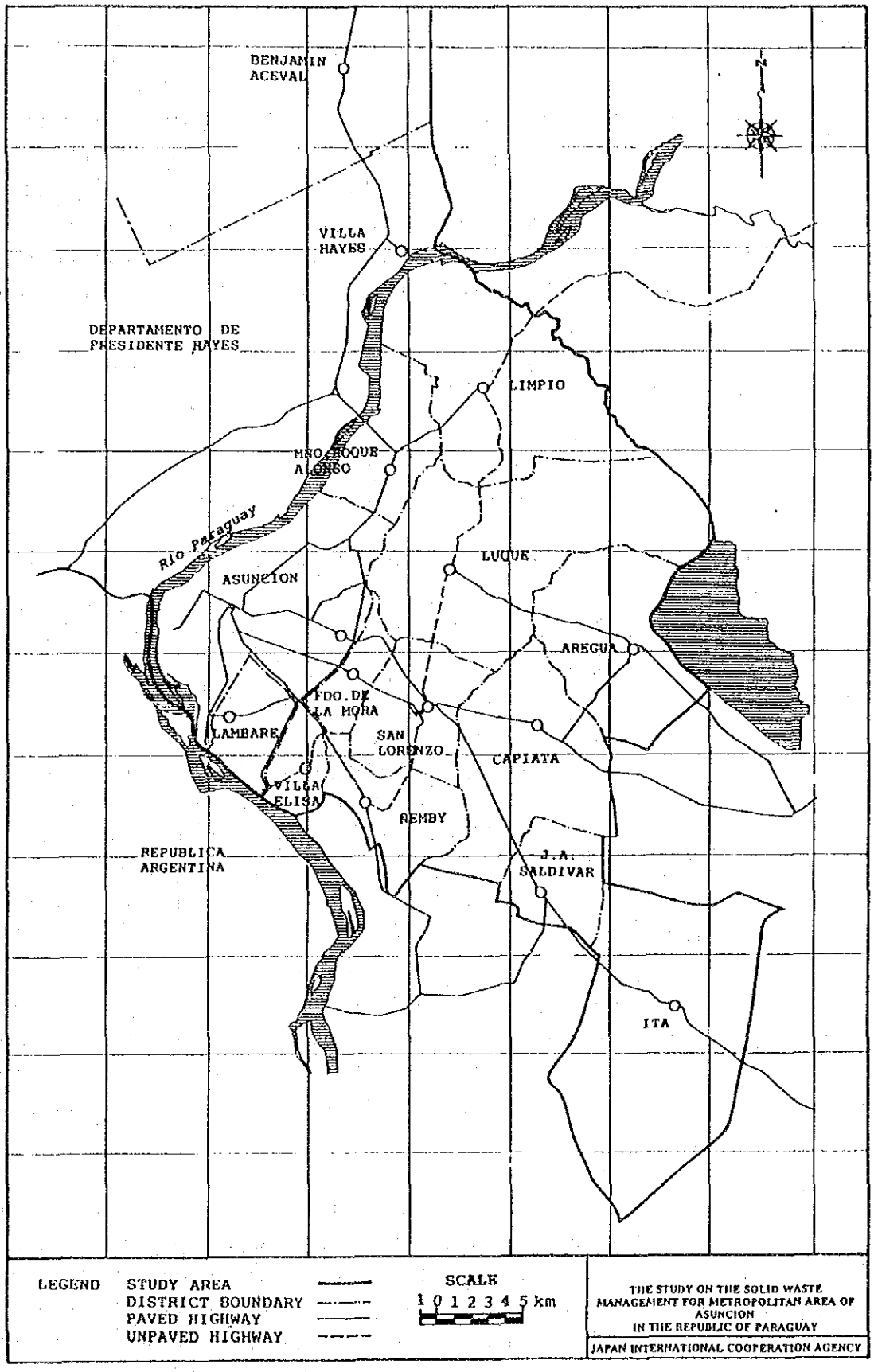

Figure 1.2a Study Area

c. Study Wastes

The wastes studied were household waste, market waste, commercial waste, street sweeping waste and institutional waste. As for the medical and industrial solid wastes, a quick diagnosis study was carried out based on the existing information and data resulting in the proposal of general recommendations for the improvement of medical and industrial solid waste management in the Metropolitan Area. Agricultural waste and animal husbandry waste were excluded from the study.

1.3 Policy of the Study

a. Utilization of Local Consultants

The eminent characteristics of an MSWM study are:

- The study has to be carried out during the time when the existing MSWM system is operating.
- The essence of MSWM is the prompt removal and appropriate processing/disposal of generated waste. An appropriate MSWM system cannot be established without the mutual cooperation of the public and administration. In this context, a proper understanding of the social and cultural background of the study area is essential in the preparation of an MSWM plan.
- The MSWM is directly related to the daily life of the people. The proposed plan would not be sufficient and workable only with the careful consideration of the intention of the administrators and officers concerned in MSWM. It should also take the opinion of the citizen into consideration.
- In order to formulate an MSWM master plan, it is indispensable to understand educational backgrounds of people in the area, their ways of thinking, customs and their daily life in addition to the present MSWM technical and institutional system, and the natural and socio-economic conditions of the Study area.

Considering the above-mentioned eminent characteristics of an MSWM study, it was very important to pursue technology transfer to not only Paraguayan counterpart personnel but also local consultants in the course of the Study. Especially, the works which need to be done continuously even after the Study should be conducted by the local consultants under the supervision of the Study Team; i.e. WACS, environmental impact studies of SWM facilities, development of an operation manual of a truck scale, etc.. Therefore, Paraguayan consultants and professionals

were utilized to successfully conduct the Study within a limited period and to make a master plan compatible with local conditions.

b. Joint Study

With the above-mentioned reasons, the Study Team proposed the joint implementation of the Study and asked cooperation and active participation of the Paraguayan side, specially regarding the following works:

- public opinion survey;
- survey on private contractors of waste collection and disposal;
- study on waste amount and composition;
- compost market survey;
- survey on scavengers;
- survey on recycling system and market for reusable materials;
- questionnaire survey on the present MSWM in the 15 municipalities in the Metropolitan area;
- survey on the industrial and medical wastes management including questionnaire survey;
- execution of a pilot project, i.e. experiment on sanitary landfill operation;
- intensive education campaign for the people in conjunction with the pilot project;
- construction of a truck scale foundation and an inspection building at the present Cateura disposal site;
- organization and institution planning;
- financial planning; and
- prompt decision making regarding the selection of the sites for primary facilities, level of the collection fees and other important matters which require the decision of the Paraguayan side.

c. Workable Plan and Appropriate Technology

Upon careful consideration of the characteristics of an MSWM study, the Study Team formulated the most workable and implementable MSWM plan for the Metropolitan Area in close cooperation with the Paraguayan counterparts. The MSWM plan, therefore, included immediate, short and middle term improvement plans. Furthermore, in the light of the financial limitation of the Metropolitan Area, the Study Team developed the most appropriate technology for both technical and institutional systems for MSWM in the area. The study and the plan were

formulated ,specially, to present and support a self-sustainable MSWM for the Metropolitan Area.

1.4 Key Assumptions

Key assumptions used in this study area are as follows:

a. Socio-economic Conditions

Items	Unit	Descriptions
1. Population - Projected Urban Population of the Whole Study Area - Annual Growth Rate	 persons %	 1992 2000 2006 1,163,595 1,537,600 1,940,700 3.72%/year
2. Economy - GDP	bill.USD	4.95 in 2000 6.06 in 2006
- Annual Increase Rate of GDP in Real Term	%	1994 - 2006 3.5%
- Future Budget Scale of the 15 Municipalities		The budget in 1994 will increase in accordance with GDP increase rate in real term.
- Income Level of the Citizens		The income will increase according to the GDP increase rate in real term/population growth rate.
- Currency Exchange Rate		1 USD = 1,880.50 Gs = 106.41 Yen
- Inflation Rate	%	20 %in 1994 20 % 1995 - 2000 and 15% 2001 - 2006 for the economic and financial analysis of the Study

b. Waste Amount and Composition

Items	Unit	1994	2000	2006
1. Waste Amount				
1-1 Waste Generation Ratio				
- MSW	g/person/day			
Household	g/shop/day	961	1,020	1,083
Shop	g/shop/day	3,186	3,382	3,590
Restaurant	g/shop/day	31,958	33,924	36,011
Market	g/shop/day	5,961	6,328	6,717
Institutional	g/employee/day	78	83	88
Street Sweeping:-				
. For the 14 other Municipalities	g/km/day	39,950	39,950	39,950
. For Asuncion	g/km/day	(254,700)	(254,700)	(254,700)
Hospital	g/bed/day	4,000	4,246	4,507
Bulky	g/person/day	0.6	0.6	0.7
- Other Wastes	g/person/day	30	32	34
1-2 Collection Ratio of Household Waste	%	As shown in Table 7.1.1a.		
1-3 Annual Increase Rate of Waste Generation		The population increase plus 1 % for waste generation increase per capita.		
2. Waste Composition				
2-1 Forecast for Waste Composition		1994	2000	2006
Combustibles		**72.8**	**75**	**79**
Kitchen waste		37.4	36	34
Paper		10.2	18	24
Textile		1.2	2	3
Plastic		4.2	5	7
Grass and Wood		19.2	13	10
Leather and Rubber		0.6	1	1
Non-Combustibles		**27.2**	**25**	**21**
Metal		1.3	2	3
Glass		3.5	5	5
Ceramic and Stone		2.5	2	2
Others (Soil, etc.)		19.9	16	11
- Total		100.0	100.0	100.0
2-2 Lower Calorific Value				
- (MSW excluding Street Sweeping and Bulky Wastes)	kcal/kg	1994	2004	2006
		1,192	1,452	1,967

c. Life Span of Equipment and Facilities

	Life Span (years)	Salvage value (%)
Container	5	0
Truck and Heavy Equipment	7	10
Machinery	15	0
Building and Civil Works	30	0

Note: The life span of other facilities for the disposal site depends on the period of its operation.

d. Executing Bodies for Technical Systems of MSWM

Items / Projects	Fund Raising and Repayment	Construction and Procurement	Operation
1. Collection			
Asuncion	Asuncion	Asuncion	Asuncion
Other 14 Municipalities	AMUAM	AMUAM	14 Municipalities
2. Street Sweeping			
Asuncion	Asuncion	Asuncion	Asuncion
Other 14 Municipalities	AMUAM	AMUAM	14 Municipalities
3. Maintenance of 1 and 2			
Asuncion	Asuncion	Asuncion	Asuncion
Other 14 Municipalities	AMUAM	AMUAM	AMUAM
4. Transfer Station			
Asuncion and F. Mora	AMUAM	AMUAM	AMUAM
Other 13 Municipalities	None	None	None
5. Final Disposal			
Chaco-i	AMUAM	AMUAM	AMUAM
Unidentified Inter-municipal	AMUAM	AMUAM	AMUAM
6. Maintenance of 4 and 5	AMUAM	AMUAM	AMUAM

e. Revenue and Expenditure for Financial Analysis

Items / Organizations	Revenue	Expenditure
1. AMUAM		
Collection	Rental Fee (Gs/ton)	Depreciation and Maintenance of Vehicles
Street Sweeping	Rental Fee (Gs/ton)	Depreciation and Maintenance of Vehicles
Transfer Operation	Tipping Fee (Gs/ton)	Depreciation and O&M of Facilities, Vehicles and Equipment
Final Disposal	Tipping Fee (Gs/ton)	Depreciation and O&M of Facilities, Vehicles and Equipment
2. Asuncion		
Collection	Collection Fee (Gs/month)	Depreciation and O&M of Vehicles
Street Sweeping	Collection Fee (Gs/month)	Depreciation and O&M of Vehicles
Transfer Operation	Collection Fee (Gs/month)	Tipping Fee
Final Disposal	Collection Fee (Gs/month)	Tipping Fee
3. Other 14 Municipalities		
Collection	Collection Fee (Gs/month)	Rental Fee of Vehicles and O&M
Street Sweeping	Collection Fee (Gs/month)	Rental Fee of Vehicles and O&M
Transfer Operation	Collection Fee (Gs/month)	Tipping Fee
Final Disposal	Collection Fee (Gs/month)	Tipping Fee

Note: 1. Asuncion Municipality will procure vehicles and equipment necessary for collection and street sweeping services and maintenance for them.
2. Tipping fee for disposal at the Chaco-i and unidentified landfill differs from each other.

f. Loan Conditions

	Repayment Schedule and Interest Rate in Real Term
- Long Term Loans	Repayment over 10 years with a 3 years grace period, 7.5% (12.5%)
- Short Term Loans	Repayment in the Following Years, 13.5% (18.5%)

1.5 Work Processes of the Study

The study commenced in June 1993 based on the Scope of Work (Appendix 1) signed between the Paraguayan Government and JICA in January 1993, and will end in August 1994.

The study consisted of the following two phases;

Phase 1 : Formulation of a Master Plan
Phase 2 : Feasibility Study on the First Priority Project

The work processes of the study are described below.

a. Phase 1 : Formulation of a Master Plan (June - December, 1993)

aa. 1st Study Work in Paraguay (June - October, 1993)

1) Submission and Discussion of Inception Report
2) Data Collection and Analysis
3) Field Survey of Present Status of MSWM
4) Installation and Operation of Truck Scale
5) Survey of Waste Amount and Composition (Winter)
6) Localization of Final Disposal Sites
7) Topographic and Soil Investigation of Cateura Landfill Site
8) Environmental Survey
9) Public Opinion Survey on MSWM
10) Study on Improvement Measures for Existing Landfill Sites
11) Forecast of Future Waste Amount and Composition
12) Study on Inter-Municipal Cooperation
13) Preliminary Examination of the Master Plan
14) Preparation of Sanitary Landfill Experiment
15) Preparation and Submission of Progress Report (1)

ab. 1st Study Work in Japan (October - December, 1993)

1) Analysis of Data Collected
2) Compilation of 1st Study Work Results in Paraguay
3) Establishment of Goals and Targets of Master Plan
4) Examination of Technical System Alternatives and Selection of an Optimum Alternative
5) Formulation of Draft Master Plan
6) Selection of the First Priority Project
7) Compilation of Interim Report

ac. 2nd Study Work in Paraguay (December, 1993)

1) Submission and Discussion of Interim Report

b. Phase 2: Feasibility Study of the First Priority Project (January – August, 1994)

ba. 3rd Study Work in Paraguay (January – March, 1994)

1) Supplementary Data Collection and Analysis
2) Survey of Waste Amount and Composition (Summer)
3) Detailed Survey of Proposed Landfill Site(s)
4) Environmental Survey for Proposed Landfill Site(s)
5) Implementation of Sanitary Landfill Experiment
6) Investigation on the First Priority Project
7) Planning of MSWM Seminar
8) Submission and Discussion of Progress Report (2)

bb. 2nd Study Work in Japan (March – May, 1994)

1) Arrangement and Analysis of Field Survey Data
2) Compilation of 3rd Study Work Results in Paraguay
3) Revision of the Draft Master Plan
4) Determination of Design Conditions for F/S
5) Preliminary Design of Primary Facilities
6) Equipment Plan
7) Organizational and Institutional Development Plan
8) Operation and Maintenance Plan
9) Estimation of Project Cost
10) Public Education Program
11) Project Evaluation
12) Implementation Plan
13) Compilation of Draft Final Report

bc. 4th Study Work in Paraguay (May – June, 1994)

1) Submission and Discussion of Draft Final Report
2) MSWM Seminar

bd. 3rd Study Work in Japan (June – July, 1994)

1) Compilation of Final Report

be. Submission of Final Report (August, 1994)

1.6 Study Organization

The Study organization and list of members are attached as Appendix 2. The study was supervised by the Supervisory Committee of the Paraguayan side and the Advisory Committee of the Japanese side.

CHAPTER 2

PROFILE OF THE STUDY AREA

CHAPTER 2 PROFILE OF THE STUDY AREA

This chapter describes the present background conditions, such as natural conditions, urban structure, social conditions, population and economic conditions related to the Study.

2.1 Definition of the Study Area

The study area covers an area under the jurisdiction of the members of the AMUAM (Association of Municipalities of the Metropolitan Area) except for San Antonio and Ypane municipalities, and is limited only to the urbanized areas of the 15 municipalities.

The 15 municipalities in the Study Area are classified into the following three categories, as shown in Figure 2.1a.

a. HUM (Highly Urbanized Municipalities):
   2 Municipalities; Asuncion and Fernando de la Mora.

b. UM (Urbanized Municipalities):
   6 Municipalities; Lambare, San Lorenzo, Capiata, Luque, M.R. Alonso and Villa Elisa.

c. LUM (Less Urbanized Municipalities):
   7 Municipalities; Nemby, J.A. Saldivar, Ita, Aregua, Limpio, Villa Hayes and Benjamin Aceval.

In this study, the formulation of a MSWM master plan was conducted in accordance with the above mentioned categories. As such the WACS (Waste Amount and Composition Survey) and POS (Public Opinion Survey) were carried out by selecting one sample municipality from each category, in order to obtain basic data for planning. Consequently, the forecast of future waste amount and composition is based on the data obtained from each category.

In relation to MSWM, the characteristics of the above-mentioned 3 categories of municipalities are summarized as follows:

a. Highly Urbanized Municipalities

Almost all area under the jurisdiction of the municipalities are urbanized. As such, it seems to be impossible to find a future landfill within the jurisdiction of the municipalities. Due to high urbanization, the present collection ratio is high.

b. Urbanized Municipalities

This category of municipalities has a densely populated area within their jurisdiction. However, it is possible to find a future landfill within the jurisdiction of each municipality; the present collection ratio is relatively high.

c. Less Urbanized Municipalities

Even the urbanized areas of these municipalities are not densely populated and it seems straight forward to find future landfills within their areas. As such, the present collection ratio is low and final disposal is less of a problem.

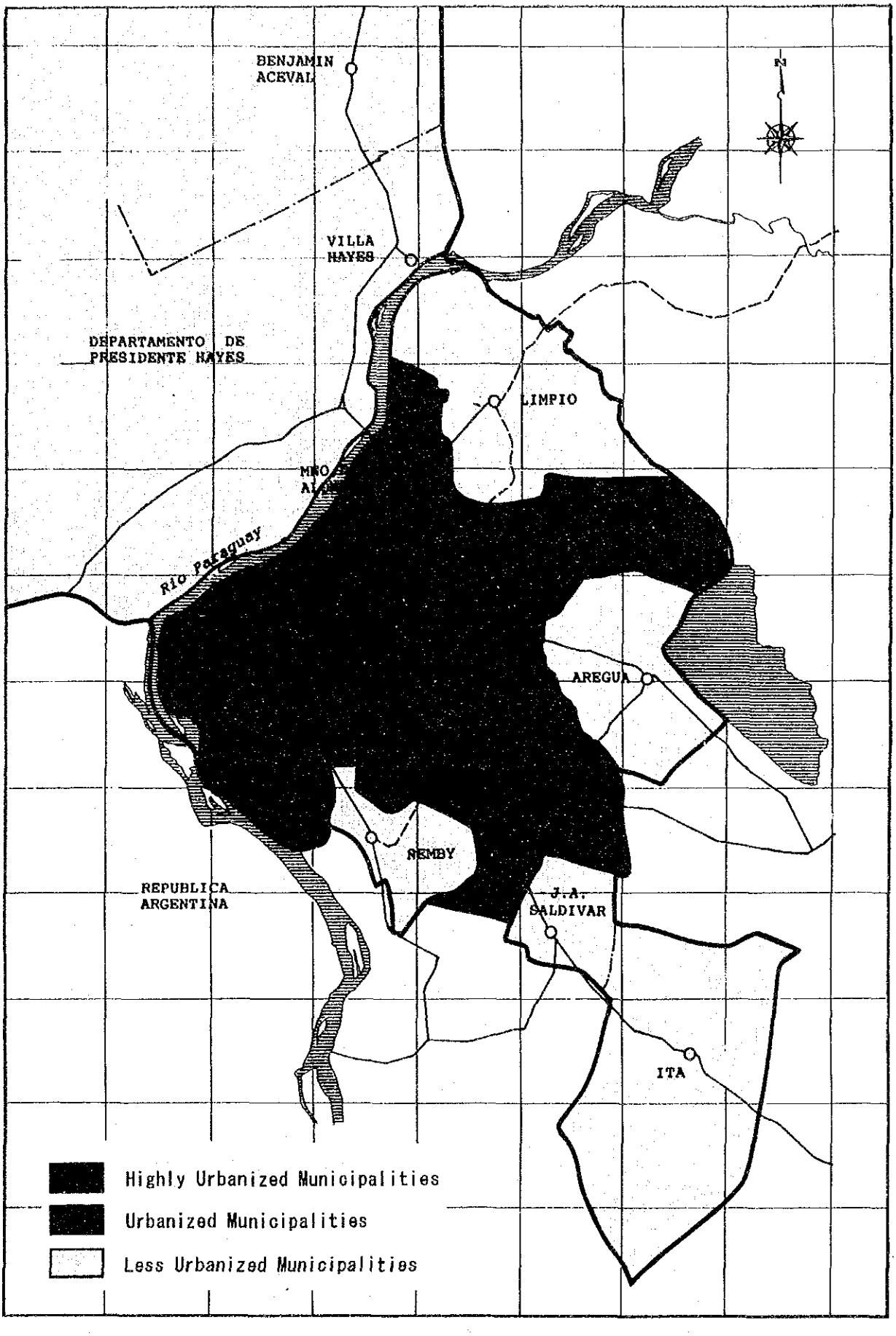

Figure 2.1a Classification of Municipalities in the Study Area

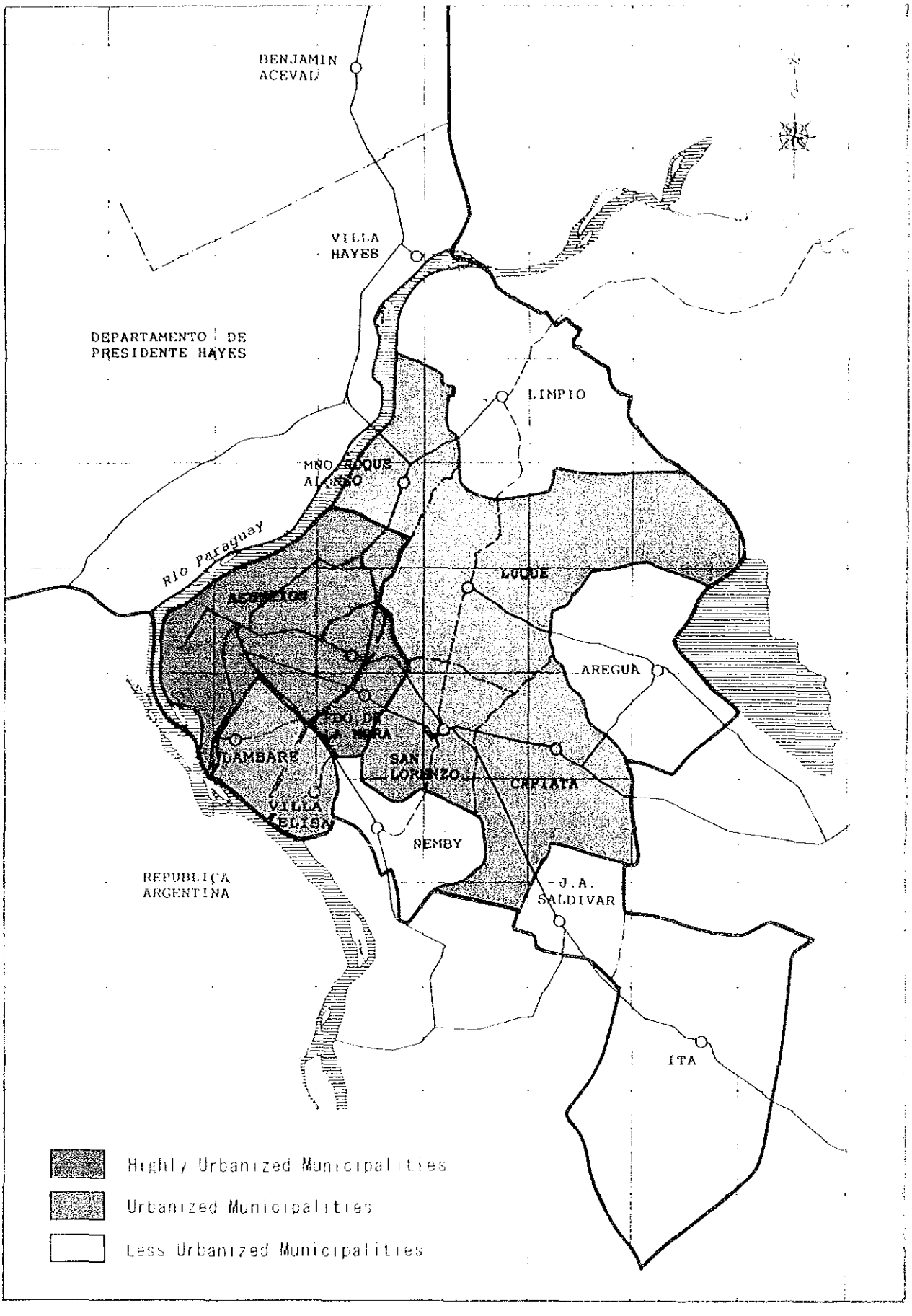

Figure 2.1a Classification of Municipalities in the Study Area

2.2 Natural Conditions

2.2.1 Location and Area

The area of Paraguay is 406,752 km^2 and the population is 4,519,327 (in 1992), with 98 % living on the east side of the Paraguay River (39 % of total area).

There is a big difference in the natural environment between the east and the west of the Paraguay River, which runs through the center of the country from north to south. This greatly affects the distribution of the population and their production activities.

Of the 15 municipalities in the Study Area, 13 including Asuncion are located on the east side bank near the confluence of the Paraguay River and the Pilcomayo River and its topography is generally flat. The total area is approximately 1,605 km^2 and population is approximately 1.28 million. The urban population and area, which is the target of the Study, are 1.16 million in 1992 and 530 km^2 respectively.

2.2.2 Climate

Paraguay is located in the sub-tropical zone and its climate is characterized by its drastic changes.

The average annual temperature is 22.5 °C. At its hottest, the average monthly temperature is 27.5 °C in January, and the coldest is 16.8 °C in July, and the difference is 10.7 °C.

The average annual precipitation is 1,356.3 mm. The yearly fluctuation of precipitation in summer is bigger than winter. The precipitation in April is the most, covering 15 % of the total yearly precipitation.

Table 2.2.2a Climate Data of Asuncion

Month	Air Temperature			Humidity	Rainfall	Wind	
	Avg	Max	Min			Speed	Direction
	°C			%	mm/month	m/s	G
Jan	27.5	33.5	22.8	71.0	143.3	1.9	South
Feb	26.5	32.5	22.1	74.0	135.7	2.2	U
Mar	25.8	31.6	21.4	75.0	123.3	1.4	U
Apr	22.7	28.1	18.9	80.0	213.5	2.2	East
May	19.5	24.5	15.8	80.0	115.1	2.8	East
Jun	17.5	22.6	13.5	78.0	68.9	3.3	N.East
Jul	16.8	22.4	12.6	74.0	49.6	2.8	South
Aug	18.5	24.2	14.1	71.0	71.3	2.5	South
Sep	20.0	25.9	15.5	69.0	95.3	2.2	South
Oct	23.3	29.2	18.6	69.0	110.2	2.8	South
Nov	25.3	31.2	20.4	68.0	90.1	2.8	South
Dec	26.7	32.7	21.8	69.0	140.0	1.9	S & U
Annual	22.5	28.2	18.1	73.2	1,356.3	2.4	

Note: U stands for unobtainable as the wind is calm and no specific direction can be determined.
For December both southerly and calm winds occurred in the same proportion.

2.3 Social Conditions

2.3.1 Administration

The country is administratively divided into 19 Departments, and more than 500 municipalities. The Departmental division did not exist until recently, and only now the Departments are being implemented by the first time elected "Governors". Governmental actions and powers are thus, basically, exercised by the National and Municipal governments.

Each municipality has its own autonomous administration, headed by an elected mayor serving a 5 year term, this mayor being controlled and supervised by a Municipal Council whose members are also elected by the citizens for the same period of time.

Some municipalities are strong and well organized, like the Asuncion municipality, with a budget of over US$25,000,000.00 (twenty five million) while others are very poor, comprising no more than 3 (three) permanent employees and a budget of less than US$25,000.00 (twenty five thousand) a year.

2.3.2 Customs and Religion

Predominantly an european-guarani population; it's cultural patterns are highly influenced by western lifestyle, from the guarani culture only a few vestiges remain, the most important being the guarani language, which is spoken by almost all the population. Together with spanish they are the official languages of the country.

The country is officially Roman Catholic, with more than 90% of the population professing it.

2.3.3 Public Health

The Public Health status of the country as a whole, reflects the situation of an average developing country. This situation is derived from a deficiency of environmental sanitation, a lack of sanitary education and a poor health services system, aggravated by the very low income of a significant part of the population.

Here are some health status indicators:

.	Average life expectancy:	66.9 years
.	Medical doctor availability :	1/1800 inhabitants
.	Average daily protein consumption:	78.6/g/person
.	Average daily energy intake:	2,873/kcal/person/day

2.3.4 Sanitation and the Environment - Policies, Legislation, Enforcement and Activities

a. Policies and Legislation

Sanitation and environmental protection policies and legislation are set by the National Government through the Ministries of Social Welfare and Public Health and the Ministry of Agriculture and Livestock, and by the National Congress. The "green side" of the environment is cared by the Undersecretary of National Resources and the Environment, an agency of the Ministry of the Interior.

Municipalities also have a role in sanitation and environmental protection, since the

" Municipal Organic Law" awards them the right to legislate on matters like water supply, sewerage, recreational waters and control of industrial activities considered to be unhealthy, dangerous or improper in respect to public health. These rights however, have been very rarely practiced by the municipalities so far.

b. Enforcement and Activities

Corresponding enforcement of legislation and actions are taken by different institutions belonging to the National Government. The most important institutions regarding sanitation are CORPOSANA – The National Sanitation Works Corporation (Corporación de Obras Sanitárias de Nacion), tied directly to the Ministry of the Interior and the SENASA – National Service of Environmental Sanitation (Servicio Nacional de Saneamiento Ambiental), belonging to the structure of the Social Welfare and Public Health Ministry.

CORPOSANA is responsible for water supply and sewerage to cities over 4,000 inhabitants, and SENASA takes care of the remaining smaller cities. Besides providing water, SENASA is also in charge of general sanitation and environmental control services for cities, regardless of their size.
On average, the public systems' coverage of potable water supply is 48.3% of all the urban population of the country, reaching 70% if we consider only Asuncion and the Lambare cities.

Concerning sewerage, only six cities in the country have this waste water collection and disposal system, three of them in the study area, Asuncion, Luque and San Lorenzo.

Environmental impacts due to economic development projects are found only in the case of the building of hydroelectrical dams, as in the case of the Itaipu and Yacireta dams.

The municipal role on sanitation and environmental matters, so far, is limited to provision of public health centers, solid waste management, parks and gardens management and to public spaces disinfection, restaurants and food dispensers control and care about some zoonosis, like canine rabies.

2.3.5 Employment

In Paraguay the total unemployment, affecting the economically active population was 8.7 % in 1992.

It should also be stressed, that the age group most affected by the lack of jobs are the young (16.1% for 15 to 19 years old), and besides the unemployment there is also an underemployment problem. This phenomena derives from the fact that Paraguay has a very homogenous economy, relying heavily on the agricultural sectors to generate employment.

Concerning income distribution, the Paraguayan situation is about the same as it's neighboring countries: the country shows a high concentration of personal income, where 10% of the wealthiest families receives 42% of all earnings, the poorest 10% earn only 1% of the national income.

2.4 Population

2.4.1 Present Population

The population of the Study area accounted for 1,292,423 in 1992 equivalent to 31.34 % of the country's total population (4.12 million), and during the 1982–1992 period, the population growth rate was 3.70 % per annum.

The population density in 1992 was estimated at an average of only 10.1 persons per square kilometer in the whole country and 805 persons per square kilometer in the Study Area (metropolitan area).

The population of the urban area (targeted population for the Study) within the Study Area rose from 403,925 in 1962 to 1,163,595 in 1992, increasing 1.42 times every ten years.

2.4.2 Household

According to the statistical data of the Direccion General de Estadisticas, Encuestas y Censos (DGEEC), Paraguay had about 868,284 households in 1992 with 4.7

persons per household on average. Urban area population, household and density in the Study Area are shown in Table 2.4.2a and the average number of persons in a household is 4.6.

Table 2.4.2a Urban Area Population, Household and Density (1992)

Items Municipalities	Urban Area (km^2) (*)	Urban population	Density (P/km^2)	Urban House-hold	Pers/Hhold
HUM					
1. Asuncion	117	502,426	4,294	111,972	4.487
2. F. Mora	20	95,349	4,767	20,884	4.566
Sub-Total	137	597,775	4,363	132,856	4.499
UM					
3. Lambare	24	99,990	4,166	21,022	4.756
4. San Lorenzo	44	133,405	3,032	28,955	4.607
5. Capiata	89	83,898	943	17,921	4.682
6. Luque	60	84,885	1,415	17,590	4.826
7. M.R Alonso	54	39,422	730	8,266	4.769
8. Villa Elisa	18	29,918	1,662	6,469	4.625
Sub-Total	289	471,518	1,632	100,223	4.705
LUM					
9. Nemby	42	27,234	648	5,894	4.621
10. J.A. Saldivar	4	2,016	504	440	4.582
11. Ita	20	14,275	714	3,071	4.648
12. Aregua	9	6,335	704	1,359	4.662
13. Limpio	20	26,396	1,320	5,796	4.554
14. Villa Hayes	3	11,843	3,948	4,823	2.456
15. Benj. Aceval	6	6,203	1,034	2,234	2.777
Sub-total	104	94,302	907	23,617	3.993
Total	530	1,163,595	2,195	256,696	4.533

Source : Direccion General de Estadisticas, Encuestas y Censos (DGEEC)

2.4.3 Population Forecast

The population projection was conducted based on the National Statistics Census data and the results of the field survey made by the Study Team as shown in Table 2.4.3a.

With a 3.66% growth rate, the population of the Study Area is expected to increase up to 2.17 million in 2006.

Table 2.4.3a Population Projections of the Study Area (1992 – 2006)

No.	Population Municipality	Population			Average Annual Growth Rate %
		1992	2002	2006	1992–2002
	Country	4,123,550	5,595,745	6,322,554	3.10
	HUM				
1	Asuncion	502,426	544,098	561,720	0.80
2	F. Mora	95,349	116,230	125,811	2.00
	Subtotal	597,775	660,328	687,531	1.00
	UM	**UM**	**UM**	UM	UM
3	Lambare	99,990	148,010	173,150	4.00
4	San Lorenzo	133,405	217,303	264,133	5.00
5	Capiata	83,898	150,249	189,685	6.00
6	Luque	116,304	208,283	262,952	6.00
7	M.R. Alonso	39,422	85,109	115,790	8.00
8	Villa Elisa	29,918	64,591	87,875	8.00
	Subtotal	502,937	873,543	1,093,586	5.68
	LUM				
9	Nemby	38,766	76,259	99,959	7.00
10	J.A.Saldivar	20,992	37,593	47,461	6.00
11	Ita	36,900	49,591	55,815	3.00
12	Aregua	24,900	44,592	56,297	6.00
13	Limpio	35,525	63,620	80,319	6.00
14	Villa Hayes	23,533	28,687	31,051	2.00
15	Benjamin Aceval	11,095	18,073	21,967	5.00
	Subtotal	191,711	318,414	392,869	5.20
	Total	1,292,423	1,852,285	2,173,985	3.66

Source: Projections made by the Study Team.
Projections for the period 2002–2006 were estimated using the 1992–2002 rates.

2.5 Urban Structure

2.5.1 Land Use

a. Regulations on Land Use

The Municipalities of the Metropolitan Area continue to grow randomly towards the outskirts, due to the lack of a Master Plan or General Guidelines concerning global policies on urban development for Asuncion and its Metropolitan Area. Therefore, only sectorial and priority problems on existing or on going situations were regulated within the urban guidelines.

In the Metropolitan Area of Asuncion, the Asuncion Urban Development Office and some vicinity municipalities (Lambare, M.R. Alonso, etc.) are making specific plans on urban development, however, it is considered difficult for municipalities in general, including the Municipality of Asuncion, to realize the plans, because of the manpower shortage and other related issues.

b. Present Land Use

The present land use map (1993) was prepared based on aerial photographs, cartographical maps, cadastral maps and field survey carried-out by the Study Team. This map is shown in Figure 2.5.1a.

The land area is classified into the following categories:

• Urban area:	340 km^2
• Industrial area:	3 km^2
• Cultivated area:	128 km^2
• Pasture area:	559 km^2
• Forest area:	255 km^2
• Others (low lands and vacant areas):	320 km^2
Total	1,605 km^2

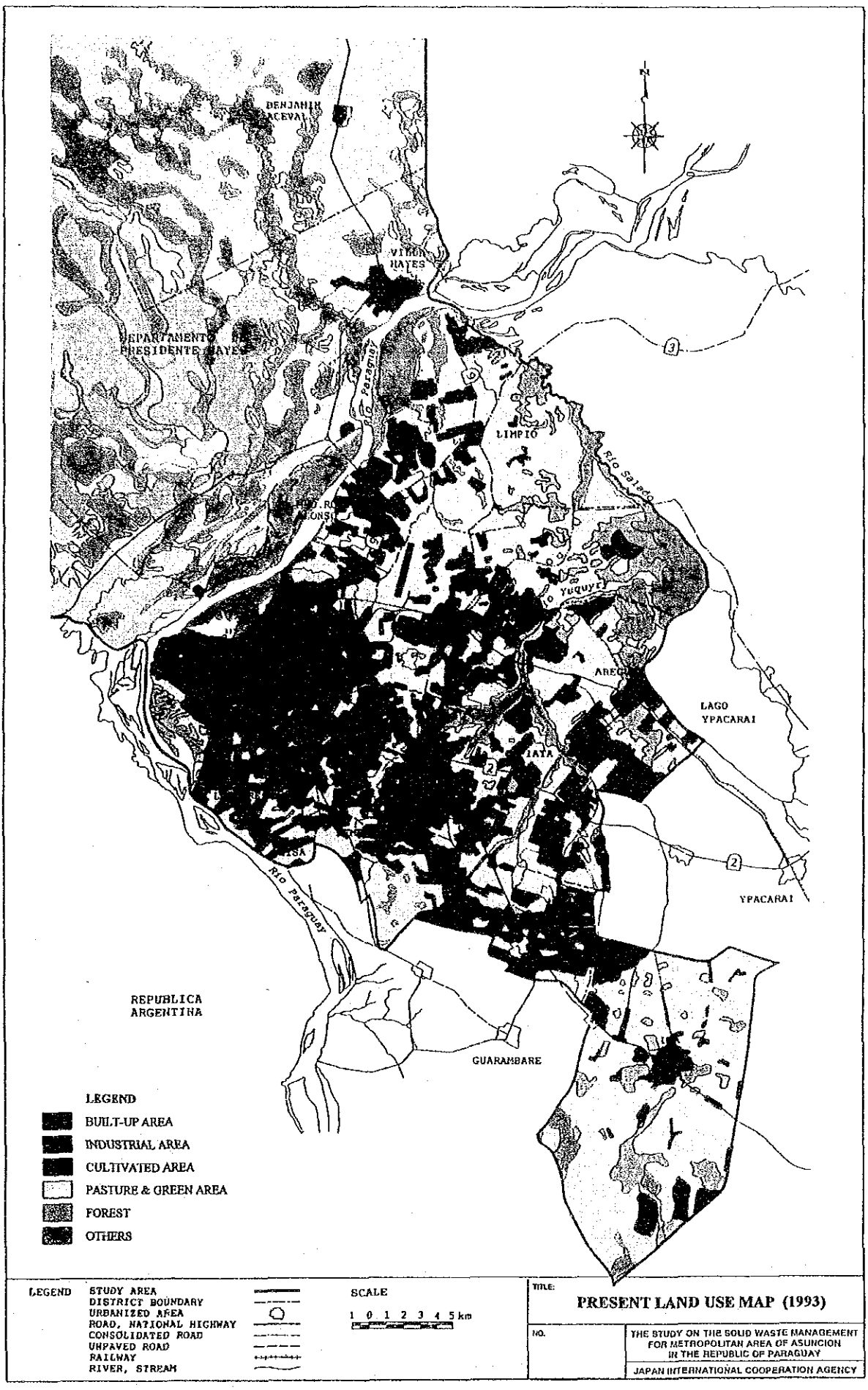

Figure 2.5.1a Present Land Use Map

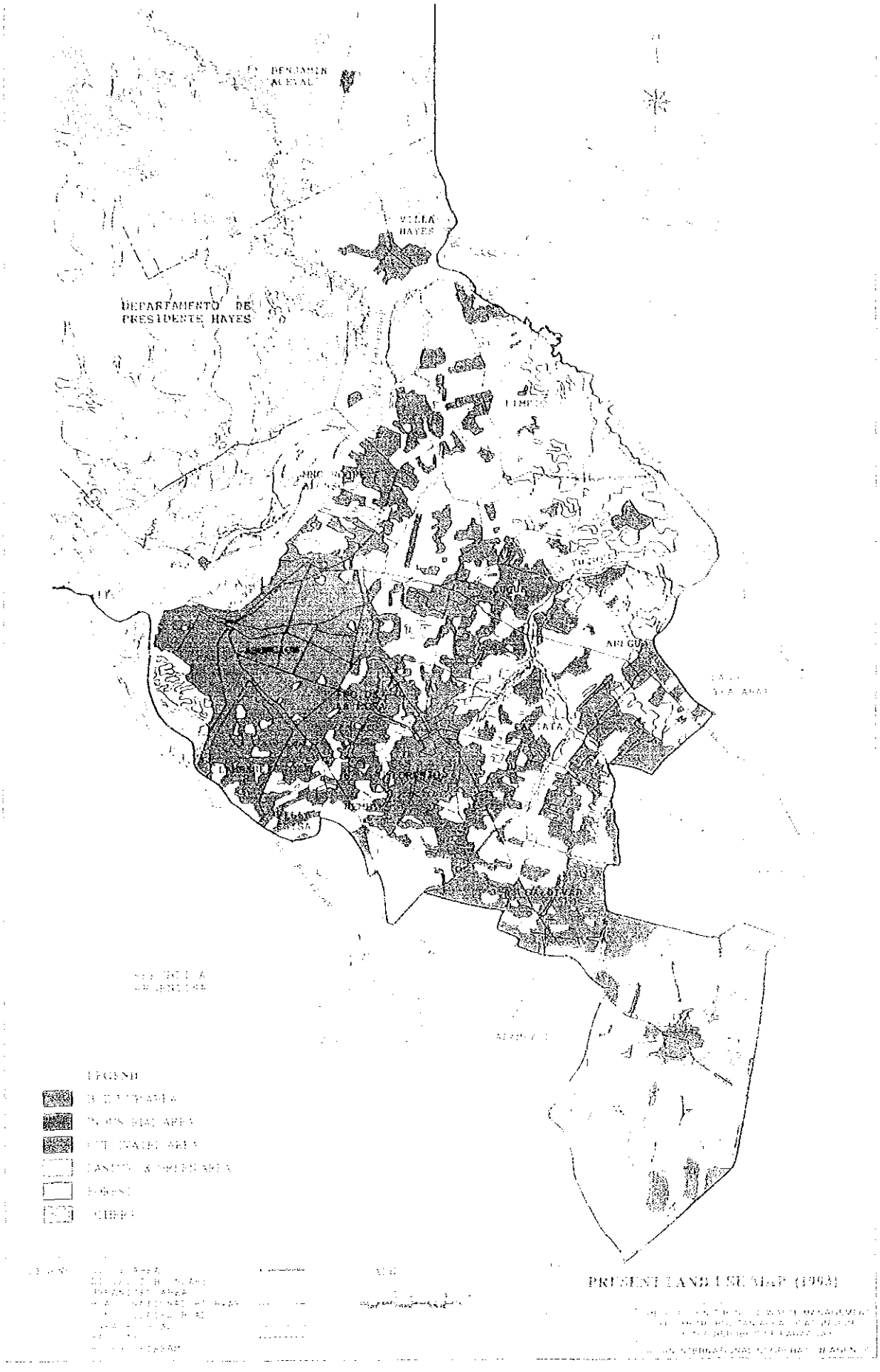

Figure 2.5.1a Present Land Use Map

c. Estimation of the Future Urban Land Use according the Trends

The future land use in the Highly Urbanized Municipalities may have no major changes from the present one. The only change could be the expansion of the commercial area toward the southeast.

The population growth in the Urbanized Municipality areas was influenced by the increase in the number of migrants from rural areas. Therefore, agricultural lands may be changed into urban areas to receive the future growth.

The future land use in the Less Urbanized Municipalities as in the HUM., may have no major changes, except its possible expansion toward the existing urban periphery.

2.5.2 Housing

Housing, according to the 1982 census (census of 1992 was not available), were mostly (96%) independent units, multi-family units such as apartments accounting for only around 4%. There are 4.6 persons per house on average, yielding 1.7 persons per room. The most frequent housing situation consists of 4 persons living in a two-room house in densely populated and in rural areas.

2.5.3 Infrastructure

a. Transportation

In the Study Area the major road network is as shown in Figure A.5.4a in Annex A. The major roads connecting Asuncion to different directions within the study area are :

- National road 1, to the southeast
- National road 2, to the east
- National road 9, to the north

At present, although the road transportation was intensified considerably, the river keeps its importance as commercial transportation and a way of communication.

Rail transport administered by the Ministry of Public Works and Communications,

is less consolidated than the road network, and the operation length of the Central Railway is 372 km.

b. Water Supply and Sewage System

CORPOSANA took responsibility over Asuncion, Fernando de la Mora, Lambare, San Lorenzo, Luque and M.R. Alonso. The rest of the municipalities are under the responsibility of SENASA, except Ita, which is supplied by private enterprises. The public water supply system serve about 55% of houses, while wells and springs are water sources for 45%.

The sewage system is partially served only in Asuncion, Lambare, San Lorenzo and Luque by CORPOSANA. The rest of the municipalities discharges its waste water into septic tank and absorbent wells. Only 15% of houses are connected to the public sewage system.

2.5.4 Urban Development Plan

The first study "Basis for the Implementation of the Development Plan in the Metropolitan Area of Asuncion (1981)" was conducted by the Municipality of Asuncion with the cooperation of the Interamerican Development Bank (BID). This study presents basic information on metropolitan area development, which constitute the first link for the arrangement and development of the metropolitan region.

In the second part of the study, "Project on Municipal Plan for Asuncion (1984)", basic guidelines were established for the development of Asuncion and its metropolitan area, and for specific sectoral projects.

A tentative master plan ("Development Guidelines for Asuncion and its Metropolitan Area") was prepared by the Municipality of Asuncion in 1985. The plan, however, was never made official because of the opinion differences of the government officials.

In the regulation plan (Decree No. 19/1993) established by the municipality of Asuncion, regulations and definitions are presented, however, no clear objectives and integrated city planning are formulated in the Plan.

Due to the lack of a basic urban development plan, Asuncion and its Metropolitan area have expanded randomly which creates various problems in the metropolitan area. In order to solve the problems a master plan for urban development in the area should be formulated to provide sufficient space to meet the population growth and the city expansion. Implementation of a master plan to guide the urbanization process, measures, land use, zoning building control, and subdivision control is urgently needed.

To achieve the objectives of the Master Plan, the following measures should be implemented:

- Standardization of plan contents that will encompass an integrated physical plan, including both social and economic elements;
- Establishment of planning standards and guidelines as references for analysis and planning;
- Specification of common premises for the formulation of goals and objectives;
- Even distribution of population for medium and long term periods according to the available area of urban open spaces and rural areas;
- Improving coordination among planners of different sectors and with those belonging to other agencies; and
- Establishment of a common city planning database.

2.6 Economic Conditions

2.6.1 National Economy

a. Past and present

The world recession in the early 1980s reduced the demand for Paraguayan exports, thereby exacerbating the weakening domestic economy resulting from the completion of the Itaipu dam. According to the World Bank, the Paraguayan economy during the 1980s grew at 1.6% annual rate, while the population grew at an estimated 3.2%, thereby indicating a decade with deteriorating living standards.

The minimal growth of the GDP observed was during the first three years of the 1990s, having grown 2.5% in 1991 and 1.8% in 1992.

According to the Central Bank of Paraguay, the consumer price index (CPI)

fluctuated between 21.8% and 31.7% during the 1985–89 period, it was 38.2% in 1990, 24.3% in 1991, and 15.1% in 1992. Unemployment during the past three years was 7.5% in 1990, 10.4% in 1991 and 8.7% in 1992. The national income per capita was estimated at US$1,219 in 1992.

b. Future Perspective

A new President and his Cabinet made public a policy to reactivate the stagnant economy. The policy includes a diversity of measures which are expected to achieve a 3.5% growth of GDP in 1994. Thereafter, the economy is expected to keep growing at a satisfactory rate in a self–sustained manner.

2.6.2 Regional Economy

The MAA accounts for around one–third, or slightly over half a million, of the economically active population (EAP) of the country.

Unemployment declined from 6.6% in 1990 to 5.1% in 1991. Underemployment also declined from 15.4% in 1990 to 9.5% in 1991.

However, the overall employment figures for 1990 and 1991 indicate worsening economic conditions nationwide and the high proportion of unskilled and self–employed workers is very disturbing. Contrariwise, main employments which are heavily concentrated in the MAA are in services, commerce, manufacturing, construction, finance and transportation concludes that economic conditions in the MAA are better than the rest of the country.

2.6.3 Income Levels

The MAA is the most urbanized area of the country with a high concentration of population and associated economic activities such as commerce, finance, manufacturing and services. This presumably implies a higher income level than the rest of the country.

From 1990 to 1991, the overall average monthly salary went up by 29% to G.374,400 for male workers, and by 87% to G.308,000 for female workers.

Among the male labor force in 1991, only unskilled and self-employed workers earned less than the average, while among female workers who earned less than the average were employees in the public sector, unskilled laborers, self-employed workers, and domestic staff. For employees in 1991, the average salary level in the private sector was higher than in the public sector, for both male and female workers.

2.6.4 Industries

Of the industries, 90% of the factories are considered small with 1 to 5 workers, 10% are medium size with 5 to 20 persons.

According to the study on solid wastes from industrial sources (Annex L), the concentration of factories in Asuncion and the Central Department is overwhelming, accounting for nearly 3,000 establishments, while each of the other Departments accounts for less than 500 factories (1988 data). Moreover, Asuncion houses 2,263 factories, while each of the Municipalities in the MAA accounts for less than 200 factories (164 in San Lorenzo, 146 in Fernando de la Mora, 78 in Luque, 77 in Capiata, 47 in Lambare).

The relative distribution of employees in the industry by factory size (classified in terms of the number of employees) are shown in Figure 2.6.4a.

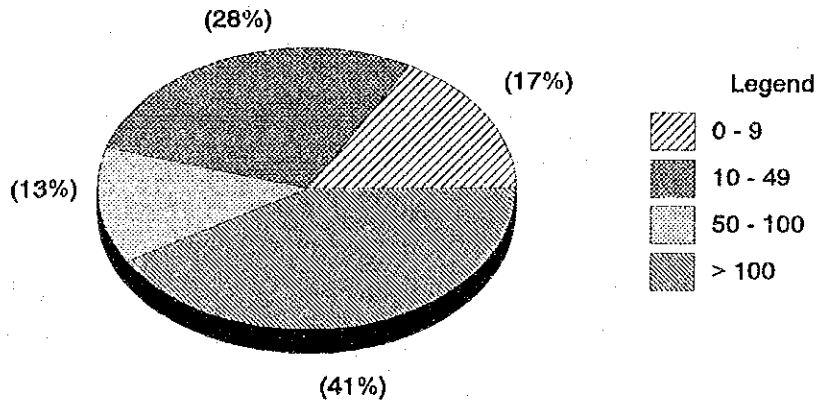

Figure 2.6.4a Relative Distribution of Total Employee by Size of Factory

2.6.5 Municipal Finance

The financial situation of Municipalities are presented as summaries of their 1993 budgets. Incomes and expenses are presented in separate tables, to highlight the main sources of income and the major expense items for three groups of Municipalities which are classified according to the degree of urbanization. The figures refer to the planned budget, not the executed budget, whereby most Municipalities show either a balance or a surplus.

The municipal income and expenditure in 1993 are summarized in Table 2.6.5a below. The details of them are presented in Tables A.6.4a to 5f in Annex A.

Table 2.6.5a Municipal Income and Expenditure, 1993 Budget

Items / Municipality	Current Income (%)	Capital Income (%)	Total Income (Thousand GS)	Current Expenses (%)	Capital Expenses (%)	Total Expenses (Thousand GS)
1. HUM						
1-1. Asuncion	85	15	50,703,300	66	34	50,703,300
1-2. F.Mora	80	20	2,125,734	64	36	2,125,734
2.UM						
2-1. Lambare	58	42	4,103,605	53	47	4,103,650
2-2. San Lorenzo	96	4	1,250,000	63	37	1,250,000
2-3. Capiata	90	10	354,600	82	18	354,600
2-4. Luque	95	5	1,423,200	67	33	1,423,200
2-5. M.R.Alonso	93	7	919,100	79	21	919,100
2-6. Villa Elisa	71	29	283,450	87	13	283,450
3. LUM						
3-1. Nemby	68	32	304,295	38	62	306,595
3-2. J.A.Saldivar	98	2	42,000	86	14	42,000
3-3. Ita	98	2	483,450	66	34	483,450
3-4. Aregua	80	20	266,149	69	31	266,150
3-5. Limpio	95	5	408,660	70	30	408,660
3-6. Villa Hayes	98	2	401,600	74	26	401,600
3-7. B.Aceval	87	13	119,811	85	15	119,811

For Municipalities in general, current income is more important than capital income. Within current income, tax income is more important than non-tax income. Taxes that serve as main sources of municipal income are on profession, commerce and industry, automobiles, construction, mass transit, publicity, shows and gambling. Since the beginning of 1993, the real estate tax became an increasingly important income source for Municipalities. There are other locally important municipal taxes, such as that on cattle slaughtering for Municipalities where stockyards are located.

It appears in general that expenses are low on non-personnel services and materials and supplies. Human resources, as good as they might be, are unable to be productive without adequate tools and materials. Also, capital expenses seem to be low, but this may be a reflection on unwillingness to incur public debt or unavailability of proper financing at the level of Municipalities. The contribution to AMUAM, although reportedly a percentage of current income, seems to be low.

2.6.6 Municipal Tax System

In general, municipal income has traditionally depended on a few taxes, such as those levied on the practice of professions, commerce and industry, as well as on automobiles, mass transit and construction.

Municipal income had a large increase in 1993, due to a Constitutional amendment whereby the collection of real estate tax changed from the jurisdiction of the Central Government to that of each Municipality. However, the Municipality transferred 15% of the land tax to the newly created Office of the Governor of the Department, and an additional 15% to the financially weak Municipalities within the Department.

The tax system for Municipalities of First, Second and Third Categories is established in Law No. 62/76. Asuncion Municipality has its own tax system promulgated in Law 881/81.

One point to keep in mind is that the solid wastes management is regarded as public utilities. As such, the legislation is clear in that the fee should not exceed the real cost of service plus administrative expenses.

2.6.7 Tax System and Utilities Charging System

Taxes in Paraguay are imposed by the National Government and the Municipal Governments. Utilities are also charged either by the National or Municipal Governments, according to which agency is providing the services.

a. National Government Taxes

The national taxation system in Paraguay is based on three deferent groups of

taxes; income tax, tax on capital, and tax on consumption, all defined and regulated by the Law No 125/91.

b. Municipal Government Taxes

Municipalities have the right to tax the construction of buildings, vehicle patents (licenses), slaughterhouses, commercial, industrial and professional activities, (usually the main source of municipal income), advertising and other less important issues. Also, from last year, municipalities can impose taxes for properties, in general the second most significant amount in the municipalities. In municipalities with adequate capacity to collect tax, like Asuncion, the property tax, being the most important, accounts for half of all the other taxes put together.

Besides taxes, municipalities impose fees for waste management, weight and measures inspection, vehicles inspection, sanitation services, pavement maintenance, fire control, etc.

Small municipalities usually face great difficulty in collecting some taxes, like the property tax. The municipal cadastre is often very outdated and they seldom use mail billing, relying only on municipal collectors or on voluntary payments. Furthermore, usually these payments can only be made in the city hall, not enabling the taxpayers to pay it by mail or through banks.

c. Public Utilities Charging

Public utilities provided on network schemes are electricity, telephone, water, sewerage and drainage. They are charged, where they are provided, based on the following schemes:

- **Electricity** – a monthly fee, issued by ANDE – National Electricity Administration (Administracion Nacional de Eletricidad)

- **Telephone**– a monthly fee issued by ANTEL – National Telephone Administration (Administracion Nacional de Telefonos)

- **Drinking water, sewerage and urban drainage** – When provided by CORPOSANA, a monthly fee is send to the user, on an amount based on metered or assumed consumption of water, and a percentage of the amount to be paid, in Guaranies, for water, for the maintenance or construction of sewerage and another percentage for the drainage system maintenance.

Solid Waste Management – many different ways of charging the users of collection and street sweeping are used, from a tax charged jointly with the property tax to direct billing, by the municipality or by the service provider, as described in the next chapter.

CHAPTER 3

FIELD SURVEYS

CHAPTER 3 FIELD SURVEYS

This chapter describes the results of various field surveys executed in this Study. These results are used as the basic data for the formulation of the MSWM Master Plan.

3.1 Waste Amount and Composition Survey

3.1.1 Objectives and Definitions

a. Objectives of the Survey

Basic information such as the quantity of solid waste generated in the survey area, the population covered with the collection services, collection area map, etc., is the key for formulation of a successful and workable solid waste management plan.

A WACS (Waste Amount and Composition Survey) was carried out in order to obtain basic information on waste generation ratio, discharge and recycling amount, amount of self-disposal and collection, and finally to clarify the waste stream in the study area.

The WACS was carried out twice in July, 1993 and February, 1994 in order to get the waste data of both winter and summer. **The average data was determined by both data.**

b. Definitions of the Wastes

In order to make the contents of the WACS and the waste stream clearly understood, the definitions of words used in the study are as follows:

ba. Household waste

Waste generated in or discharged from households including waste from shops. However, those generated through commercial activities are excluded.

bb. Commercial waste

Only refers to wastes generated and discharged from shops through their commercial activities. Shops include restaurants, hotels, drug stores, grocery shops, printing shops, private offices, etc..

bc. Market waste

Waste generated in or discharged from markets both for wholesale and retailing.

bd. Institutional waste

As for the institutional waste, government office waste is examined in the Study.

be. Street sweeping waste

Street sweeping waste include all wastes generated by the following cleansing services:

- Street sweeping waste; and
- Public area cleansing waste, which is generated from parks and green area cleansing and cleaning-up operation of illegal dumping sites.

bf. Hospital waste

Hospital waste in this study includes non-infectious waste generated in hospitals and excludes infectious waste.

bg. Bulky waste

Abandoned bulky items (such as furniture and vehicles), which are discharged from the above-mentioned categories, is considered as bulky waste in the Study.

bh. Other waste

Other wastes in the Study are the wastes which are disposed of at the present disposal sites in the Study area and are not classified as MSW (items ba. to bg.).

3.1.2 Method of the Survey

a. Method of the Waste Amount Survey

Waste amount survey used in this study is divided into the following three methods:

- Generation ratio survey at generation sources;
- Final disposal amount survey at the present landfills, in the study area; and
- Interview survey at the generation sources.

In addition, the results of the POS (Public Opinion Survey) was referred to for the final determination of the amount. The method applied to the WACS is tabulated in Table 3.1.2a.

Table 3.1.2a Method of Waste Amount Survey

Category	Generation Ratio Survey	Disposal Amount Survey	Interview Survey
MSW (Total)		X	
Household Waste	X		X
Commercial	X		
Market Waste	X		X
Institutional	X		
Street Sweeping	X		
Hospital Waste			X
Bulky Waste		X	
Others (Total)		X	
Industrial Waste		X	X
Others		X	

Note: The item given "X" was surveyed in the Study.

b. Selection of Sampling Points for the Generation Ratio and Composition Survey

In order to obtain the representative generation ratio of each category of waste, the category of waste, generation sources and sampling quantity for the WACS is summarized in Table 3.1.2b. Regarding bulky and other wastes, only their amount were studied by means of observation at the present landfills.

Table 3.1.2b Category of Wastes, Generation Sources and Sampling Quantity for WACS

Category of Waste	Generation Sources	In Winter			In Summer		
		(1) Sampling Area (Nos.)	(2) Sampling Area (Nos.)	(1)x(2) Number of Samples (Nos.)	(3) Sampling Area (Nos.)	(4) Sampling Numbers per Area (Nos.)	(3)X(4) Number of Samples (Nos.)
Household Waste	Residential Area (High Income)	4	5	20	6	5	30
	Residential Area (Middle Income)	4	5	20	6	5	30
	Residential Area (Low Income)	4	5	20	6	5	30
Commercial Waste	Commercial Area (Restaurants)	2	2 or 3	5	2	5	10
	Commercial Area (Other Shops)	2	2 or 3	5	2	5	10
Market Waste	Markets	1	2	2	1	2	2
Institutional Waste	Institutions (Government Offices)	1	5	5	1	5	5
Street Sweeping Waste	Street Sweeping	1	2	2	1	2	2
Total		19	———	79	25	———	119

c. Method of the Generation Ratio and Composition Survey

Method of the Survey is tabulated in Table 3.1.2c. Upon consideration of daily fluctuation of generated waste, the survey was conducted continuously for 8 days. The data of the first day is used only for a reference.

Waste composition survey mainly consists of physical composition and chemical analysis. In the winter, both analyses were executed. In the summer, however, physical composition and moisture content of the chemical analysis were executed to compare with the winter data.

Table 3.1.2c Method of the Survey

Generation Source	Collection of Sample	Waste Amount Survey	Waste Composition Survey
Residential Area (High Income)	by plastic bag	by spring balance	Analysis Items - ASG (Apparent Specific Gravity) - Physical composition in wet base (kitchen waste, paper, textile, plastic, glass, grass and wood, leather and rubber, metal, ceramic and stone, others) - Chemical Analysis + Three contents (moisture, combustibles, ash) + Lower calorific value + Ultimate analysis (carbon, hydrogen, nitrogen, sulphur, chlorine, oxygen)
Residential Area (Middle Income)	by plastic bag	by spring balance	
Residential Area (Low Income)	by plastic bag	by spring balance	
Commercial Area	by plastic bag	by spring balance	
Market	by pick-up trucks	by weighbridge	
Institution	by plastic bag	by spring balance	
Street Sweeping	by plastic bag	by spring balance	

ca. Method of the Generation Ratio Survey

Before the execution of the WACS, required numbers of plastic bags were distributed to residences, shops and offices selected as sampling points.

Samples discharged from markets were collected by pick-up trucks.

Amount of waste was measured by each sampling point. Samples carried in plastic bags were measured using a spring balance and samples of market waste were measured at the truck scale.

cb. Method of Waste Composition Survey

The composition of waste was measured in wet base in accordance with the following seven categories:

- residential area (High Income)
- residential area (Middle Income)
- residential area (Low Income)
- commercial area (Restaurant)
- commercial area (Others)
- markets

- institutions

Physical composition and chemical analyses were conducted on the following items:

- Physical Composition
  The physical composition was measured in wet base in winter and the samples were divided into the 10 items.
- Moisture Content
- Chemical Analysis:
  - Ash content;
    Ash content in this Study refers to ash after the combustion of the combustible and non-combustible items, i.e. metal, glass, ceramic and soil, others.
  - Combustible content;
  - Lower calorific content;
  - Ultimate analysis.
    Ultimate analysis was done on the carbon, hydrogen, nitrogen, sulphur, chlorine and oxygen contents in wastes.

d. Period and Schedule of the Survey

The Survey was conducted in winter, from 19th to 26th July 1993, and in summer, from 31th January to 7th February, 1994.

3.1.3 Findings

a. Waste Amount

aa. Determination Number of Generation Sources

Population, number of shops, number of public officers and length of street sweeping streets in the Study area were obtained from counterparts as shown in Table 3.1.3a.

Table 3.1.3a Population, Number of Shops, Number of Public Officers and Length of Streets Swept in 1993

Category	Population (person)	Shop		Market (Shop)	No.of Public Officers (persons)	Length of Streets Swept (km)
		Restaurant (Shop)	Others (Shop)			
Highly Urbanized Mu.	**603,701**	**633**	**19,582**	**4,676**	**21,715**	**266**
Asuncion	506,445	454	17,102	4,676	19,974	264
Fernando de la Mora	97,256	179	2,480	0	1,741	2
Urbanized Mu.	**499,560**	**262**	**9,617**	**700**	**9,091**	**40**
Lambare	103,990	55	1,600	0	1,827	6
San Lorenzo	140,075	73	3,000	700	2,398	6
Capiata	88,932	47	1,571	0	1,476	0
Luque	91,676	48	2,190	0	2,124	28
M.R. Alonso	42,576	22	800	0	720	0
Villa Elisa	32,311	17	456	0	546	0
Less Urbanized Mu.	**98,797**	**52**	**3,526**	**210**	**3,416**	**9**
Nemby	28,868	15	1,054	0	708	0
J.A.Saldivar	2,137	1	58	0	350	0
Ita	14,846	8	464	150	605	6
Aregua	6,462	3	321	0	425	2
Limpio	27,716	15	1,340	60	648	1
Villa Hayes	12,317	6	121	0	478	0
Benjamin Aceval	6,451	3	168	0	202	0
Total	**1,202,058**	**947**	**32,725**	**5,586**	**34,222**	**315**

Sources:

Population; Direccion General de Estadisticas, Encuestas y Censos.

Shops; Sistema Comercial e Industrial, Municipalidad de Asuncion

Markets; Direccion de Mercados, Municipalidad de Asuncion

No. of Public officers; Recursos Humanos, Sector Publico Municipalidad de Asuncion, F.Mora etc.

Length of Sweeping Street; 15 municipalities

ab. Waste Generation Ratios

Based on the WACS conducted in July 1993 and February 1994, we concluded that the generation ratios of each generation source is as follows:

Table 3.1.3b Waste Generation Ratio

	Unit	1994
1. MSW		
Household	g/person/day	961
Shop	g/shop/day	3,186
Restaurant	g/shop/day	31,958
Market	g/shop/day	5,961
Institutional	g/employee/day	78
Street Sweeping	g/km/day	39,950
		(254,700)
Hospital	g/bed/day	4,000
Bed	g/person/day	0.6
2. Other wastes (ISW)	g/person/day	30

Note: The generation ratio for Asuncion shown in parentheses is calculated by the actual disposal amount observed by the truck scale at the Cateura Landfill while the ratios for the other 14 municipalities is the one obtained from the WACS conducted by the JICA Study Team.

The generation ratio of household waste, 961 g/person/day, is very high in comparison with those of the other countries as shown in Table 3.1.3c.

Table 3.1.3c Generation Ratio of Household Wastes

Country	City	Year	Population	Household waste (g/person/day)	MSW (g/person/day)
Paraguay	Asuncion	1993	506,445	961	1,312
Poland*1	Poznan	1992	590,500	654	769
	Lublin	1992	352,500	400	508
Laos*2	Vientiane	1991	142,700	753	987
Malaysia*3	Pulau Pinang	1988	559,300	504	640

Source:

*1: The Study on the Solid Waste Management for Poznan City, the Republic of Poland, May 1993.

*2: The Study on the Solid Waste Management System Improvement Project in Vientiane, Lao People's Democratic Republic, August, 1992.

*3 The figure is not generation ratio but disposal amount from "Solid Waste Management Study for Pulau Pinang and Seberand Perai Municipalities, August, 1989"

The reasons why the generation ratio of household waste is so high are that:

- The generation of the garden wastes, which consists of grass and wood, and others (soils, etc.), is extremely high (44.2%) in comparison with those in Poznan, Pulau Pinang, Rio de Janeiro (1991), Tokyo (1972), which are 10.3%, 22.2%, 16.7%, 16.6%, respectively.

- Most of the garden wastes are generated from detached houses. In the Study area, the proportion of detached houses is very high and average site area of a detached house is large enough (average 450m^2) to produce an enormous amount of garden wastes according to the results of the POS.

- According to the interview survey conducted in July 1993 to the sampling household of the WACS, self disposal by means of burning, etc. and source recycling by means of feeding domestic animals are 245 g/person/day and 54 g/person/day respectively in the collection service area. Consequently the discharge (or collection) ratio comes 662 g/person/day. This is a reasonable ratio.

b. Waste Composition

The waste composition of the Study area is summarized in Table 3.1.3d.