

THE MUNICIPALITY OF THE CENTRAL DISTRICT  
THE REPUBLIC OF HONDURAS

**THE STUDY  
ON  
SOLID WASTE MANAGEMENT  
OF  
THE URBAN AREA  
OF  
TEGUCIGALPA'S CENTRAL DISTRICT**

**FINAL REPORT  
VOLUME III**

**REVISED MAIN REPORT**

**MARCH 1999**

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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE MUNICIPALITY OF THE CENTRAL DISTRICT  
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## PREFACE

In response to a request from the Government of the Republic of Honduras, the Government of Japan decided to conduct The Study on Solid Waste Management of the Urban Area of Tegucigalpa's Central District in the Republic of Honduras and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Honduras a study team headed by Mr. Takeshi Tomiyasu, KOKUSAI KOGYO CO. LTD., four times between December 1997 to March 1999. In addition, JICA set up an advisory committee headed by Dr. Hidetoshi Kitawaki, a professor of Toyo University, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Honduras, and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Honduras for their close cooperation extended to the study.

March, 1999



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Kimio Fujita  
President  
Japan International Cooperation Agency

March, 1999

Mr. Kimio Fujita  
President  
Japan International Cooperation Agency

**Letter of Transmittal**

Dear Mr. Fujita,

We are pleased to submit to you the report on The Study on Solid Waste Management of the Urban Area of Tegucigalpa's Central District in the Republic of Honduras.

This report consists of three main components, a study on the present waste management situation, a solid waste management master plan until the year 2010, and a feasibility study on the priority projects for the urban area of Tegucigalpa's Central District.

Just before the termination of this Study, Honduras was hit by Hurricane Mitch, which caused severe damage to the country. Due to this damage, an additional study was carried out and revisions were made to the original premises on which the master plan was based, and subsequently the original master plan for solid waste management, and the original feasibility study on the priority projects.

The study on the present waste management situation assesses the present waste management situation of the urban area of Tegucigalpa's Central District after carrying out eleven basic surveys.

The master plan comprises a forecast of waste generation amounts; a planning framework with phased goals, targets, and strategies; the best technical system; the financial system; and the organizational and institutional system. Since improvement of the organizational and institutional system is necessary to materialize the master plan and to establish a sustainable solid waste management system, it was given the highest priority. To this end, several recommendations were made, they being, the establishment of an independent solid waste management authority and the introduction of the new waste fee collection system.

The feasibility study was conducted on the priority projects proposed to be undertaken between the years 1999 and 2002. These consist of improvements of the organizational and institutional system, the waste collection and haulage system, and the construction of new final disposal site. These projects were evaluated from financial, economic, technical, social and environmental aspects and were found to be feasible in all aspects.

During the study, four pilot projects were carried out. Two of these, the "Campaign for Raising Awareness on Solid Waste Issues" and the "Experiment on the Implementation of the Best Collection System for Marginal Areas", promoted the active participation of the counterparts and residents, provoking a strong positive response.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Health and Welfare. We also wish to extend our sincere gratitude to the Government of the Republic of Honduras, the Municipality of the Central District, the Embassy of Japan and the JICA office in the Republic of Honduras.

Finally, we hope that this report will help improve and enhance solid waste management and urban environment sanitation in Tegucigalpa's Central District in Honduras.

Respectfully,



Takeshi Tomiyasu  
Team Leader

The Study on Solid Waste Management of the  
Urban Area of Tegucigalpa's Central District in  
the Republic of Honduras

## **Outline of the Solid Waste Management Plan**

### **1. Policy for the Solid Waste Management Plan**

Most current problems related to solid waste in the Central District are attributed to a weak institutional system, especially to the inefficient financial system, and some problems in the technical system. At present, new projects cannot be expected to become successful unless an appropriate institutional system is established prior to implementation. Therefore, first priority was given to the improvement of the institutional system.

### **2. Improvement of the Institutional System**

The institutional system was formulated based on the following concepts.

- a) Establishment of a sound financial system without funding from donor agencies.
- b) Giving first priority to the establishment of a sound revenue system.
- c) Extending private sector involvement to reduce investment share, since it will be difficult for the Municipality of the Central District (AMDC) to bear the required investment for the solid waste management (SWM) work alone.
- d) Improvement of management system prior to extending private sector involvement in SWM, to minimize contracting out rates and ensure good service quality.

#### **2.1 Organizational System**

- a) In 1999, the Solid Waste Management Executing Unit (SWEU), which will be a temporary organization to be directly under the Mayor's office, will be established.
- b) By 2001, the Municipal Cleansing Corporation (MCC) which is a Solid Waste Management Autonomous Entity will be established. The AMDC will hold at least 51% of the whole capital of the MCC.

#### **2.2 Waste Fee Collection System**

In 2001, the joint billing of waste collection fees and electricity charges will begin.

## 2.3 Waste Collection Fee System

The new waste collection fee system shown below will take effect in 2001. The new business waste collection fee tariff, on the other hand, was put into effect by AMDC in January 1999 in line with the Study Team's recommendation.

Type of waste		Waste Fee		
		2001 -2002	2003 -2007	2008 -2010
Residential waste <sup>1</sup> :	High income group (Lps/house/month)	63	70	80
	Middle income group (Lps/house/month)	22	33	36
	Low income group (Lps/house/month)	11	18	20
Non- Residential waste	Business waste (Lps/ establishment /month)	Annual business income		
		Up to Lps 50,000.00.	Lps.40.00	
		Lps.50,000.01 - 100,000.00	Lps.80.00	
		Lps.100,000.01 - 300,000.00	Lps.125.00	
		Lps.300,000.01 - 600,000.00	Lps.180.00	
		Lps.600,000.01 - 1,000,000.00	Lps.240.00	
		Lps.1,000,000.01 - 2,000,000.00	Lps.325.00	
		Lps.2,000,000.01 - 5,000,000.00	Lps.500.00	
		Lps.5,000,000.01 - 10,000,000.00	Lps.700.00	
		Lps.10,000,000.01 - 15,000,000.00	Lps.800.00	
		Lps.15,000,000.01 - 20,000,000.00	Lps.1,000.00	
		Lps.20,000,000.01 - 30,000,000.00	Lps.1,300.00	
		Lps.30,000,000.01 - 40,000,000.00	Lps.1,500.00	
Lps.40,000,000.01 - 60,000,000.00	Lps.1,600.00			
more than Lps.60,000,000.01	Lps.1,800.00			
	Large amount discharger (Lps/ton)	480	530	
	Direct haulage discharger (Lps/ton)	50	55	

Note: The basic business waste collection fee starts at Lps50/establishment/month.

## 2.4 Management System

- The MCC's accounting, financing, planning, monitoring and supervision capabilities will be improved.
- The involvement of the private sector in SWM will be gradually extended.
- The operation of collection and haulage services will be gradually shifted from the public sector to the private sector. In that process the MCC will directly operate at least 25% of the collection and haulage works.
- The MCC will hold an open bid so that proceedings are transparent to the general public.
- The MCC limits the amount to be collected in one contract area to less than 50 ton/day.
- The contract rate of collection and haulage work will be kept at less than Lps. 300 per ton.

<sup>1</sup> The following considerations were taken into account to determine the residential waste collection fee. 1) To introduce the cross-subsidy mechanism (i.e., the affluent pay for the less well off). 2) To keep the proposed rate below the amount that people are willing to pay (WTP). 3) To keep the proposed rate below 1.0% of the resident's income. Refer to page 46.



### 3. Technical System

#### 3.1 Discharge and Storage

- a) The MCC will not bear any costs related to storage system except for the cost of the communal containers.
- b) The MCC will promote the use of plastic bags or plastic containers for storage of waste.
- c) The separate discharge system will begin in areas where they are feasible from 2008.

#### 3.2 Collection and Haulage

- a) The executing body from 1999 to 2000 will be the AMDC's SWEU. After 2001 the executing agency will be the MCC.
- b) The private sector's involvement will be gradually extended, but the MCC will directly operate at least 25% of the entire collection and haulage works.
- c) Collection frequency

City center and high income residential areas: three times a week  
Other areas: twice a week

- d) Type of collection equipment

The standard type of collection equipment and collection method proposed are as follows.

Area	Collection Equipment	Collection Method
Standard residential areas	15m <sup>3</sup> Compactor truck	Curb collection
Commercial areas	15m <sup>3</sup> Compactor truck	Curb collection
Busy commercial areas	8m <sup>3</sup> Compactor truck	Curb collection
Marginal areas	5.5 m <sup>3</sup> and 10 m <sup>3</sup> container truck	Point collection
Street waste	5.5 m <sup>3</sup> and 10 m <sup>3</sup> container truck	Point collection

### 3.3 Processing, Treatment and Recycling

#### 1) Basic Policy

- a) Neither major processing nor treatment plants for municipal solid waste, to be operated by the MCC, will be introduced provided that acquisition of a landfill site and its operation do not impose too much effort on the proposed waste management authority.
- b) The AMDC's SWEU will promote recycling activities by encouraging the participation of the private sector and avoid direct involvement in the execution of recycling activities.
- c) A separate discharge system will be firstly introduced in the high income residential areas, where more recyclable materials are included in the generated wastes, and gradually expanded to the middle and low income residential areas.

## **2) Implementation Plan**

- a) In 2004, the first recycling program (collection of recyclable waste at markets and public square) will be implemented.
- b) In 2008, the second recycling program (collection of recyclable waste at schools) will be implemented.
- c) In 2007, a recycling company will be jointly established by the AMDC and the private sector. This company will have a manual sorting plant near the new disposal site and start its operation by employing scavengers in 2008.
- d) In 2008, the MCC will prohibit entry to the disposal site.
- e) In 2008, the MCC will start separate collection officially.

## **3.4 Street Sweeping System**

- a) The manual sweeping method will be maintained until 2010 except in some trunk roads.
- b) The following improvement measures will be executed.
  - Economic utilization of micro-enterprises
  - Appropriate distribution of immovable litter boxes along streets
  - Appropriate allocation of collection stations for street sweeping waste
  - Introduction of a new type of cart for carrying street sweeping waste collected
  - To acquire small site offices in proper locations for street sweeping works

## **3.5 Final Disposal**

### **1) Existing Final Disposal Site**

- a) In 1999, conditions in the existing disposal site will be improved in order to improve the sanitary level.
- b) Scavengers cooperation and participation will be encouraged.

### **2) New Final Disposal Site**

- a) In 1999, the F/S study, EIA study, official selection of the site, land acquisition, detailed design and contractor selection will be conducted.
- b) In 2000, the new final disposal site will be constructed.
- c) In 2001, the operation of the new disposal site will commence.

### **3) Final Disposal Site for the Next Term**

- a) In 2008, the site selection will start.
- b) In 2011, the construction of the new final disposal site will commence.
- c) In 2012, the operation of the following new disposal site will start

### 3.6 Maintenance and Operation

The private sector's involvement in SWM will be extended in order to reduce the burden and work load of the authority responsible for SWM.

### 3.7 Hygiene Education

- a) Hygiene education will be reinforced and continued through the Alcaldia Mobile Campaign.
- b) Classes on waste education will be conducted using the textbook "Basura", the video on solid waste, etc.

## 4. Project Costs

### 4.1 Costs for the Revised Master Plan Projects

The cost for the master plan projects covers the whole SWM costs required from 1999 to 2010.

unit: million Lps

		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Collection & Haulage	Investment	0.0	40.9	0.0	0.0	0.0	0.0	0.0	0.0	40.9	0.0	0.0	0.0
	O & M	11.0	11.5	12.7	12.7	14.6	12.7	16.5	12.7	14.6	14.6	12.7	14.6
	Contract-out	13.8	13.8	21.9	21.9	21.9	32.9	32.9	43.8	43.8	54.8	65.7	65.7
Street Sweeping	Investment	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.4	0.0	0.0
	O & M	2.8	2.8	3.3	3.5	3.5	3.5	3.7	3.9	4.1	4.2	4.4	4.6
	Contract-out	6.7	6.7	6.7	7.1	7.1	7.1	7.5	7.9	8.2	8.6	9.0	9.3
Recycling	Investment	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	2.7	0.7	0.0	0.0
	O & M	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.5	1.0	1.0	1.0
Final Disposal	Investment	3.7	42.4	0.0	3.7	1.2	0.0	13.4	7.8	0.7	7.4	0.7	4.7
	O & M	5.0	5.2	5.6	5.7	6.6	6.8	6.8	6.9	7.8	8.0	9.0	9.0
Indirect Cost	O & M	2.8	2.9	3.9	3.9	4.4	4.2	4.9	4.3	4.8	5.0	4.9	5.3
Total	Investment	3.7	84.1	0.0	3.7	2.8	0.0	13.4	7.8	45.1	8.4	0.7	4.7
	O & M	21.7	22.5	25.5	25.8	29.1	27.7	32.4	28.3	31.8	32.8	32.0	34.4
	Contract-out	20.6	20.6	28.6	29.0	29.0	40.0	40.3	51.7	52.0	63.3	74.7	75.0
	Total	45.9	127.2	54.2	58.5	60.8	67.7	86.1	87.7	128.9	104.6	107.4	114.2

### 4.2 Costs for Revised Priority Projects

The cost for the priority projects covers the investment from 1999 to 2002 and the O & M costs from 1999 to 2010.

unit: thousand Lps

		1999	2000	2001	2002	2003	2004-2010
Collection & Haulage	Investment	0	40,876	0	0	0	40,876
	O & M	11,029	11,497	12,721	12,721	14,593	102,151
	Contract-out	13,834	13,834	21,900	21,900	21,900	153,300
Street Sweeping	Investment	0	818	0	0	0	1,227
	O & M	2,840	2,840	3,316	3,500	3,500	28,371
	Contract-out	6,730	6,730	6,730	7,104	7,104	57,579
Final Disposal	Investment	3,703	42,408	0	3,689	720	30,466
	O & M	4,982	5,222	5,605	5,685	5,693	39,852
Indirect Cost	Investment	2,828	2,934	3,896	3,943	4,282	30,667
Total	Investment	3,703	84,102	0	3,689	720	72,570
	O & M	21,679	22,493	25,538	25,850	28,068	201,042
	Contract-out	20,564	20,564	28,630	29,004	29,004	210,879
	Total	45,946	127,158	54,168	58,543	57,792	484,490

## **5. Project Evaluation**

The implementation of the master plan is not highly likely going to incur any technical, social or environmental problems.

through its implementation, it is estimated that approximately 600,000 people will benefit from the waste collection.

The financial evaluation shows that the implementation of the revised master plan will incur a 12.1% FIRR, which exceeds the cut-off rate of IDB (12%). The implementation of the revised priority projects is also considered to incur 13.8%, which is also over 12%.

The master plan will incur an EIRR of 5.7% and generate various unquantifiable benefits.

## **6. Recommendations**

In October 1999, around the end of the Study, Honduras was hit by the devastating Hurricane Mitch. The hurricane caused serious damage to the Central District, incurring major financial losses on the AMDC. Since the Study was prepared with due consideration of the impacts of the disaster on the SWM plan, the feasibility of the plan proposed in the Study was not affected, especially as the positive financial effects of the early introduction of the new business waste collection fee tariff have somehow offset the negative effects of the disaster. Therefore, the AMDC should implement this revised master plan and the revised priority projects based on the strategies proposed in this study.

Nonetheless, in the revised master plan, the improvement of the institutional system has to be conducted first, as a sound institutional system significantly contributes to the success of any project.

One thing that has to be reiterated, however, is that in spite the major financial losses the AMDC is going through as a result of the hurricane, there have been no significant SWM problems in the Central District as of March 1999. This is due to the fact that AMDC gave the sector priority in budget allocation as it considers that the services provided by the sector satisfies one of the basic human needs. Unfortunately, this makes other sectors suffer. Therefore, the AMDC should think and take various potential measures, including requesting aid from international cooperation organizations, in order to recover sanitary conditions and public safety.

## List of Volumes

Volume I	Summary
Volume I(S)	Summary (Spanish Version)
Volume II	Main Report
Volume II(S)	Main Report (Spanish Version)
Volume III	Revised Main Report
Volume III(S)	Revised Main Report (Spanish Version)
Volume IV	Annex
Volume V	Data Book

### Note:

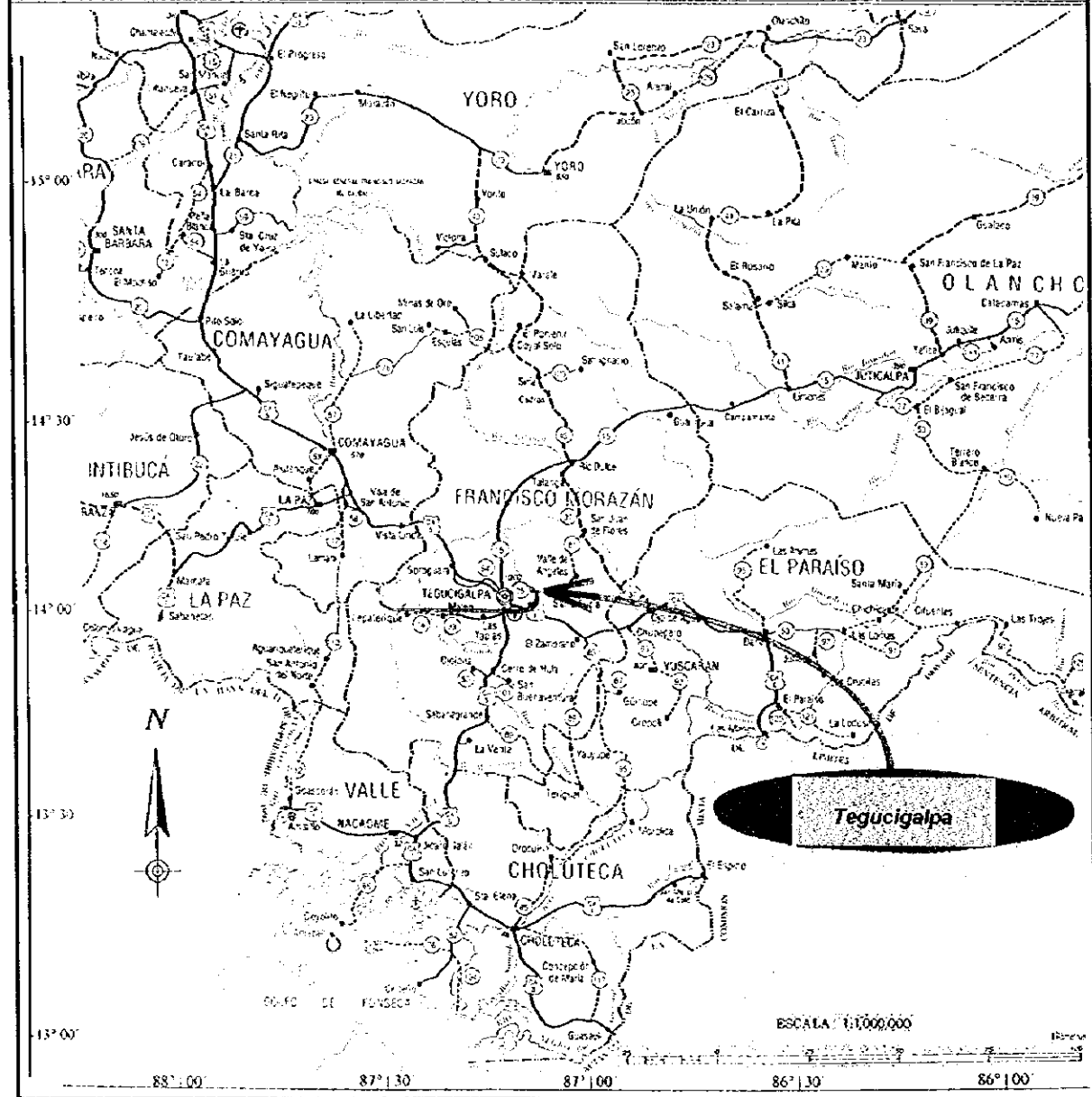
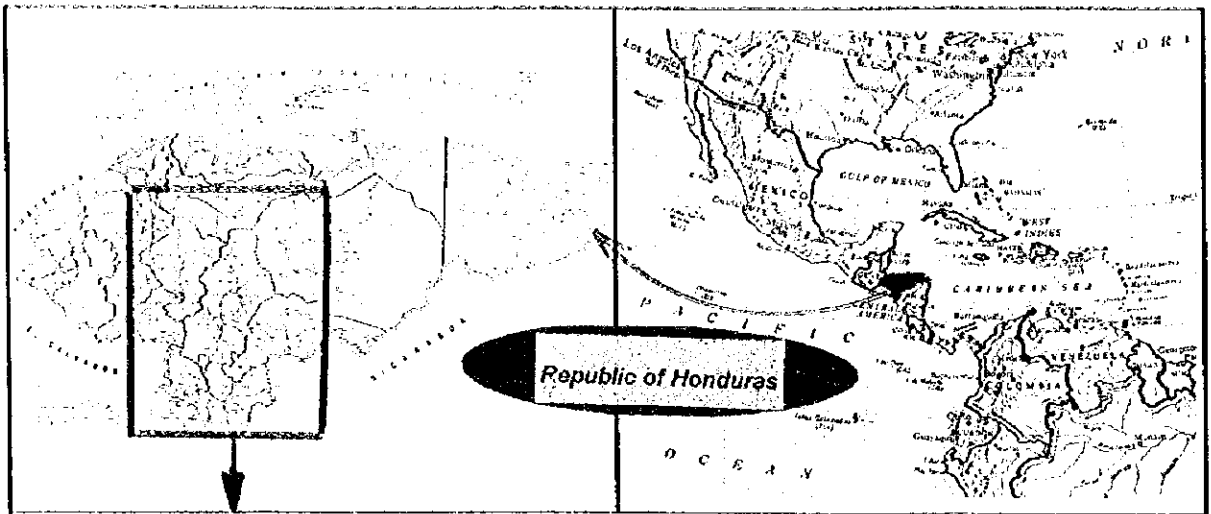
The revised main reports (English and Spanish) are being made taking into account the effect of Hurricane Mitch on solid waste management works.

Since the other reports were made before Hurricane Mitch hit Honduras, its effect on solid waste management works was not taken into account.

Although the revised main reports (English and Spanish) best illustrate the current conditions, the other reports should also be referred to for detail.

## ***This is the Revised Main Report.***

In this report, the project cost is estimated using the March 1999 prices and at an exchange rate of 1US\$ = 119.15 Japanese Yen = 13.52 Lempiras.



*The Location Map of the Study Area*

*Plate 1: Field Investigations (I) Waste Amount and Composition Survey*

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**Waste Amount Survey**



Collection of household waste samples



Weighing of waste samples

**Waste Composition Survey**



Waste samples were brought into the survey site



Thorough mixing of collected waste samples

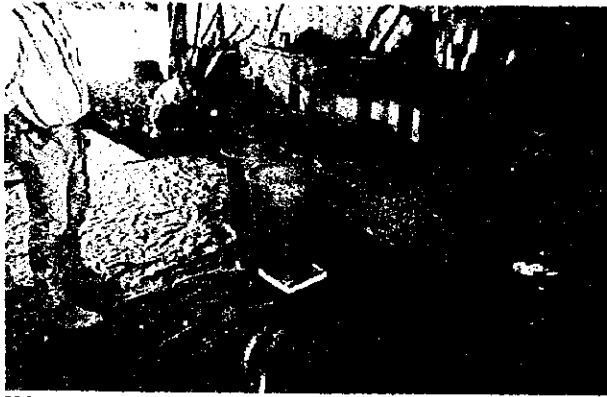


After proper mixing, the waste was divided into four segments of approximately the same size



Two segments of diagonally opposite waste were removed and the remaining waste was mixed again until the volume was reduced to the desired volume.

*Plate 2: Field Investigations (2) Waste Amount and Composition Survey*



Waste samples were put into a calibrated plastic bucket to record volume and weight



Analysis of physical composition of waste samples

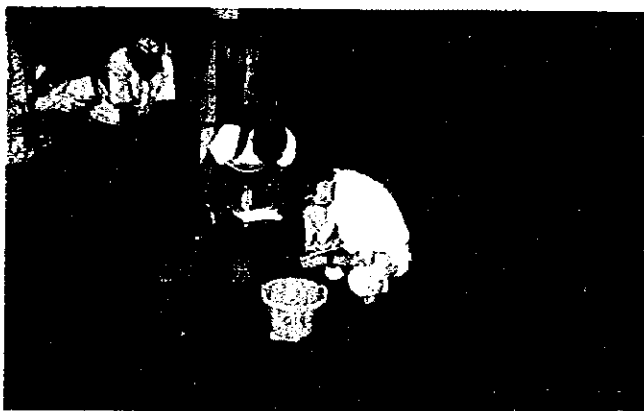


Samples were divided into 10 components



Waste samples were categorized into paper, fiber, grass & wood, plastics, rubber, leather & metal, bottles & glass, stones, food wastes, and others.

**Analysis of the three components of mixed samples**



The samples divided into 10 components were measured individually.



The samples were dried, incinerated and subjected to the three components analysis.



*Plate 3 : Field Investigations (3) Disposal Amount Survey, Public Opinion Survey, Workshop (PCM), Present Final Disposal Site Conditions*

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**Disposal Amount Survey**



Determining the waste load and loading capacity of municipal and private collection vehicles

**Public Opinion Survey**



Interview of 300 households from the high, middle, and low-income areas on waste discharge and collection services

**PCM Workshop**

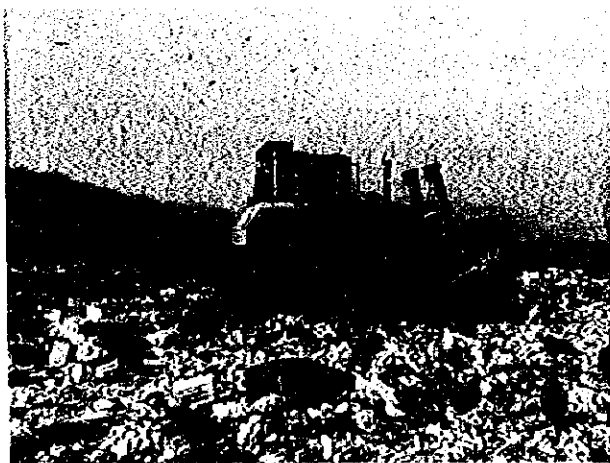


A workshop was held to discuss the different ways the final disposal site could be improved, inviting a total of 15 people representing the residents, the AMDC, scavengers and the JICA study team.

**Present Final Disposal Site Conditions**



Scavengers' burning of copper wire in their aim to recover copper occasionally sets fire to the wastes.



The final disposal site is equipped with 3 bulldozers.



About 100 scavengers are always on the lookout for recoverable materials.

*Plate 4: Waste Collection Service*



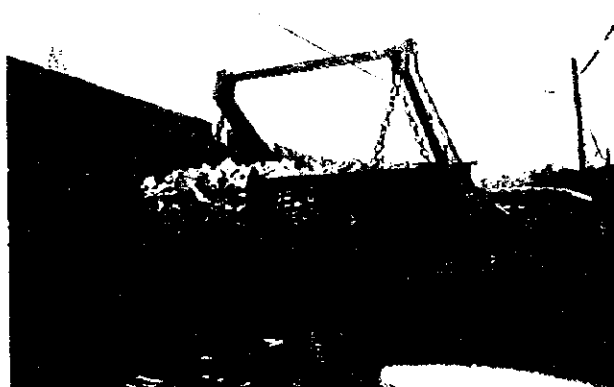
Waste collection vehicle: 15m<sup>3</sup> compactor truck



Waste collection vehicle: 15m<sup>3</sup> compactor truck



Waste collection vehicle: 12m<sup>3</sup> dump truck



Waste collection vehicle: hoist truck



A 15m<sup>3</sup> roll-on roll-off truck  
(private company vehicle)



A 15m<sup>3</sup> compactor truck loading waste from a 4.6m<sup>3</sup>  
container (private company vehicle)

*Plate 5: Pilot Project (1) Campaign for Raising Awareness on Solid Waste Issues  
Pilot Project (2) Experimental Implementation of the Best Collection system for  
Marginal Areas*

**(1) Campaign for Raising Awareness on  
Solid Waste Issues**

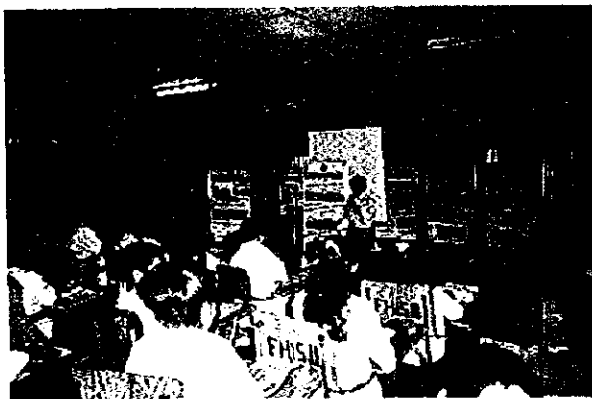


**Logotype contest :**  
The 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> prize winners of the logotype contest, held by a local newspaper, and the campaign mascot



**Campaign goods :**  
Banners (30), posters (3,000), stickers (large: 5,000, small: 10,000) were made for the campaign.

**(2) Experimental Implementation of the Best  
Collection System for Marginal Areas**



**Educational programs on solid waste issues:**  
The educational texts and panels produced by the counterpart and the study team were used to conduct an educational program.



**Illegal dumpsite in San Martin/Ayestas  
(Before the clean-up operation)**



**The illegal dumpsite at San Martin/Ayestas (After  
the clean-up operation). The breeding of flies  
and generation of foul smell were controlled.**



**The suitability of the container collection system in  
marginal areas where collection is unsatisfactory  
was studied. The clean-up operation of the illegal  
dumpsite was carried out to encourage the  
residents to dump waste into the containers and to  
be proud of their area.**

**(3) Experimental Improvement of the Final Disposal Site**

**1) Facility Improvement**

**a) Improvement of security facilities (gates, fences)**

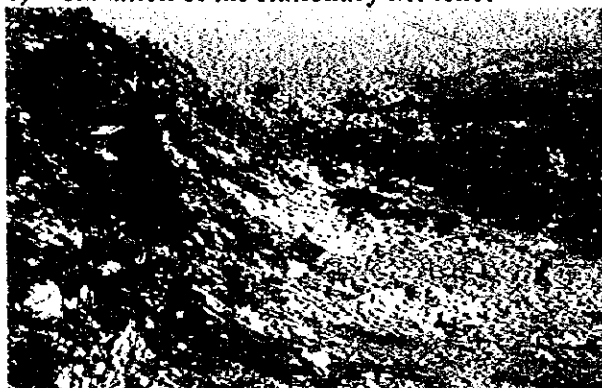


Entrance to the final disposal site (Before)



The gate constructed at the entrance to the final disposal site (After)

**b) Installation of the stationary net fence**

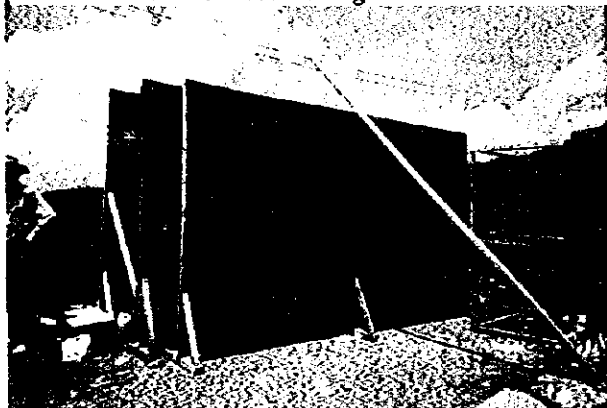


Shoulder of the final disposal site slope (Before)



Shoulder of the final disposal site slope (After)

**c) Manufacture and use of a movable net fence to prevent waste from scattering**



To minimize waste scattering at the landfill section, net fences that can be moved from one landfill section to another, depending on which section is being used, were made and installed.

**d) Installation of gas removal facilities**



To speedily remove, dissolve, and stabilize gases generated by the covered wastes, and to prevent explosions at the site, gas removal facilities were installed.

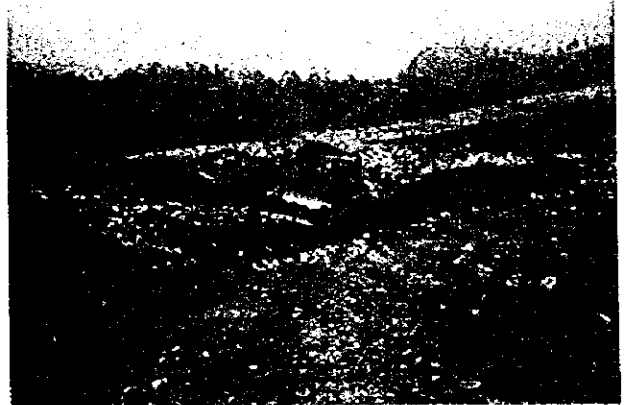
**Plate 7: Pilot Projects (3) Experimental Improvement of the Final Disposal Site  
Pilot Project (4) Improvement of the Managerial Capability of the Cleansing Department**

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**2) Demonstration of landfill techniques & hands-on-training on sanitary landfill techniques**  
Guidance on sanitary landfill techniques was extended using municipal owned machinery.



54 trucks of waste were hauled to the sanitary landfill experiment yard.



Waste was leveled and immediately covered.

**3) Sanitary Improvement through Scavenger Participation**



Completed first sanitary landfill layer



Formulation of final disposal site operation regulations with scavenger participation

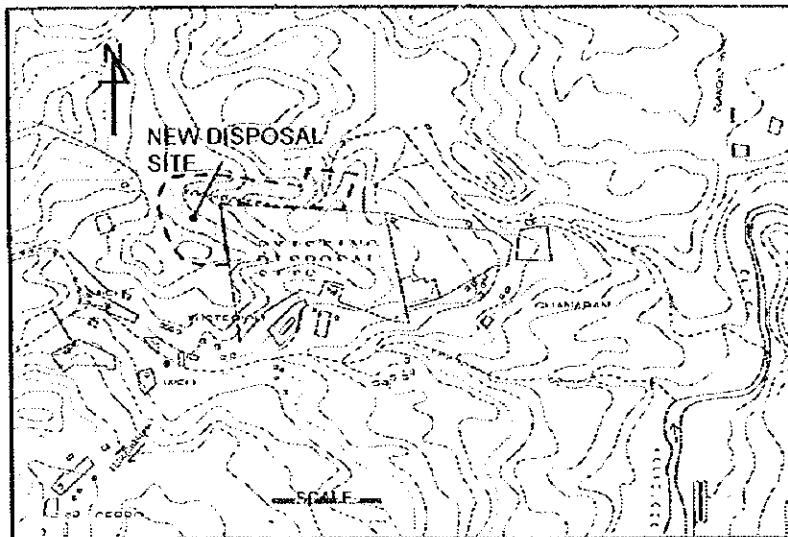
**(4) Improvement of the Managerial Capability of the Cleansing Department**

Methods to effectively use various data were introduced and the staff were made to recognize the importance of proper management methods, to upgrade their managerial capabilities.



*Plate 8: New Final Disposal Candidate Site*

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## Contents

Preface	
Letter of Transmittal	
Outline of the Plan	
List of Volumes	
Location Map of the Study Area	
Plates	
Plate 1: Field Investigations (1) Waste Amount and Composition Survey	
Plate 2: Field Investigations (2) Waste Amount and Composition Survey	
Plate 3: Field Investigations (3) Disposal Amount Survey, Public Opinion Survey, Workshop (PCM), Present Final Disposal Conditions	
Plate 4: Current Condition of Waste Collection Services	
Plate 5 to 7: Pilot Projects	
Plate 8: New Final Disposal Candidate Site	
Contents .....	i
List of Tables.....	iii
List of Figures .....	iv
Glossary.....	v
Abbreviations .....	vi
	Page:
<b>1. Outline of the Study</b>	<b>1</b>
1.1 Background .....	1
1.2 Scope of the Study .....	2
1.3 Work Processes of the Study.....	3
1.4 Policies of the Study.....	3
1.5 Persons Involved .....	4
<b>2. Present Features of the Municipal Solid Waste Management     (SWM)</b>	<b>5</b>
2.1 Profile of the Study Area.....	5
2.2 Findings through the Field Surveys .....	5
2.3 SWM Conditions after Hurricane Mitch.....	8
2.4 Assessment of Current Municipal SWM .....	15
<b>3. The Revised SWM Master Plan</b>	<b>19</b>
3.1 Future Projection for the Master Plan .....	19
3.2 Examination of the Best Technical System.....	22
3.3 Outline of the Master Plan .....	25
3.4 The SWM Master Plan.....	32
3.5 SWM Project Cost .....	35

<b>4. Implementation of Pilot Projects</b>	<b>37</b>
4.1 Campaign for Raising Awareness on Solid Waste Issues.....	37
4.2 Experiment on the Implementation of the Best Collection System for Marginal Areas.....	38
4.3 Experiment on the Improvement of Existing Final Disposal.....	38
4.4 Improvement of the Managerial Capability of the Cleansing Section.....	39
<b>5. Feasibility Study for the Revised Priority Projects</b>	<b>40</b>
5.1 Outline of the Priority Projects .....	40
5.2 Improvement of Institutional System.....	43
5.3 New Disposal Site.....	48
5.4 Environmental Consideration .....	58
5.5 Improvement of the Collection and Haulage System.....	67
5.6 Revised Priority Projects Cost .....	68
<b>6. Project Evaluation</b>	<b>70</b>
6.1 Technical Evaluation.....	70
6.2 Social Evaluation .....	72
6.3 Environmental Evaluation.....	75
6.4 Financial Evaluation.....	76
6.5 Economic Evaluation.....	83
<b>7. Conclusions and Recommendations</b>	<b>85</b>
7.1 Conclusions.....	85
7.2 Recommendations.....	88
<b>8. Proposed Medical and Industrial Waste Management Policies</b>	<b>92</b>
8.1 Medical Solid Waste Management Policies.....	92
8.2 Industrial Solid Waste Management (ISWM) Policies.....	92

## Appendix

### Record of Pilot Projects Implementation



## List of Tables

	Page:
Table 1: Generation Amount of MSW.....	6
Table 2: Composition and Physical Properties (Wet base).....	6
Table 3: Weights by Type of Vehicles.....	7
Table 4: New Business Waste Collection Fee.....	11
Table 5: Potential Revenue from the New Business Waste Collection Fee and the Estimated Revenue Decrease by Hurricane Mitch.....	12
Table 6: Changes in Municipal Revenue.....	13
Table 7: Main Equipment Owned by the Cleansing Department.....	15
Table 8: List of Equipment Owned by CCSM.....	15
Table 9: GDP and GRDP in Tegucigalpa.....	19
Table 10: Projection of Population by Income Level Group.....	19
Table 11: Projected Waste Generation Growth Rate (until 2010).....	20
Table 12: Projected Waste Generation Amount Rates (until 2010).....	21
Table 13: Projected Waste Generation Amounts (until 2010).....	21
Table 14: Waste Composition Forecast of Residential Waste.....	22
Table 15: Potential Subsystems for SWM in the Central District.....	23
Table 16: The Best SWM Technical System.....	24
Table 17: Targets for Establishment of Major Technical System.....	26
Table 18: Summary of the Costs Involved in SWM Works.....	35
Table 19: Estimated Unit SWM Costs.....	36
Table 20: Target for the Priority Projects.....	40
Table 21: Contents of the Priority Projects.....	41
Table 22: Disposal Site Space Requirements.....	50
Table 23: Land-Use.....	57
Table 24: Final Disposal Equipment Plan.....	58
Table 25: Construction Cost for the First Phase.....	59
Table 26: Investment Schedule of Equipment for Final Disposal.....	60
Table 27: O & M Cost for Final Disposal.....	60
Table 28: Planned Rate of Direct Operation and Contracting Out Works.....	67
Table 29: Planned Number of Equipment to be Directly Operated.....	67
Table 30: Investment Schedule for Final Disposal.....	68
Table 31: O & M Cost for Final Disposal.....	68
Table 32: Investment Schedule for Waste Collection Equipment.....	69
Table 33: Required Cost for Operation and Maintenance.....	69
Table 34: Project Cost Summary of the Revised Priority Projects.....	69
Table 35: Proposed Waste Collection Fee Rate for Residential Waste.....	73
Table 36: Summary of the SWM Master Plan Environmental Evaluation.....	75
Table 37: Condition for the Revised Master Plan's Financial Evaluation.....	76
Table 38: Cases to be Examined for the Revised Master Plan's Financial Evaluation.....	77
Table 39: Estimated SWM Costs and Waste Amount.....	78
Table 40: Result of FIRRs for 4 Cases.....	78
Table 41: Condition for the Revised Priority Projects' Financial Evaluation.....	80
Table 42: Cases to be Examined for the Revised Priority Projects' Financial Evaluation.....	81
Table 43: Estimated SWM Costs and Waste Amount for the Revised Priority Projects.....	82
Table 44: Result of FIRRs for 3 Cases.....	82
Table 45: Project Cost Summary of the Revised Priority Projects.....	88

## List of Figures

	Page:
Figure 1: Study Area .....	2
Figure 2: 1998 Central District Waste Stream .....	7
Figure 3: Zones Affected by Flooding and Landslides Caused by Mitch in the Central District	9
Figure 4: Revenue and Expenditure for SWM in 1997 .....	18
Figure 5: Waste Generation Amount Forecast until 2010 .....	27
Figure 6: Master Plan of Service Population .....	27
Figure 7: Master Plan of Waste Collection and Haulage .....	27
Figure 8: Waste Stream Forecast for the Central District .....	28
Figure 9: "1st Stage" Organizational Chart of SWM Executing Unit .....	43
Figure 10: "1st Stage" Proposed Hierarchy Level of SWM Executing Unit .....	44
Figure 11: "2nd Stage" Organizational Structure of SWM Autonomous Entity .....	46
Figure 12: Work Schedule for Private Sector Participation .....	47
Figure 13: Location Map of New Disposal Site .....	48
Figure 14: Leachate Collection Drains - Cross Sections .....	54
Figure 15: Topographical Map of New Site .....	61
Figure 16: Stage 1 Development Plan .....	62
Figure 17: Typical Section Through New Landfill .....	63
Figure 18: Profile of New Landfill .....	64
Figure 19: New Disposal Site Facilities Plan .....	65
Figure 20: Final Closure Plan of Disposal Site .....	66
Figure 21: Cash Flow Diagram for Case 4 .....	79
Figure 22: Cash Flow Diagram for Case 3 .....	83

## Glossary

<i>AMDC's Solid Waste Executing Unit (SWEU)</i>	A provisional waste management authority under the current AMDC administrative structure.
<i>Municipal Cleansing Corporation</i>	An autonomous waste management agency that will be established by 2001.
<i>Municipal Corporation</i>	The legislative council of the AMDC.
<i>Non-Residential Waste</i>	Municipal solid wastes that are generated from sources other than residences. For the purpose of this study, non-residential waste is divided into business waste, waste from large dischargers, and waste hauled directly (direct haulage) to the final disposal site.
<i>Residential Waste</i>	Municipal solid wastes that are generated from only residential sources. For the purpose of this study, residential waste is divided into wastes from high income residences, middle income residences, and low income residences.

### List of Abbreviations

Abbreviation	English	Español	Abbreviation
AMDC	Municipality of the Central District	Alcaldía Municipal del Distrito Central	AMDC
BCIH	Central Bank of Honduras	Banco Central de Honduras	BCIH
BSC	Billing Service Company	Compañía Factoradora	CF
CBO	Community Based Organization	Comunidades de Base	CB
CESCCO	Center of Studies on Control of Polluting Agents	Centro de Estudios sobre Control de Contaminantes	CESCCO
CPI	Consumer Price Index	Índice de Precios al Consumidor	IPC
DAS	Disposal Amount Survey	Estudio de Cantidad de Disposición	ECD
DC	Central District	Distrito Central	DC
DEI	Executive Bureau of Revenue	Dirección Ejecutiva de Ingresos	DEI
DFR	Draft Final Report	Borrador de Informe Final	BI/F
EIA	Environmental Impact Assessment	Evaluación de Impacto Ambiental	EIA
EIRR	Economic Internal Rate of Return	Tasa Interna de Retorno Económica	TIRE
ENEE	National Company of Electricity	Empresa Nacional de Energía Eléctrica	ENEE
FENAFUTH	Honduras National Soccer Federation	Federación Nacional Autónoma de Fútbol de Honduras	FENAFUTH
FIRR	Financial Internal Rate of Return	Tasa Interna de Retorno Financiera	TIRF
GDP	Gross Domestic Product	Producto Interno Bruto	PIB
GRDP	Gross Regional Domestic Product	Producto Regional Interno Bruto	PRIB
ICR	Inception Report	Informe Inicial	I/IN
IDB	Inter-American Development Bank	Banco Interamericano de Desarrollo	IDB
ISW	Industrial Solid Waste	Residuo Sólido Industrial	RSI
ITR	Interim Report	Informe Intermedio	I/IT
JICA	Japan International Cooperation Agency	Agencia de Cooperación Internacional del Japón	JICA
MCC	Municipal Cleansing Corporation	Empresa Municipal de Limpieza	EML
METROPLAN	Urban Planning Office of AMDC	Oficina de Planificación Urbana de la AMDC	METRO-PLAN
M/M	Minutes of Meeting	Minuta de Reunión	M/R
M/P	Master Plan	Plan Maestro	P/M
MSW	Municipal Solid Waste	Residuo Sólido Municipal	RSM
OCS	Optimal Collection System	Sistema Óptimo de Recolección	SOR
O & M	Operation and Maintenance	Operación y Mantenimiento	O y M
PAHO	Pan American Health Organization	Organización Panamericana de la Salud	OPS
PCM	Project Cycle Management	Manejo de Ciclo de Proyecto	MCP
POS	Public Opinion Survey	Encuesta de Opinión Pública	EOP
P/R	Progress Report	Informe de Avance	I/A
PS	Public Sector	Sector Público No Financiero	SPNF
RAC	Residual Ash Content	Residuo de Ceniza	RC
SANAA	National Autonomous Service of Water and Sewerage	Servicio Nacional Autónomo de Acueductos y Alcantarillados	SANAA
SAS	Scavenger Attendance Survey	Muestreo sobre la Asistencia de los Recuperadores	MAR
SECPLAN	Secretariat of Planning, Coordination and Budget	Secretaría de Planificación, Coordinación y Presupuesto	SECPLAN (antes)
SEDA	Secretariat of Environment	Secretaría del Ambiente	SEDA (antes)
SEP	Secretariat of Public Education	Secretaría de Educación Pública	SEP

Abbreviation	English	Español	Abbreviation
SERNA	Secretariat of Natural Resources and Environment	Secretaría de Recursos Natural y del Ambiente	SERNA
SETCO	Technical Secretariat of International Cooperation	Secretaría Técnica de Cooperación Internacional	SETCO
SHCP	Secretariat of Finance and Public Credit	Secretaría de Hacienda y Crédito Público	SHCP
SIS	Scavenger Interview Survey	Encuesta a Recuperadores	ER
SOPTRAVI	Secretariat of Public Works, Transport and Housing	Secretaría de Obras Públicas, Transporte y Vivienda	SOPTRAVI (antes SECOPT)
SW	Solid Waste	Residuos Sólidos	RS
S/W	Scope of Work	Alcance de Trabajo	A/T
SWAS	Scavenger Waste Amount Survey	Muestro Sobre la Cantidad de Residuo Recuperado	MSCR
SWEU	Solid Waste Management Executing Unit	Unidad Ejecutora de los Residuos Sólidos	UERS
SWM	Solid Waste Management	Manejo de Residuos Sólidos	MRS
UDAPE	Unit of Economic Policies' Analysis	Unidad de Análisis de Políticas Económicas	UDAPE
UNAH	National Autonomous University of Honduras	Universidad Nacional Autónoma de Honduras	UNAH
UNPF	United Nations Population Fund	Fondo de Población de las Naciones Unidas	FNUAP
USCS	Unified Soil Classification System	Sistema de Clasificación de Unificada de Suelos	USCS
USD	US Dollars	Dólares Americanos	USD
USW	Uncompacted Specific Weight	Peso Específico No Compactado	PENC
WACS	Waste Amount & Composition Survey	Estudio de Cantidad y Composición de Residuos	ECCR
WAGR	Waste Amount Generation Rate	Encuesta de Cantidad y Generación de Residuos	ECGR
WCF	Waste Collection Fee	Tarifa por Recolección de la Basura	TRB
WHO	World Health Organization	Organización Mundial de la Salud	OMS
WTP	Willingness to Pay	Voluntad de Pago	VP

# Chapter 1

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*Outline of the Study*

# 1. Outline of the Study

## 1.1 Background

As of 1998, the population in the urban area of the Central District in the Republic of Honduras is approximately 850 thousand; however, with the remarkable population increase, coupled with urban migration, the population is estimated to reach 1.35 million in 2010.

At present, approximately 64% of the urban population is provided with regular waste collection services. Because, the services offered by the municipality of the Central District (AMDC) cannot cope with the rapid increase in illegal settlements, the results are illegal waste dumping or open burning of waste by residents of these areas. It is also difficult to collect the waste from these districts as most are located on steep terrain.

No environmental protection measures except waste covering is carried out in the present final disposal site. Although there are soil and heavy equipment for coverage, soil coverage is not being carried out on time due to fuel shortages. Therefore, problems such as offensive odors, waste scattering, unsightly view, and the increase in scavengers are intensifying and, furthermore, the number of critics to the disposal site is on the rise.

These problems can be attributed to the following: 1) an insufficient waste fee collection system and financial system for solid waste management (SWM); 2) the administrative agency's defective organizational structure and implementation system; and 3) lack of administrators and engineers for the formulation and implementation of an appropriate SWM plan.

Currently, the Central District's critical solid waste management system is providing its services mostly with the waste collection vehicles, equipment for final disposal sites, and spare parts that were provided under the Japanese Grant Aid Program in 1993. Although four years has passed and these equipment will soon need to be renewed, there is no replacement plan because the financial situation of AMDC is extremely critical. It can be expected that the solid waste management works will collapse with the expiration of the equipment's lifespan.

Under these circumstances, the Government of Honduras officially requested the Government of Japan, to carry out a study on the solid waste management (SWM) of the urban area of Tegucigalpa's Central District in order to improve environmental and sanitary conditions. In response to the request, the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, commissioned Kokusai Kogyo Co. Ltd., as a consulting company for this study.

Around the end of the Study, Honduras was hit by the devastating Hurricane Mitch. Since the hurricane caused serious damage to the Central District, the study period was extended to take account of the impacts of the disaster on the SWM plan.

## 1.2 Scope of the Study

### 1.2.1 Objectives of the Study

The Study aims to:

- Formulate a Master Plan on SWM by focusing on the main issues identified in the Preparatory Study.
- Carry out the Feasibility Study of the priority projects.
- Transfer of technology to counterpart personnel regarding the study of SWM and SWM planning methods.

### 1.2.2 Study Area

This Study covers the urban area of the Central District, as of 1998, and the forecast urban areas in 2010, as shown in Figure 1.

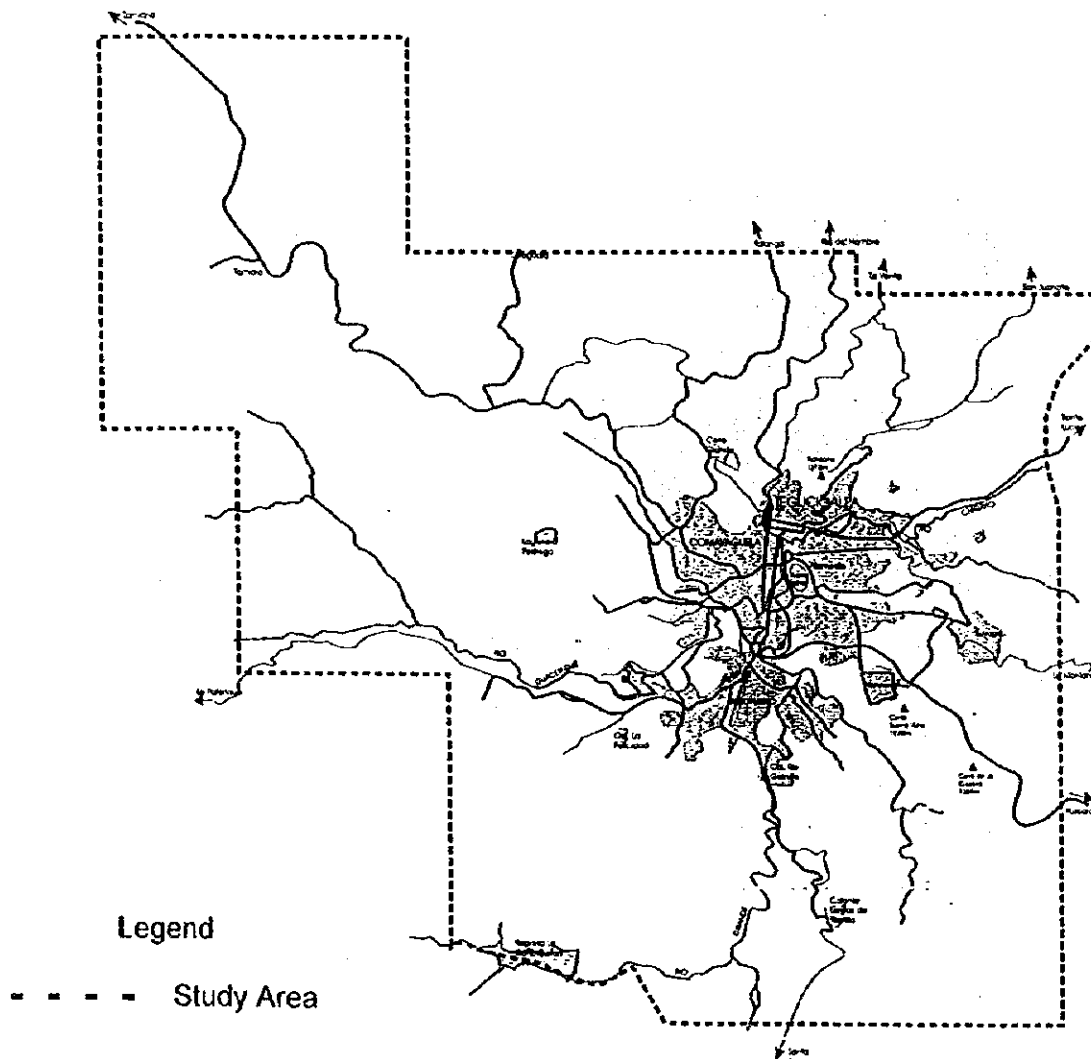


Figure 1: Study Area



### **1.2.3 Wastes Targeted**

This Study targets residential waste, market waste, commercial waste, street waste, and institutional waste. The study proposes general recommendations on how to properly handle such medical waste and industrial waste based on existing information. In addition, a part of the waste that resulted from the Hurricane Mitch is also included in the plan.

### **1.2.4 Target Year**

The Master Plan covers the period between 1999 and 2010.

## **1.3 Work Processes of the Study**

The Study began in January 1998, based on the Scope of Work (S/W), signed between the Honduras Government and JICA in August 1997, and ended in November 1998.

The study period consisted of the following two phases.

- Phase I (Jan. - Mar. 1998): Formulation of the Solid Waste Management Master Plan
- Phase II (May - Mar. 1999): Feasibility Study for the Priority Projects proposed in the Master Plan

## **1.4 Policies of the Study**

Based on the understanding of the present situation and SWM issues in the urban area of the Central District, the following were established as basic policies of this Study.

### **a. Formulation of a Practical Plan**

A two phase plan (an immediate plan and a full-scale plan) was established. The basic policy for the short term plan was to enhance the plan's workability with the premise of obtaining the municipality and the Cleansing Department's cooperation. The long term plan proposed thorough solutions, including organizational and institutional reconstruction, by establishing a sufficient preparation period in order to solve further problems in the future.

### **b. Formulation of a Sustainable Plan**

The factor that significantly sets solid waste projects apart from other infrastructure projects, such as construction of roads and dams, is the small capital and high operation and maintenance costs it requires. In terms of investment, the operation and maintenance plan is far more important than the facility and equipment plan. Therefore, the formulation of a sustainable operation and maintenance plan was given priority.

### **c. Appropriate Technology**

The operation and maintenance plan is an integral part of the SWM plan. It is necessary that the either AMDC or the Cleansing Department independently carry out O&M

using whatever resources they possess (technology, finance, and human resources). Thus, the basic policy for the technical plan would be the use of technology currently available in Honduras and the introduction of new technology suited to local conditions.

#### d. Participation

Changes in the SWM system directly affect the residents, as waste is the result of their daily activities. Separate collection, recycling, self disposal, as well as the construction and operation of a final disposal site cannot be carried out without the consent and cooperation of the residents. Accordingly, resident participation was encouraged during the planning phase, and the opinions of the residents are fully reflected in the plan.

## 1.5 Persons Involved

### 1.5.1 Members of the Study Team

Name	Assignment
Takeshi TOMIYASU	Team Leader & Solid Waste Management Planning
Akira DOI	Collection and Transport Planning & Waste Amount and Waste Composition Surveys
Kozo BABA	Management and Financial Planning
Jose ARELLANO V.	Final Disposal Site Planning
Masaharu KINA	Environmental Consideration
Jorge Alberto RODRIGUEZ M.	Social Consideration & Public Education Programs / Final Disposal Site Planning
Andrew DORMAN	Facility Design & Cost Estimation
Victor Ojeda R.	Institution and Organization Planning
Valerio GUTIERREZ	Translator
Ayako IDO	Administrative Coordinator

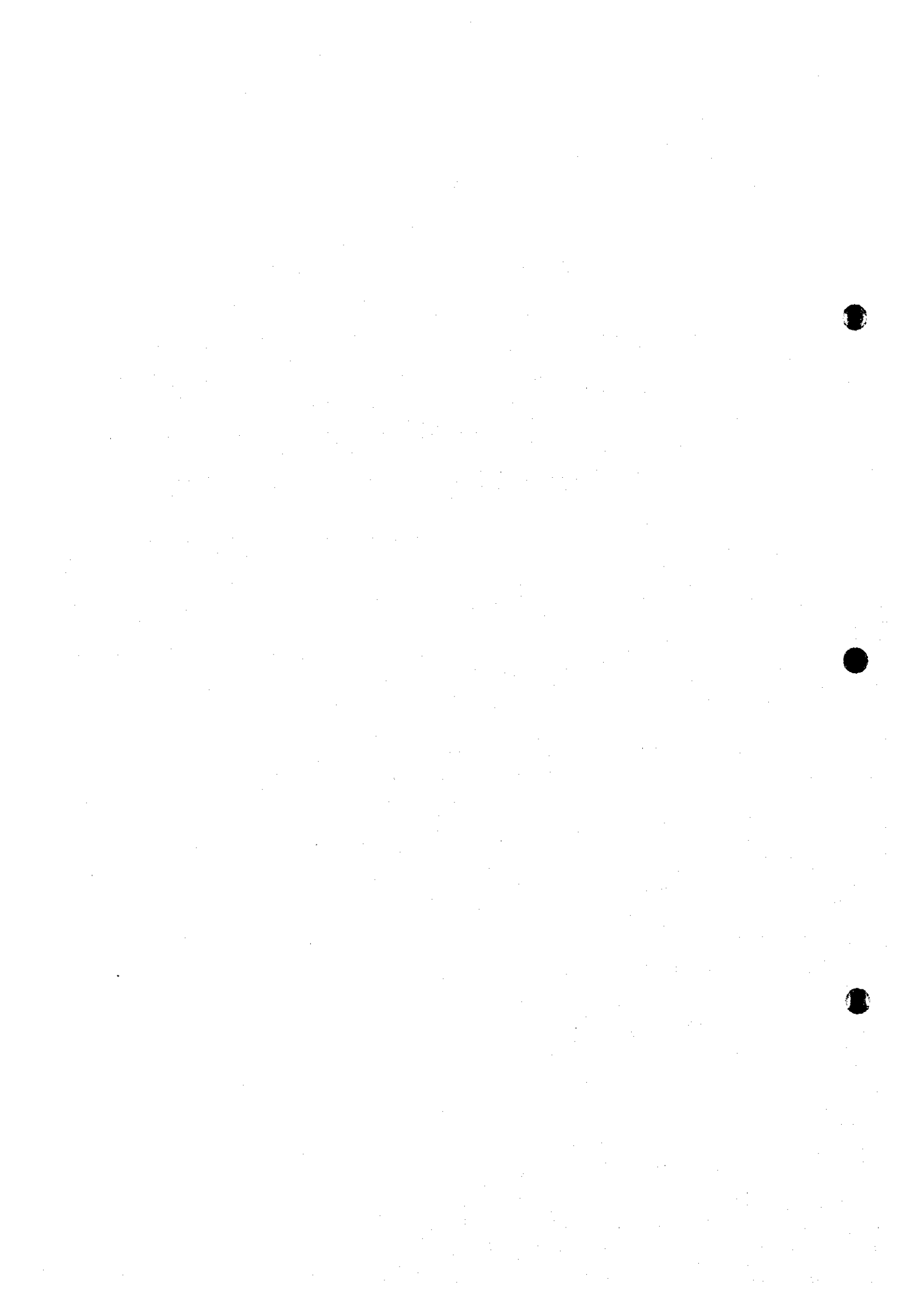
### 1.5.2 Members of the Honduran Counterpart

Name	Assignment
Pastor Mendez	Chief coordinator
José Adolfo Aguilar	Administration staff of solid waste with basic computer knowledge
Marcos Matamoros	Institutional and organizational system
Angela Victoria Sánchez	Financial accounting
Marlon Aguilera	Final disposal
Pastor Mendez / Humberto Medina	Collection and haulage
Karla Lezama / Graciela Castellanos	Environmental education and social promotion
Jenny Sager	Administrative Coordinator
Myrna B. Oyuela	Secretary

# Chapter 2

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*Present Features of  
the Municipal Solid Waste  
Management*



## **2. Present Features of the Municipal Solid Waste Management (SWM)**

### **2.1 Profile of the Study Area**

One of the characteristic features of the Study Area is its topography. It is mountainous and lies at an elevation between 900 masl and 1,535 masl. However, most of the urban area is located between 1,000 and 1,300 masl.

According to a survey conducted by METROPLAN on 457 barrios and housing developments in the Central District, 27% of the area has a natural slope gradient between 15% and 60%; this poses a strain on waste collection activities because collection vehicles are not designed to ascend gradients exceeding 20%.

### **2.2 Findings through the Field Surveys**

#### **2.2.1 Field Surveys**

Many useful findings were obtained through various field surveys, conducted to understand the present conditions, during the study. Detailed information on these field surveys are compiled in the Annex as shown below.

Title	Annex
Waste Generation Amount Survey	2
Survey on Waste Composition and Properties of Waste	3
Disposal Amount Survey	4
Survey on Recycling System	5
Survey on Scavengers	6
Survey on Private Collectors	7
Time and Motion Survey	8
Public Opinion Surveys	9
Large Dischargers' Opinion Surveys	10
Compost Demand Survey	11
Project Cycle Management Workshop on Final Disposal	12

## 2.2.2 Waste Amount Survey

The generation amount from all sources is tabulated in Table 1. A population of 848,859 translates into a residential WAGR of 375 g/person/day and a MSW WAGR of 564 grams per Central District citizen per day.

Table 1: Generation Amount of MSW

Waste Category	Unit	WAGR	Number	Waste generation amount tons/day
<b>Residential Waste</b>				
High income	g/capita/day	541	169,772	92.9
Middle income	g/capita/day	343	254,658	87.4
Low income	g/capita/day	328	424,430	139.1
<b>Total Residential</b>				<b>318.4</b>
<b>Non-Residential Waste</b>				
Commercial	g/establishment/day	3,270	17,504	57.2
Restaurant	g/restaurant/day	24,900	1,810	45.1
Institutional	g/employee/day	100	131,003	13.1
Market	g/stall/day	3,670	5,000	18.4
Street Sweeping	kg/km/day	163.9	180	29.5
<b>Total Non-Residential</b>				<b>162.3</b>
<b>Total Waste Generated Per Day</b>				<b>480.6</b>

## 2.2.3 Waste Composition Survey

Table 2: Composition and Physical Properties (Wet base)

	Components	Residential Waste				Market Waste
		High income	Middle income	Low income	Weighted Average	
Combustibles	Food wastes	51.2%	54.4%	37.9%	47.2%	82.8%
	Paper and CB	12.9%	12.7%	10.1%	11.5%	6.7%
	Textiles	2.0%	1.9%	3.8%	2.8%	0.0%
	Plastic	6.2%	8.3%	6.7%	7.1%	2.7%
	Grass & Wood	16.5%	10.0%	10.6%	11.6%	2.9%
	Leather & Rubber	0.4%	0.0%	4.2%	2.2%	0.1%
	Sub-total		89.2%	87.2%	73.3%	82.4%
Incombustibles	Metal	2.8%	1.1%	1.9%	1.9%	0.2%
	Glass	4.5%	2.3%	3.8%	3.5%	0.1%
	Ceramic & stone	3.5%	9.3%	21.0%	12.1%	4.4%
	Others	0.0%	0.2%	0.0%	0.1%	0.0%
	Sub-total		10.8%	12.8%	26.7%	17.6%
Uncompacted Specific Weight		0.21 kg/l	0.20 kg/l	0.19 kg/l	0.20 kg/l	0.3 kg/l
Moisture Content		52.8%	42.8%	38.8%	46.5%	68.5%
Lower Calorific Value						
	Karisato's Formula (calories/gram)	1,568	1,987	1,568	1,683	908
	Dulong's Formula (calories/gram)	1,522	1,956	1,668	1,615	747

N.B.: CB = Cardboard

### 2.2.4 Waste Final Disposal Amount

The disposal amount, calculated based on the study's findings, is significantly lower than the amount estimated by the Cleansing Department. The difference is attributed to the average truck weights used by the Cleansing Department to estimate waste amount are too high. The following table shows the average weights by type of vehicle as determined by the survey in the study and those used in February 1998 by the Cleansing Department.

Table 3: Weights by Type of Vehicles

Type of Vehicle	tons/load used by the Cleansing Section	tons/load measured by this study	Difference
Flat compactor (13m <sup>3</sup> )	6.26	5.7	-0.56
Fiat dump truck (8m <sup>3</sup> )	6.26	2.9	-3.36
Hino compactor (15m <sup>3</sup> )	6.26	6.4	+0.14
Nissan dump truck (12m <sup>3</sup> )	6.26	3.9	-1.36
Hino dump truck (8m <sup>3</sup> )	6.26	5.3	-0.96
M. Benz dump truck (8m <sup>3</sup> )	6.26	3.2	-3.06
Hino arm-roll truck (12m <sup>3</sup> )	6.26	2.8	-3.46
Hino hoist truck (5.5m <sup>3</sup> )	6.26	1.3	-4.96
Private vehicles - small	3.5	0.3	-3.2
Private vehicles - medium	3.5	0.7	-2.8
Private vehicles - large	3.5	1.5	-2.0

### 2.2.5 Waste Stream in 1998

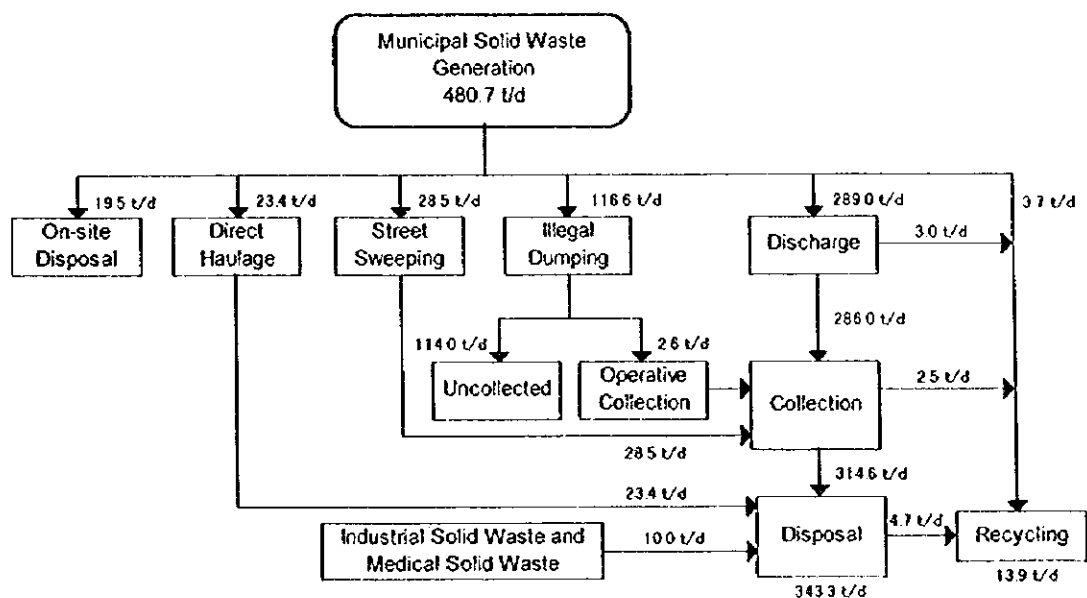


Figure 2: 1998 Central District Waste Stream

## **2.3 SWM Conditions after Hurricane Mitch**

The exceedingly strong hurricane Mitch hit Honduras from the 25th to 31st of October 1998. It first hit Swan Island before moving south-west to the Bay Islands. The center of the hurricane moved southwards to the mainland passing near Trujillo where it weakened into a tropical storm. On October 30, it passed through the central region of Honduras, including Tegucigalpa and then continued westward penetrating Guatemala.

The hurricane caused huge damage to Honduras and was the greatest disaster for Honduras in the twentieth century.

### **2.3.1 General Damage**

The damage caused by the hurricane nationwide includes approximately 7,000 deaths, 12,000 injuries, 8,000 missing persons, and the destruction of 189 bridges (75% of bridges nationwide).

In the Central District, damage mostly resulted from flooding and landslides. In particular, landslide north of the city center blocked the Choluteca River, resulting in the inundation of a wide section of Comayagua District, a densely populated commercial area.

According to a map of flooded areas and landslides prepared by SOPTRAVI, about 260 ha were flooded, while 110ha were affected by landslides (see Figure 3).

The Central District is reported to have had 300 deaths, 80 injuries. The number of people taken to shelters on the first day amounted to about 250,000. Seven (7) bridges were washed away and 6 were severely damaged. The number of buildings damaged by flood and landslides in the Central District is 1,472 (1.2%).



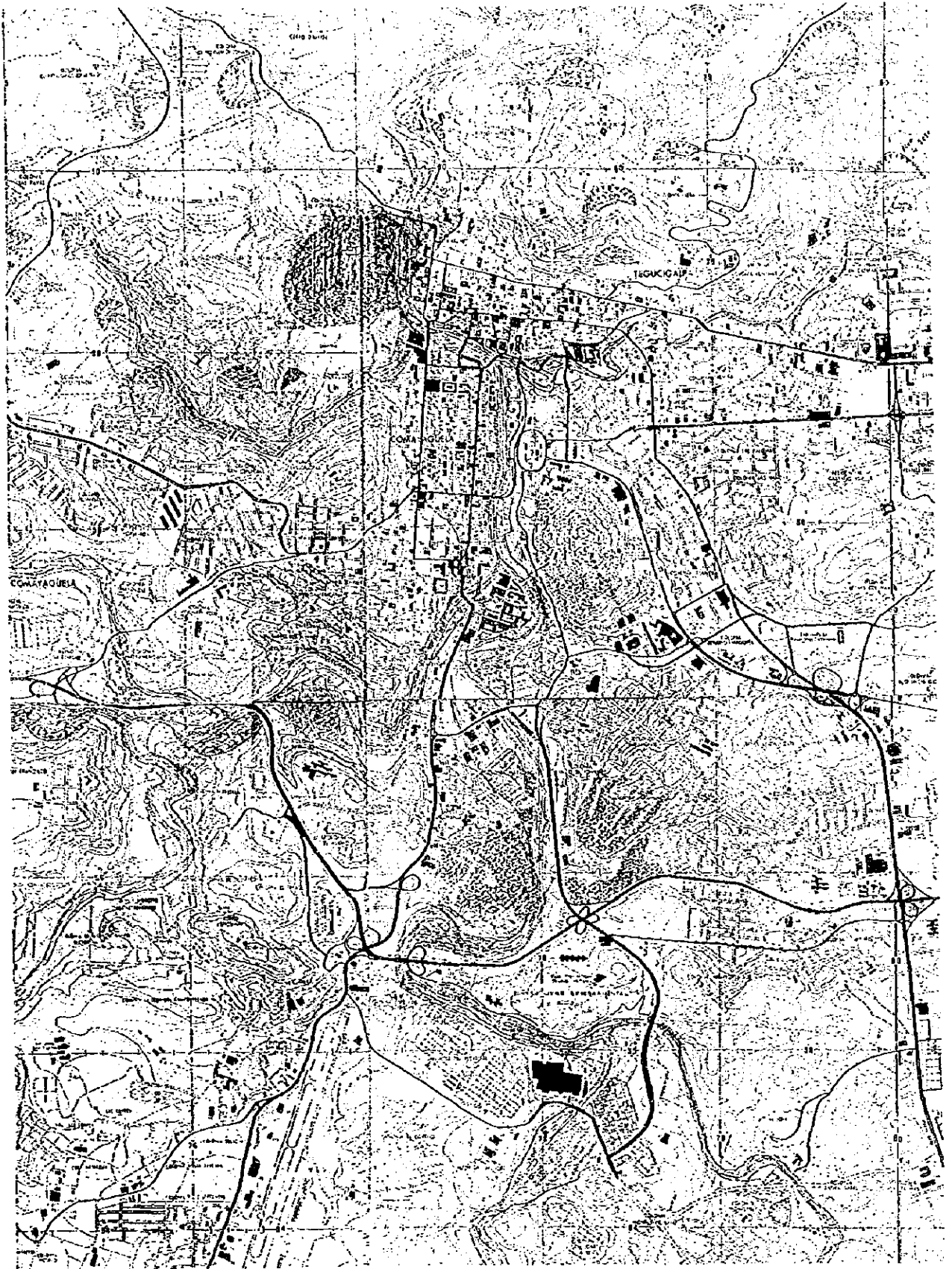


Figure 3: Zones Affected by Flooding and Landslides Caused by Mitch in the Central District

## 2.3.2 Socioeconomic Situation

### a. National Economy

National economic conditions were seriously affected by the onslaught of Hurricane Mitch. The estimated damage to infrastructure was about US\$1,928.7 million, and the decrease in Gross Domestic Product (GDP) in 1998 and 1999 has been estimated at about US\$832 million. In total, the hurricane's direct impact on the nation's economy has been estimated to correspond to US\$2,760.8 million, about 60% of the annual GDP.

Concerning damage in infrastructure, the reconstruction of road networks and bridges has been estimated to cost US\$469.5 million. SANAA is estimated to suffer a loss of US\$108.6 million from damage related to water supply systems.

The agriculture and livestock industry was seriously affected by Mitch. Damage in November and December alone reached US\$185.1 million. Damage to the manufacturing industry and the commerce, restaurant and hotel industry is estimated at US\$155.8 million and US\$38.5 million, respectively.

As for indirect damage, the loss in exports is estimated at US\$600 million, while imports increased by US\$700 million. The revenue of the Central Government is estimated to decrease by US\$304.2 million<sup>1</sup>.

GDP in 1998 was 2 percent (2.8%) less than the preliminary forecast and is estimated to be 2 % lower in 1999<sup>2</sup>.

On the other hand, the United Nations Economic Commission for Latin America and the Caribbean (CEPAL) estimated a direct damage of US\$2,004.7 million and indirect damage of US\$1,788.9 million. They also estimated the reconstruction cost to amount to US\$2,472.0 million and a resulting balance of payment of US\$1,256.9 million. The 1998 GDP is estimated to decrease by 2.7%, and by 6.8% in 1999<sup>3</sup>.

### b. AMDC's Finances

#### b.1 Revenue from Residential Waste Collection Fee

The present residential waste collection fee is established based on the property value. Therefore, loss in property value leads to a decrease in revenues from residential waste collection fee.

The houses damaged by Mitch were limited to specific areas; more than 50% of the buildings destroyed only made up 1.2% of the total number of buildings in the area. The decrease in the amount of waste collection fee collected jointly with property taxes is estimated at 1.5%, according to the data prepared by the cadastre department in the AMDC.

Besides the damage incurred by Mitch, the remarkable increase in revenues from the waste collection fee after September due to the introduction of identity codes should be taken into account as well. The measure incurred a 43% increase in the 1998 revenues in comparison to last year. In the last 5 months, the waste collection revenue increased

<sup>1</sup> Necesidades Urgentes y Lineamientos del Plan Maestro de la Reconstrucción Nacional

<sup>2</sup> El Heraldo, 9 February, 1999

<sup>3</sup> Honduras: Evaluación de los Daños ocasionados por el Huracán MITCH

by 116%. However, due to hurricane Mitch, the October revenues decreased to 79% of the previous year. Fortunately, it rebounded in November to 47% higher than that of 1997 and further increased in December by 193% compared to the previous year.

## b.2 Revenue from Business Waste Collection Fee

Forecasts on revenue from business waste collection fee were made taking two factors into consideration. One is increase in revenue resulting from the introduction of the new business waste collection fee tariff in January 1999. The other is decrease in revenue due to the businesses' reduced willingness and ability to pay as a result of the devastating effects of Hurricane Mitch.

The former business waste collection fee chart was complicated and was hardly ever applied therefore. The Study Team recommended in the DF/R submitted in October 1998 a new charging system whereby the business waste collection fee is determined based on the income. After making small alterations, AMDC approved the proposed system in December 1998. The system was implemented from January 1999 (see Table 4). The new business waste collection fee system is estimated to bring about a revenue 1.385 times the old one.

Table 4: New Business Waste Collection Fee

Annual business income	Fee Rate (establishment/month)
Up to Lps 50,000.00	Lps.40.00
Lps.50,000.01 - 100,000.00	Lps.80.00
Lps.100,000.01 - 300,000.00	Lps.125.00
Lps.300,000.01 - 600,000.00	Lps.180.00
Lps.600,000.01 - 1,000,000.00	Lps.240.00
Lps.1,000,000.01 - 2,000,000.00	Lps.325.00
Lps.2,000,000.01 - 5,000,000.00	Lps.500.00
Lps.5,000,000.01 - 10,000,000.00	Lps.700.00
Lps.10,000,000.01 - 15,000,000.00	Lps.800.00
Lps.15,000,000.01 - 20,000,000.00	Lps.1,000.00
Lps.20,000,000.01 - 30,000,000.00	Lps.1,300.00
Lps.30,000,000.01 - 40,000,000.00	Lps.1,500.00
Lps.40,000,000.01 - 60,000,000.00	Lps.1,600.00
more than Lps.60,000,000.01	Lps.1,800.00

Source: La Gaceta, 6 December 1998, AMDC

On the other hand, the revenue from the business waste collection fee is estimated to increase in 1999 and 2000 as a result of Hurricane Mitch. A 30% decrease in the number of payees is also estimated, and this is forecast to incur a 15% decrease in the revenues. However, with the new charging system, the revenue is expected to increase after 2001 in proportion to the increase in GDP.

Table 5: Potential Revenue from the New Business Waste Collection Fee and the Estimated Revenue Decrease by Hurricane Mitch

Annual Sale	New Revenue Potential			Effects Incurred by Mitch		
	Number of Payees	Fee Rate Lps/month	Revenue 10 <sup>3</sup> Lps/Year	Effect Incurred by Mitch %	Estimated Number of Payees	Revenue 10 <sup>3</sup> Lps/Year
< Lps.50,000	9,692	40	4,652	40	5,820	2,794
- 100,000	1,200	80	1,152	27	880	845
- 300,000	1,250	125	1,875	16	1,050	1,575
- 600,000	1,110	180	2,398	14	950	2,052
- 1,000,000	569	240	1,638	12	500	1,440
- 2,000,000	651	325	2,539	9	590	2,301
- 5,000,000	750	500	4,501	8	690	4,140
- 10,000,000	179	700	1,508	8	165	1,386
- 15,000,000	154	800	1,477	6	144	1,382
- 20,000,000	128	1,000	1,538	6	121	1,452
- 30,000,000	103	1,300	1,600	4	98	1,529
- 40,000,000	77	1,500	1,385	2	75	1,350
- 60,000,000	51	1,600	985	2	50	960
> 60,000,000	26	1,800	554	2	25	540
Total	15,940		27,802		11,158	23,746

Source: Financial Department, AMDC

### b.3 IDB's Loan

The IDB approved a loan for US\$40 million, of which US\$1 million will be allocated for SWM improvement. The loan has a 40-year repayment and a 10-year grace period. Interest is 1% during the grace period and 2% for the following 30 years. According to the loan agreement, the first US\$12 million of the loan, including US\$500,000 for SWM improvement, should be spent before September 1999.

### b.4 AMDC's Overall Finances

The AMDC's revenue increased despite the disaster.

The collection of the property tax has increased in September because of the introduction of identity codes with the billing system. The total property tax in 1998 increased by 46% compared to 1997. Over the final 5 months of 1998, the collection was 51% higher than 1997. With the hurricane hitting in October, the collection in this month was 18% lower than the previous year. However, the collection in November was 55% higher than the collection on the same month of the previous year. In December, a 93% increase from the same month in the previous year was recorded.

However, the AMDC had to get a loan of Lps.20 million for salaries for the final 2 months of 1998, and a loan of Lps.40 million for expenses during Hurricane Mitch.

The infrastructure of the Central District was seriously damaged due to the hurricane. However, the extent (including rehabilitation costs) of the damage has not been calculated yet.

The 1999 municipal budget is Lps.561.4 million, 1.36 times the 1998 primary budget. The actual revenue in 1998 was Lps.345.5 million. Therefore, the AMDC must collect 1.62 times more this year than it did in 1998. The revenue plan is expected to increase revenues from public service fees as shown in the following table.

Table 6: Changes in Municipal Revenue

Items	Municipal Revenue (1,000 Lps)				Ratio	
	1997	1998	1998	1999	1998/1997	1999/1998
	Actual (A)	Budget (B)	Actual (C)	Budget (D)	(C/A)	(D/B)
Total Revenue	181,324	412,395	345,539	561,447	1.906	1.361
Current Revenue	179,633	281,895	237,418	273,254	1.322	0.969
Direct Tax	83,400	164,475	122,154	110,655	1.465	0.673
Indirect Tax	9,061	26,400	12,616	19,480	1.392	0.738
Recovery of Credit	28,389	58,300	29,459	58,156	1.038	0.998
Public Service Fee (PS)	57,920	30,720	71,949	84,191	1.242	2.741
Rental Fee	863	2,000	1,239	771	1.436	0.386
Capital	1,691	130,500	108,121	288,193	63.950	2.208
Transfer	1,257	123,000	103,447	286,000	82.300	2.325
Sales of assets		4,500	767	2,193	-	0.487
Donation	434	3,000	3,907		9.007	0.000
Reference: within PS fee						
Waste Tax	19,711	20,000	26,398	30,261	1.339	1.513

Source: Financial Department

### b.5 Financial Improvement Policy

In spite of the damage it suffered from Hurricane Mitch, the AMDC still adheres to the implementation policy adopted for drastic improvements in the municipal tax collection system and municipal financial system. In fact, the AMDC has already introduced in January 1999 the new business waste collection fee system proposed by the JICA Study Team for implementation in 2001. In addition, it is actively making the preparations for the joint billing of waste collection fees and electricity charges in 2000 as proposed by the Study Team. The AMDC, therefore, aims to actively promote the institutional improvement measures proposed by the team.

### 2.3.3 Technical System

#### a. Sanitary Conditions

As of February 1999, the Central District has been generally clean except for some areas not covered by the collection service and the surroundings of public waste containers. The same condition was generally observed before the onslaught of Hurricane Mitch.

#### b. Collection and Haulage

##### b.1 Collection and Haulage Route

Although 13 bridges in the Central District were severely damaged by the flood, only the Juan Ramón Molina bridge which connects Tegucigalpa and Comayagua below the National Stadium was destroyed in the area covered by the collection service. On 16 February 1999, the Bailey-type bridge reinstalled by the U.S. Marine Corps and holds more weight than the previous one was opened for passage. Collection and haulage operations resumed their former routes after the opening of the bridge.

##### b.2 Waste Collection Equipment and Facilities

Due to the flood that resulted from the hurricane, AMDC lost a 12m<sup>3</sup> container and a 5.5m<sup>3</sup> container, while the private company contracted by AMDC lost three large

containers. In view of the amount of equipment used for waste collection, however, this type of loss is quite insignificant.

### **b.3 Maintenance of Equipment**

The operation rate of the AMDC's fleet, especially the Fiat compactors and Fiat dump trucks purchased in 1988, has remarkably decreased from 80% before Mitch to 50% after Mitch. This is mainly attributed to:

- Overuse of vehicles for removal of huge debris after the hurricane.
- Untimely purchase of necessary spare parts.
- Obsolete conditions.

## **c. Final Disposal**

### **c.1 Hurricane Waste**

The amount of hurricane waste carried to the existing disposal site from October 1998 until the end of February 1999 was estimated at approximately 250,000 m<sup>3</sup>. Waste resulting from the hurricane consists mainly of soil and some building debris and trees as well. Most of the waste disposed of seems suitable for use as waste cover, and can, therefore, be excavated and utilized as such later.

The amount of hurricane waste, still remaining in the city as of March 1999, which will be hauled to the existing disposal site is approximately 50,000m<sup>3</sup>.

### **c.2 Existing Disposal Site Remaining Capacity**

Based on the topographical survey data and the master plan for disposal site development for this Study, the existing site has a remaining capacity of 2,440,000m<sup>3</sup> and is therefore fully capable of accommodating waste until the end of 2006.

However, the approximately 300,000m<sup>3</sup> of hurricane waste collected will use up the site's space equivalent to two years' worth of waste. It implies that the remaining useful life of the existing disposal site has been shortened by two years, that is until the end of 2004.

### **c.3 Condition of Landfill Equipment**

Due to the tremendous disposal work after Hurricane Mitch, shortage in funds for the purchase of necessary spare parts, and lack of proper maintenance, two of three bulldozers are out of order as of March 1999, although there are still three at the existing disposal site.

### **c.4 Facilities in the Disposal Site**

The tarmaced 350m access road extending from the Olancho Road to the filling area, the entrance gate, signboards, site office, storehouse, wire fence, and nets to prevent waste scattering are still in good condition. Only the animal trap at the entrance has been filled with soil, allowing animal entry into the site. Favorable slope conditions were observed.

Table 7 shows the inventory of main SWM equipment owned by the AMDC, while Table 8 shows those owned by the private waste collection company.

Table 7: Main Equipment Owned by the Cleansing Department

Work Category	Description	Year Purchased	Unit	Quantity
Collection and Haulage	15m <sup>3</sup> Compactor	1993	units	11
	13m <sup>3</sup> Compactor	1988	units	9
	12m <sup>3</sup> Dump truck	1993	units	10
	6m <sup>3</sup> Dump truck	1988	units	5
	Arm-roll truck	1993	units	1
	Hoist truck	1993	units	1
	12m <sup>3</sup> Container for Arm-roll truck	1993	nos.	12
	5.5m <sup>3</sup> Container for hoist truck	1993	nos.	10
Street Sweeping	Only manual work	-	-	-
Final Disposal	Final disposal site in Guanábana	since 1977	ha	31.7
	Bulldozer CAT D7	1993	units	3
	Wheel loader	1993	units	2
	Dump truck	1993	units	3
Maintenance	Workshop in Colonia 21 de Octubre	-	place	1
	Mobile workshop	1993	units	1
Supervision, Inspection, etc.	Pick-up	1993	units	1
Administration	Office building in Colonia 21 de Octubre	1994	unit	1

Table 8: List of Equipment Owned by CCSM

Equipment	Capacity	Numbers	Year Manufactured
Compactor	15.3m <sup>3</sup>	6	1989 - 1992
Container	4.6m <sup>3</sup>	78	1998
Roll-on roll-off	-	2	1989, 1990
Container	15.3m <sup>3</sup>	23	1998
Large truck	21.4m <sup>3</sup>	1	1988
Street sweeper	-	2	1991, 1992

## 2.4 Assessment of Current Municipal SWM

### 2.4.1 Technical System

At present, the most prevalent SWM technical system in the Study Area is rudimentary, composed only of collection and haulage of waste, mainly using compactors and dump trucks, and final disposal; it is exclusive of major processing, intermediate treatment or recycling systems. This system is basically appropriate for the Study Area as long as the acquisition of land for the disposal site is financially and/or socially unproblematic. However, considering the worldwide trend that incorporates conservation issues into solid waste management, a recycling system should be introduced gradually so long as it does not affect the financial sustainability of the cleansing work.

Considering that the present waste collection coverage rate in the city has reached 64% and the standard of cleanliness is generally maintained, the present waste collection service level is assessed to be fair except in areas that do not receive a regular waste collection service. Often, these are low income residential areas, where lack of a frequent service has left unhygienic conditions that have often been blamed for outbreaks of dengue fever. The expansion of a regular waste collection service, therefore, should be a continuous endeavor.

As for the collection and haulage system, the present compactor collection system functions adequately, however the present collection and haulage plan can be seen as inappropriate because the allocation of the present collection areas has no rational explanation. The efficiency of the dump truck collection system was found to be average; the reason is not only attributable to the type of vehicle used but also inferior road conditions, low accessibility, lack of people's cooperation in discharging manner, etc. In order to improve the general collection work efficiency, various measures, for example promoting a more conscientious discharge manner, phasing-out the dump truck collection system and replacing it with a more appropriate system, etc. should be examined.

The present recycling activities rely mainly on scavengers operating at the disposal site and collection workers' sorting work. Although both activities contribute to recycling, they are informal and also impose negative impacts to the present solid waste management system. It is, therefore, necessary for the governmental organizations to gradually participate in recycling and strengthen the control of informal recycling activities.

As for the final disposal system, no appropriate environmental protection measures are taken except soil coverage. Also, bulldozers operating at the landfill are not provided with sufficient amounts of diesel fuel and entry of scavengers to the site is unrestricted. Therefore, the condition of the disposal site is unacceptable. On examination of the environmental impact the disposal site poses on its environs, it is observed that the flow of leachate from the disposal site is very minimal and the generated leachate percolates into the ground before reaching the Choluteca River. It can be predicted that the impact by leachate would be marginal because the water quality of Choluteca River is far greater and worse than the leachate from the site. This is due to the discharge of raw sewage from Tegucigalpa and Comayagua into Choluteca River upstream from the disposal site. In addition, the existing disposal site is located far from the water basins for the Central District. Consequently, it is concluded that the existing disposal site does not pose a serious threat to the surrounding environment. However, there are some considerable negative effects caused by nuisances, offensive odors, and unsightly view etc., because it faces the main road: the number of critics to the final disposal site is on the rise.

The existing disposal site area is 31.7 hectares, of which only 12 hectares are used for landfilling. The construction of a new final disposal site has become an urgent need as the life span of the existing site has become shorter (until 2004) as a result of the disposal from 1998 until 1999 of waste (approximately 300,000m<sup>3</sup>) resulting from the hurricane. The existing disposal site has a favorable natural condition in terms of environmental protection and haulage of waste. The sanitary condition will be enhanced by improving some facilities, training staff in operation techniques and raising awareness among the municipalities' staff and citizens. Therefore, the best option is considered to be the utilization of the existing disposal site, for as long as possible, providing the landfill operation level is improved. In addition, planning and construction of a new final disposal site should proceed deliberately while the existing disposal site has a reserve.

All street sweeping work is carried out manually, and it is effectively supported by many trash boxes recently installed along the streets. In consideration of the general cleanliness within the city that is maintained by an appropriate number of street



sweepers, it is judged that the present system is appropriate except the collection system of street sweeping waste.

As for maintenance of equipment, the present technical system is believed to be suitable, considering the high operation rate of compactor trucks and the fact that many ten year-old FIAT compactors still function. However, repair works often take quite a long time. This is mainly due to the inherent bureaucracy that has a disposition to long processing procedures before spare parts are purchased.

## **2.4.2 Institutional and Organizational System**

### **a. Legal Framework**

Legislation related to SWM is found in a variety of laws, regulations, and decrees. Consequently, there is no specific legal framework to help develop SWM, creating a situation that undermines the authorities' position to manage the services effectively.

### **b. Institutional Structure**

Although the service provided by the AMDC's Cleansing Department is very important, and it is responsible for hundreds of workers, vehicles, and important funds, the hierarchic level of this section is comparatively low-ranking, affecting its ability to plan, manage, and operate services appropriately.

This situation leads to slow decision making and prolonged administrative transactions, specially for acquisition of spare parts for vehicles and machinery, as a result productivity is affected.

### **c. Organization Structure of the Cleansing Department**

An analysis of the results obtained during this study revealed that there is considerable weakness in the operation and the administrative structure of this section.

- Goals and objectives are poorly defined by this section; because of this, officials become confused, thus creating a situation where activities are uncoordinated.
- There are neither service plans nor medium and long term development plans. Authorities have not emphasized the importance of cleansing services, personnel transfer takes place with each new administration, and, as a result, there are very few plans and programs to cater for medium term and long term service needs. An obvious consequence is that the system is only able to administer day to day issues, and problems are left to workers who have been with the institution over a longer period (driver and mechanics).

### **d. Public Participation**

It is noteworthy that recently there have been changes in the public's image and perception of SWM. The AMDC has been making efforts to improve the cleanliness of the city. However, this initiative should be taken together with the institution's structural reform so that the development of this public service becomes an ongoing venture; and with time, the public will be inclined to be supportive and loyal to the institution's cause.

### 2.4.3 Financial System

Regarding the financial situation of SWM works in 1997, the revenue from the waste collection fee, i.e. Lps. 20 million, seemed to be sufficient to cover the expenditure, which was Lps. 18 million.

However, expenditure including depreciation for vehicles and equipment donated in 1993 was Lps. 25 million, that was 1.4 times the expenditure. Considering the fact that more than 15 US\$/ton is necessary to provide sufficient collection services and more than 3 US\$/ton is necessary to dispose these waste in developing countries, at least Lps. 36 million is needed to provide sufficient SWM in the Central District.

The actual collection rates of the waste collection fees in 1997 were 49% for residential waste collection fee, which is collected jointly with the property tax, and 74% for the non-residential waste collection fee, which is collected jointly with the business income tax. Even if the collection rate of waste collection fees reach 100%, the total revenue will be Lps.32 million; it is insufficient to operate SW services and to finance the replacement of equipment.

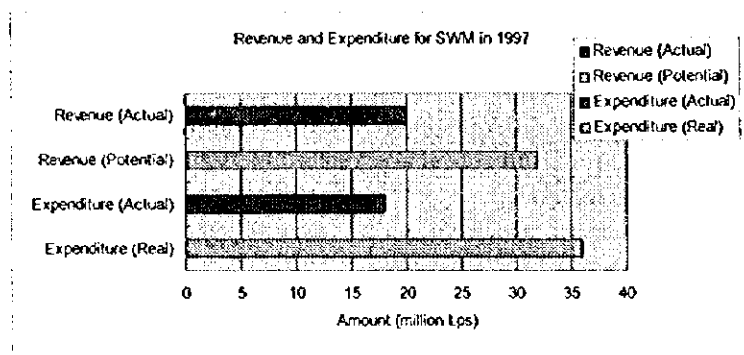


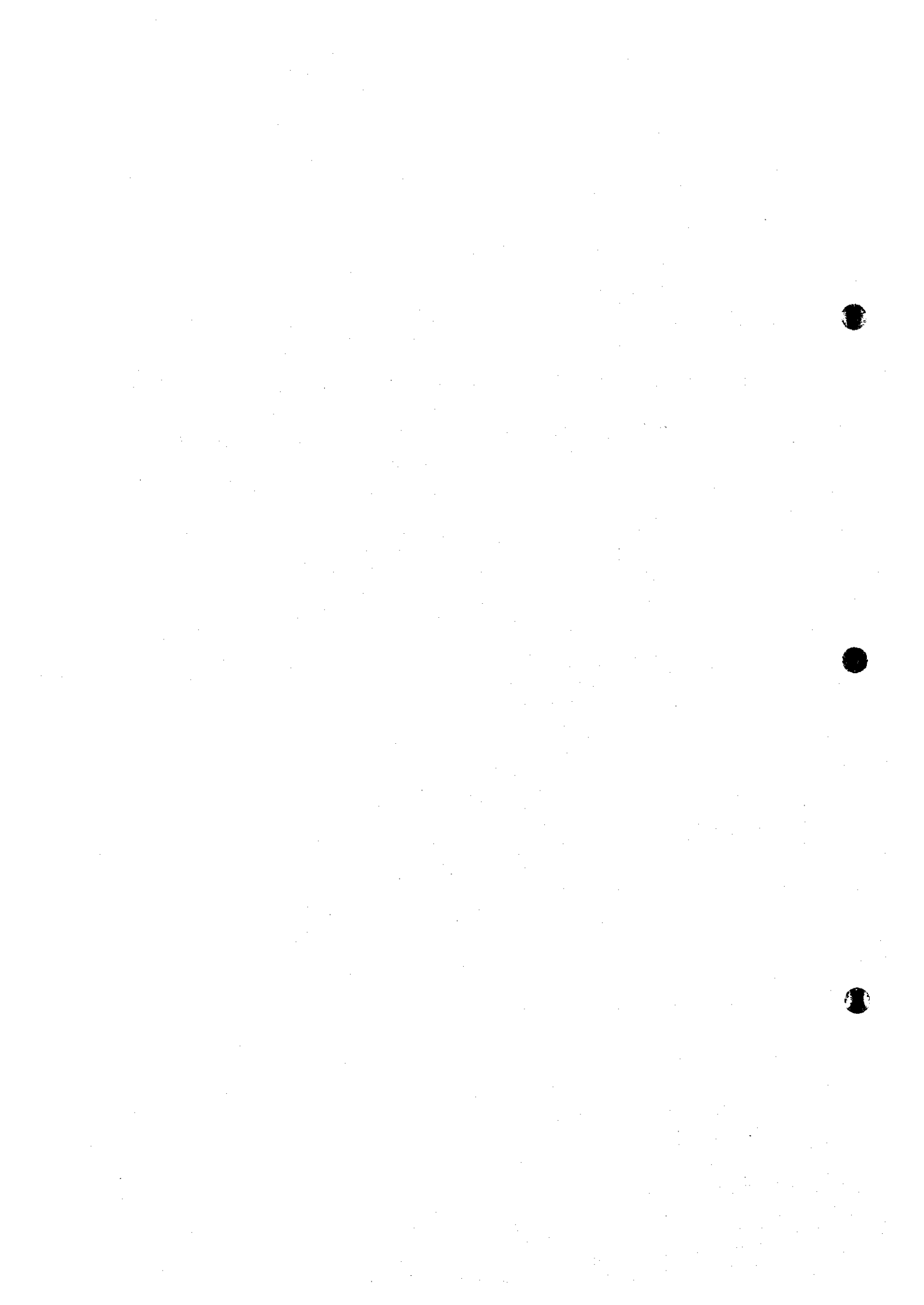
Figure 4: Revenue and Expenditure for SWM in 1997

The reason why the SWM works can be currently managed by the AMDC is mainly because of the equipment and the spare parts were granted in 1993. Although four years have passed and these equipment are due for renewal, no replacement plan is being prepared because the financial situation of the AMDC is extremely critical. The solid waste management works are likely to be in disarray with the expiration of the equipment's lifespan.

# Chapter 3

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## *The Solid Waste Management Revised Master Plan*



### 3. The Revised SWM Master Plan

#### 3.1 Future Projection for the Master Plan

##### 3.1.1 Socioeconomic Indices

###### a. GDP and GRDP

National economic conditions generally affect the economy of the Central District. Increase in foreign aid and in imports, however, have mitigated these effects. Because the 7% increase assumed in the M/P seems difficult to realize, a 5.9% increase will be assumed instead for 1998 while 4.3% will be assumed for 1999.

Major national disasters are usually followed by increased reconstruction work. Accordingly, the 6% increase in GRDP assumed in the draft M/P for 2001 will be modified to 7%.

The GDP and GRDP in Tegucigalpa are shown in Table 9.

Table 9: GDP and GRDP in Tegucigalpa

Unit: million Lps*				
Year	GDP	Rate of Increase (%)	GRDP	Rate of Increase (%)
1997	53,330		13,609	
1998	54,823	2.8	14,416	5.9
1999	53,727	-2.0	15,041	4.3
2000	56,950	6.0	16,094	7.0
2001	60,367	6.0	17,221	7.0
2002	63,386	5.0	18,254	6.0
2003	66,555	5.0	19,349	6.0
2004	69,883	5.0	20,510	6.0
2005	73,377	5.0	21,741	6.0
2006	76,312	4.0	22,828	5.0
2007	79,365	4.0	23,969	5.0
2008	82,539	4.0	25,168	5.0
2009	85,841	4.0	26,426	5.0
2010	89,274	4.0	27,747	5.0

Note: \* Constant price in 1997  
Source: Financial Department

###### b. Population

Table 10 shows the projection of population by income level group until 2010.

Table 10: Projection of Population by Income Level Group

Year	Population Ratio			Population			
	High	Middle	Low	Total	High	Middle	Low
1998	20.0%	30.0%	50.0%	848,859	169,772	254,658	424,430
1999	19.5%	31.5%	49.0%	882,322	172,053	277,931	432,338
2000	19.0%	33.0%	48.0%	917,104	174,250	302,644	440,210
2001	18.5%	34.5%	47.0%	953,257	176,353	328,874	448,031
2002	18.0%	36.0%	46.0%	990,835	178,350	356,701	455,784
2003	17.5%	37.5%	45.0%	1,029,895	180,232	386,211	463,453
2004	17.0%	39.0%	44.0%	1,070,495	181,984	417,493	471,018
2005	16.5%	40.5%	43.0%	1,112,695	183,595	450,641	478,459
2006	16.0%	42.0%	42.0%	1,156,558	185,049	485,754	485,754
2007	15.5%	43.5%	41.0%	1,202,151	186,333	522,936	492,882
2008	15.0%	45.0%	40.0%	1,249,541	187,431	562,293	499,816
2009	14.5%	46.5%	39.0%	1,298,799	188,326	603,942	506,532
2010	14.0%	48.0%	38.0%	1,350,000	189,000	648,000	513,000

### 3.1.2 Waste Amount and Composition

#### a. Waste Generation Amount

##### a.1 Target Waste

Waste is defined as materials arising from human and animal activities that are considered as useless or unwanted items<sup>4</sup>. All materials, however, eventually lose their worth. The waste generation amount is, therefore, closely associated with the population and per capita consumption, a relationship that implies that the waste generation amount increases with the increase in GRDP.

In this study, the following assumptions were made to forecast the waste generation amount.

- 1) The generation amount of all types of wastes, except street waste, will be directly proportional to the population.
- 2) The waste generation amount rates of all types of waste, except street waste, will increase by 50% of the annual GRDP growth rate.
- 3) The waste generation amount rate of street waste will remain constant until 2010.

Table 11 shows the relationships between the waste generation growth rate adopted for this study and the projected GRDP growth rate until 2010.

Table 11: Projected Waste Generation Growth Rate (until 2010)

Year	GRDP Growth	Waste Amount Generation Growth Rate	
		Excluding street wastes	Street waste
1998	6.0%	103.0%	0.0%
1999	4.3%	102.2%	0.0%
2000	7.0%	103.5%	0.0%
2001	7.0%	103.5%	0.0%
2002	6.0%	103.0%	0.0%
2003	6.0%	103.0%	0.0%
2004	6.0%	103.0%	0.0%
2005	6.0%	103.0%	0.0%
2006	5.0%	102.5%	0.0%
2007	5.0%	102.5%	0.0%
2008	5.0%	102.5%	0.0%
2009	5.0%	102.5%	0.0%
2010	5.0%	102.5%	0.0%

<sup>4</sup> Excerpt taken from: "Integrated Solid Waste Management - Engineering Principles and Management Issues"; McGraw-Hill Series in Water Resources and Environmental Engineering, 1993.

Table 12 shows the waste generation amount rates projected based on the projected growth rate shown in Table 11.

Table 12: Projected Waste Generation Amount Rates (until 2010)

Year	Municipal Waste								Industrial & Medical Waste kg/c/d
	Residential			Non-residential					
	High kg/c/d	Middle kg/c/d	Low kg/c/d	Commercial kg/c/d	Restaurant kg/c/d	Institution kg/c/d	Market kg/c/d	Street kg/km/d	
1998	0.541	0.343	0.328	0.067	0.053	0.015	0.022	158.300	0.012
1999	0.557	0.353	0.338	0.069	0.055	0.016	0.022	158.300	0.012
2000	0.569	0.361	0.345	0.071	0.056	0.016	0.023	158.300	0.012
2001	0.589	0.374	0.357	0.073	0.058	0.017	0.024	158.300	0.013
2002	0.610	0.387	0.370	0.076	0.060	0.017	0.024	158.300	0.013
2003	0.628	0.398	0.381	0.078	0.062	0.018	0.025	158.300	0.014
2004	0.647	0.410	0.392	0.081	0.063	0.018	0.026	158.300	0.014
2005	0.666	0.422	0.404	0.083	0.065	0.019	0.027	158.300	0.015
2006	0.686	0.435	0.416	0.085	0.067	0.020	0.027	158.300	0.015
2007	0.703	0.446	0.426	0.088	0.069	0.020	0.028	158.300	0.015
2008	0.721	0.457	0.437	0.090	0.071	0.021	0.029	158.300	0.016
2009	0.739	0.469	0.448	0.092	0.073	0.021	0.030	158.300	0.016
2010	0.758	0.480	0.459	0.094	0.074	0.022	0.030	158.300	0.017

Table 13 shows the projected waste generation amounts until 2010 based on the projected waste generation rates and the projected population. The daily waste generation amount is forecast to increase from 491 t/d in 1998 to 1,050 t/d in 2010.

Table 13: Projected Waste Generation Amounts (until 2010)

Year	Municipal Waste											Total
	Residential				Non-residential							
	High	Middle	Low	Sub-total	Commercial	Restaurant	Institution	Market	Street	ISW, MSW	Sub-total	
1998	92	87	139	318	57	45	13	18	28	10	172	491
1999	96	98	146	340	61	48	14	20	28	11	182	522
2000	99	109	152	360	65	51	15	21	28	11	192	552
2001	104	123	160	387	70	55	16	22	28	12	204	591
2002	109	138	168	415	75	59	17	24	30	13	219	634
2003	113	154	176	443	81	63	18	26	30	14	232	676
2004	118	171	185	474	86	68	20	28	30	15	247	720
2005	122	190	193	506	92	73	21	30	32	16	264	770
2007	131	233	210	575	105	83	24	34	35	18	299	874
2008	135	257	218	611	112	88	26	36	36	20	318	929
2009	139	283	227	649	120	94	27	38	38	21	338	988
2010	143	311	236	690	127	100	29	41	40	22	360	1,050

## a.2 Hurricane Waste

The hurricane waste to be taken into account in the revised Master Plan is:

- a) Approximately 250,000 m<sup>3</sup> of hurricane waste hauled to the existing disposal site in 1998.
- b) Approximately 50,000m<sup>3</sup> of uncollected hurricane waste and debris in the Central District, which will be hauled to the existing disposal site in 1999.

## b. Waste Composition

The waste composition forecasts for 2004 and 2010 are as shown in Table 14.

Table 14: Waste Composition Forecast of Residential Waste

Items	1998		2004		2010	
	Rate	Amount (tons/day)	Rate	Amount (tons/day)	Rate	Amount (tons/day)
<b>Combustibles</b>						
Kitchen wastes	46%	220	42%	304	40%	422
Paper and CB	12%	58	13%	94	15%	158
Textiles	3%	14	3%	22	3%	32
Plastic	7%	34	8%	58	8%	84
Grass & Wood	12%	58	12%	87	12%	127
Leather & Rubber	2%	10	2%	14	2%	21
Sub-total	82%	394	80%	579	80%	844
<b>Non-combustibles</b>						
Metal	2%	10	3%	22	4%	42
Glass	3%	14	4%	29	5%	53
Ceramic & Dirt	13%	63	12%	87	10%	105
Others	0%	0	1%	7	1%	11
Sub-total	18%	87	20%	145	20%	211
<b>Total</b>	<b>100%</b>	<b>481</b>	<b>100%</b>	<b>724</b>	<b>100%</b>	<b>1,055</b>
Lower Calorific Value by Karisato's Formula	1,667 cal/g		1,723 cal/g		1,761 cal/g	
by Dulong's Formula	1,615 cal/g		1,734 cal/g		1,778 cal/g	

N.B.: CB = Cardboard

## 3.2 Examination of the Best Technical System

Considering the current situation and background of SWM in the study area, the following are policies for the selection of a technical system:

- 1) Systems and technologies to be adopted should be simple so that operation and maintenance are both easy and inexpensive.
- 2) Requirements for foreign financing to purchase, operate and maintain facilities should be minimal. The use of locally available materials and services should be maximized.
- 3) Technical system proposals have to be consistent with the institutional requirements to ensure their efficiency.

The screened potential subsystems for the Central District are listed in Table 15.



Table 15: Potential Subsystems for SWM in the Central District

Technical Systems	Technical Sub-systems	Sub-system Components
Discharge and Storage	• Source Separation	• Mixed discharge • Separate discharge
	• Type of Storage Equipment	• Paper or plastic sacks • Dustbins • On-site waste storage • Containers (1 to 2 m <sup>3</sup> ) • Large communal containers (more than 5 m <sup>3</sup> )
Primary Collection	• Type of Collection System	• Handcart • Animal drawn cart • Pedal cart • Motorized cart
Secondary Collection and Haulage	• Collection Frequency	
	• Collection Method	• Mixed collection • Separate collection
	• Collection System	• Point collection • Curb side collection • Door-to-door collection • Bell collection • Public container collection
	• Collection Schedule	• Day collection • Night collection
	• Collection Vehicle	• Compactor truck • Tractor and trailer • Dump truck • Detachable truck
	• Transfer Station	•
Street Sweeping	• Cleaning Method	• Manual street sweeping • Mechanical cleaning • Vacuum cleaning • Flushing
Processing and Treatment System	• Incineration	
	• Refuse Derived Fuel (RDF)	
	• Biogas Production	
	• Pyrolysis	
	• Composting	• Collective compost plant • On-site compost plant
	• Size Reduction	
	• Mechanical and Manual Sorting	
Recycling	• Government Related	
	• Private Sector Centered	
Final Disposal	• Method of Sanitary Landfill	• Four different sanitary level
Maintenance of Vehicles and Equipment	• Preventive Service Workshop	
	• Full Service Workshop	

Following the examination of various SWM technical sub-systems, the selection of the best SWM technical systems for the Central District were proposed in Table 16.

Table 16: The Best SWM Technical System

Category	Proposed Technical System
Discharge and Storage	<ol style="list-style-type: none"> <li>1) Source separation <ul style="list-style-type: none"> <li>• Separating recyclable and non recyclable wastes</li> </ul> </li> <li>2) Type of storage <ul style="list-style-type: none"> <li>• Plastic sacks and plastic containers for common areas</li> <li>• Communal containers for marginal areas</li> </ul> </li> <li>3) Collection frequency <ul style="list-style-type: none"> <li>• More than twice a week</li> </ul> </li> <li>4) Collection method <ul style="list-style-type: none"> <li>• To introduce the separate collection for wastes</li> </ul> </li> <li>5) Type of collection method <ul style="list-style-type: none"> <li>• Most areas: Curb collection</li> <li>• Marginal areas: Point collection with communal containers</li> </ul> </li> <li>6) Collection time <ul style="list-style-type: none"> <li>• Most areas: Day collection</li> <li>• Traffic congested areas: Night collection</li> </ul> </li> <li>7) Type of collection vehicles <ul style="list-style-type: none"> <li>• Most areas: Compactor trucks</li> <li>• Marginal areas: Detachable container trucks</li> </ul> </li> <li>8) Haulage system <ul style="list-style-type: none"> <li>• Direct transport by motor vehicles</li> </ul> </li> </ol>
Primary Collection	Primary collection is required only in marginal areas. Hand cart and pedal cart systems will be used.
Secondary Collection and Haulage	<p>Most areas</p> <ul style="list-style-type: none"> <li>• 15 m<sup>3</sup> compactor trucks</li> <li>• 8 m<sup>3</sup> compactor trucks</li> </ul> <p>Marginal areas</p> <ul style="list-style-type: none"> <li>• 5.5 m<sup>3</sup> hoist trucks</li> </ul> <p>Street sweeping waste</p> <ul style="list-style-type: none"> <li>• from 5.5 m<sup>3</sup> to 10 m<sup>3</sup> container trucks</li> </ul>
Street Sweeping	<ul style="list-style-type: none"> <li>• Manual sweeping</li> </ul>
Processing and Treatment	<ul style="list-style-type: none"> <li>• Only on-site/community based composting is encouraged.</li> </ul>
Recycling	<ul style="list-style-type: none"> <li>• Recycling activities are encouraged through educational programs.</li> </ul>
Final Disposal	<ol style="list-style-type: none"> <li>1) Existing disposal site <ul style="list-style-type: none"> <li>Level 2: Sanitary landfill with a surrounding dike and daily soil coverage</li> </ul> </li> <li>2) New disposal site <ul style="list-style-type: none"> <li>Level 3: Sanitary landfill with a liner to prevent leachate from seeping into the ground</li> </ul> </li> </ol>
Maintenance of Vehicles and Equipment	<ul style="list-style-type: none"> <li>• Preventive services are allocated to the AMDC workshop and large-scale maintenance services private garages.</li> </ul>

### 3.3 Outline of the Master Plan

#### 3.3.1 Goals and Targets

##### a. Goals

The principal goal of the SWM master plan is:

*"To establish a Sound Solid Waste Management System in order to beautify the Central District by the target year 2010".*

The master plan aims to:

- A. Establish a financially sustainable, accountable, and stable solid waste management system.
- B. To improve the unsightly view in the city caused by waste.
- C. Minimize the negative environmental impacts caused by solid waste management.
- D. Provide all citizens with an acceptable level of hygiene.

The proposed measures to be taken, in order to attain the goals, are summarized below.

No.	Proposed Measures	Effect			
		A	B	C	D
1	Improvement of the Institutional and Organizational System				
1.1	Establishment of an autonomous institution	X			
1.2	Establishment of a self-supporting accounting system	X			
1.3	Improvement of the waste fee system	X			
1.4	Reduction of the municipality's involvement in activities	X			
2	Improvement of Managerial Capability of the Executing Body				
2.1	Establishment of a data control system	X			
2.2	Improvement of the cost control system	X			
2.3	Improvement of the financial planning system	X			
2.4	Scaling down the required procurement procedures	X			
2.5	Training human resources in the solid waste management sector	X	X	X	X
2.6	Introduction of private sector participation	X	X		
3	Improvement of the Sanitary Level of the Disposal Site				
3.1	Improvement of facilities at the disposal site			X	X
3.2	Training on proper sanitary landfilling operation			X	X
4	Improvement in the Efficiency of the Collection and Haulage System and Expansion of Collection Service Areas				
4.1	Improvement of the collection and haulage plan	X	X		X
4.2	Establishment of an optimal collection system for problematic areas	X	X		X
4.3	Promotion of primary collection by CBOs	X	X		X
4.4	Promotion of adequate self disposal	X	X		X
4.5	Improvement of the efficiency of the street sweeping system	X	X		X
4.6	Promotion of recycling	X	X	X	X
5	Education				
5.1	Raising awareness on solid waste	X	X	X	X
5.2	Hygiene education	X	X	X	X
5.3	Promotion of public cooperation	X	X	X	X

Note: x show effective measures.

## b. Targets

In order to achieve the principle goal of the master plan, the targets for the establishment of major technical system components are proposed and tabulated in Table 17. Figure 5 to illustrate the proposed master plan.

Table 17: Targets for Establishment of Major Technical System

Items	unit	1999	2001	2003	2005	2007	2009	2010
<b>A. Main Targets</b>								
Collection Rate	%	64	72	72	79	79	85	85
Recycling Rate	%	3	4	4	4	4	5	5
Street Sweeping Length	km	180	180	190	200	220	240	250
Final Disposal	Level 1				Level 2 <sup>5</sup>			
<b>B. Detailed Targets</b>								
<b>1. Waste Generation Amount</b>								
Residential Waste	t/d	340	387	443	506	575	649	690
Non-residential Waste	t/d	143	163	188	216	246	279	288
Street Sweeping Waste	t/d	28	28	30	32	35	38	40
<b>2. Waste Collection Amount</b>								
Collection of Residential Waste	t/d	228	290	333	410	467	561	598
Collection of Non-Residential Waste	t/d	72	98	113	151	172	224	238
Collection of Street Waste	t/d	28	28	30	32	35	38	40
Direct Haufage	t/d	29	33	38	43	49	56	60
On-site Disposal	t/d	21	23	27	31	35	39	42
Recycling	t/d	7	9	11	20	22	25	27
Uncollected	t/d	127	96	110	68	75	23	24
<b>3. Service Rate</b>								
High Income Residents	%	64%	72%	72%	79%	79%	85%	85%
Middle Income Residents	%	90%	100%	100%	100%	100%	100%	100%
Low Income Residents	%	70%	80%	80%	90%	90%	93%	93%
<b>4. Service Population</b>								
<b>4.1 Service Population</b>								
High Income Residents	t/d	154,848	176,353	180,232	183,595	186,333	188,326	189,000
Middle Income Residents	t/d	194,552	263,099	308,969	405,577	470,642	561,666	602,640
Low Income Residents	t/d	216,169	246,417	254,899	287,075	295,729	354,572	359,100
<b>4.2 Unserved Population</b>								
High Income Residents	t/d	17,205	0	0	0	0	0	0
Middle Income Residents	t/d	83,379	65,775	77,242	45,064	52,294	42,276	45,360
Low Income Residents	t/d	216,169	201,614	208,554	191,384	197,153	151,959	153,900
<b>5. Final Disposal Amount</b>								
Municipal Waste	t/d	345	436	499	622	707	880	916
Others	t/d	11	12	14	16	18	21	22

<sup>5</sup> Level 2.5 means the sanitary landfill with simple leachate treatment system in a permeable structure.

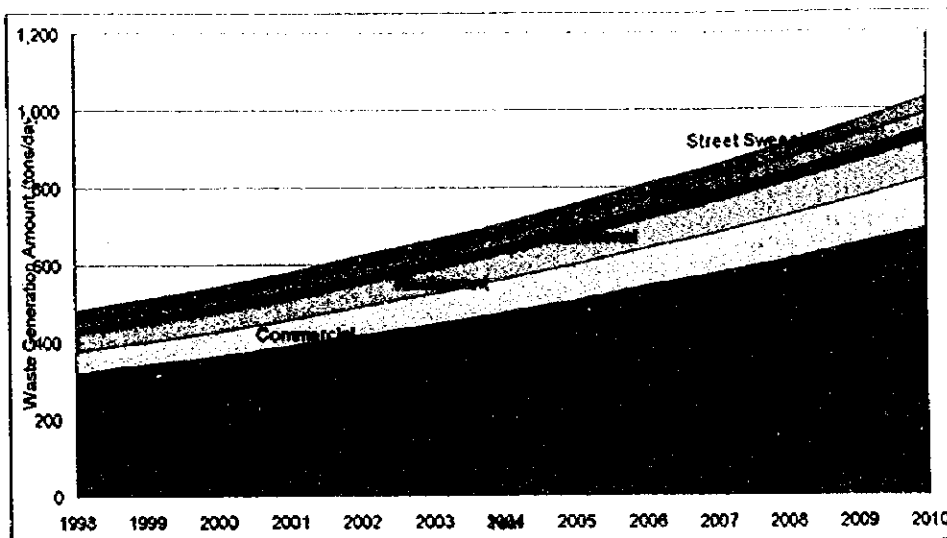


Figure 5: Waste Generation Amount Forecast until 2010

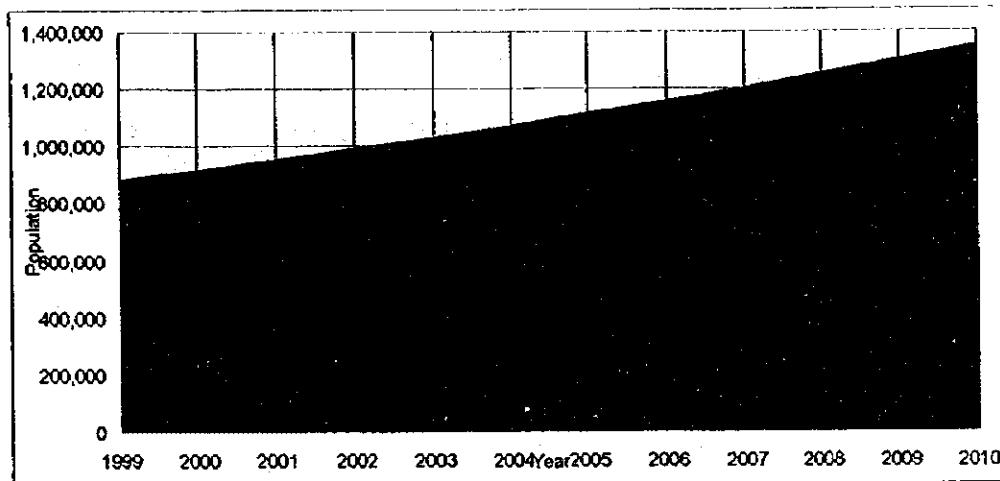


Figure 6: Master Plan of Service Population

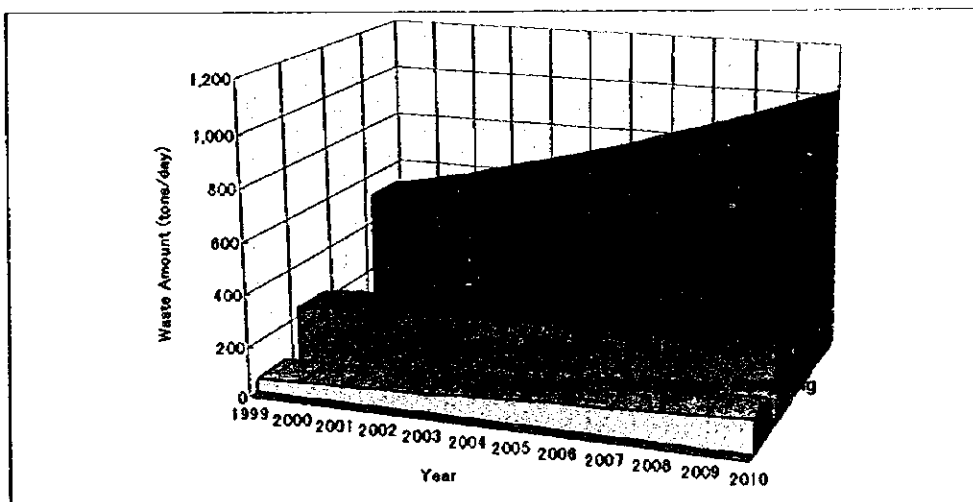


Figure 7: Master Plan of Waste Collection and Haulage

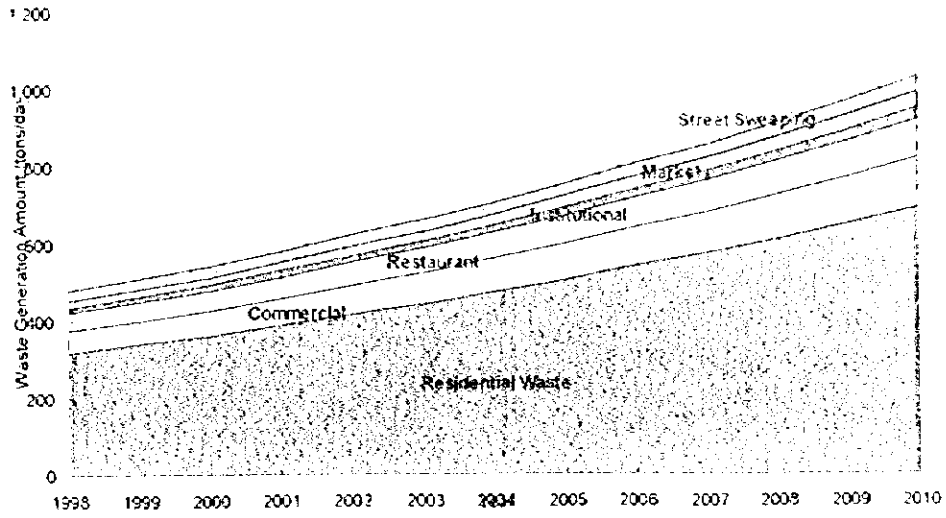


Figure 5: Waste Generation Amount Forecast until 2010

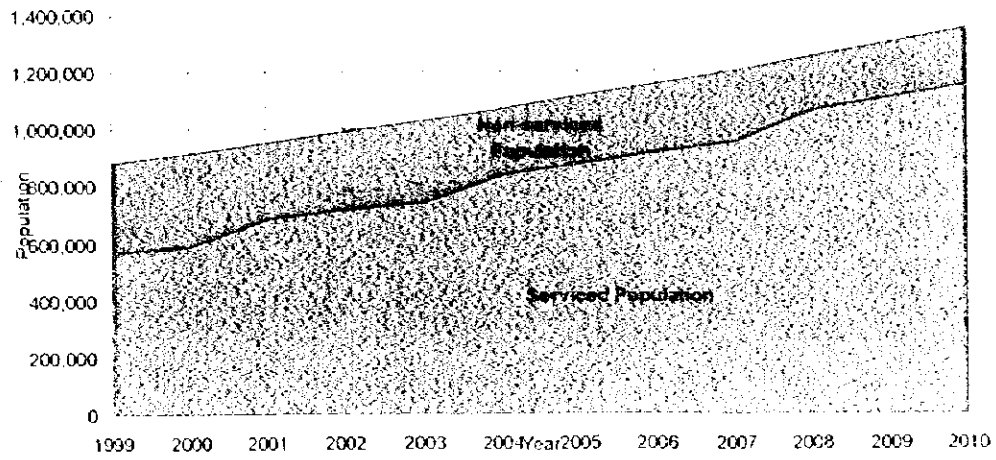


Figure 6: Master Plan of Service Population

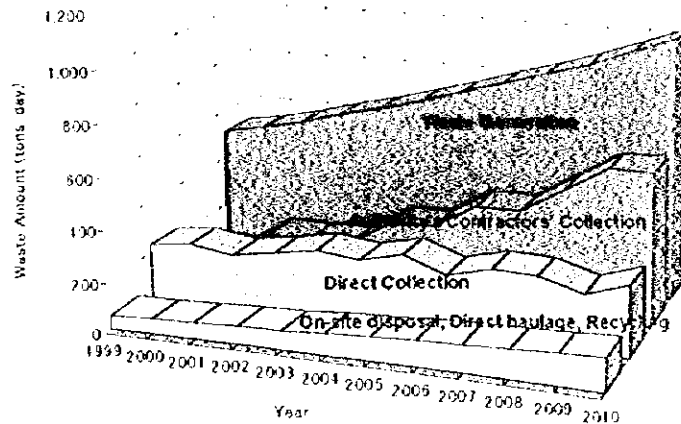


Figure 7: Master Plan of Waste Collection and Haulage

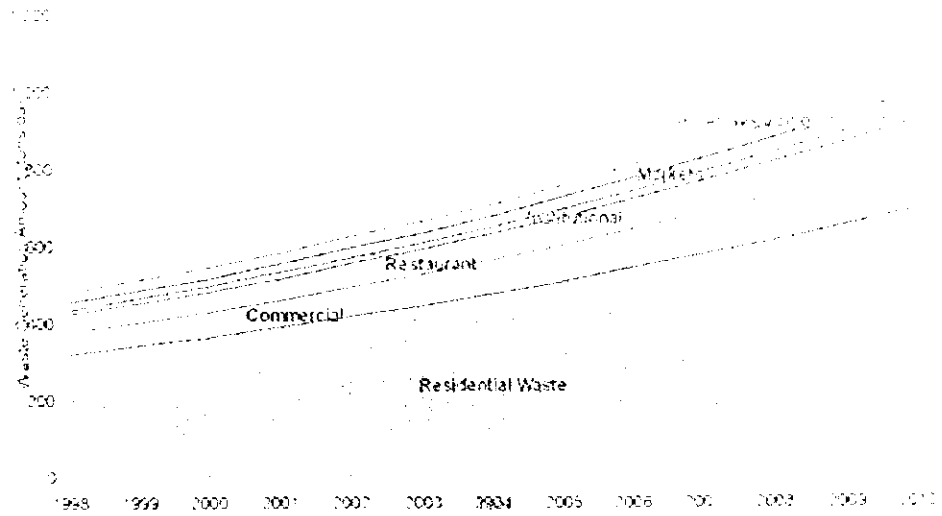


Figure 5 Waste Generation Amount Forecast until 2010



Figure 6 Master Plan of Service Population

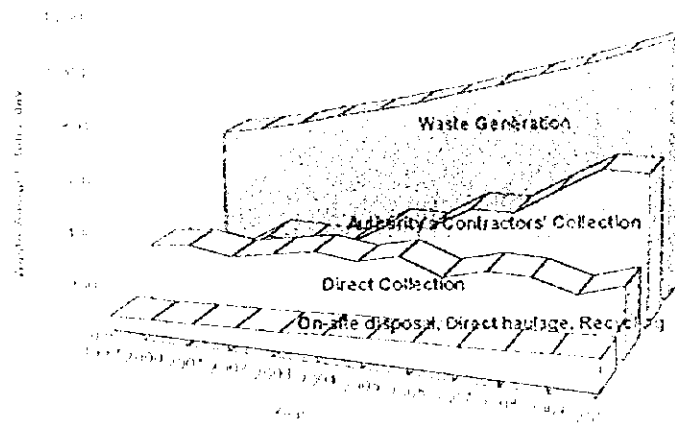


Figure 7 Master Plan of Waste Collection and Haulage

Figure 8: Waste Stream Forecast for the Central District

