

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

**MUNICIPALITY OF MANAGUA
THE REPUBLIC OF NICARAGUA**

**THE STUDY
ON
THE IMPROVEMENT OF
THE SOLID WASTE MANAGEMENT SYSTEM
FOR
THE CITY OF MANAGUA**

**FINAL REPORT
VOLUME I
SUMMARY**

MAY 1995

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In this report, project cost is estimated at January 1995 price and at and exchange rate of
1 US\$ = Yen 102.20 = 7.1183 C\$.

PREFACE

In response to a request from the Government of the Republic of Nicaragua, The Government of Japan decided to conduct a master plan and feasibility study on the Solid Waste Management for the City of Nicaragua in the Republic of Managua and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Nicaragua a study team headed by Mr. Takeshi Tomiyasu, Kokusai Kogyo Co., Ltd. four times between April 1994 and March 1995.

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

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

I wish to my sincere appreciation on the officials concerned of the Republic of Nicaragua for their close cooperation extended to the team.

May 1995



Kimio Fujita
President
Japan International Cooperation Agency



May 1995

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

LETTER OF TRANSMITTAL

Dear Sir,

We are pleased to submit to you the study report on the Solid Waste Management for the City of Managua, Nicaragua. This study contains the master plans until 2010 and the feasibility studies on the priority projects.

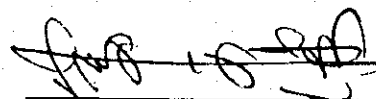
The MSWM master plans were formulated for the City of Managua based on the phased targets and the optimum technical systems which mainly comprise of a new sanitary landfill site.

The feasibility studies were executed for the priority projects which consisted of improvement of collection and public area cleansing system, construction of the new landfill site, improvement of the existing workshop and promotion of public awareness, cooperation and participation. The study concluded that implementation of the priority projects by the Municipality of Managua supported by grant aid was appropriate.

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. And from the Nicaraguan side we also wish to express our deep gratitude to the Ministry of Health and the Municipality of Managua, the Agency of Potable Water and Sewerage, Ministry of External Cooperation, the Embassy of Japan in the Republic of Nicaragua, and the JICA office in the Republic of Nicaragua.

Finally, we hope that this report will be effectively used for the implementation of the project.

Respectfully,



Takeshi Tomiyasu

Team Leader

The Study on the Improvement of
the Solid Waste Management System
for the City of Managua



**THE STUDY ON THE IMPROVEMENT OF
THE SOLID WASTE MANAGEMENT SYSTEM FOR
THE CITY OF MANAGUA**

BRIEF SUMMARY

1. MSWM Master Plan

1.1 Goal

The goal of the MSWM Master Plan is

"Development and Realization of a Beautiful and Sanitary Environment in the City of Managua towards the 21st Century through Citizens' Participation and Establishment of Self-sustainable Solid Waste Management."

1.2 Targets

Targets for collection, street sweeping, public cleansing and final disposal services are set up as follows:

	Unit	1995	2000	2010
1. Population (Urban Area)	Inhabitants	877,817	1,131,052	1,610,943
2. Collection Coverage	% (inhabitants)	77.0 (675,919)	90.0 (1,017,947)	100.0 (1,610,943)
Collection Area A 1)	% (inhabitants)	66.7 (585,504)	66.7 (754,412)	66.7 (1,074,449)
Collection Area B 2)	% (inhabitants)	10.3 (90,415)	23.3 (263,535)	33.3 (536,444)
3. Street Sweeping Distance	km	331	350	350
4. Public Cleansing Area (Park & Green Area) 3)	ha	16.7	45	45
5. Sanitary Landfill Level	-	Level 1	Level 3	Level 4

Note: 1) Collection Area A: Residential Area Collection Coverage (100%)
 2) Collection Area B: Squat Area
 3) Sanitary Landfill Level: Level 1: Controlled Tipping
 Level 2: Leachate Circulation System
 Level 3: Leachate Treatment System

1.3 Technical and Institutional Systems for the Master Plan

- Collection System

The following are the schemes to be carried out to achieve the targets of the Master Plan.

Collection Area A: Curb collection system using compactor trucks

Collection Area B: Container collection system using hoist trucks or bell collection system using compactor trucks

Large generation sources: Container collection system using hoist trucks or compactor trucks with container

- Public Cleansing

Cleansing Works: Manual Method

Collection and Haulage: Container Method

- Construction of New Sanitary Landfill Site in Acahualinca (Sanitary Landfill Level)

Year 2000 - 2009 : Sanitary Landfill Level 3 (leachate circulation system)

Year 2010- : Sanitary Landfill Level 4 (leachate treatment system)

- Equipment Operation & Maintenance

Improvement of the existing Los Cocos Workshop for preliminary maintenance.

- Administration and Organization

Continuation of SWM by strengthening and expanding the role of PCO in ALMA.

- Privatization

The following measures are proposed for the privatization of MSWM based upon the policy of ALMA and the policies behind the privatization of govern-

ment enterprises.

- * Service to be privatized : Collection and haulage of household waste in collection area A
- * Target year for phased privatization
 - 2000 : 50% of households in Collection Area A
 - 2010 : 100% of households in Collection Area A
- * The role of ALMA in the privatization of collection services
 - 1) Lease vehicles and equipment for collection and haulage
 - 2) Supervision of private concessionaires
 - 3) Maintenance of vehicles and equipment
- * The role of the private concessionaires
 - 1) Payment of rental fee for vehicles and equipment
 - 2) Payment of license fee for the consignment of cleansing works
 - 3) Payment of tipping fee at final disposal site
 - 4) Payment of maintenance fee for vehicles and equipment
- * Incentives for private concessionaires for the payment of tipping fees

ALMA will give the following incentives to private concessionaires:

- 1) 2000-2004 : 60% discount rate for tipping fee
- 2) 2005-2009 : 30% discount rate for tipping fee
- 3) 2010- : 0% discount rate for tipping fee

- Financial Plan

- * Basic principle:
"Beneficiary Pay Principle"-- the beneficiaries of the collection services are to pay waste fees to ALMA.
- * Revenue of ALMA:
 - 1) Waste collection fees from residents
 - (1) Waste collection fees from residents in Collection Area A where collection is directly carried out by the municipality
 - (2) Waste collection fees from residents in Collection Area B
 - 2) Income from Private Concessionaires
 - (1) Rental fees for vehicles and equipment for collection and haulage
 - (2) License fee for consignment of services
 - (3) Tipping fees at final disposal site

3) Income from private companies conducting direct haulage to final disposal site

(1) Tipping fees based on waste amount

4) Appropriated funds from the general account of ALMA

* The following items should be given special consideration in the formulation of the financial plan of ALMA

1) Share of SWM budget in the general account of ALMA: within 10%

2) Share of Waste fee in household income in Collection Area A: within 1%

The following will share the deficit in the SWM expenses for Collection Area B where most of the residents are not only unwilling but also incapable of paying:

1) Large generation sources

2) Residents in collection area A

3) ALMA

* Income of private concessionaires

1) Waste collection fees imposed on the residents of Collection Area A.

1.4 Selection of Priority Projects

The following are the priority projects selected by the Study Team and the Nicaraguan counterpart as projects to be completed by 2000, in accordance with the Master Plan target year, 2010:

- Improvement of collection and public area cleansing system
- Construction of the proposed new sanitary landfill site in Acahualinca
- Improvement of the existing Los Cocos workshop
- Promotion of public awareness, cooperation and participation

2. Initial Investment Cost for Priority Projects

The contents and initial investment costs of the Priority Projects are presented in the table below.

Project	Executing Bodies	Description	Total Amount (C\$mill.)	Local Portion (C\$mill.)	Foreign Portion (US\$thou.)
Improvement of Public Area Cleansing System	ALMA	Total Initial investment Cost	114.33	-	16,071
		Sub-total	110.23	-	15,495
		Equipment for collection service etc. Compactors, Compactors with lift, Hoist Trucks, Containers (1.0m ³ and 7.0m ³), Dump Trucks, Wheel loaders, Motor Graders, Pickups			
		Sub-total	4.10	-	576
		Equipment for public cleansing service Compactors with lift, Hoist Trucks			
Construction of Acahualinca Newly Proposed Land-fill Site	ALMA	Total Initial investment Cost	148.57	20.52	17,999
		Sub-total	122.78	20.52	14,374
		- Land Acquisition (93ha.)		(not included)	
		- Construction of ANPLS (Phase I) * Capacity 2,600,000 m ³ * Design life year 6 years * Target landfill operation Level 3 * Facilities: Site office, Garage, Truckscale, Fence, Dike, Leachate circulation facilities, etc.			
		Sub-total	25.79	-	3,625
- Equipment for landfill operation Bulldozers, Landfill compactors, Wheel Loaders, Dump trucks, Motor Graders, Wheel excavators, Pickups					
Improvement of existing Los Cocos Workshop	ALMA	Total Initial investment Cost	11.50	0.88	1,492
		sub-total	8.84	0.88	1,118
		- Construction of Workshop Building Enlargement of maintenance shed, Container shed, Pavement			
		Sub-total	2.66	-	374
		- Maintenance equipment Maintenance machine and tools, Mobile workshop			
Promotion of Public Awareness, Cooperation and Participation	ALMA	Total Initial investment Project Cost	0.68	-	96
		- Equipment for public education Station wagon with video set			
Grand Total Initial investment Cost			275.08	21.40	35,648

3. Project evaluation

3.1 Economic and Financial Evaluation of Priority Projects

The results of the economic and financial evaluation of the priority projects are explained below:

It is not possible to determine whether the construction of the new landfill site is economically feasible or not because its benefits are difficult to quantify. Financially, however, all the priority projects are feasible if the foreign currency portion of the Initial Investment Cost is financed by foreign subsidies.

Project	Economic Evaluation			Financial Evaluation			
	Benefits (B)	Cost (C)	EIRR (%)	Revenue	Expenditure	FIRR by Project (%)	FIRR 3 combined Projects
(1)Improvement of Collection and Public Area Cleansing System	Eliminates expenses for the removal of illegally dumped waste	Investment 1), O&M cost	24.1%	-Waste fee -License fee -Rental fee	Investment 1), O&M of vehicles	9.8	9.0
(2)Improvement of Existing Los Cocos Workshop	Curtailement of investment and O & M Costs as services of private concessionaires are more efficient than the municipality's	Investment 1), O&M cost	12.5%	-	Investment 1), O&M	-	
(3)Promotion of Public Awareness, Cooperation and Participation	Eliminates expenses for the removal of illegally dumped waste	Investment 1), O&M cost	34.0%	-	Investment 1), O&M	-	
(4)Construction of Proposed New Landfill Site	Eliminates expenses for the removal of illegally dumped waste	Investment 1), O&M cost	-	-Tipping fee	Investment 1), O&M of facilities, vehicles and equipment	29.6	

Note: 1)Foreign currency portion of initial investment is assumed to be financed by foreign Subsidies.

3.2 Combined financial evaluation of the 3 projects (Improvement of collection and public area cleansing system, Improvement of existing Los Cocos Workshop, and Promotion of public awareness, cooperation and Participation)

These 3 projects were financially evaluated as one due to the similarities in the nature of their activities.

- **Financial Evaluation of Private Companies for Concession**

Financial Evaluation of private companies was conducted under the following two assumptions:

- * The management of the cleansing service by these concessionaires will be 30 % more efficient than ALMA.
- * The concessionaires will be given tipping fee incentives.

Incentive discount rate 2000–2004:	60%
Incentive discount rate 2005–2009:	30%

Under these assumptions, the FIRR of private companies is estimated at 7.7%. However due to the assumptions involved, the privatization of the public cleansing service should be carried out with extreme care.

- **Financial Capability of Collection Area A**

The residents in collection Area A are financially capable of paying the imposed collection fees. The collection fee is estimated to amount to within 1% of every household income in Collection Area A, regardless of the fact that the amount shall partly subsidize the collection service expenses for area B.

- **Municipal Financial Capability**

If the foreign currency portion of the initial investment cost is financed by subsidies from the central government or grant aid from foreign countries, part of the income from waste collection will be reserved internally as funds which will enable ALMA to shoulder the budget for the second and third investments.

This is also assumed to gradually curtail the share of ALMA in the cleansing costs, from C\$ 19.2 million in 2000 to C\$ 13.2 million in 2010. Consequently, instead of appropriating 7.6% (1998) of its budget for cleansing costs, ALMA will only spend 3.4% in 2010. Based on this assumption, ALMA may be considered financially capable of carrying out MSWM.

Using a loan to cover the initial investment cost will only bury ALMA deep in financial debt, as the collection fees will be used for repayment, thereby further obliging ALMA to obtain another loan for the second and third investments. This method of financing will incur a total debt of C\$ 300 million.

Conclusively, the initial investment cost should be covered through subsidies from the central government or grant aid from foreign entities.

4. Recommendations

4.1 Promotion of the establishment of a community organization for area sanitation

The establishment of an organization in the community is proven to be necessary not only for the expansion of collection services but also for the sanitation of the squat areas as well. In order to promote this activity, the functions of PCO should be strengthened and expanded.

4.2 Leachate treatment in the new Acahualinca landfill site

The proposed level of sanitary landfill operation for ANPLS is level 3, leachate circulation system, for 2000 and level 4, leachate treatment system, for 2010. The main factor that contaminates the water quality of Managua Lake is sewage water from the city rather than leachate from the landfill site.

The Master Plan formulated for the construction of a sewage system in Managua City states the Study Team's recommendation to the Nicaraguan Side of the combined utilization of the treatment plant not only for sewage but also for leachate, in order to minimize the investment cost required for the construction of leachate treatment facilities after 2010.

4.3 Privatization of MSWM

The municipality has a plan to partly privatize MSWM in accordance with the policies of the central government of Nicaragua. The privatization process will require ALMA to carefully check the capacity of private companies which may participate in the competitive bidding for MSWM services. Bidding will be carried out to ensure highly efficient collection services and minimum municipal cost.

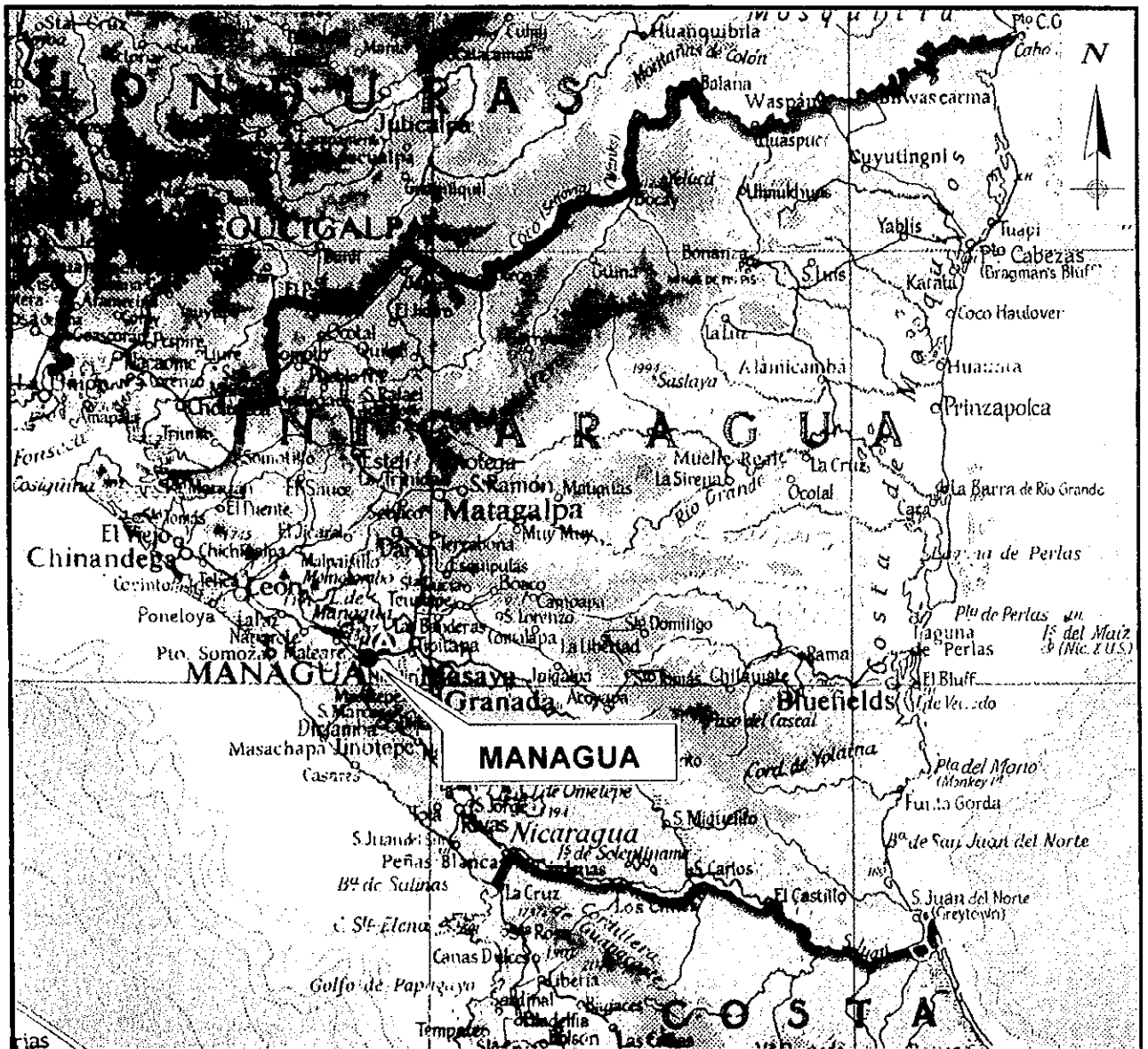
4.4 Financial Source

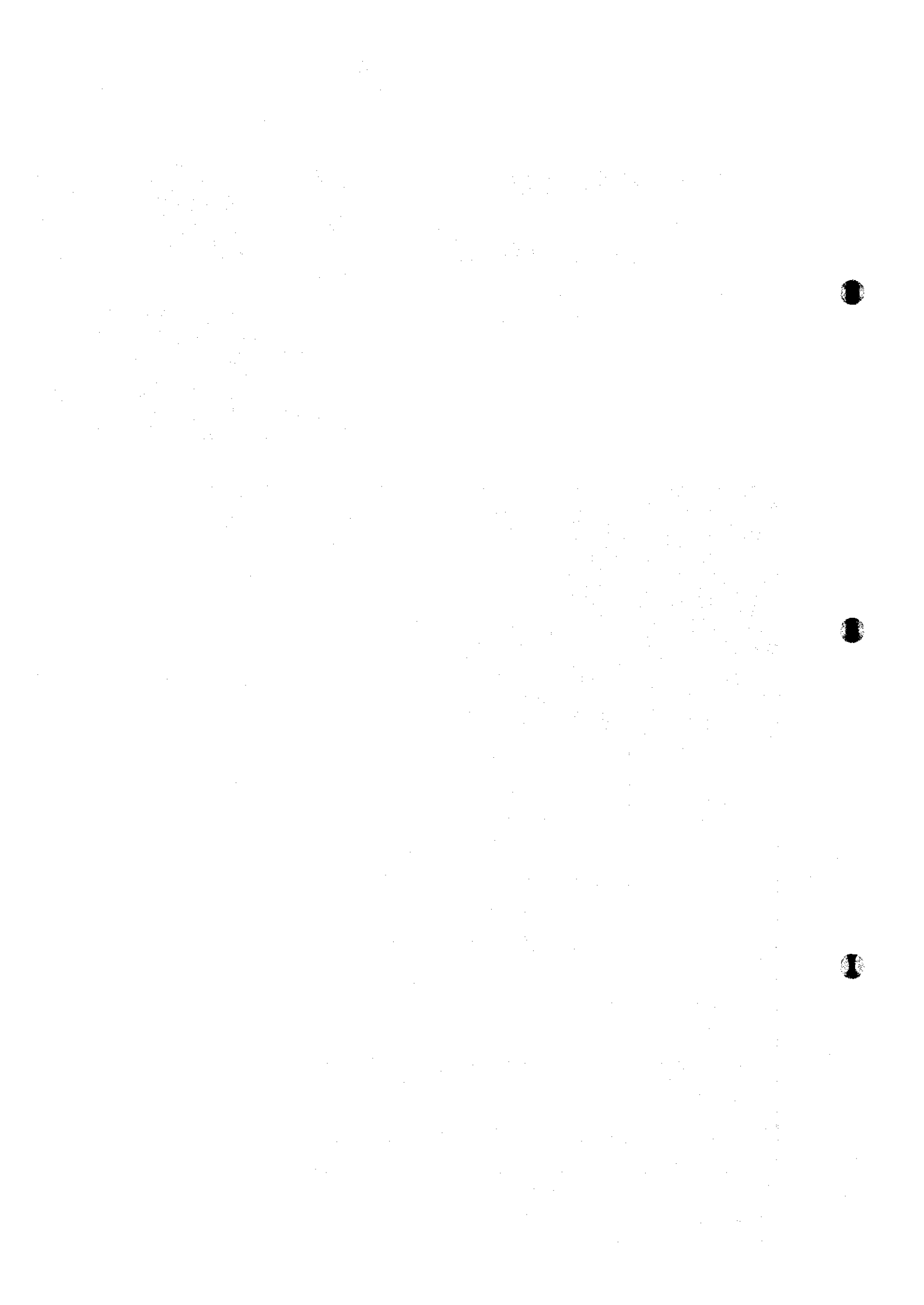
It would be very difficult for ALMA to recover the entire cost to be spent on the priority projects with the waste collection and tipping fee and revenue from private concession. The investment costs should be subsidized by the central government, or with grant aid from bilateral and multilateral agencies. ALMA must therefore, strive to acquire such sources to successfully implement the projects.

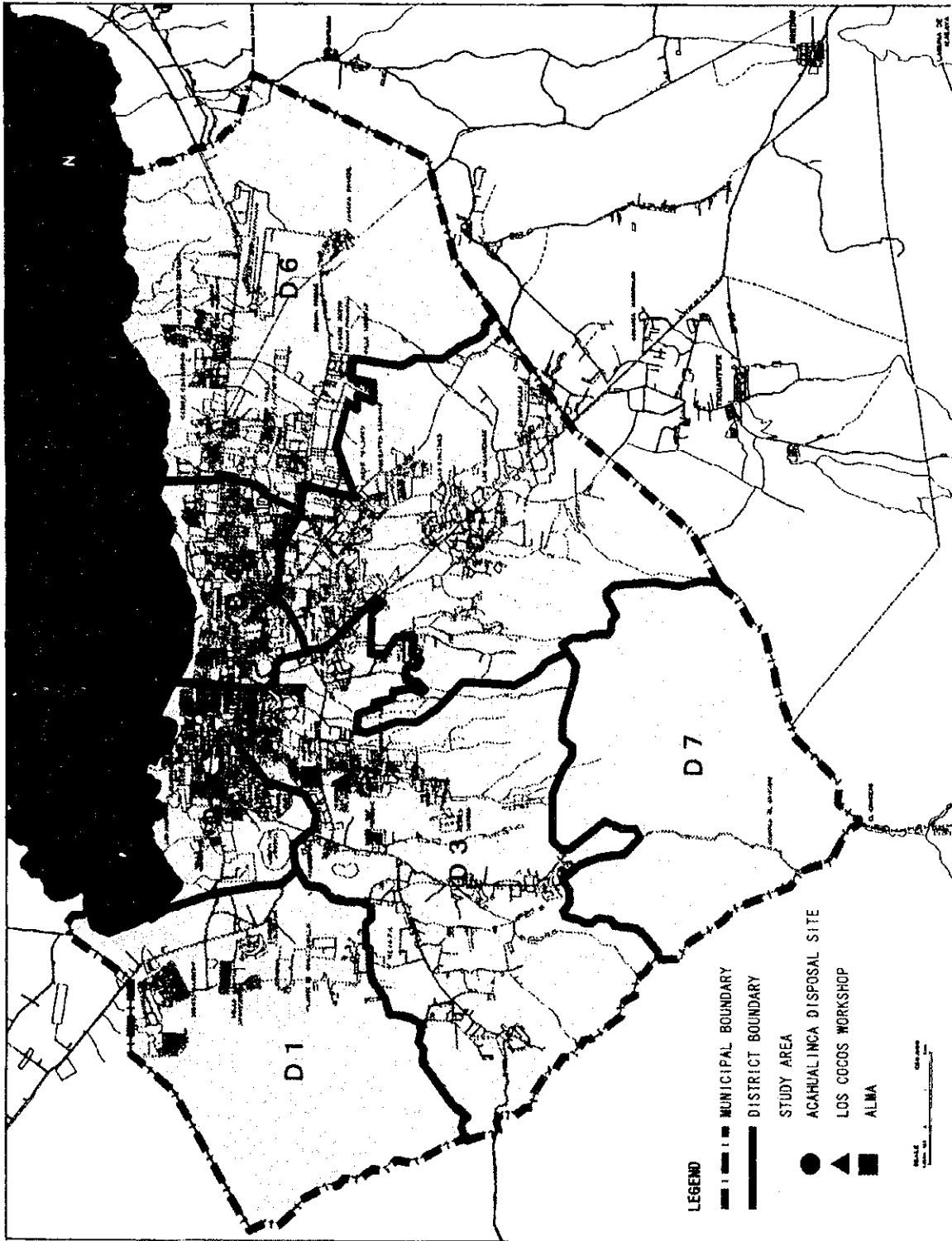
All 4 of the selected priority projects are financially feasible and are indispensable to achieve the targets of the MSWM Master Plan. In order to allow ALMA to realize as many of these projects as possible, the Study Team requested the Nicaraguan side to rank these four priority projects according to importance.

Location Map of

The Study Area (1)







THE STUDY ON THE IMPROVEMENT OF THE SOLID WASTE
 MANAGEMENT SYSTEM FOR THE CITY OF MANAGUA
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Location Map of The Study Area (2)



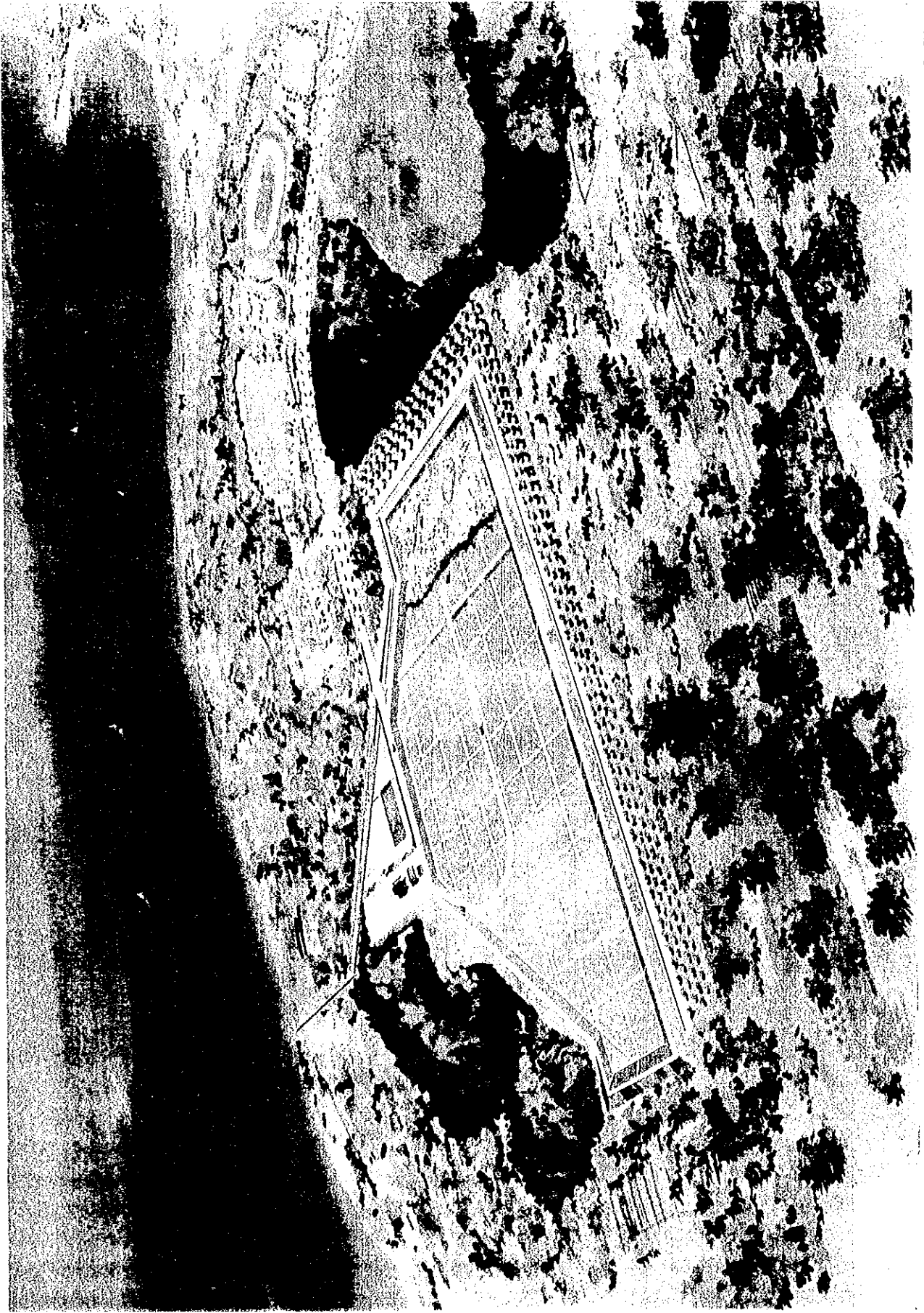
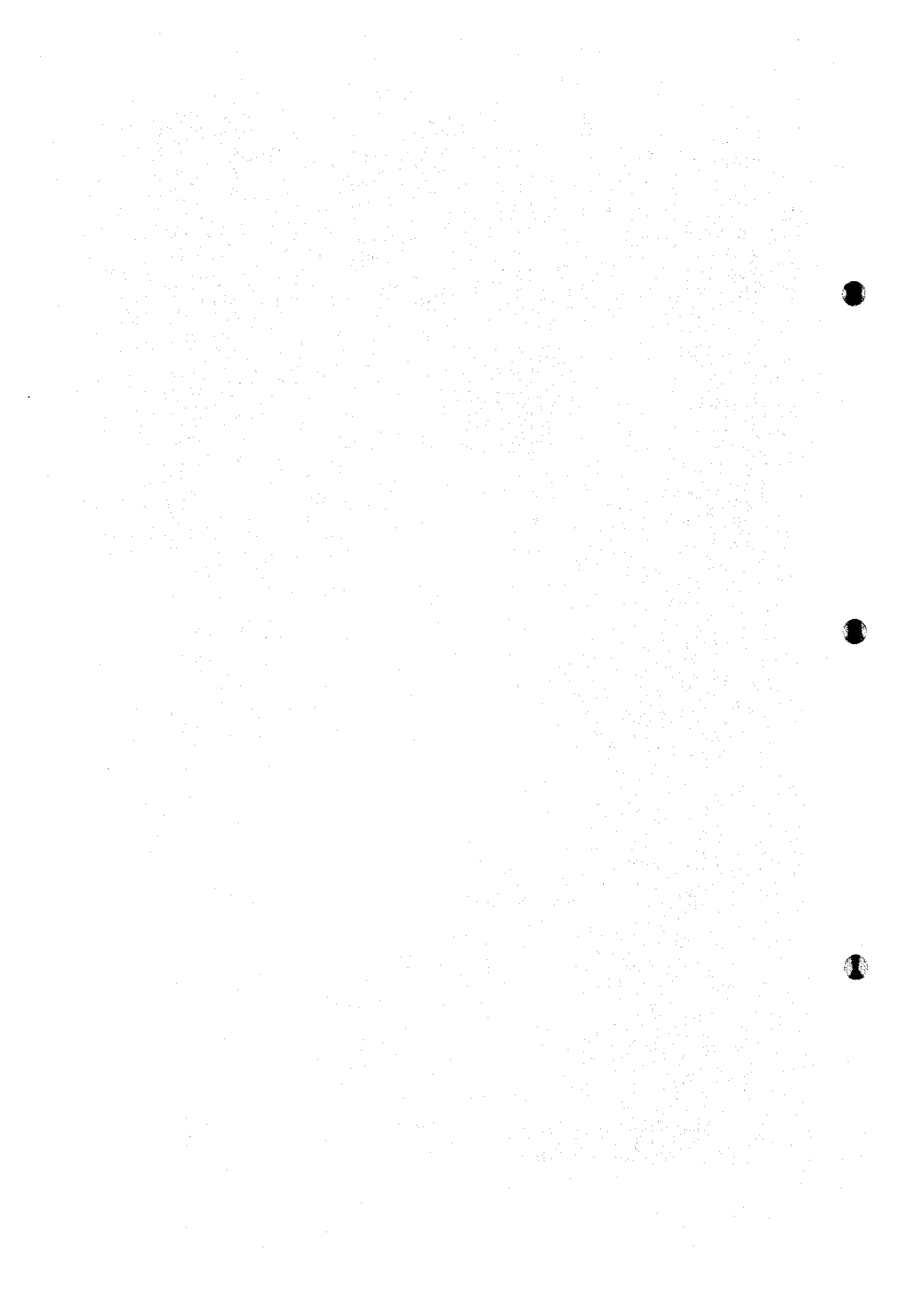


Plate 1: Image of Proposed New Final Disposal Site



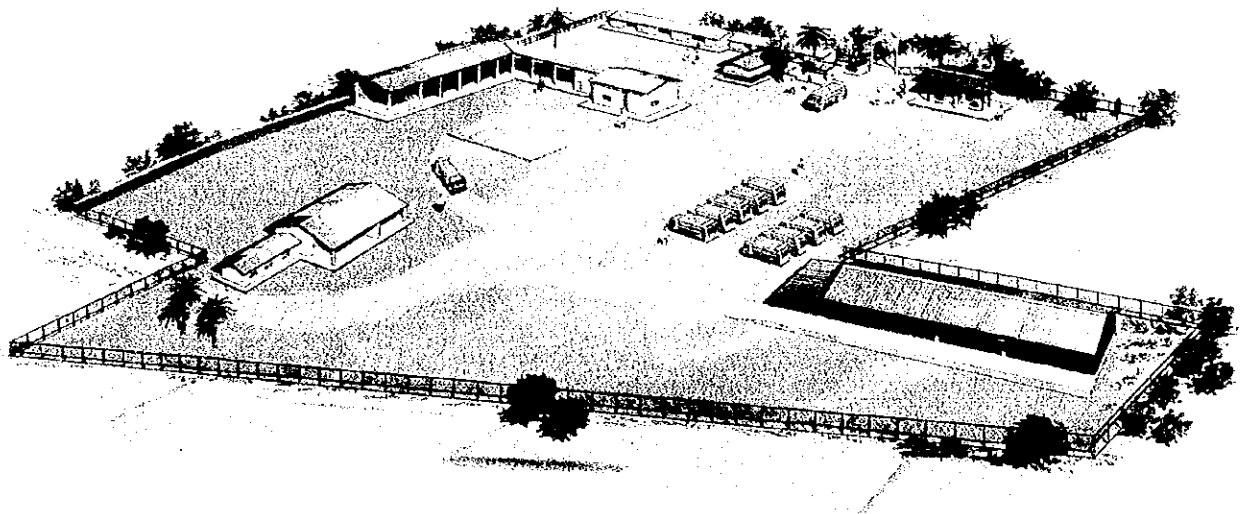
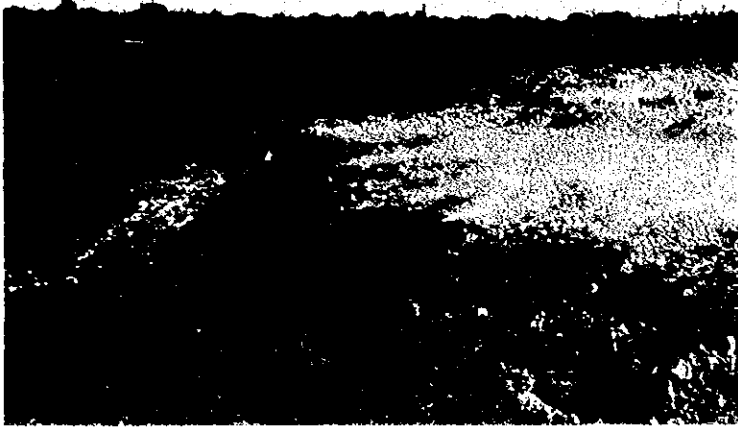


Plate 2: Image of Improved Los Cocos Workshop



*Acahualinca Final
Disposal Site*



Los Cocos Workshop



*Collection Work by
Compactor Truck*



Plate 3: Present MSWM in the Study Area





*Weighing waste
amount discharged by
houses*

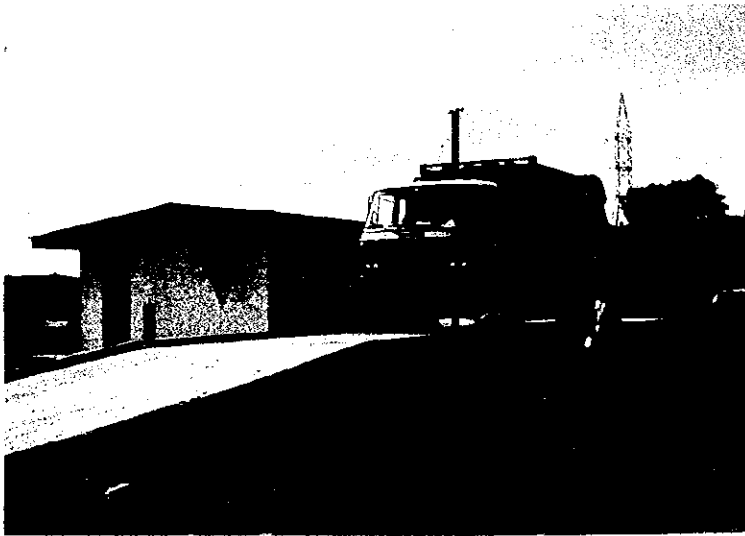


*Sorting waste sample
by waste categories*

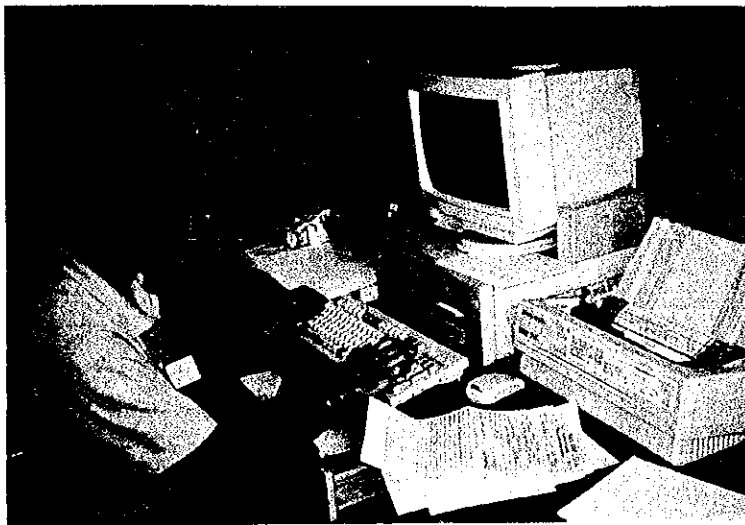


*Measuring ammonia
and methane at
Acahualinca disposal
Site*





Truck Scale Inspection Building constructed by Managua Municipality and JICA in Acahualinca disposal Site



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



Geological Survey carried out in the Present Acahualinca Disposal Site





*Area Improvement
Activities carried by
residents*



*Container bed
constructed by JICA*



*Bell collection system
with cooperation of
residents*

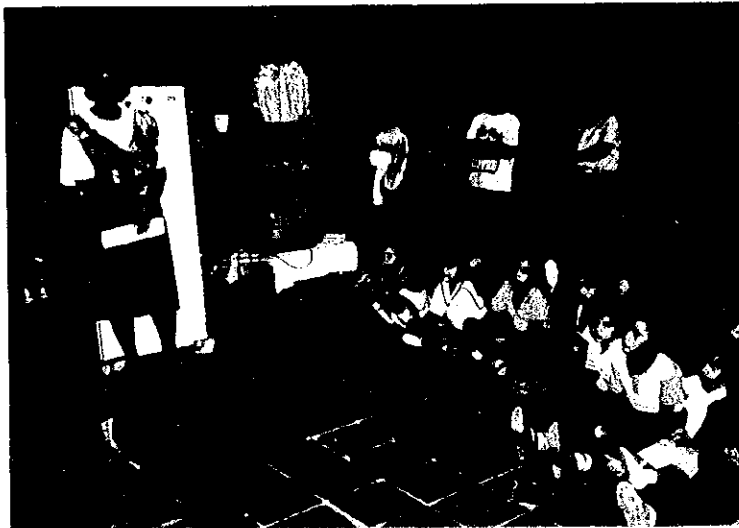




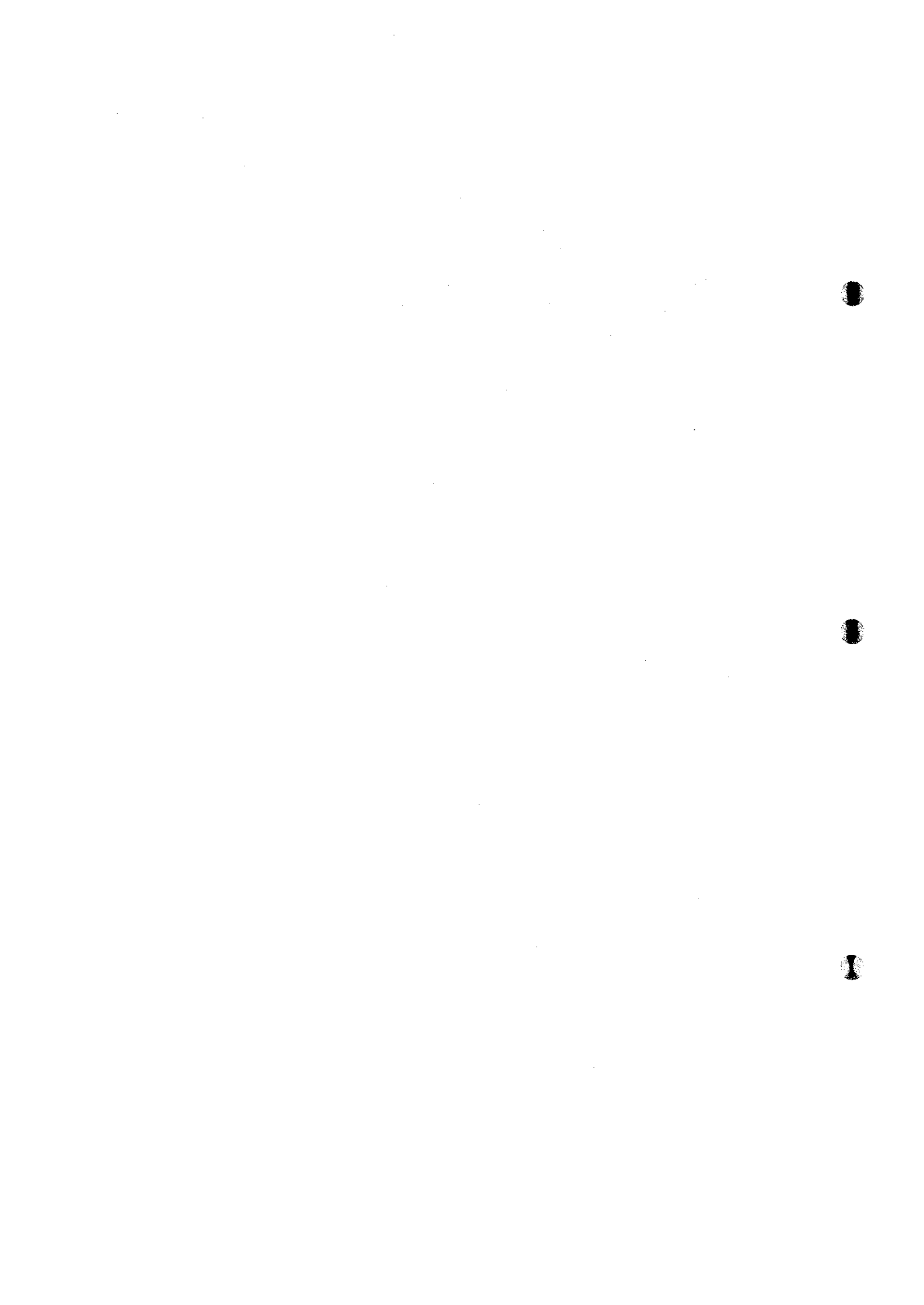
Lecture on sanitary education given to the residents in the collection experiment area by the Study Team

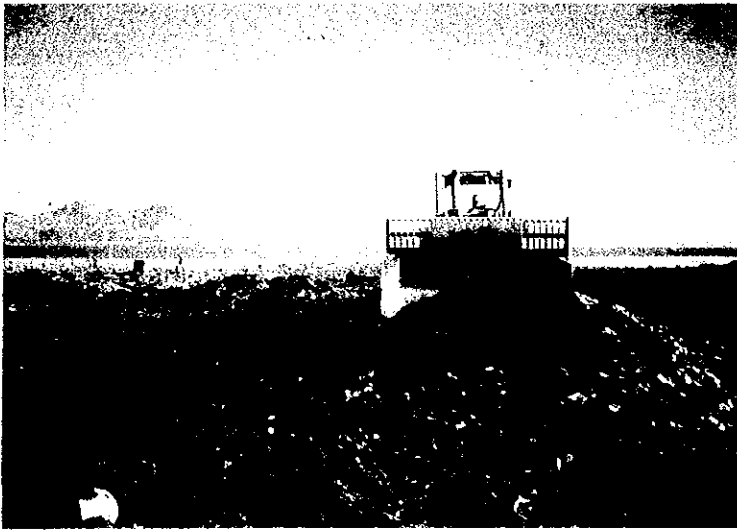


Lecture on sanitary education given to the residents in collection experiment area by the Municipal staffs



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





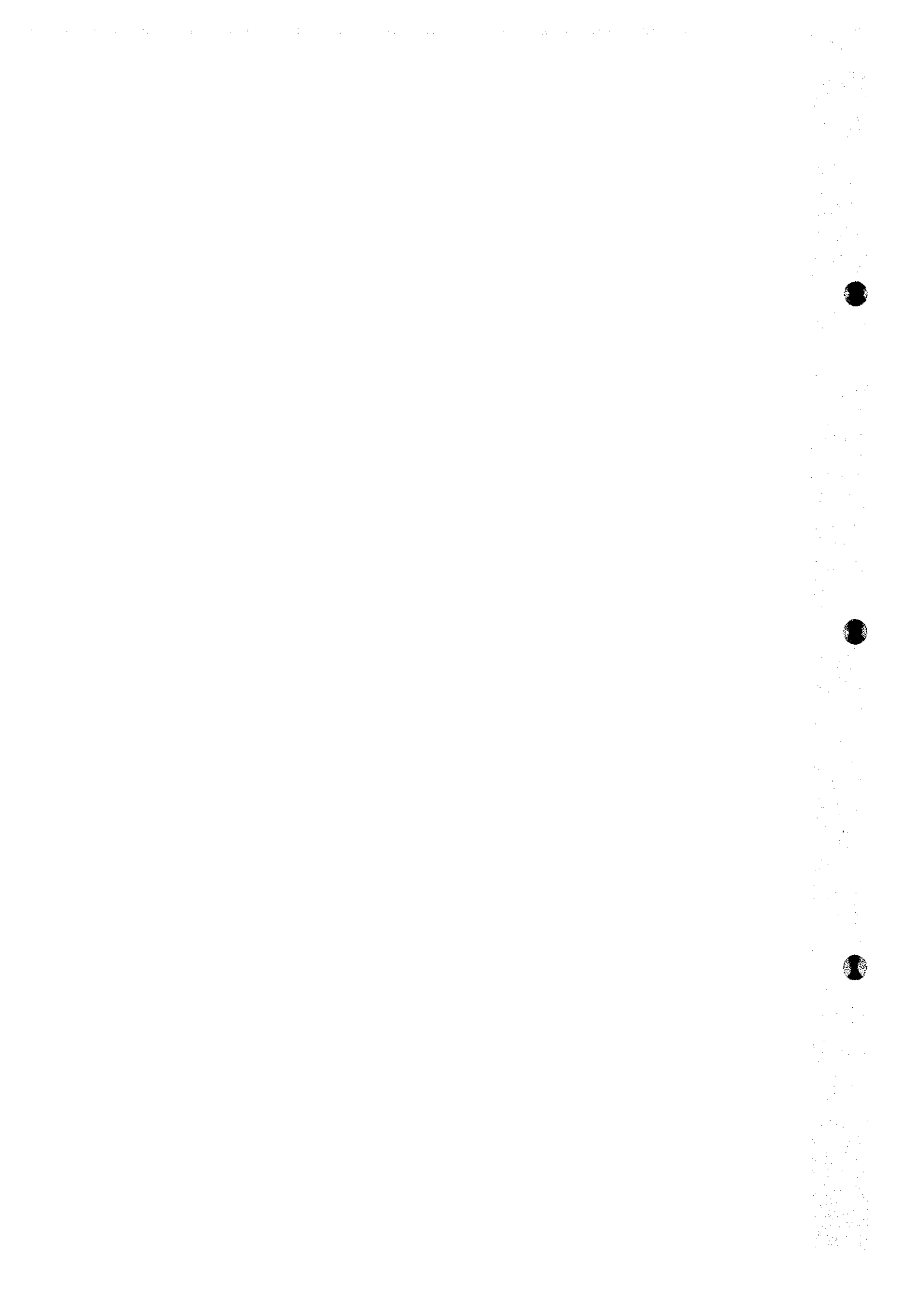
*Construction of dike
by using the waste*



*Gas removal
facilitated installed on
the waste compacted
and covered by soil*



*Completion of final
covering the waste
and Gas removal
facilities installed*



**THE STUDY
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THE SOLID WASTE MANAGEMENT SYSTEM
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VOLUME II MAIN REPORT

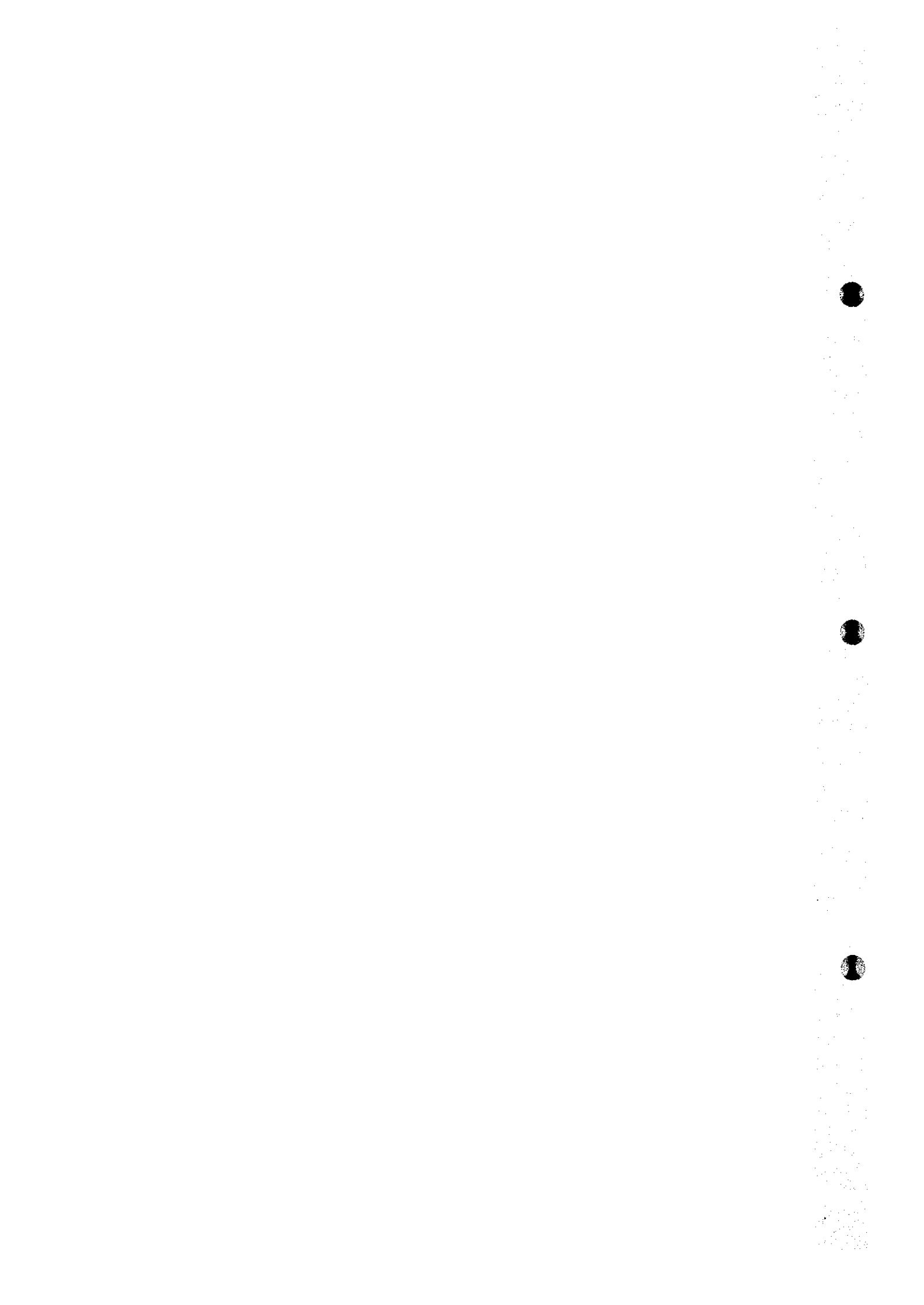
VOLUME II (S) MAIN REPORT (Spanish Version)

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- B Waste Amount and Composition Survey
- C Public Opinion Survey
- D Investigation of Present and Candidate Disposal Sites
- E Other Field Surveys
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- N General Recommendation for the Improvement of Medical
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- O Environmental Evaluation

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This is the SUMMARY.



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ABBREVIATIONS

ORGANIZATIONS AND INSTITUTIONS

ALMA	:	Municipality of Managua
BAVINIC	:	Housing Bank of Nicaragua
BCN	:	Central Bank of Nicaragua
CSE	:	Electoral Supreme Council
DCO	:	District Coordination Office
DEE	:	Department of Environmental Education
DO	:	District Office
EU	:	European Union
FIDEG	:	International Foundation for the Global Economic Challenge
IDB	:	International Development Bank
INAA	:	Nicaragua Institute of Aqueducts and Sewering
INE	:	Nicaraguan Institute of Energy
INEC	:	Nicaraguan Institute of Statistics and Census
INETER	:	Nicaraguan Institute of Territorial Studies
IRENA	:	Nicaraguan Institute of Natural Resources and the Environment
JICA	:	Japan International Cooperation Agency
JICE	:	Japan International Cooperation Center
MAN	:	Nicaraguan Environmental Movement
MARENA	:	Ministry of Environmental and Natural Resources
MCT	:	Ministry of Construction and Transport
MEDE	:	Ministry of Economy and Development
MINSAL	:	Ministry of Health
MIPRES	:	Ministry to the Presidency
MERO	:	Maintenance and Recovery of Equipments Head Office
MWSHO	:	Municipal Works and Services Head Office
PCO	:	Panamerican Health Organization
PHO	:	Panamerican Health Organization
PIDMA	:	Program for Environment Program
UNDP	:	United Nations Development Program
UNI	:	National Engineering University
WHO	:	World Health Organization

REPORT AND STUDY

ANPLS	:	Acahualinca Newly Proposed Landfill Site
ASG	:	Apparent Specific Gravity
DF/R	:	Draft Final Report

DWAS	:	Disposal Waste Amount Survey
F/R	:	Final Report
F/S	:	Feasibility Study
HCV	:	Higher Calorific Value
IC/R	:	Inception Report
IEE	:	Initial Environmental Evaluation
ISW	:	Industrial Solid Waste
ISWM	:	Industrial Solid Waste Management
IT/R	:	Interim Report
LCV	:	Lower Calorific Value
M/M	:	Minutes of Meeting
MSW	:	Municipal Solid Waste
MSWM	:	Municipal Solid Waste Management
N.A.	:	Not Available
O&M	:	Operation and Maintenance
POS	:	Public Opinion Survey
P/R	:	Progress Report
RDF	:	Refuse Derived Fuel
RIDS	:	Registered Illegal Dump Site
S/W	:	Scope of Work
SWM	:	Solid Waste Management
T/R	:	Terms of Reference
WACS	:	Waste Amount and Composition survey

SOCIO-ECONOMY

EIRR	:	Economic Internal Rate of Return
FIRR	:	Financial Internal Rate of Return
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
GRDP	:	Gross Regional Domestic Product
US\$:	U.S.dollar
C\$:	Cordoba
p.a.	:	per annum
mill.	:	million
bill.	:	1,000 million

UNIT

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

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1. INTRODUCTION

1.1 Background

A civil war which lasted for 8 years has destroyed the social infrastructure and consequently worsened the economy of the Municipality of Managua (ALMA) (area : 330km², population : 1.1 million), in the Republic of Nicaragua. Furthermore, the rapid increase in population has made the generation of solid waste more complex and the actualization of environmental problems difficult. The management of solid waste in ALMA has become a critical problem.

To overcome the above problems and to systematically improve the situation, the preparation of a Solid Waste Management (SWM) Master Plan for ALMA is considered to be a very effective approach, technically as well as financially. However, this approach has never been practiced in ALMA as Nicaragua has never prepared any SWM plan.

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

1.2 Scope of the Study

a. Objectives of the Study

The objectives of the Study are:

- to formulate a Master Plan for the improvement of SWM of ALMA up to the target year 2010.
- to conduct a Feasibility Study for the priority projects of the Master Plan up to the target year 2000.

b. Study Area

The study only covered the urbanized area of the whole area under the administration of ALMA. The study area is shown in the location Map.

c. Study Wastes

The wastes considered in this study were household waste, market waste, commercial waste, street sweeping waste and institutional waste. As for medical and industrial solid waste, recommendations were made for the improved handling of these waste types based on the results of a quick study carried out on existing information, data, surveys at the existing disposal site and interview results.

1.3 Policy of the Study

a. Joint Study

The political and socioeconomic arena of Nicaragua is undergoing rapid changes. A joint study should be carried out with the Nicaraguan Counterparts therefore as they are familiar with prevailing local conditions, in order to accurately determine the present solid waste management situation and for the formulation of an SWM plan that is best suited to future conditions. Field surveys, e.g., Waste Amount and Composition Survey (WACS), Public Opinion Survey (POS), were especially carried out in close cooperation with the counterparts, as a means of extending technology transfer. The study was carried out smoothly as discussions were held until mutual agreement was attained concerning policies involved in the selection and conclusion of candidate disposal sites, selection of optimum alternatives for the Master Plan, and the selection of priority projects.

Pilot projects, e.g., collection experiment, sanitary landfill experiment, and sanitary education campaigns, were conducted in cooperation with the Nicaraguan counterparts to verify the appropriateness of the plans and for the immediate improvement of SWM. The results led to the proposal of the following systems and technologies, which are presently being carried out by the municipality:

- Introduction of container and bell collection system in the non-collection area and its O & M system.
- Improve sanitary conditions, carry out technological transfer and implement

O & M system, through the conduct of daily covering waste activities, installation of gas removal facilities, dyke construction, etc., in the present disposal site.

- Conduct public health and sanitation education campaigns in non-collection area and primary schools using videos and pamphlets.

b. Workable Plan and Appropriate Technology

Upon careful consideration of the SWM characteristics, the Study Team formulated the most workable and implementable SWM plan for the Municipality in close cooperation with the Nicaraguan counterparts.

The following are the items that explain the financial state of the municipality, and were taken into account for the formulation of the SWM Plan:

(i) Limited budget of ALMA

The 1995 budget of ALMA is C\$ 205 million, 8.6% of which, C\$ 18 million, is appropriated for cleansing services.

(ii) Decrease in collection rate of waste fees

A decrease in the collection rate of waste fees resulted from a new ordinance which stipulates the separate collection of waste fees from electricity and telephone bills.

The essential part of the SWM Plan entails:

- (i) Introduction of the container and bell collection system
- (ii) Introduction of a waste fee collection system in the service area, including the squat area

The plan is not only considered technically and institutionally appropriate, but will also make SWM sustainable to ALMA.

1.4 Key Assumptions

The key assumptions used in this study are as follows:

a. Socioeconomic Conditions

Items	Unit	Descriptions
1. Population		
- Projected Urban Population in the Whole Study Area	persons	1995 2000 2010 877,817 1,131,052 1,610,943
- Annual Growth Rate	%	1995-2000 5.2%/year 2001-2010 3.6%/year
2. Economy		
- GDP	US\$bill.	2.25 in 2000 3.40 in 2010
- Annual Increase Rate of GDP in Real Term	%	1995 3.5% 1996 4.0% 1997 4.5% 1998-2000 5.0% 2001-2005 4.5% 2006-2010 4.0%
- GRDP	US\$bill.	The share contributed by Managua will increase until 2000 because of centralization of population and administrative functions. 1995 0.93 2000 1.24 2010 1.87
- Future Budget of the Municipality of Managua	US\$mill.	Increase in the 1995 budget in accordance with real term GRDP increase rate. 1995 27.4 2000 36.5 2010 55.4
- Income Level of Citizens	US\$/M	Increase in income according to the GRDP increase rate in real term/population growth rate. 1995 368.6 2000 381.6 2010 406.2
- Currency Exchange Rate		1 US\$ = C\$ 7.1183 = ¥ 102.20
- Inflation Rate	%	0 %, 1995 - 2010, for the economic and financial analysis of the Study

b. Waste Amount and Composition

Items	Unit	1995	2000	2010
1. Waste Amount				
1-1 Waste Generation Amount	ton/day	921.7	1,280.4	2,171.8
- MSW		712.2	1,013.0	1,766.6
Household (Area A)		396.4	580.1	1041.2
Household (Area B)		197.9	289.7	519.8
Commercial (Restaurants)		26.3	33.1	50.3
Commercial (Others)		0.4	0.4	0.4
Market		26.9	33.9	51.4
Institutional		2.4	2.9	4.0
Hospital		6.5	8.3	12.5
Street Sweeping:-		16.5	17.4	17.4
Park & Green Area		1.4	3.8	3.8
Directly Hauled		37.5	43.4	65.8
- ISW		209.5	267.4	405.2
Industrial 1)		9.2	11.6	17.5
Directly Hauled 3)		5.7	255.8	387.7
Illegally Dumped 2) 3)		194.6	-	-
1-2 Collection Ratio of Household Waste	%	77.0	90.0	100.0
1-3 Annual Increase Rate in Household Waste Generation		0.55% of GDP growth rate for an increase in household waste generation per capita.		
2. Waste Composition				
2-1 Physical Composition		1995	2000	2010
Combustibles	%	76.6	78	80
Kitchen waste		34.8	35	35
Paper		7.4	9	11
Textile		2.0	2	2
Plastic		4.2	5	7
Grass and Wood		26.1	25	23
Leather and Rubber		2.1	2	2
Non-Combustibles		23.4	22	20
Metal		1.8	2	2
Glass		2.9	3	3
Ceramic and Stone		7.5	7	6
Others (soil, etc.)		11.2	10	9
Total		100.0	100.0	100.0
2-2 Lower Calorific Value		1995	2000	2010
- (MSW excluding street sweeping and bulky wastes)	kcal/kg	1,254	1,336	1,494

- Note: 1) Industrial waste amount is limited to waste collected by the Municipality.
 2) Illegally dumped waste amount is limited to waste collected by the Municipality.
 3) Illegally dumped waste was forecasted using directly hauled waste figures.

c. Life Span of Equipment and Facilities

	Life Span (years)	Salvage value (%)
Containers	5	0
Trucks and heavy eEquipment	7	10
Machineries	15	0
Building and civil works	30	0

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

d. Executing Bodies for Technical Systems of MSWM

ALMA is the executing body for the technical system, i.e. fund raising, procurement, maintenance and operation of equipment, except for operations in collection area A. In 2000, 50% of the households in collection area A will receive collection services from private concessionaires; this number will increase to 100% in 2010.

1.5 Work Process of the Study

The study commenced in April of 1994 based on the Scope of Works (S/W) signed by the Nicaraguan Government and JICA in October 1993, and ended in May 1995. The study consisted of the following two phases:

Phase 1 : Formulation of a Master Plan

Phase 2 : Feasibility Study of Priority Projects

2. PROFILE OF THE STUDY AREA

2.1 Profile of the Study Area

a. Definition of the Study Area

aa. Definition and Present Population of the Study Area

The Study Area is defined as the whole urban area under the administration of the Municipality of Managua (ALMA).

The present population of the Study Area is tabulated in Table 2.1a.

Table 2.1a Present Population, Density, and Number of Households (1994)

District	Area (km ²)	Population			Density (pers/km ²)	Household	Person/ Household
		Total	Urban	Rural			
D1	60.41	92,890	63,556	29,334	1,538	10,192	9.1
D2	18.65	134,696	134,696	-	7,222	22,062	6.1
D3	71.45	195,410	134,833	60,577	2,735	29,423	6.6
D4	16.61	204,711	204,711	-	12,325	28,465	7.2
D5	72.12	209,045	144,241	64,804	2,899	33,052	6.3
D6	69.97	220,855	152,390	68,465	3,156	35,316	6.3
D7	231.44	14,261	-	14,261	62	1,186	12.0
Total	540.65	1,071,868	834,427	237,441	1,983	159,696	6.7

Source: Population estimated by the Study Team based on 1991 CSE electoral data

- 1) 31.6% of rural population was added to district 1
- 2) Part of district 7; population based on CSE data was divided into D3 & D5 (rural population)
- 3) Population provided by ALMA was used for district 7

ab. Collection Service Area

For SWM, the Study Area was divided into two areas: the urban and rural area. Waste collection service is principally provided only in the urban area which is further divided into collection and non-collection service areas. Collection service area consists of area A and area B. It is difficult to collectively locate the collection and non-collection areas in the map because they are all intermingled with each other.

The collection area is divided into two according to the city layout from which the collection method is based upon. The collection areas are as follows:

Collection Area A: City layout is good. Waste is discharged in front of the premises by the residents and is collected by municipal collection vehicles.

Collection Area B: The passage of collection trucks (compactor trucks) is hampered by poor road conditions and illegal connections to the main electric power outlets. Therefore, waste is discharged at areas designated by the municipality, and collected by municipal wheel loaders and dump trucks.

Non-Collection Area: The conditions in this area are similar to area B. Because of shortage of collection equipment, residents in this area are obliged to dispose waste at channels or roadsides.

b. Social Conditions in the Study Area

ba. Population

baa. Present Population in Nicaragua

The last population and housing census carried out in Nicaragua was in 1971; none has been carried out since then by INEC due to the outbreak of civil war. The 1993 statistical data of INEC placed the total population of the country at about 4.3 million.

bab. Population Forecast in the Study Area

The future population by District and urbanized area are projected as shown in Table 2.1b.

Table 2.1b Projected Urban Population by District

District	1994	1995	2000	2005	2010
D1	63,556	66,861	86,149	102,813	122,701
D2	134,696	141,700	182,578	217,895	260,044
D3	134,833	241,844	182,764	218,117	260,308
D4	204,711	215,356	277,483	331,157	395,215
D5	144,241	151,742	195,516	233,336	278,471
D6	152,390	160,314	206,562	246,519	294,204
D7	0	0	0	0	0
Total	834,427	877,817	1,131,053	1,349,838	1,610,944

c. Infrastructure of the Study Area

ca. Housing

More than 33% of the total dwellings are in poor condition, badly in need of replacement or renovation. Most of these dwellings are located in progressive and spontaneous settlement areas where fundamental changes in government policies and urban planning strategies are necessary for a better and effective housing service. Collection is hardly carried out in this area due to the absence of good access roads which will allow the passage of large collection vehicles (15m³ compactor truck), and the absence of a waste collection service has rendered the area insanitary. To resolve this situation, a waste collection system that suits the infrastructure condition in this area should be selected.

cb. Transportation

cba. Roads in the City of Managua

The Municipal Works and Services Head Office of ALMA is responsible for the construction and maintenance of roads and bridges. As of May 1994, the road network in ALMA totals 1,112.5 km. By surface type, asphalt and block accounted for approximately 709km (64 %); 331km (46.7%) is covered by the street sweeping services.

cc. Water Supply and Sewerage System

cca. Water Supply

The water supply works in Managua City are undertaken by INAA. The most serious problem in Managua's water supply sector is the difficulty in meeting the demands of the very rapidly increasing population of the capital.

ccb. Sewerage System

The sewerage system consists of concrete 130 km collection pipes and 160 km conveyance pipes, and is based on the gravity system. Sewage is discharged, without any prior treatment into Lake Managua, at sixteen different places. The lake water is considerably contaminated, and the largest pollutant loads are sewage and industrial waste water rather than leachate from the disposal site.

cd. Electricity

In the urban area, 95 % of the houses have electricity. In low income areas, many of the houses with electricity get their power from illegal connections that are hazardous and hamper the access of compactor trucks.

ce. Urban Development in the Study Area

ALMA is the central agency responsible for the preparation of city plans and for coordination with other governmental agencies.

The Town Planning Head Office of ALMA prepared the "Urban Development Plan for Managua", and has recently prepared the Master Plan for the central area as well as specific plans on urban development. However, at present, it is difficult for ALMA and the central government to realize the plans due to shortage of funds, etc. Delay in the implementation of the urban development plan is one of the reasons preventing the development of an efficient waste collection system.

d. Administration

da. Sanitation and the Environment

The national government delegates the administration of issues concerning public sanitation and the environment to INAA and MARENA. Municipalities also play a significant role in promoting public sanitation mainly in terms of SWM, food

control, storm water drainage installation, etc. On the other hand, they have a very limited role in environmental control. Although environmental Head Offices are established in some municipalities, like Managua, the concerns of these offices are usually restricted to tree planting, environmental education and some specialized fields of study, and the investigation and resolution of public complaints related to bad odors, water discharge and improper solid waste disposal.

e. Economic Conditions

ea. Gross Domestic Product (GDP)

aaa. GDP

The actual GDP in 1994 is estimated at US\$405 million, 3% more than the previous year. GDP per capita is approximately US\$400. On the other hand, the Gross Regional Domestic Product (GRDP) per capita in the city of Managua is considered to exceed US\$800. GRDP per capita in Managua is assumed to be approximately US\$880 in 2010, increasing slightly after 1998 due to the formulation and implementation of the Master Plan.

eab. Foreign Debt

The Nicaraguan foreign debt increased from US\$ 9.7 billion in 1989 to US\$ 10.8 billion in 1992, 5.8 times the GDP, which is 48 times the annual export amount, and became a serious obstacle to the development of the country.

The financial sources for the priority projects were carefully examined in order to formulate an appropriate financial plan. The examination was carried out to establish a self-sustainable solid waste management plan for the city of Managua taking into account whether they should rely on lending organizations or foreign donations as financial sources.

eb. Central Government Finances

The 1995 budget shows a revenue of US\$387 million and an expenditure of US\$424million, figures that still continue to put the economy in the red. There are no subsidies flowing in from the government for ALMA or for SWM projects.

ec. Municipal Finance

eca. Budget

The financial situation of ALMA in 1993 and 1994 was also in the red. The 1995 budget is projected to be 25 % more than the 1994 budget because ALMA expects a 68% increase in non-tax income. The finances of the municipality has been very limited.

ecb. Revenue

The operation, management and investments of the city are financed from public sales taxes, vehicle license tax, cemetery services fees and general service fees. Waste fees share 7.6% of the revenue of ALMA. Taxes and fees are managed by the Tax Collection Head Office.

ecc. Expenditures

Municipal budget is divided roughly into current operational costs and investments cost. The salary of municipal employees is the highest item in the list of expenses. Investment costs occupy around 30-40% of the total expenditures; municipal debts were relatively small then.

The PCO 1994 budget is assumed to have appropriated US\$820,000, 8% of the municipal budget, for solid waste management.

2.2 Field Survey

a. Field Survey

Basic information, such as the quantity and quality of solid waste generated in the study area, population covered by collection services, etc., is the key to a successful and feasible MSWM plan. In order to clearly understand the present MSWM, the following field surveys were conducted:

- time and motion study for waste collection works
- survey on scavengers
- survey on the recycling system and the market for reusable materials
- Public Opinion Survey (POS: a total of 180 households, shops and restaurants were surveyed)

- investigation of present and future disposal sites
- study on waste amount and composition both in winter and summer

Upon consideration of the importance of the survey, the WACS and POS are briefly described below.

b. Waste Amount and Composition Survey

ba. Method of the Survey

A Waste Amount and Composition Survey (WACS) was carried out both in summer (April to May 1994) and winter (November to December 1994) in order to obtain the basic information on waste generation ratio, discharge and recycling amount, amount of self-disposal and collection, and finally to clarify the waste stream in the study area. A WACS is a combination of several field surveys, i.e. generation ratio survey, disposal amount survey, and POS.

bb. Findings

bba. Waste Generation Ratios

Based on the WACS conducted in the summer and winter of 1994, the generation ratios of each generation source are as follows:

Table 2.2a Waste Generation Ratio

Waste type	Unit	1994
Household	g/person/day	664
Shop	g/shop/day	999
Restaurant	g/shop/day	13,828
Market	g/shop/day	3,875
Institution	g/employee/day	61
Street Sweeping	g/km/day	49,850
Hospital	g/bed/day	2,897
Park and Green Area	g/ha/day	83,800

bbb. Waste Composition

The composition of waste in the Study area is summarized in Table 2.2b.

Table 2.2b Results of the Waste Composition Survey

Classification	Unit	Household				Commercial			Markets	Institu- tions	Roads
		High Income	Middle Income	Low Income	Weighted Avg.	Restaurants	Others				
		(µg/l)	(%)	(%)	(%)	(%)	(%)	(%)			
Physical Composition (wet base)	Apparent Specific Gravity	0.19	0.16	0.22	0.20	0.32	0.04	0.28	0.25	0.16	
	Combustibles										
	Kitchen waste	54.35	43.66	29.02	34.86	62.63	4.60	38.77	9.98	13.14	
	Paper	12.55	9.05	2.98	5.37	10.40	82.34	7.40	73.02	5.86	
	Textile	2.59	1.65	1.95	1.87	0.25	0.15	1.20	2.99	4.23	
	Plastic	6.15	4.74	3.29	3.88	3.80	8.51	5.81	4.90	4.59	
	Grass and wood	11.44	23.61	29.93	27.11	10.39	0.00	28.60	3.90	42.33	
	Leather and rubber	0.21	0.54	2.87	2.00	0.00	0.39	0.75	0.03	2.09	
	Sub-total	87.29	83.26	70.04	75.09	87.47	95.99	82.53	94.82	72.24	
	Incombustible										
Metal	2.72	1.09	1.94	1.69	3.68	3.73	1.44	1.88	4.86		
Glass	4.69	3.27	2.61	2.91	5.81	0.00	2.07	0.00	0.27		
Ceramic and stone	2.05	4.16	10.50	8.07	1.60	0.00	4.16	0.00	8.02		
Others (soil, etc)	3.25	8.22	14.91	12.24	1.44	0.28	9.80	3.30	14.61		
Sub-total	12.71	16.74	29.96	24.91	12.53	4.01	17.47	5.18	27.76		
Total	(%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	
Chemical Analysis	Three contents										
	Combustibles										
	Moisture	28.13	29.47	27.97	28.47	24.77	81.68	26.29	67.45	32.30	
	Ash	58.30	43.82	37.27	40.27	60.06	6.93	49.68	22.63	28.07	
	Total	13.57	26.71	34.76	31.26	15.17	11.39	24.03	9.92	39.63	
	Sub-total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	
	Carbon	16.19	18.23	18.54	18.34	14.79	41.32	18.02	33.14	21.50	
	Hydrogen	2.31	2.54	2.54	2.53	2.05	6.14	2.54	4.80	2.93	
	Nitrogen	0.56	0.74	0.78	0.76	0.65	0.35	0.69	0.44	0.88	
	Sulphur	0.04	0.05	0.05	0.05	0.04	0.04	0.05	0.04	0.06	
Chlorine	0.27	0.25	0.24	0.24	0.18	0.86	0.28	0.44	0.28		
Oxygen	8.76	7.66	5.82	6.55	7.06	32.97	4.45	28.59	6.65		
Total	28.13	29.47	27.97	28.47	24.77	81.68	26.03	67.45	32.30		
Lower Calorific Value	(kcal/kg)	1,022	929	1,045	1,006	909	914	2,810	1,246		
C/N Ratio	-	29.01	24.69	23.94	24.39	23.00	119.81	26.28	75.77	24.51	

bbc. Waste Stream

The waste stream in the Study Area was prepared for future studies and presented in Figure 2.2a and Table 2.2c.

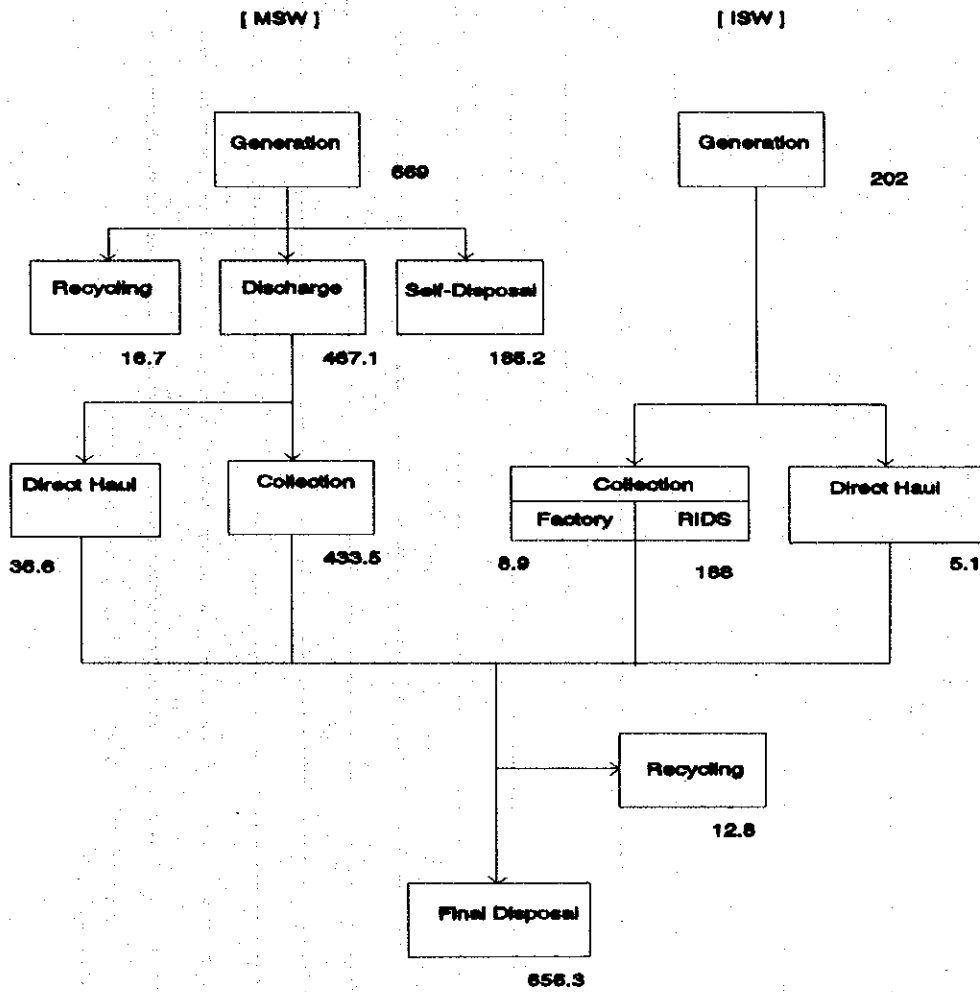


Figure 2.2a Present Waste Stream in the Study Area (unit : ton/day)

Table 2.2c Present Waste Stream in the Study Area (unit:ton/day)

Type of Waste	Generation	Source Recycling	Self-disposal	Discharge (Collection)	Recycling	Direct Haulage	Final Disposal
Household Waste	554.1	16.7	185.2	352.2	-	-	352.2
Commercial Waste (Restaurant)	25.4	0.0	0.0	25.4	-	-	25.4
Commercial Waste (Others)	0.4	0.0	0.0	0.4	-	-	0.4
Market Waste	26.0	0.0	0.0	26.0	-	-	26.0
Institutional Waste	2.3	0.0	0.0	2.3	-	-	2.3
Hospital Waste	6.3	0.0	0.0	6.3	-	-	6.3
Street Sweeping waste	16.5	0.0	0.0	16.5	-	-	16.5
Park & Green Area Waste	1.4	0.0	0.0	1.4	-	-	1.4
Directly Hauled MSW	36.6	0.0	0.0	0.0	-	36.6	36.6
Total MSW	669.0	16.7	185.2	430.5	-	36.6	467.1
Industrial Waste Collected 1)	8.9	0.0	0.0	8.9	-	-	8.9
Waste from RIDS 2)	188.0	0.0	0.0	188.0	-	-	188.0
Directly Hauled ISW	5.1	0.0	0.0	0.0	-	5.1	5.1
Total ISW	202.0	0.0	0.0	196.9	-	5.1	202.0
Total	871.0	16.7	185.2	627.4	12.8	41.7	666.3

Note 1) Industrial waste collection amount is limited to waste collected by the Municipality.
 2) RIDS(Registered Illegal Dump Site)

c. Public Opinion Survey

A Public Opinion Survey (POS) was carried out in order to understand the reasoning of the public regarding MSWM, which will be taken into account in the formulation of the Master Plan.

The waste fee amount imposed on the residents is based on the length of the front grounds of every household that comes in contact with the street. By using this as a basis, along with the type and structure of the houses, the residents were classified into high, middle and low income groups (Refer to Table 2.2d).

The salient features of the results of the POS are as follows:

- Houses are built in areas averaging approximately 300 m².
- Approximately 80% of the interviewees in the low income group and 70 % in the middle and high income group use reusable nylon sacks and disposable plastic bags, respectively, as waste containers due to their manageability and because many of them find the materials satisfactory as waste containers.
- Approximately 80 % of the interviewees intend to cooperate by carrying waste to the communal containers.
- Approximately 90 % of the people are satisfied with the present waste collection services.
- The method of waste collection is curb collection.
- Only a few of the people are aware of composting and heat recovery as methods of recycling and resource recovery. 50 % of those interviewed were aware of the recycling of paper, while only 15 % were aware of composting.
- Almost 100% of interviewees express necessity of public cooperation and participation on SWM.
- The average fee presently collected by income group per month and the average amount these groups are willing to pay are summarized in Table 2.2e.

Table 2.2d Household Expenditure by Income Group

No.	Expenditure (C\$/month)	Residence Classification (%)		
		low income group	middle income group	high income group
1	less than 500	37.5	10.0	0.0
2	500 - 1,500	52.5	45.0	10.0
3	1,500 - 3,000	7.5	20.0	10.0
4	3,000 - 5,000	0.0	10.0	17.5
5	5,000 - 7,000	0.0	7.5	22.5
6	7,000 - 10,000	0.0	0.0	5.0
7	more than 10,000	0.0	0.0	15.0
8	I do not know	2.5	7.5	20.0

Table 2.2e Public Opinion on Waste Collection Fee

		Average fee presently collected per house (C\$/month)	Average amount residents are willing to pay (C\$/month)	Difference
Residential Area	Low income group	7.3	10.5	44% up
	Middle income group	14.0	13.7	2% down
	High income group	65.4	52.5	20% down
	Average	11.8	13.2	19% up

Note: The average fee presently collected and the amount residents are willing to pay were calculated in accordance with the following population ratio:

- High : 4%
- Middle: 33%
- Low : 63%

- Approximately 36 % of the interviewees have had guidance on proper waste discharge method.
- Nearly 100 % of the interviewees understand the necessity of public cooperation and express desire to participate.

2.3 Present Situation and Evaluation of MSWM

a. Technical System

The technical system in February 1994 and its evaluation are summarized in Table 2.3a.

b. Institutional System

ba. Present Institutional System

The present institutional system of the Municipality is summarized below.

- The municipality's budget for SWM has become very limited as a result of the National Government's action to separate waste taxes from electricity bills and telephone bills.
- Maintenance of vehicles and equipment for cleansing service is mainly conducted in the Maintenance and Recovery of Equipment Office (MREO) under MWSHO. The Public Cleansing Office (PCO) also carried out light maintenance work.
- There is almost no coordination between the activities of the Municipality, the Ministry of Health and the Ministry of the Environment and Natural Resources.
- A training program shall be sought for all employee levels, since only very few professionals have had the opportunity to attend courses on solid waste issues.
- The operational and support services control shall be analyzed and planned properly to ensure the effective use of the various information and data available.

Table 2.3a Evaluation of the Present MSWM Technical System

Items	Present System	Evaluation
<p>1. Discharge & Storage</p> <ul style="list-style-type: none"> - Source Separation - Waste Container - Discharge Point 	<p>Not established.</p> <p>Nylon sacks are commonly used in the residential area.</p> <p>15m³ or 0.83m³ containers are used to collect waste from commercial areas, markets, hospitals, institutions, and factories.</p> <p>In front of the premises (collection area A).</p> <p>Discarding at registered illegal dump sites (collection area B).</p>	<p>Discharge and storage condition should be fully examined in terms of the market for recycled materials, resident participation, and MSWM financing.</p> <p>A source segregation system of infectious waste in hospitals shall be established.</p> <p>Nylon sacks are suitable in residential areas as they are cheap, easy to handle and recyclable.</p> <p>The capacity and size of containers should be examined.</p> <p>The discharge point for collection area A is suited to the present collection system. The sanitary condition of the area used for the registered illegal dump site shall improve if the scattered waste around the sites is removed.</p>
<p>2. Collection & Haulage</p> <ul style="list-style-type: none"> - Service Coverage - Collection Level System - Frequency - Collection Efficiency 	<p>The service coverage of residential areas is 77.0% of the urban area.</p> <p>Almost 100% of collection area A is covered (66.7% of the urban area). About 30.8% of collection area B is covered (10.3% of the urban area).</p> <p>Curb collection system in collection area A.</p> <p>The collection system is a combination of wheel loaders and dump trucks in collection area B.</p> <p>Container collection system in commercial areas, markets, hospitals, institutions and factories.</p> <p>Three times a week in most of collection area A. Collection frequency is not regular in collection area B. Since the capacity of 15m³ containers is too large for some facilities, it is difficult to establish the collection frequency and route.</p> <p>Working hours is normally 6 hours a day.</p>	<p>The collection service shall cover the entire urban area through proper collection system.</p> <p>The curb collection system in collection area A is suitable because of its efficiency. The container or bell collection system shall be examined for collection area B. The container system is efficient and reliable in these generation sources. The collection capacity shall be improved by replacement and increase in the number of vehicles and containers.</p> <p>Collection frequency will be determined based on sanitary conditions and operation costs. The collection frequency and route of 15³ container system shall be examined by using a truck scale.</p> <p>It shall be examined by using a truck scale.</p>
<p>3. Street Sweeping and Park and Green Area Cleansing Service</p> <ul style="list-style-type: none"> - Responsible Organization - Cleansing System 	<p>Street sweeping ... District Coordination Office (DCO). Park and Green Area Cleansing ... Beautification Head Office(BHO)</p> <p>Manual</p>	<p>Present manual sweeping and cleansing system is suitable to reduce high unemployment ratio, so it should be extended or implemented where it is not provided.</p>
<ul style="list-style-type: none"> - Discharge Point 	<p>Discarding at registered illegal dump sites.</p>	<p>Installation of containers for street sweeping and Park and Green Area cleansing shall be studied to improve sanitary conditions and for the beautification of the area.</p> <p>In order to prevent littering by citizens, the municipality should install public containers in the core area of the city in addition to the enforcement of anti-littering regulations.</p>

Items	Present System	Evaluation
<p>4. Intermediate Treatment</p> <ul style="list-style-type: none"> - Recycling - Composting 	<p>Recycling is mostly conducted by private enterprises, including scavengers at the Acahualinca disposal site, collection crew, intermediaries and purchasers. Approximately 13 tons/day of reusable materials is recycled in the study area. Main recyclable materials are glass, iron, aluminum, plastic, paper and cardboard, etc. These materials are exported to neighboring countries because the market in Nicaragua is limited.</p> <p>The municipality is executing a pilot project on composting of market waste targetting a production of 4.8 tons/month. The operation and control of the pilot project should improve compost quality and quantity. The use of compost is limited to fertilizing trees along the roadside.</p>	<p>Recycling and composting should be fully studied in terms of marketability, public participation in source segregation, MSWM financing, and as a countermeasure against unemployment.</p>
<p>5. Final Disposal</p> <ul style="list-style-type: none"> - Outline <ul style="list-style-type: none"> . Location . Distance . Disposal Amount . Landfill Area . Year of Commencement . Working Hour . Method of Landfill . Number of Landfill Equipment . Number of Scavengers . Number of Personnel - Landfill Level - Sanitary Condition 	<p>Acahualinca</p> <p>Approximately 10km from the main generation source.</p> <p>Approximately 2,000m³/day (not compacted).</p> <p>Approximately 40ha.</p> <p>1975</p> <p>12 hr/day</p> <p>Semi-controlled tipping</p> <p>Bulldozer: 2 units Landfill compactor: 4 units Water tank truck: 2 units</p> <p>Approximately 250 persons</p> <p>20 persons</p> <p>Incoming waste to the disposal site is dumped under the control of a supervisor, without water treatment and waste covering.</p> <ul style="list-style-type: none"> . As the present disposal area has been formed without prior planning, the boundary of the site is not clearly defined. . As the waste is disposed without covering, lighter wastes are scattered and blown by the wind. . The scavengers illegally live in the site. 	<p>Based on the present annual amount of the waste disposed at Acahualinca, approximately 220 thousand cubic meters, the present disposal site can be used further for another four or five years.</p> <p>These present conditions corrupt the surrounding sites, and the quality of sanitation should be improved.</p>
<p>5. O & M for Equipment</p>	<p>At Los Cocos workshop, preventive maintenance procedures are executed, such as lubrication and oil change.</p> <p>Complicated repair and maintenance of collection vehicles and equipment are conducted in the central workshop together with other municipal machinery.</p>	<p>In order to establish the efficient use of vehicles and equipment for MSWM, the present workshop for the Public Cleansing Office shall be improved.</p>

bb. Evaluation of Present Institutional System

- The intensive organization of all SWM related activities shall fall under the supervision of the present PCO. This is expected to further coordinate cleansing activities by the efficient use of equipment and manpower, particularly in the removal of RIDS scattered throughout the city.

This reorganization will contribute to the efficient use of SWM vehicles. The waste fee collection system shall be improved and reinforced to establish a stable financial source. The following improvement measures are proposed:

- . Enforcement of household fee collection activities, arrangement of residential register, gradual increase of collection fees
- . Impartiality in the collection of fees from large companies by setting up fixed criteria
- . Introduction of tipping fee collection at the disposal site
- . Allot revenue from property tax to partly cover street sweeping, parks and green areas cleansing costs.

Measures shall also be taken to improve the handling of affairs within the PCO and among the several Municipal Organizations involved in solid waste activities.

3. THE MASTER PLAN

3.1 Selection of Candidate Final Disposal Sites

In order to formulate the MSWM Master Plan for the Study Area, the Nicaraguan Coordinating Committee presented the Study Team the following six potential sites:

- Acahualinca
- Santa Ana
- Cuajachillo
- San Judas
- Villa Fontana
- Esquipulas

Based on the Team's evaluation report of the six potential sites, the Nicaraguan Coordinating Committee decided to select Acahualinca, Santa Ana and Esquipulas as candidate disposal sites for the study of Master Plan alternatives.

3.2 Examination of Technical System Alternatives for Master Plan

a. Work Flow of the Examination

The examination and selection works of the optimum technical system alternative were divided into two stages, that is, Stage A for the examination of technical sub-system components and Stage B for the selection of the optimum technical system alternatives for ALMA. The Study flow diagram of these works is shown in Figure 3.2a.

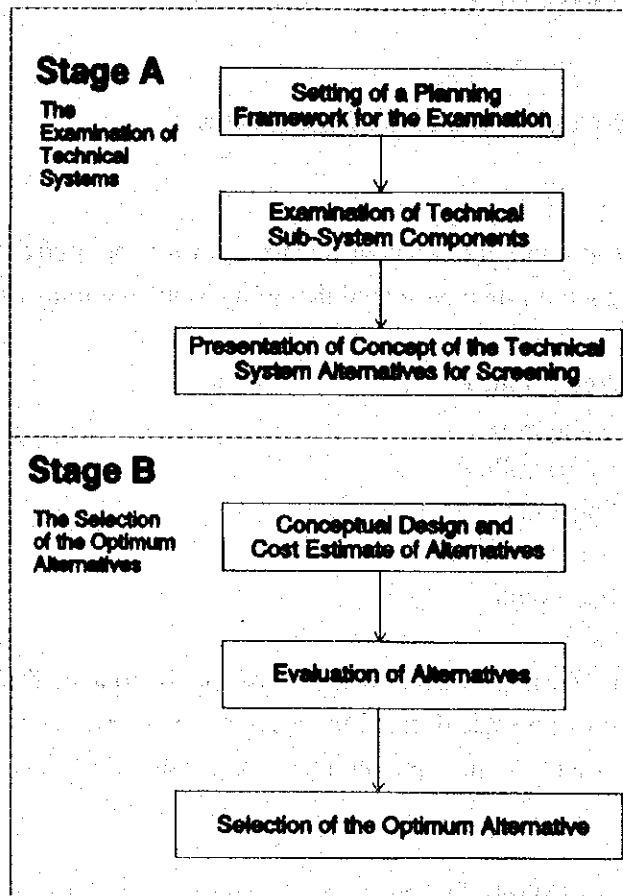


Figure 3.2a Study Flow Diagram of the Examination of Technical System Alternatives

b. Planning Framework for the Examination

The planning framework, i.e. targets, target year, future population, forecast on waste amount and composition, future economic and financial conditions, etc., was set up for the examination work.

c. Examination of Technical Sub-Systems Component

The MSWM technical system consists of several sub-systems, that is, discharge and storage, collection and haulage, intermediate treatment, final disposal, etc.. Each technical sub-system has various sub-system components, for example, incineration, composting, Refuse Derived Fuel (RDF), etc., for intermediate

treatment. Various sub-system components were examined and primarily screened for the comparison of the technical system alternatives.

d. Presentation of Technical System Alternatives

After the examination of each technical sub-system component, a technical system alternative was presented by combining the selected items.

The candidate alternatives are summarized in Table 3.2a.

Table 3.2a Technical System Alternatives

Disposal	Site	Transfer System	Alternative No.
Centralized Disposal	Acahualinca	Without	A-1
	Santa Ana	Without	A-2
		With	A-3
	Esquipulas	Without	A-4
Separate Disposal	Santa Ana & Esquipulas	Without	A-5

e. Preliminary Design and Cost Estimation

The preliminary design and cost estimation of the following systems and facilities for each of the 5 alternatives presented were carried out:

- Collection and Haulage
- Street Sweeping
- Park & Green Area Cleansing
- Sanitary Landfill

The annual MSWM expenses of the 5 alternatives in 2010 are tabulated in Table 3.2b.

Table 3.2b Annual MSWM Expenses in 2010 by Alternative

Item	Unit	Alternative				
		A-1	A-2	A-3	A-4	A-5
1. Unit Expenses						
1-1 Collection & Haulage	C\$/ton	87.57	110.96	102.61	94.16	92.76
1-2 Street sweeping	C\$/ton	800.00	802.62	800.27	800.73	801.09
1-3 Park & Green Area Cleansing	C\$/ton	3,100.65	3,150.68	3,140.42	3,103.85	3,143.97
1-4 Final disposal	C\$/ton	41.33	43.91	43.91	49.07	56.50
1-5 Administration	C\$/ton	3.73	3.73	3.73	3.73	56.50
2.Total Expenses						
2-1 Collection & Haulage	million C\$ /year	46.60	59.05	54.61	50.11	49.37
2-2 Street sweeping	million C\$ /year	5.84	5.86	5.84	5.85	5.85
2-3 Park & Green area cleansing	million C\$ /year	5.66	5.75	5.73	5.66	5.74
2-4 Final disposal	million C\$ /year	29.55	31.40	31.40	35.09	40.40
2-5 Administration	million C\$ /year	2.02	2.02	2.02	2.02	2.02
2-6 Grand Total	million C\$ /year	89.67	104.07	99.60	98.72	103.37

f. Evaluation

The overall evaluation of each aspect i.e. technical, social, environmental and financial, are elaborated in Table 3.2c. The results of the evaluation show A-1 to be the best alternative. The following are the results of the evaluation that carried so much weight in the selection of alternatives:

- Disposal site acquisition is simple as the sites involved are municipal property
- No impact on drinking water
- Least cost alternative

Overall evaluation is summarized in Table 3.2c.

Table 3.2c Summary of Overall Evaluation

Criteria	Alternative				
	A-1	A-2	A-3	A-4	A-5
a. Technical Evaluation	A	A	B	A	A
b. Social Evaluation	A	B	B	B	B
c. Environmental Evaluation	B	C	C	B	C
d. Financial Evaluation	A	C	B	B	C
Overall Assessment	A	C	B	B	C

Note: A: good B: fair C: poor

3.3 The Master Plan

a. Planning Framework

aa. Goal, Targets and Strategy

aaa. Goal

Development and Realization of a Beautiful and Sanitary Environment in the City of Managua towards the 21st Century through Citizens' Participation and Establishment of Self-sustainable Solid Waste Management

aab. Targets

Table 3.3a shows the targets to attain the goal of the Master Plan of SWM.

Table 3.3a Targets for Collection, Street Sweeping, Public Cleansing and Final Disposal Services

	Unit	1995	2000	2010
1. Population (Urban Area)	Inhabitants	877,817	1,131,052	1,610,943
2. Collection Coverage	% (inhabitants)	77.0 (675,919)	90.0 (1,017,947)	100.0 (1,610,943)
Collection Area A	% (inhabitants)	66.7 (585,504)	66.7 (754,412)	66.7 (1,074,449)
Collection Area B	% (inhabitants)	10.3 (90,415)	23.3 (263,535)	33.3 (536,444)
3. Street Sweeping Distance	km	331	350	350
4. Public Cleansing Area (Park & Green Area)	ha	16.7	45	45
5. Sanitary Landfill Level	-	Level 1	Level 3	Level 4

aac. Strategy Elements

The goal is to be specifically obtained through:

- Establishment of a self-sustainable solid waste management system.
- Provision of collection services in the urban area of ALMA, including the illegal settlement area, and establishment of a reliable collection system under which regular services can be provided.
- Construction of sanitary disposal sites employing sufficient measures for human and environmental protection.
- Establishment of efficient street sweeping and public area cleansing systems.
- Improvement of the Waste Fee System, including its collection system, under the Beneficiary-Pay-Principle where service recipients pay waste fees.
- Introduction of appropriate privatization measures for MSWM in order to reduce municipal and residential burden.
- Establishment of appropriate legislations and regulations through the modification and revision of existing ones.
- Establishment of roles befitting the organizations involved in solid waste management.
- Strengthening management and administration systems.
- Development of public participation and education programs.
- Development of solid waste management human resources.
- Securing funds for capital investment for the equipment and facilities necessary for the realization of the goal, specially during the time of take off.

ab. Target Year and Population

aba. Target Year

The Master Plan shall cover the period between 1995 to 2010. The period of the plan is divided into the following three stages.

Table 3.3b Target Year by Category of Plan

Category of Plan	Target Year
Master Plan	1995 - 2010
Medium Term Improvement Plan	2001 - 2010
Short Term Improvement Plan for F/S	1997 - 2000
Immediate Improvement Plan	Present - 1996

abb. Population Forecast in the Study Area

The absence of a national census on population led the Study Team to estimate the present and future population based upon existing data, i.e., utilized voters list, etc. The Nicaraguan side approved the forecasted population of Managua.

The future population by district and urban area are projected as shown in Table 3.3c.

Table 3.3c Population Projection by Target Year and District

District	1995		2000		2010	
	Total	Urban	Total	Urban	Total	Urban
D1	97,720	66,861	125,911	86,149	179,333	122,701
D2	141,700	141,700	182,578	182,578	260,044	260,044
D3	205,571	141,844	264,875	182,764	377,258	260,308
D4	215,356	215,356	277,483	277,483	395,215	395,215
D5	219,915	151,742	283,357	195,516	403,582	278,471
D6	232,339	160,314	299,365	206,562	426,382	294,204
D7	15,003	0	19,331	0	27,532	0
Total	1,127,605	877,817	1,452,900	1,131,052	2,069,347	1,610,943

Source: Population estimates of the Study Team based on data provided by CSE and ALMA

ac. Future Waste Amount and Composition Forecast

aca. Forecast on Future Waste Amount

i. Methodology for the Forecast

- Household Waste

$$[\text{WGR-H in X year}] = [\text{WGR-H in (X-1) year}] \times [1 + (\text{GDP in X year}/100)]$$

WGR-H: Waste generation Ratio /day/person (based on the 1994 generation ratio of 664 g/person/day)

GDP:	1995	3.5%
	1996	4.0%
	1997	4.5%
	1998-2000	5.0%
	2000-2005	4.5%
	2006-2010	4.0%

$$[\text{WGA-H in X year}] = [\text{WGR-H in X year}] \times [\text{Population in X year}]$$

WGA-H: Total household waste generation amount

- Commercial, market, institutional, hospital and directly hauled waste

$$[\text{WGA-LGS in X year}] = [\text{WGA-LGA in (X-1) year}] \times [1 + (\text{GDP in X year}/100)]$$

WGA-LGS: Waste generation amount at large generation sources

- Street sweeping, park and green area

$$[\text{WGA-PCA}] = [\text{WGR-PCA}] \times [\text{Services coverage}]$$

WGA-PCA: Street sweeping and park & green area waste

WGR-PCA: Waste generation ratio of street sweeping and park & green area

Street sweeping waste generation ratio: 49,890 g/km/day

Parks & green area cleansing waste generation ratio: 83,800 g/ha/day

ii. Forecast Waste Amount

Based on the above-mentioned assumptions, the forecasted household waste, MSW and ISW generation ratio were presented in Tables 3.3d and 3.3e.

Table 3.3d Forecast Household Waste Generation Ratio

	Unit	1995	2000	2010
Household Waste	g/person/day	682	769	969

Table 3.3e Forecast Waste Generation Amount

(unit: ton/day)

Generation Source		1995	2000	2010
MSW	Household Waste: Area A	396.4	580.1	1,041.2
	Household Waste: Area B	197.9	289.7	519.8
	Commercial Waste: Restaurants	26.3	33.1	50.3
	Commercial Waste: Others	0.4	0.4	0.4
	Market Waste	26.9	33.9	51.4
	Institutional Waste	2.4	2.9	4.0
	Hospital Waste	6.5	8.3	12.5
	Street Sweeping Waste	16.5	17.4	17.4
	Park & Green Area Waste	1.4	3.8	3.8
	Directly Hauled Waste	37.5	43.4	65.8
Sub-total		712.2	1,013.0	1,766.6
ISW Waste	Industrial Waste	9.2	11.6	17.5
	Directly Hauled Waste	5.7	255.8	387.7
	Illegally Dumped Waste	194.6	-	-
	Sub-total	209.5	267.4	405.2
Total		921.7	1,280.4	2,171.8

Note: Industrial waste amount is limited to waste collected by the Municipality.
 Illegally dumped waste amount is limited to waste collected by the Municipality.
 Illegally dumped waste was forecasted using directly hauled waste figures.

acb. Forecast Waste Composition

Since there are no available data in the Study Area, analysis was carried out by comparing the data provided by the WACS and other countries, assuming that changes in waste composition would generally result in waste characteristics inherent in a developed economy:

Table 3.3f shows the forecast MSW composition in the Study Area.

Table 3.3f Forecast MSW Composition

unit: %

Composition	1995	2000	2010
1. Combustibles	76.6	78	80
Kitchen Waste	34.8	35	35
Paper	7.4	9	11
Textile	2.0	2	2
Plastic	4.2	5	7
Grass and Wood	26.1	25	23
Leather and Rubber	2.1	2	2
2. Non-Combustibles	23.4	22	20
Metal	1.8	2	2
Glass	2.9	3	3
Ceramic and Stone	7.5	7	6
Others (Soils, etc.)	11.2	10	9
Total	100.0	100	100

Note: MSW here excludes street sweeping and bulky wastes.

acc. Forecast Calorific Value

The future LCV of waste was estimated in order to examine the alternatives of the Master Plan. In case a separate collection system will not be introduced, the LCV of mixed waste is estimated as shown in Table 3.3g.

Table 3.3g Forecast Lower Calorific Value

Year	Lower Calorific Value (kcal/kg)
	Mixed Waste
1995	1,254
2000	1,336
2010	1,494

ad. Future Waste Stream

The future waste streams are presented in Table 3.3h and Figure 3.3a.

Table 3.3h Future Waste Stream in Managua

Category		Unit	Year		
			1995	2000	2010
MSW	a.Generation	ton/day	712.2	1,013.0	1,766.6
	b.Self Disposal	ton/day	198.1	196.4	223.3
	c.Recycling at Generation Source	ton/day	17.9	26.2	47.0
	d.Collection	ton/day	458.7	747.0	1,430.5
	e.Directly Hauled MSW	ton/day	37.5	43.4	65.8
ISW	f.ISW collected by the Municipality	ton/day	9.2	11.6	17.5
	g.ISW from RIDS	ton/day	194.6	0.0	0.0
	h.Directly Hauled ISW	ton/day	5.7	255.8	387.7
i.	Recycling	ton/day	14.0	20.1	36.4
j.	Waste amount at Final Disposal Site per day	ton/day	692.3	1,037.7	1,865.1
k.	Waste amount at Final Disposal Site per year (jx365)	ton/year	252,690.0	378,761.0	680,762

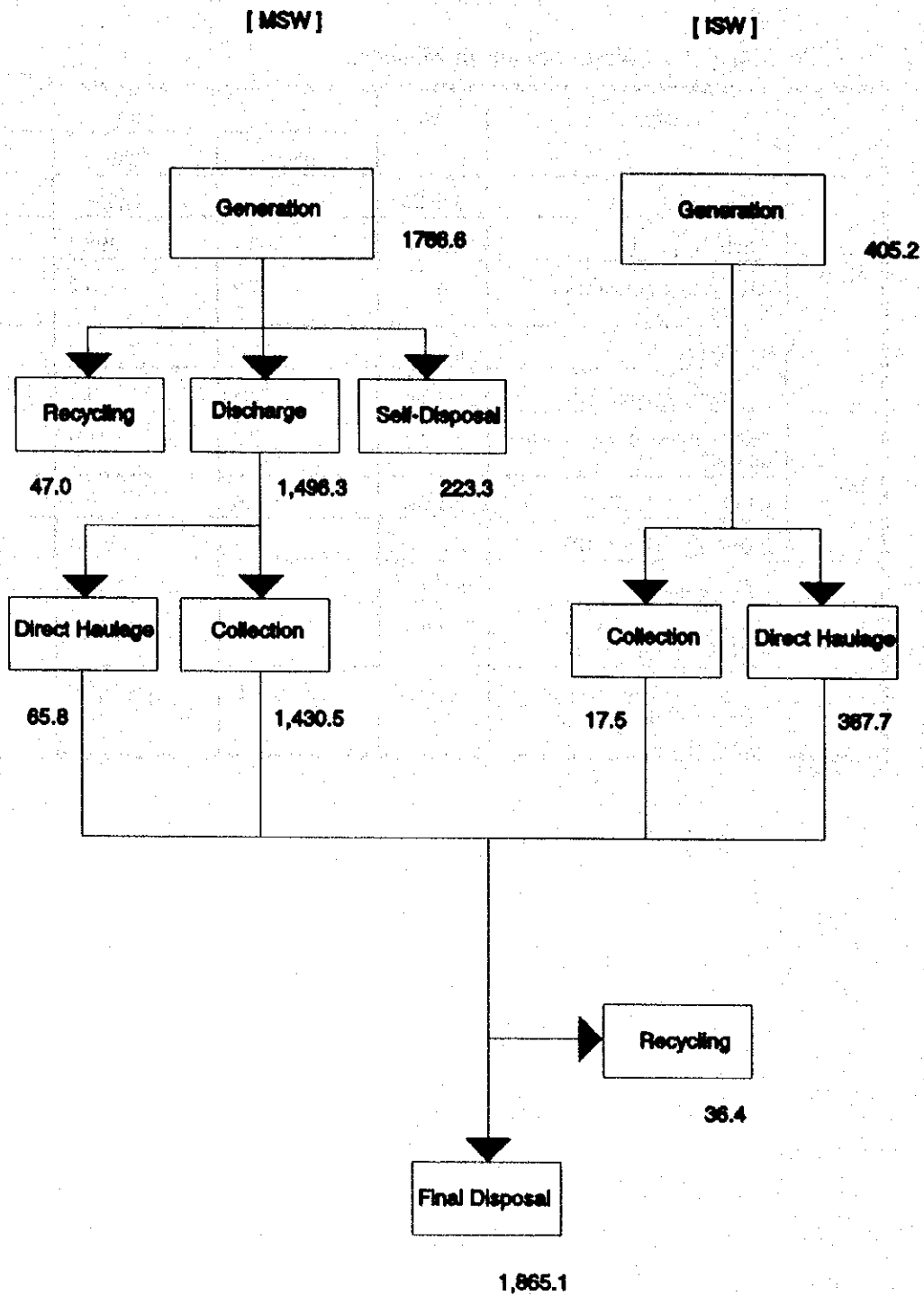


Figure 3.3a Forecasted Waste Stream in 2010 in the Study Area
(unit : ton/day)

b. MSWM Master Plan

The technical system as well as the institutional system proposed in the MSWM Master Plan for the Municipality are presented in Tables 3.3h and 3.3i.

Table 3.3i Technical System of the MSWM Master Plan

Item	Year	1995	2000	2010
1. GENERAL				
Total Population		1,127,065	1,452,900	2,069,347
Urban Area Population		877,817	1,131,053	1,610,944
Service Population		675,919	1,017,947	1,610,944
2. WASTE STREAM				
Generation		912.2 tons/day	1,280.4 tons/day	2,171.8 tons/day
Self-disposal		198.1 tons/day	196.4 tons/day	223.3 tons/day
Recycled Amount at Generation Sources		17.9 tons/day	26.2 tons/day	47.0 tons/day
Collection		662.5 tons/day	758.6 tons/day	1,448 tons/day
Recycled Amount (Recycling Material)		14.0 tons/day	20.1 tons/day	36.4 tons/day
Direct Haulage		43.2 tons/day	299.2 tons/day	453.5 tons/day
Final Disposal		692.3 tons/day	1,037.7 tons/day	1,865.1 tons/day
3. DISCHARGE & STORAGE				
Type of Containers				
- Collection area A		Nylon sacks or plastic bags	Nylon sacks or plastic bags	Nylon sacks or plastic bags
- Collection area B		Open heaping	Communal containers/ Nylon sacks or plastic bags	Communal containers/ Nylon sacks or plastic bags
- Large generation sources (commercial areas, markets, hospitals, institutions, etc.)		Communal containers	Communal containers	Communal containers
- Street sweeping, parks & green areas		Open heaping	Communal containers	Communal containers

Item	Year	1995	2000	2010
4. COLLECTION & HAULAGE				
Collection Ratio		77%	90%	100%
Service Population and ratio		675,919 (77%)	1,017,947 (90%)	1,610,944 (100%)
- in Area A (%)		585,504 (66.7%)	754,412 (66.7%)	1,074,449 (66.7%)
- in Area B (%)		90,415 (10.3%)	263,535 (23.3%)	536,444 (33.3%)
Non-service Population and ratio		201,898 (23.0%)	113,105 (10%)	0 (0%)
Collection System				
- Collection area A		Curb collection	Curb collection	Curb collection
- Collection area B		Open heaping	Container/ Bell collection	Container/ Bell collection
- Large generation sources		Container	Container	Container
Collection Frequency				
- Collection area A		Thrice a week	Thrice a week	Thrice a week
- Collection area B		Irregular	Thrice a week	Thrice a week
- Large generation sources		Every day except holi- days	Every day except holi- days	Every day except holi- days
Collection Frequency				
- Collection area A		Compactor trucks without public con- tainers	Compactor trucks without public containers	Compactor trucks without public containers
- Collection area B		Wheel loaders & dump trucks	Hoist trucks with con- tainers/ Compactor trucks without public containers	Hoist trucks with contain- ers/ Compactor trucks without public containers
- Large generation sources		Compactor trucks with public containers/ Roll-on, Roll-off trucks	Compactor trucks with public containers	Compactor trucks with public containers
Haulage System		Direct; by collection vehicles	Direct; by collection vehicles	Direct; by collection vehicles
Main Equipment (Unit)				
- Compactor (15.3m ³)		47	55	86
- Compactor with container		4	3	4
- Hoist truck		(4)	20	71
		(Roll-on Roll-off Truck)		
- Container (1m ³)		Approx. 250 units (0.83m ³)	157	154
- Container (7m ³)		Approx. 20 units (15m ³)	127	127
5. STREET SWEEPING				
Sweeping System		Manual sweeping	Manual sweeping	Manual sweeping
Covered Road Length		331 km	350 km	350 km
Main Equipment (Unit)		Combination of wheel loader and dump truck		
- Open truck		-	2	2
- Container (1m ³)		-	116	116
6. PARK & GREEN AREA				
Cleansing System		Manual sweeping	Manual sweeping	Manual sweeping
Cleansing Area		16.7 ha	45 ha	45 ha
Main Equipment (Unit)		Combination of wheel loader and dump truck		
- Hoist Truck		-	1	1
- Container (7m ³)		-	4	4

Item	Year	1995	2000	2010
7. INTERMEDIATE TREATMENT		None	None to be introduced	None to be introduced
8. FINAL DISPOSAL				
Landfill Method		Sanitary landfill Level 1: controlled tipping	Sanitary landfill Level 3	Sanitary Landfill Level 4
Disposal Site		Acahualinca	Acahualinca N.P.L.S	Acahualinca N.P.L.S
Area of the Site		40 ha	100 ha	100 ha
Landfill Owner		Municipality	Municipality	Municipality
Distance form Main Generation Source		6.5 km	8.3 km	8.3 km
Topography		Flat	Flat	Flat
Service Area		Municipality	Municipality	Municipality
Waste Subject		Municipal and non-hazardous industrial wastes	Municipal and non-hazardous industrial wastes	Municipal and non-hazardous industrial wastes
Year of Commencement		1975	1997	1997
Estimated Expiry Date		1997	2010	2010
Former Land Use		Arable land		
Future Land Use		Park	Park	Park
Working Hours		6:00 - 18:00	6:00 - 18:00	6:00 - 18:00
Main Equipment (Unit)				
- Bulldozer		2	5	8
- Landfill Compactor		4	3	4
- Wheeloader		0	1	1
- Dump Truck		0	2	3
- Motor Grader		0	1	1
- Wheel Excavator		0	1	1
- Water Tanker		2	1	1
- Pick-up Truck		0	2	2
9. EQUIPMENT OPERATION & MAINTENANCE				
Vehicle Depot				
- Location		Los Cocos workshop	Los Cocos Workshop	Los Cocos workshop
Workshop				
- Location		Los Cocos workshop	Los Cocos Workshop	Los Cocos workshop
- Responsible organization		Public Cleansing Office (PCO)	PCO	PCO
- Number of personnel		37	43	43

Table 3.3j Outline of the Institutional System of the MSWM Master Plan

Items	Year	1995	2000	2010
1. GENERAL				
Total Population		1,071,868	1,452,900	2,069,347
Urban Area Population		834,427	1,131,053	1,610,944
Service Population		642,100	1,017,947	1,610,944
2. ADMINISTRATION AND ORGANIZATION				
Responsible Organization		Public Cleansing Office	Public Cleansing Office	Public Cleansing Office
Organization Chart		Refer to ANNEX F.3	Refer to M/R Chapter 7	Refer to M/R Chapter 7
Number of Personnel				
- Administration		Administration 19		
		Planning & Management 2	54	54
		Inspection 12		
- Collection & Haulage		Collection 221	190	204
- Public Area Cleansing		Street Sweeping 206	369	369
		Park & Green 35		
- Final Disposal		Final Disposal 20	31	36
- Equipment Maintenance		Equipment Maintenance 24	43	43
TOTAL		539 persons	687 persons	706 persons
Type of Management				
- Collection & Haulage Area A		Municipality(PCO)	Municipality(50%), Concession(50%)	Concession(100%)
Area B		-	Municipality(PCO)	Municipality(PCO)
Large Generation sources		Municipality(PCO)	Municipality(PCO)	Municipality(PCO)
- Street Sweeping		Municipality(DO)	Municipality(PCO)	Municipality(PCO)
- Final Disposal		Municipality(PCO)	Municipality(PCO)	Municipality(PCO)
- Equipment O&M		Municipal(PCO)	Municipality(PCO)	Municipality(PCO)
- Public Relation Assistant		-	Municipality(PCO)	Municipality(PCO)
- Budget Control		-	Municipality(PCO)	Municipality(PCO)
3. FINANCE				
Budget (million C\$)				
- for the whole municipality		205.2	273.4	414.9
- for MSWM		17.6	69.6	80.3
Collection & Haulage		9.6	27.2	30.1
Public Cleansing Service		7.0	5.8	5.8
Disposal		0.7	34.3	42.1
Workshop		0.3	1.5	1.5
Promotion		0.0	0.8	0.8
- Unit Cost(C\$/ton)				
Collection & haulage		56.2	98.2	56.9
Public Cleansing Service		1071.4	753.4	753.4
Disposal		2.8	90.4	61.8
Workshop		1.6	5.5	2.9
Promotion		0.0	2.7	1.6

Items	Year	1995	2000	2010
State of Cadastre Registration		Incomplete	Completed	Completed
Fee Charging				
- Collection area A		Waste fee depends on the frontal length of the premises (No collection service)	Waste fee is collected by the concessionaire	Waste fee is collected by the concessionaire
- Collection area B			Waste fee and subsidy from Municipality	Waste fee and subsidy from Municipality
- Large generation sources		Waste fee	Waste fee based on the volume of the waste	Waste fee based on the volume of the waste,
- Directly hauled to disposal site		no charge	Tipping fee based on the amount of the waste	Tipping fee based on the amount of the waste
4. PRIVATIZATION		Not established	Semi-privatization	Semi-privatization
Method of Privatization		-	Concession	Concession
Work Share of Private Contractor		-	50% of Area A	100% of Area A
5. REGULATION & GUIDELINES		None		
For Littering			Public Cleansing Code	Public Cleansing Code
For Storage, Discharge and Collection			Solid Waste Management Code <SWM Code>	Solid Waste Management Code <SWM Code>
For Final Disposal			Solid Waste Management Code <SWM Code>	Solid Waste Management Code <SWM Code>
6. PUBLIC COOPERATION		None		
Responsible Organization			Public communications assistant	Public communications assistant
Method of Public Education			by using video set	by using video set

c. Phased Implementation Plan

Phased implementation plan of the MSWM Master Plan for ALMA is summarized and illustrated in Table 3.3k and Figure 3.3b, 3.3c.

Table 3.3k Targets and Concrete Measures of Each Phase to Realize the Master Plan

Plan	Targets	Concrete Measures
Immediate Improvement Plan (present - 1996)	Technical Improvement	
	1. To improve collection efficiency	- By using data obtained from truck scale
	2. To establish the system for collection area expansion	- Through organization of community association and promotional activities by the District Office - Establishment of waste fee collection system by community in squat areas
	3. To establish the system for the sanitation of the area	- Through organization of community associations and promotional activities by the District Office; - Establishment of funds to improve area condition, i.e. roads and drains
	4. To sanitize the present Acahualinca disposal site	- Construction of dike - Improvement of approach road - Transfer of techniques, i.e., daily waste covering, - construction of gas removal facility
	5. To execute public education programs on sanitation	- Education program on sanitation using videos and booklets - Promotional activities by the District Office and Environmental Protection Head Office
	Institutional Improvement	
	1. Settlement of the new section in PCO to follow up pilot projects 2. Increasing the waste fee collection ratio 3. Starting the planning and control process 4. Establishment of a training program 5. Establishment of supervision structure for illegal dumping of waste 6. Initiation of administrative improvements	These activities can be carried out by the existing municipal staff, provided training is supplied and proper support is given by the Managua Municipal authorities.

Short Term Improvement Plan (1997 -2000)	1. To attain 90% collection service	<ul style="list-style-type: none"> - Provision of cleansing equipment of good quality - Improvement of the collection and public area cleansing system
	2. To start sanitary landfill with leachate circulation (Level 3)	<ul style="list-style-type: none"> - Construction of the Acahualinca newly proposed landfill site (ANPLS) - Installation of the leachate circulation facilities - Operation of sanitary landfill (Level 3)
	3. To strengthen maintenance capability	<ul style="list-style-type: none"> - Improvement of existing Los Cocos workshop for maintenance of cleansing equipment
	4. To establish public education programs on sanitation	<ul style="list-style-type: none"> - Promotion of public awareness, cooperation and participation using materials on sanitation
Medium Term Improvement Plan (2001 - 2010)	1. To attain 100% collection service	<ul style="list-style-type: none"> - Provision of cleansing equipment of good quality
	2. To start sanitary landfill with leachate treatment (Level 4)	<ul style="list-style-type: none"> - Installation of the leachate treatment facilities - Operation of sanitary landfill (Level 4)



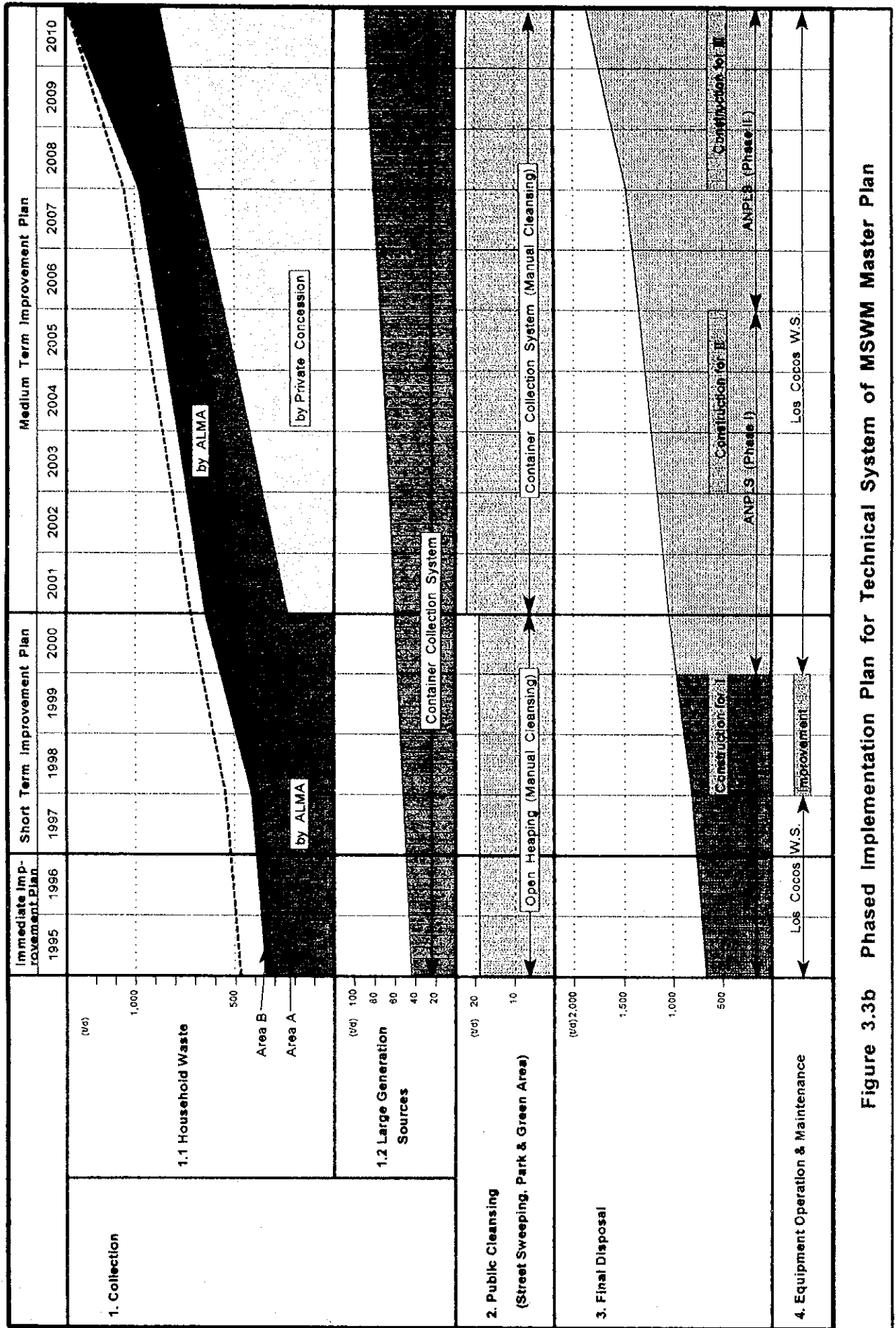
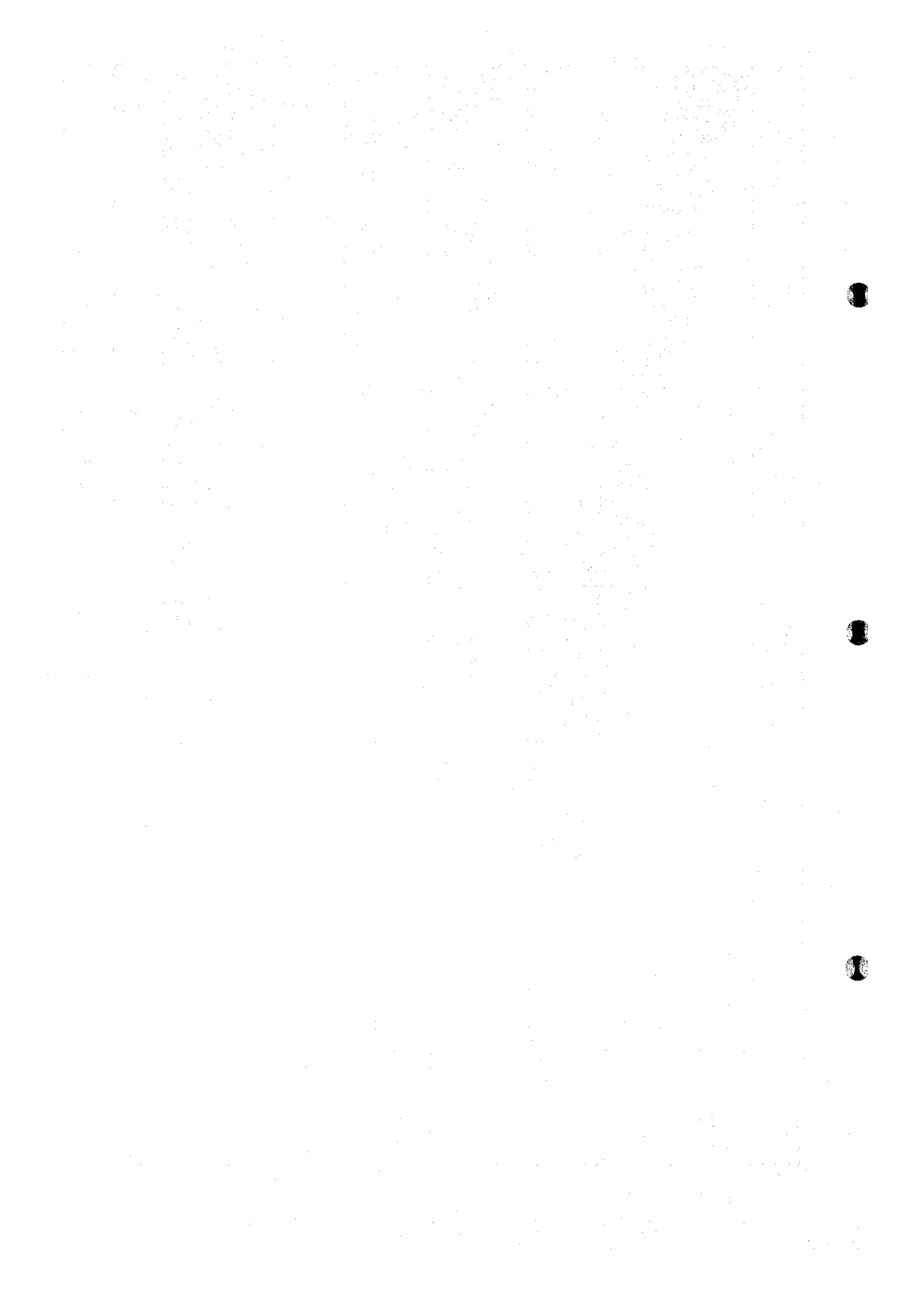


Figure 3.3b Phased Implementation Plan for Technical System of MSWM Master Plan



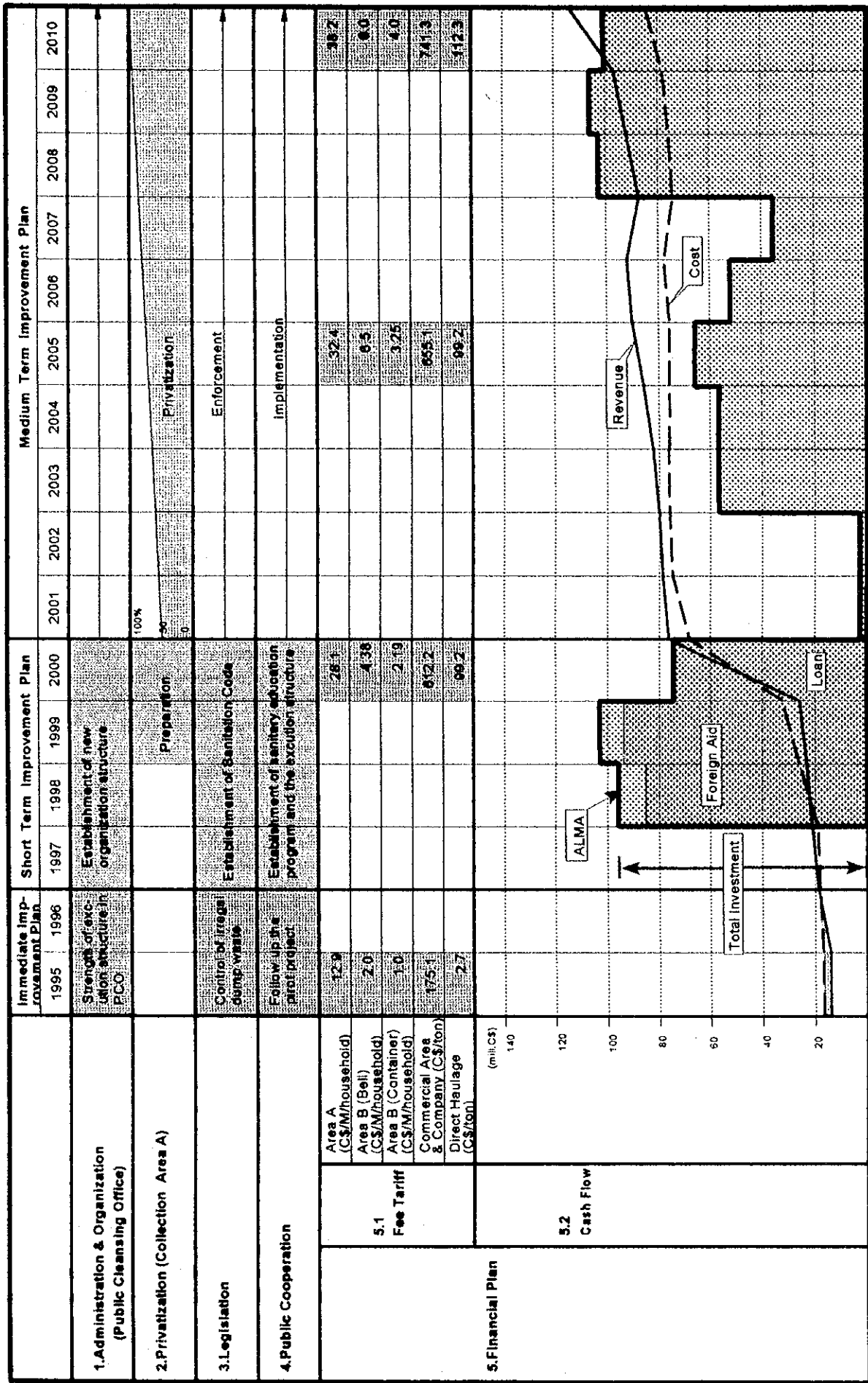


Figure 3.3c Phased Implementation Plan for Institutional System of MSWM Master Plan

4. PILOT PROJECTS

4.1 Collection Experiment

a. Objectives

Collection Area B is predominantly made up of squat settlements where basic infrastructure, i.e., road condition, is very poor. This is mainly the condition that hampers the efficient conduct of waste collection services in the area, inevitably leaving the residents without choice but to illegally discharge household waste at channels or roadsides. The collection experiment was carried out in order to determine the collection system most suitable to Collection Area B, to improve sanitary conditions.

b. Findings

ba. Container and Bell Collection System

The container and bell collection system requires a lot more public cooperation than the other collection systems. More than 75% of households that participated in the experiment answered that 80% of the households receiving collection services found them satisfactory. These figures indicate residents' approval of the experimental collection systems, and consequently prove the feasibility of extending collection services to these areas and sanitary improvement in the city of Managua.

bb. Establishment of an Executing Organization in the Municipality

The organization structure shown in Figure 4.1a was established to provide assistance to the experiment, and to function efficiently in carrying out regular collection service, coordination with residents and public education. The establishment of an organization in ALMA proved to be very important in the extension of collection services.

bc. Establishment of an Organization Responsible for Promoting Sanitation in the Community

The establishment of an organization in the community is proven to be necessary as it shall act as a mediator between the residents and ALMA, to establish coordination between the 2 parties conducting sanitation activities, which will help extend the collection area and sanitize the squat settlements.

Therefore, ALMA should positively promote the establishment of this kind of organization to improve the sanitary condition in the area.

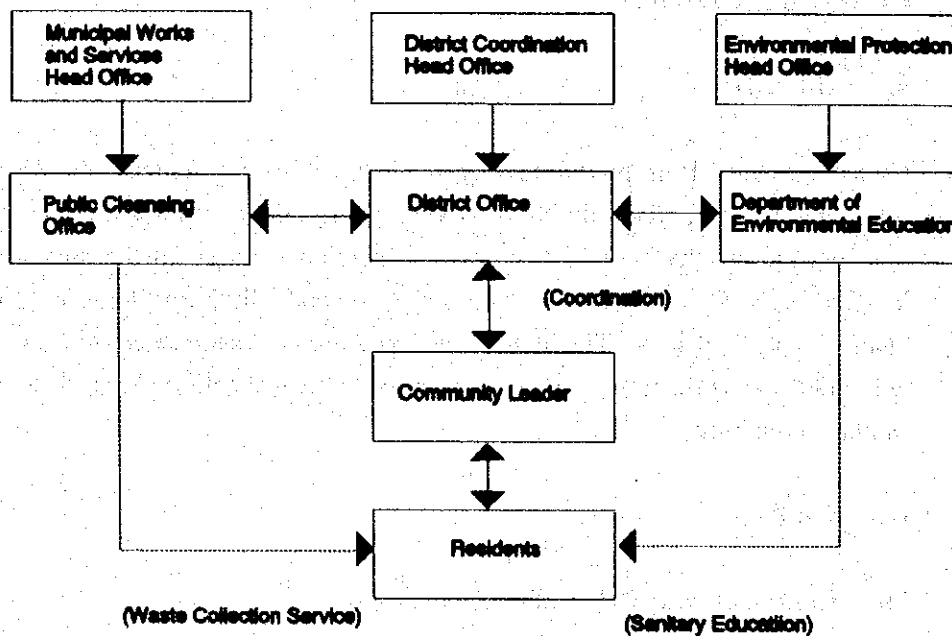


Figure 4.1a ALMA'S Execution Organization for Collection Experiment

bd. Establishment of Primary Collection System by Community

The primary collection system incorporated in the container collection system was proven to be effective in the squat area and therefore, should be implemented for the extension of services to other areas.

Primary collection system should be established in the squat areas under the supervision of ALMA which will also support the community to be covered by extended collection services.

be. Establishment of Waste Fee System in the Squat Area

Waste fee system in the squat area was established as shown in Fig.4.1.b, based upon the beneficiary pay principle. The system collection was adopted in the collection experiment and residents who understood the system paid their bills. Basically waste management service fee, inclusive of extension of collection service area, should be covered by waste fees from beneficiaries, therefore, it is

further recommended that the waste fee system shall be applied to the residents in the squat areas.

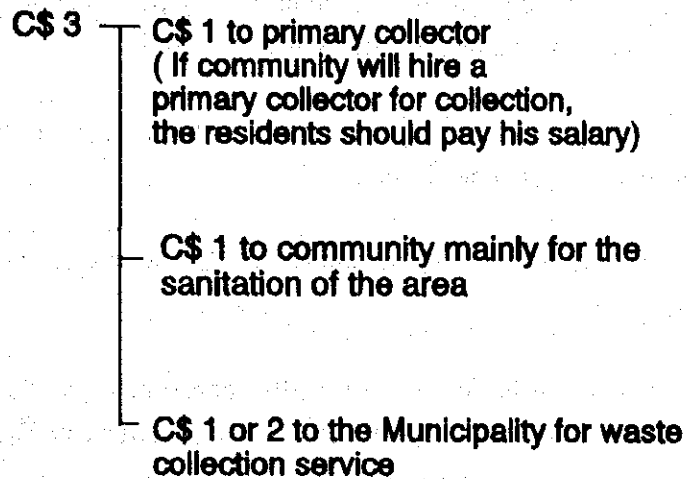


Figure 4.1b Waste Fee System in Collection Area B

bf. The Construction of the Platform

Container beds were constructed for the container collection system, and were effective in preventing damages. At the same time, sloping platforms with steps were constructed on the beds to facilitate waste discharge. It is proven that the construction of sloping platforms is effective in helping children and primary collectors with handcarts discharge their waste.

bg. Extension of Collection Services

The communities involved in the collection experiment were selected taking into account the percentage of households which expressed to participate in the experiment. The community of Hialeah requested to be included in the experiment after the selection of experimental area was finalized.

The study team recommended the inclusion of Hialeah in the experiment to the Municipality for the extension of collection area and in accordance with the methodology proposed in the collection experiment. Thereafter ALMA started the preparations for the implementation of collection services in Hialeah.

4.2 Sanitary Landfill Experiment

a. Objectives

The sanitary landfill experiment aims to inform the people in the neighboring areas of the importance of sanitary landfill practices.

- to sanitize the area of the existing Acahualinca disposal site as stated in the immediate improvement plan.
- to verify the workability of sanitary landfill works proposed in the Master Plan

The items carried out in the sanitary landfill experiment and the relevant roles of the JICA Study Team and the Municipality are presented in Table 5.1a.

Table 4.2a Role Assignment for the Sanitary Landfill Experiment

Items for the Experiment	JICA	ALMA
1. Improvement of approach road	Planning, Construction Supervision	Supervision
2. Covering of wastes	Planning, Supervision	Construction, Supervision
1)3. Construction of dike	Planning, Supervision	Construction, Supervision
4. Installation of gas removal facilities	Planning, Construction, Supervision	Construction Supervision

b. Findings

The findings obtained from the experiment are as follows:

- i. The improvement of the approach road provided the collection vehicles with an access to the dumping site. It also made landfill operations possible even during raining days.
- ii. Final covering indeed immediately prevented waste scattering, generation of bad odor and the crowding of birds, etc.. The final covering of waste was done by the construction department of ALMA in the completed landfill area because PCO is not sufficiently equipped for earth works. Heavy equipment,

namely, bulldozers, landfill compactors, etc., shall be under the control of PCO. These equipment will be used to facilitate final covering works which will be carried out daily at the disposal site in the near future.

- iii. The daily covering of waste was executed by PCO. The covering soil was hauled from the city and heaped beside the area where waste is normally dumped. The covering materials were used after waste is compacted. The dumping site gradually improved and became sanitary after the daily waste covering activities commenced; the activity did not require additional capital.
- iv. Gas removal facilities were installed by the study team at the place where final covering was done, and showed the process, which was altogether new, to the Nicaraguan side. ALMA independently installed gas removal facilities, putting into practice knowledge acquired, at the current disposal site. The material used for gas removal facilities was construction waste hauled to the disposal site. It is confirmed that even though the dumping site has been extended, PCO will still be able to install gas removal facilities by itself.
- v. The enclosing dike made of waste was constructed to make the boundaries clear and prevent waste scattering. Since PCO was aware of its effect, they built one at the northwest side of the existing disposal site.

Conclusively, the sanitary landfill experiment is quite successful, especially because it proves that, except for the leachate circulation system, ALMA is capable of operating the sanitary landfill level 3.

4.3 Public Education Campaign

a. Objectives

Taking the poor public sanitary education system in Nicaragua and the need for an effective system into consideration, the objectives of the Public Education Campaign were set as follows:

- i. Explain the magnitude and urgency of the solid waste issue in the City of Managua.
- ii. Stress the benefits of an adequate solid waste management and the harm of an improper one to public health, welfare and the environment as related to the daily life of the general population.

- iii. Point out that the active participation of the whole population can solve the problems related to solid waste in the community.
- iv. Underline the costs involved in solid waste management as a public service, and the adverse effects of improper waste management habits on SWM, i.e., illegal dumping increases the costs and reduces efficiency.
- v. Promote adequate disposal habits and public participation in matters related to solid waste management.

b. Findings

- i. District offices have good organizational structures which can be very helpful to public education campaigns and other matters in need of communal participation. Also, the social promotion departments of the districts are very useful in obtaining public participation for such activities as the collection experiment, system modification and evaluations.
- ii. Surprisingly enough, residents presented a strong willingness to cooperate and participate in projects as long as their areas benefit from it, specially those projects related with sanitation or disease control.
- iii. The Environmental Bureau has a well organized Environmental Education Department managing and coordinating public education campaigns. This department has extensive experience regarding public education and has very good relation with the district offices and the residents.
- iv. Furthermore, the Municipality of Managua has approved a project in which the Environmental Bureau will increase its financial and physical resources. This project includes the construction of an environmental library and a video projection room which the Municipality plans to use in the future for environmental public education campaigns and programs. Also, the Environmental Bureau will use the educational tools prepared by the Study Team to continue public education programs regarding SWM beyond the study period.

c. Recommendations

- i. The Environmental Education Department should carry out all public education programs in the future for the Municipality. For this purpose the Public Cleansing Office should have a Social Awareness, Social Promotion or Public Education section to cooperate with the Environmental Education

Department in the coordination of all activities related with communal participation in solid waste management in Managua. Moreover, this new section as well as the Public Cleansing Office itself, should maintain its relationship with the district offices, which is usually based on cooperation and assistance, in order to achieve its goals.

- ii. The Municipality of Managua should establish a budget for the Environmental Education Department solely for the promotion and implementation of public sanitation programs and activities to achieve long term educational goals, besides the present budget assignment.
- iii. The Nicaraguan Health Ministry or MINSA is responsible for the welfare of all citizens. The Municipality should therefore coordinate its efforts with them to increase efficiency and reduce costs. Furthermore, MINSA has a Health Education Department and social workers which can be very helpful to the Municipality in implementing public education and citizen participation programs.
- iv. The Press Office of the Municipality of Managua should play an important role in public sanitary education programs. The Cleansing Department and specially the Environmental Education Department should inform the Press Office periodically about the environmental and health situation in Managua and their campaigns, events and other efforts to educate the public. At the same time the Press Office should constantly issue press releases to publications, television and radio stations.
- v. The Environmental Education Department should use the educational tools prepared by the Study Team. Specifically, this department should establish a program using those tools, in environmental education sessions at the future environmental library.