

# **CHAPTER 10**

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## **FEASIBILITY STUDY OF PRIORITY PROJECTS**



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*This chapter firstly describes the preliminary designs of the MSWM technical subsystems, the institutional plan and project cost estimation of priority projects. Secondly it evaluated the projects and conclude that these projects are feasible.*

### **10.1 Preliminary Design of Technical System**

#### **10.1.1 Design Conditions**

##### **a Priority Projects**

##### **aa. Phased Improvement Plan**

A stepwise approach is necessary to achieve the targets of the proposed Master Plan in consideration of the financial limitations and difficulties in obtaining public cooperation. Consequently, the phased improvement plan is proposed as follows:

- i. Phase I 1997-2000
- ii. Phase II 2001-2010

To successfully implement the phase I project, immediate improvement measures will be taken prior to its commencement.

##### **ab. Selection of Priority Projects**

The Master Plan consists of various projects, some of which – those pertaining to technical systems for 2000 (Phase I) – will be given priority. A Feasibility Study will then be carried out on these priority projects.

The following are the priority projects proposed by the Study Team to the Coordinating Committee during the meeting on IT/R held in October 1994:

- Improvement of the collection and public area cleansing system
- Construction of the sanitary landfill at the proposed site in Acahualinca
- Improvement of the present Los Cocos workshop for maintenance of the cleansing equipment

- Promotion of public awareness, cooperation and participation

The Feasibility Study commenced in January 1995 after the Coordinating Committee approved the priority projects selected by the Study Team.

**ac. Details of the Priority Projects**

The details of the priority projects are outlined below:

- i. Improvement of the collection and public area cleansing system
  - Extension of collection service area
  - Establishment of public cleansing system
  - Establishment of adequate operation and maintenance system
  - Provision of collection equipment
- ii. Construction of sanitary landfill at the proposed site in Acahualinca
  - Land expropriation
  - Construction of approach road
  - Construction of enclosure dike
  - Installation of leachate circulation system
  - Provision of landfill equipment
- iii. Improvement of the present Los Cocos workshop
  - Construction of workshop building
  - Provision of maintenance equipment
- iv. Promotion of public awareness, cooperation and participation
  - Provision of promotional tools and equipment

**b. Design Conditions**

The design conditions are tabulated in the ensuing table.

Table 10.1.1a Design Conditions

Items	Basic Concept
Target Year	2000
Target Area	Managua Municipal Urban Area
Population	1,452,900
Service Population	1,131,052
Collection Waste Amount	759 tons/day
Street Sweeping Length	350 km
Public Cleansing Area	45 ha
Disposal Amount	1,038 tons/day
Sanitary Landfill Level	Level-3
Distance to landfill from Generation Source	8.3 km
Waste Stream	Figure 10.1.1a

**c. Key Assumptions**

**ca. Key assumptions for design**

The preliminary design of the priority projects made use of the following key assumptions:

Table 10.1.1b Key Assumptions for Design

Design Items	Applied Value	Unit	Remarks
<b>1. Storage and Collection</b>			
1-1 ASG of Waste in Compactor(s)	0.45	ton/m <sup>3</sup>	
1-2 ASG of Waste in Container(s)	0.22	ton/m <sup>3</sup>	
1-3 Rate of Operation of Vehicles	0.9	%	
<b>2. Public Cleansing</b>			
2-1 AGS of Waste in Compactor	0.45	ton/m <sup>3</sup>	
2-2 AGS of Waste in Container	0.22	ton/m <sup>3</sup>	
<b>3. Final Disposal</b>			
3-1 ASG of MSW	1.0	ton/m <sup>3</sup>	After compaction

**cb. Annual work days and work efficiency**

The annual working days are determined as follows:

- Total days per year : 365
- Sundays : 53
- Public holidays : 15

- total working days : 297 days/year

The assumed number of hours for equipment use is 8 hours per day, while equipment rate of operation is assumed at 0.9.

**cc. Life span of equipment and facilities**

Table 10.1.1c Life Span of Equipment and Facilities

	Life Span (years)	Salvage Value
Containers	5	0
Trucks and Heavy Equipment	7	10
Machineries	15	0
Buildings, Roads, Drains, etc.	30	0

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

**d. Waste stream**

In order to carry out the preliminary design and cost estimation, the waste stream in the year 2000 was formulated and presented in Figure 10.1.1a.

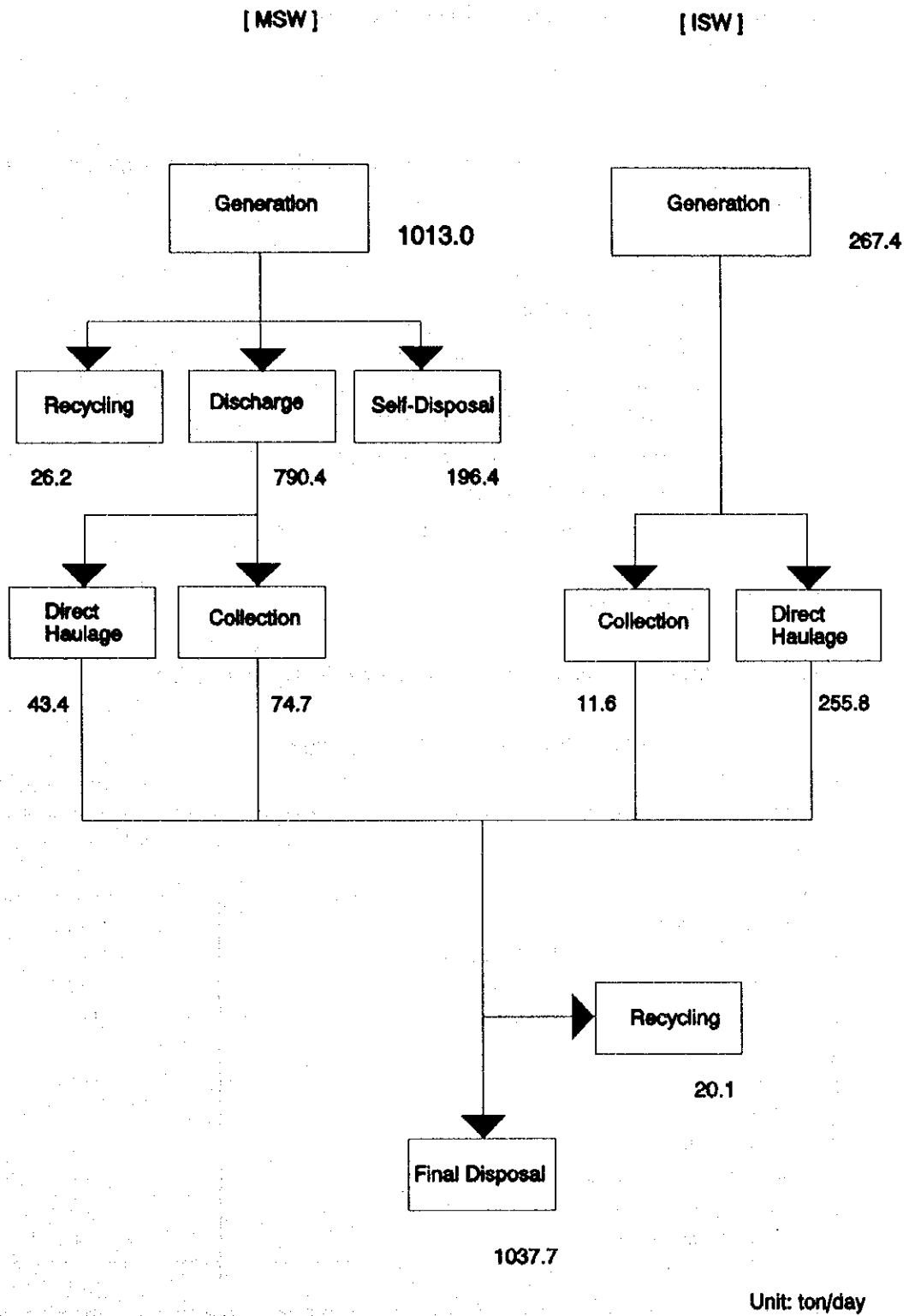


Figure 10.1.1a Waste Stream Diagram of Managua in 2000

## 10.1.2 Improvement of the Collection and Public Cleansing System

### a. Discharge, Storage and Collection System

#### aa. Wastes

The wastes dealt with in the discharge, storage, collection and haulage plans are as follows:

- Household waste
- Commercial waste
- Market waste
- Institutional waste
- Hospital waste (non-infectious)
- Industrial waste (non-hazardous)
- Street sweeping waste
- Park and green area waste

#### ab. Discharge Amount

The waste discharge amount in 2000 is shown in Table 10.1.2.a.

Table 10.1.2a Waste Discharge Amount in 2000

unit: ton/day

Type of Waste	Discharge Amount
- Household waste	
Area-A	479.7
40% of Area-B	67.0
60% of Area-B	100.6
- Commercial waste	
Restaurant	33.1
Others	0.4
- Market waste	33.9
- Institutional waste	2.9
- Hospital waste (non-infectious)	8.3
- Industrial waste (non-hazardous)	11.6
- Street sweeping waste	17.4
- Park & green area waste	3.8
<b>Total</b>	<b>758.7</b>



**ac. Storage System**

**aca. Storage System**

The proposed storage system is summarized in Table 10.1.2b below.

**Table 10.1.2b Proposed Storage System**

Category of Wastes	Storage System
- Household waste	Area-A Nylon sacks or plastic bags
	40% of Area-B Nylon sacks or plastic bags
	60% of Area-B 7.0m <sup>3</sup> communal containers
- Commercial waste	Restaurant Nylon sacks or plastic bags
	Others 7.0m <sup>3</sup> communal containers
- Market waste	7.0m <sup>3</sup> communal containers
- Institutional waste	1.0m <sup>3</sup> communal containers
- Hospital waste (non-infectious)	1.0m <sup>3</sup> communal containers
- Industrial waste (non-hazardous)	1.0m <sup>3</sup> communal containers
- Street sweeping waste	1.0m <sup>3</sup> communal containers
- Park & green area waste	7.0m <sup>3</sup> communal containers

**acb. Required Number of Containers**

The number of containers required is calculated as,

Items	Required Number of Containers
1.0m <sup>3</sup> Container	155
7.0m <sup>3</sup> Container	127

**ad. Collection System**

**ada. Collection System**

The proposed collection system is summarized below.

**Table 10.1.2c Proposed Collection System**

Collection System	Type of Waste
Compactor trucks (15.3m <sup>3</sup> )	Household waste (Area-A) Household waste (40% of Area-B) Commercial waste (Restaurant)
Compactor trucks (15.3m <sup>3</sup> ) with container (1.0m <sup>3</sup> )	Commercial waste (Others) Institutional waste Industrial waste
	Hospital waste
	Street sweeping waste
Hoist trucks with container (7.0m <sup>3</sup> )	Household waste (60% of Area-B) Market waste Park and green waste

**adb. Estimation of Required Number of Collection Vehicles**

The required number of collection vehicles was determined based on the estimated daily amount of waste for collection shown below.

**Table 10.1.2d Daily Collection Amount by Collection System in 2000**

unit: ton/day

	Daily Collection Amount	Remarks
Compactor trucks (15.3m <sup>3</sup> )	340.0	
	239.8	50% of Area-A by Private Sector
	579.8	
Compactor trucks (15.3m <sup>3</sup> ) with container lift	14.9	Commercial, Institutional, Industrial waste
	8.3	Hospital waste
	17.4	Street sweeping waste
	40.6	
Hoist Trucks	138.3	
Total	758.7	

The required number of vehicles is presented in the following table.

Table 10.1.2e Required Number of Vehicles in 2000

	ALMA	Private (50% of Area-A)	Total
Compactor trucks (15.3m <sup>3</sup> )	32	23	55
Compactor trucks (15.3m <sup>3</sup> ) with container lift	3	-	3
Hoist trucks (7.0m <sup>3</sup> )	20	-	20

**abc. Other Equipment to be Required for Collection Works**

It is necessary that the collection vehicles and road maintenance equipment should function efficiently. The collection routes in Area B get easily damaged by heavy rain and become impassable as a result. In order to continue collection services even under bad weather conditions, these routes must be kept well maintained at all times, and to do so would require the procurement of road maintenance equipment.

In addition to the collection vehicles, the procurement of the following equipment was proposed for road maintenance:

- (1) Wheel Loader (0.7m<sup>3</sup> class) 3 units
  - removal of obstacles on the road
  - spreading of filling material
  
- (2) Dump Truck (8m<sup>3</sup> class) 6 units
  - transport of filling material
  - haulage and disposal of removed obstacles
  
- (3) Motor Grader 1 unit
  - road surfacing
  - earth drain construction

(4) Pickup 6 units

- inspection and supervision of collection works

**adc. Required Number of Drivers and Collectors**

The present disposition of collection crew will be adopted (1 driver and 3 workers per collection vehicle).

Table 10.1.2f Required Number of Drivers and Collectors

Position	Number of employees
Driver	94
Collector	282

**b. Public Cleansing Service**

Public cleansing services consist of street sweeping and park and green area cleansing works. The administration of these services is proposed under the same organization mentioned in the institutional recommendation.

**ba. Street Sweeping**

**baa. Sweeping System**

The present manual sweeping system shall be continued due to the following reasons:

- high unemployment rate in the Study Area
- poor road conditions such as relatively narrow streets, low asphalt and concrete pavement rate, poor condition of stormwater drains and curb stones, lack of parking areas, etc.

**bab. Storage System**

As for the storage of swept waste, the use of 1.0 m<sup>3</sup> public containers is proposed.

## **bac. Required Equipment and Workers**

### **i. Proposed Sweeping Length and Amount of Waste to be Swept**

The target length of streets and the amount of waste to be swept are shown in Table 10.1.2g.

Table 10.1.2g Length and Waste Amount for Street Sweeping

street length	350 km
waste amount	17.4 tons/day

### **ii. Required Number of Equipment**

The number of containers required to store swept waste is calculated using the same method used in the previous section and presented in Table 10.1.2h.

The number of vehicles required for the collection of swept waste is also calculated in the manner shown in the previous section. A pickup was added to the proposed number of vehicles for inspection and supervision.

### **iii. Required Number of Sweepers**

The required number of sweepers is calculated in accordance with the following assumptions and is shown in Table 10.1.2h:

- Capacity of a sweeper: 0.5 km/day
- Frequency of sweeping: twice a week

Table 10.1.2h Required Number of Equipment and Sweepers

Items	Required Number
<b>1. Equipment</b>	
- Compactors (15.3m <sup>3</sup> ) with Container lift	2
- 1.0 m <sup>3</sup> Containers	115
- Pickup	1
<b>2. Personnel</b>	
- Sweepers	234

**bb. Parks and Green Area Cleansing**

**bba. Cleansing System**

The present manual cleansing system shall be continued due to the same reasons presented for street sweeping services.

**bbb. Storage System**

As for the storage of park and green area waste, the use of 7.0 m<sup>3</sup> public containers is proposed.

**bbc. Required Equipment and Workers**

**i. Proposed cleansing area and amount of waste**

The target area for park and green area cleansing services and the amount of waste are shown in Table 10.1.2i.

Table 10.1.2i Area and Waste Amount for Park and Green Area Cleansing

Area	45 km
Waste amount	3.8 tons/day

**ii. Required number of equipment**

The required number of vehicles for collection of park and green area waste is calculated in the manner shown in the previous section and is presented in Table 10.1.2j. A pickup was added to the proposed number of vehicles for inspection and supervision.

**iii. Required number of cleaners**

The required number of park and green area cleaners is calculated in accordance with the following assumptions:

- Capacity of a cleaner: 0.4 ha/day
- Frequency of cleansing: once a week

**Table 10.1.2j Required Number of Equipment and Cleaners for Park and Green Cleansing**

Items	Required Number
<b>1. Equipment</b>	
- Hoist Truck	1
- 7.0 m <sup>3</sup> Container	4
- Pickup	1
<b>2. Personnel</b>	
- Cleaner	113

**c. Recycling**

**ca. Introduction**

"Recycling" is the re-utilization of non-valuable materials as resources or refers to the collection and reproduction of these for effective reuse. Recycling reduces the waste disposal amount and decreases the wasteful use of natural resources. Therefore, with increase in waste generation, recycling is expected to play a very important role in the future municipal solid waste management.

According to the Team's survey on the present recycling system, the recycling system mainly established by the private sector functions well. The recycling business per se, however, is not stable, as it is easily influenced by the fluctuating market prices of salvaged materials.

**cb. Strategy**

There are many types of recycling activities and they are classified either as profitable or non-profitable recycling activities. Profitable recycling activities should be executed by private companies with support from the local administration and the public for stability. Non-profitable recycling activities should be initiated by the administration, and must utilize as much public cooperation as possible.

Recycling conditions in Central and South American countries are indicative of the unprofitability of recycling plants. Upon careful consideration of the limited financial resources and the scavenger population, the introduction of a recycling facility shall be carefully examined to avoid conflict with the present private sector.

**cc. Planned Recycling Activities**

**cca. Administrative Support for Private recycling Businesses**

Private recycling businesses are quite unstable as they are highly dependent on the market price of reusable materials which are prone to radical fluctuations.

However, the expansion of private recycling businesses should be promoted as their activities significantly contribute to the reduction of the disposal amount of waste and consumption of raw materials.

Since fluctuating demands for and selling prices of reusable materials greatly impede the development of private recycling businesses, the municipality should control and stabilize market conditions.

**ccb. Promotion of Public Cooperation Initiated by the Administration**

Public cooperation is the most effective means of curtailing high collection work costs, which usually render the majority of recycling businesses unprofitable.

The public opinion survey indicated that nearly all of the interviewees showed willingness to cooperate in recycling activities, a factor that should be utilized for the collection of recyclable materials.

In order to promote public cooperation in the collection of recyclable materials, the municipality should establish incentives to stimulate and motivate the public. The cost for such activities might be cheaper than the cost for treatment of wastes.

**cc. Introduction of On-Site Composting of Household waste**

Composting is technically the simplest way of utilizing waste. The production of composts of acceptable quality necessitates the supply of qualified organic wastes after segregation, a process not often satisfactorily executed in largely populated areas. However the on-site composting method is easy to apply for wastes of detached houses because it requires very little investment.

Waste producers are also compost users, therefore, the production of good quality compost largely depends on the householder's efforts on segregation. Given the aforementioned considerations, the introduction of on-site composting method to the detached housing area would be effective for the reduction of waste disposal amount.



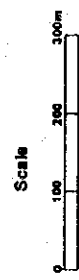
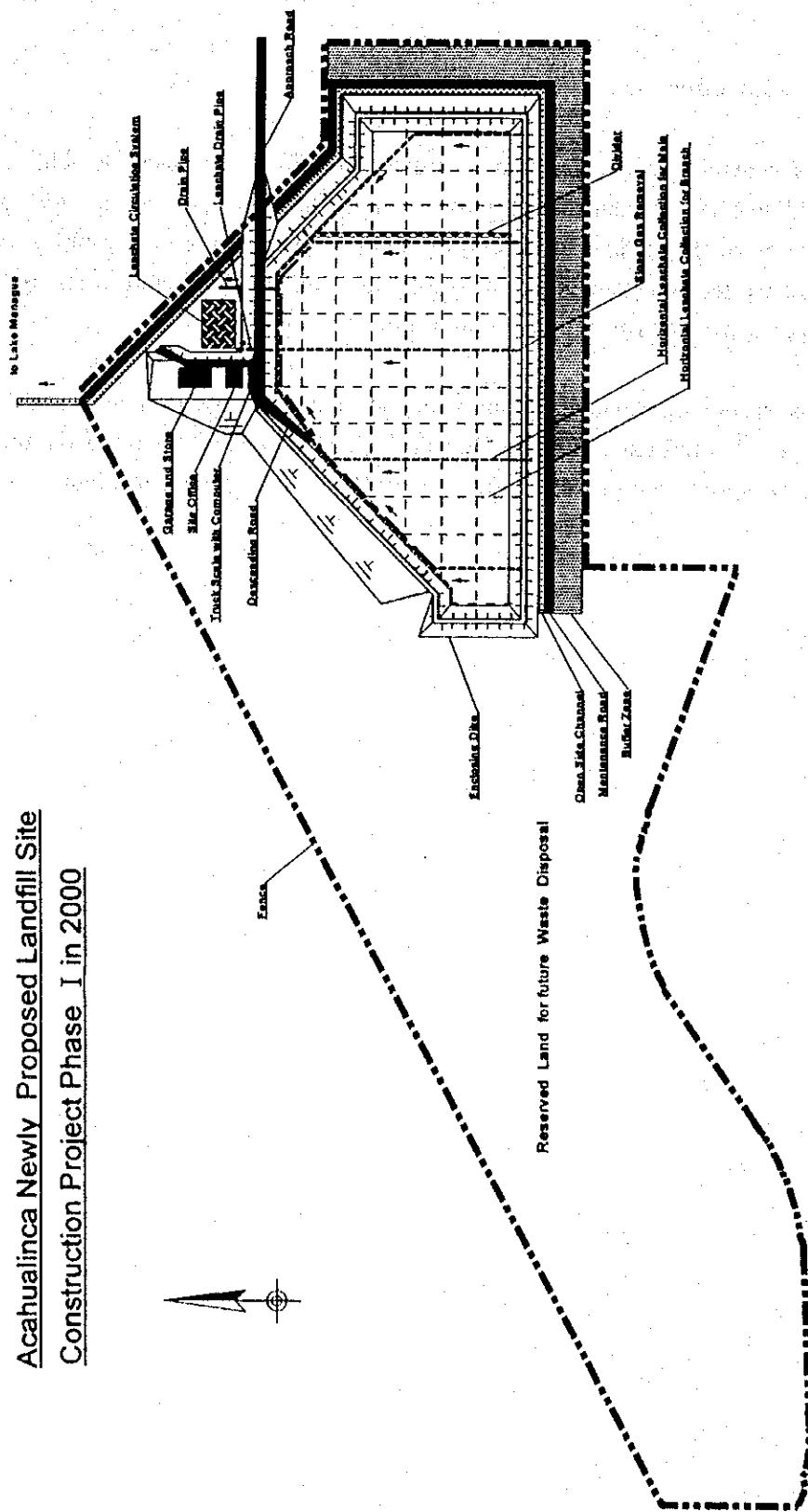
### **10.1.3 Construction of the Acahualinca Newly Proposed Landfill Site**

#### **a. Introduction**

It is generally recognized that a sanitary landfill is the basic element in modern solid waste management, proving the fact that the disposal of most wastes is acknowledged in spite of efforts for re-utilization. By giving priority to modern solid waste management, the City of Managua should therefore strengthen final disposal activities to minimize environmental impacts.

This section presents the preliminary design and cost estimates for the newly proposed landfill site in Acahualinca selected by the Coordinating Committee. The site comprises an area of approximately 93.0 ha, as shown in Figure 10.1.3a.

**Acahualinca Newly Proposed Landfill Site  
Construction Project Phase I in 2000**



Construction Project Phase I in 2000	
Drawing No.	DS002
The Study on the Improvement of the Solid Waste Management System for the City of Managua Japan International Cooperation Agency	

Figure 10.1.3a Location of the Acahualinca Newly Proposed Landfill Site

**b. Design Conditions**

**ba. Target Level of Landfill Operation**

- Target Level : Level 3 in 2000
- : Level 4 in 2010

The operation of landfill level 3 requires the following:

- . weighing of waste input with a truck scale
- . prevent leachate seepage
- . daily waste covering with soil
- . screening of working areas from outsiders
- . prompt release of gas
- . minimize leachate quantity discharged outside
- . adequate drainage system
- . proper access road
- . leachate collection and circulation system

**bb. Commencement of Sanitary Landfill Operation**

The operation of the ANPLS is planned to commence at the beginning of 2000.

**bc. Estimated Waste Disposal Amount and Required ANPLS Capacity**

The amount of waste to be disposed of in the proposed landfill site is estimated in the previous chapter.

Leachate treatment facilities installation is proposed for 2010 in the Master Plan. Accordingly, the capacity of ANPLS should be designed taking into consideration the installation term of these facilities.

Landfill construction should be carried out by section, with each section having a life span of 3 to 6 years. Therefore, the construction of the landfill which shall be utilized until 2016, according to the Master Plan, will be divided into 4 sections: the 1st section for 1999 to 2005, 2nd section for 2006 to 2010, 3rd for 2011 to 2013 and 4th for 2014 to 2016.

The estimated annual waste disposal amount in the ANPLS and the site's required capacity are presented in Table 10.1.3a.

Table 10.1.3a Estimated Daily Waste Disposal Amount in ANPLS and ANPLS Required Capacity

unit: ton/day

	Year	Daily Waste Amount (ton/day)	Annual Landfill Volume (m <sup>3</sup> /year)	Accumulated Volume & Required Capacity (M <sup>3</sup> )
Present Acahualinca Disposal Site	1995	692.3	252,690	252,690
	1996	732.6	267,399	520,089
	1997	777.9	283,934	804,022
	1998	854.9	312,039	1,116,061
	1999	939.9	343,064	1,459,124
Phase I	2000	1,037.7	378,761	378,761
	2001	1,093.7	399,201	777,961
	2002	1,153.8	421,137	1,199,098
	2003	1,216.6	444,059	1,643,157
	2004	1,282.4	468,076	2,111,233
	2005	1,352.5	493,663	2,604,896
Phase II	2006	1,421.7	518,921	518,921
	2007	1,495.2	545,748	1,064,669
	2008	1,609.7	587,541	1,652,209
	2009	1,732.5	632,363	2,284,572
	2010	1,865.1	680,762	2,965,333
Phase III	2011-2013		680,841	2,042,523
Phase IV	2014-2016		680,841	2,042,523
Total				9,654,798

**c. Facility Design**

The proposed disposal site shall be equipped with the following facilities:

**- Main facilities**

- Enclosing structure : enclosing dike and divider
- Drainage system : open side channel, on-site drain, culvert drain, interceptor drain on reclaimed area, slope drain and diversion canal
- Access : main approach road, temporary access road

**- Environmental protection facilities**

- Buffer zone
- Litter scattering prevention facilities
- Gas removal facilities
- Leachate collection facilities
- Leachate circulation facilities

- . Seepage control facilities
- . Slope protection
- **Buildings and accessories**
  - . Site office
  - . Truck scale
  - . Storage building
  - . Safety facilities : gates, fences and street lights
  - . Fire prevention facilities : water tank and extinguisher
  - . Others : parking lot and car wash

**d. Equipment and Personnel Plan**

**da. Equipment Plan**

The following equipment is required for operation of the Sanitary landfill.

**Table 10.1.3b Equipment Plan for the ANPLS**

Description	Unit	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Bulldozer (21 tons)	unit	0	5	5	5	5	6	6	6	6	7	7	8	8
Landfill Compactor (20 tons)	unit	0	3	3	3	3	3	3	3	3	4	4	4	4
Wheel Loader (1.2m <sup>3</sup> )	unit	0	1	1	1	1	1	1	1	1	1	1	1	1
Dump Truck (10 tons)	unit	0	2	2	2	2	2	2	2	2	2	2	2	2
Motor Grader (130 PS)	unit	0	1	1	1	1	1	1	1	1	1	1	1	1
Wheel Excavator (0.7m <sup>3</sup> )	unit	0	1	1	1	1	1	1	1	1	1	1	1	1
Water Tanker (5m <sup>3</sup> )	unit	0	1	1	1	1	1	1	1	1	1	1	1	1
Pickup	unit	0	2	2	2	2	2	2	2	2	2	2	2	2

**db. Personnel Plan**

The manpower plan for the ANPLS is presented in Table 10.1.3c.

**Table 10.1.3c Manpower Plan for the Acahualinca Proposed Landfill Site**

Description	unit	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Manager	person	1	1	1	1	1	1	1	1	1	1	1	1	1
Foreman	person	2	2	2	2	2	2	2	2	2	2	2	2	2
Truck-scale operator	person	3	3	3	3	3	3	3	3	3	3	3	3	3
Machine operator	person	4	9	16	16	16	17	17	17	17	19	19	21	21
Mechanic	person	1	1	1	1	1	1	1	1	1	1	1	1	1
Worker	person	5	5	5	5	5	5	5	5	5	5	5	5	5
Clerk	person	2	2	2	2	2	2	2	2	2	2	2	2	2
Security	person	1	1	1	1	1	1	1	1	1	1	1	1	1

**e. Environmental Monitoring**

In the process of carrying out landfill work, a monitoring (or supervision) plan which includes inspection of water quality and activities that lead to scattering of solid wastes, should be prepared in order to prevent the deterioration of the environment at the final disposal site.

**i. Water quality monitoring**

The following shall be monitored for water quality control:

- groundwater (existing wells)
- surface water in surrounding drain
- leachate

**ii. Waste monitoring**

The following wastes shall be monitored:

- wastes directly hauled by the generators themselves, particularly monitoring the haulage of unacceptable industrial wastes
- wastes scattered outside the site limit
- illegal dumping

**f. Cost Estimates**

**fa. Construction Cost of the ANPLS**

The preliminary drawings of the ANPLS are presented in Drawing No. DS003. The construction cost of phase I was estimated based on the work quantities derived from those drawings. The construction costs of phases II and III were estimated based on the estimated cost of phase I.

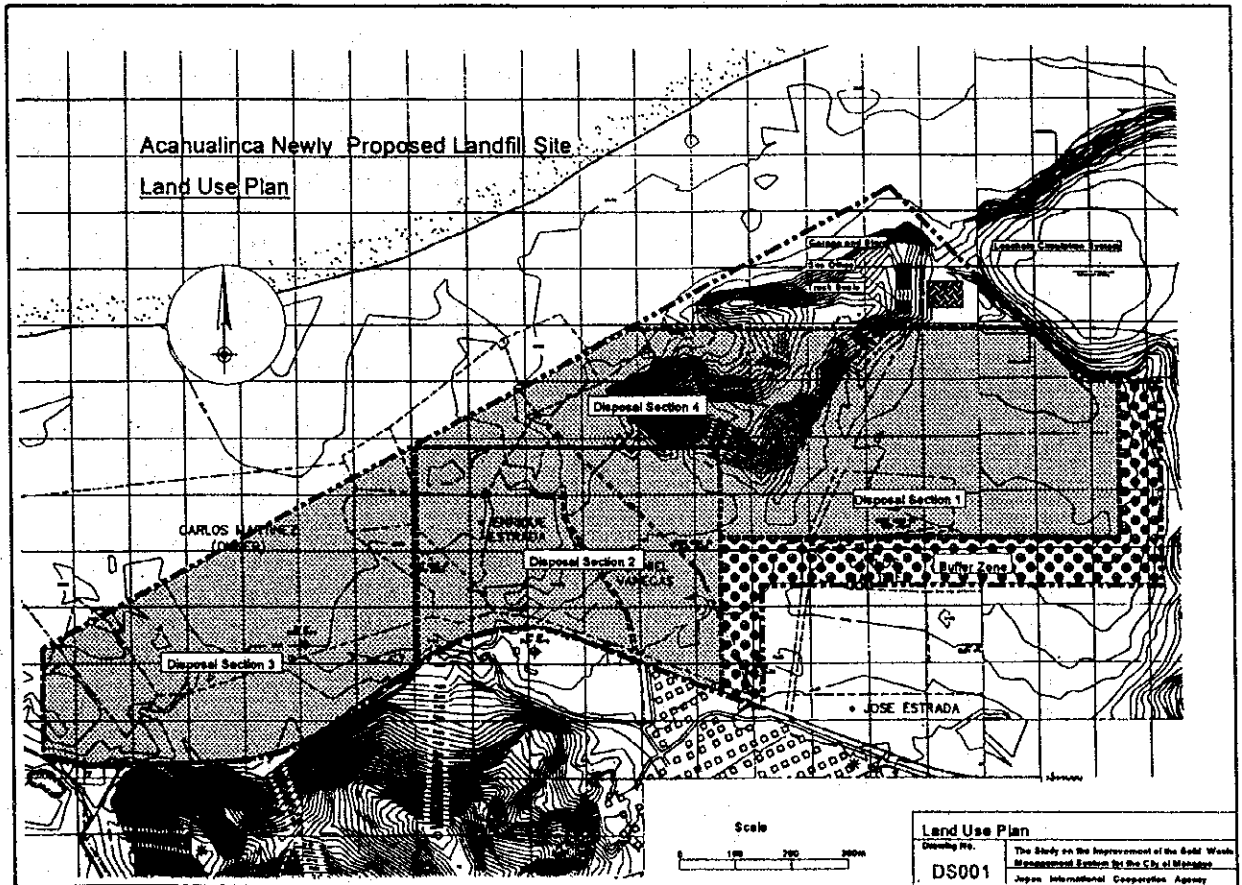
**fb. O & M Cost**

The O&M cost was estimated based on the estimated equipment and manpower plan.

**fc. Land Acquisition Cost**

The land selected for the construction of the future final disposal site is privately

owned. Although it was not included in the cost estimation process, the land acquisition cost is assumed to be C\$2.8 million for 93 hectares (official price = C\$3.00/m<sup>2</sup>).



Drawing DS001: Land Use Plan of Final Disposal Site

**fd. Construction Cost**

The cost of the construction of the Acahualinca Newly Proposed Landfill Site by phase is estimated as shown in Table 10.1.3d.

**Table 10.1.3d Construction Cost of the Acahualinca Newly Proposed Landfill Site by Phase**

No.	Items	Phase I (thou. C\$)	Phase II (thou. C\$)	Phase III (thou. C\$)	Phase IV (thou. C\$)	Total Cost from 1997 to 2010 (thou. C\$)
1	<b>Site clearing and preparation</b>	5,776	7,768	4,194	5,330	23,067
2	<b>Enclosing structures</b>	7,371	9,914	5,352	6,802	29,439
2.1	Enclosing dike	7,272	9,780	5,280	6,710	29,042
2.2	Divider	99	134	72	92	397
3	<b>Drainage system</b>	2,643	3,554	1,919	2,439	10,555
3.1	Open side channel	616	828	447	568	2,460
3.2	On-site drain	88	119	64	81	352
3.3	C-Pipe (I)	53	71	38	49	211
3.4	C-Pipe (II)	476	641	346	440	1,903
3.5	Under ground drain	166	223	121	153	663
3.6	Vertical drain	1,231	1,656	894	1,136	4,918
3.7	Diversion Canal	12	16	9	11	2
4	<b>Road</b>	5,029	6,763	3,651	4,641	20,084
4.1	Main approach road (asphalt paved)	2,721	3,659	1,976	2,511	10,866
4.2	Temporary road (gravel road)	1,793	2,412	1,302	1,655	7,161
4.3	Descending road	515	693	374	475	2,057
5.	<b>Environmental Protection Facilities</b>	64,302	86,477	193,688	59,336	256,803
5.1	Buffer zone	331	445	240	305	1,321
5.2	Litter scattering Prevention facilities	376	506	273	347	1,503
5.3	Gas removal facilities	226	304	164	209	903
5.4	Horizontal leachate collection for branch	4,433	5,962	3,219	4,091	17,705
5.5	Horizontal leachate collection for main	3,444	4,631	2,500	3,178	13,753
5.6	Leachate drain pipe	56	75	41	52	224
5.7	Leachate circulation system	1,832	2,465	1,331	1,691	7,318
5.8	Slope turfing	53,306	71,690	38,704	49,190	212,891
5.9	Monitoring facilities	276	371	200	254	1,101
5.10	Leachate treatment facilities	21	29	15	20	85
6	<b>Building and accessories</b>	4,176	2,425	1,547	1,966	10,114
6.1	Fence	2,143	2,425	1,547	1,966	8,081
6.2	Site office	653	0	0	0	652
6.3	Garage and store	512	0	0	0	512
6.4	Truck scale with computer	157	0	0	0	157
6.5	Furnitures	397	0	0	0	397
6.6	Water & Electric Supply	315	0	0	0	315
7	<b>Miscellaneous</b>	8,930	11,690	21,035	8,051	49,706
8	<b>Contingency (15%)</b>	14,734	16,773	30,181	11,552	73,240
9	<b>Design and supervision (10%)</b>	9,823	11,182	20,121	7,701	48,827
<b>Total Construction Cost (mill.C\$)</b>		<b>122.8</b>	<b>139.8</b>	<b>251.5</b>	<b>96.3</b>	<b>610.3</b>



fe. Operation and Maintenance Cost

In compliance with the landfill level design, the required quantities of equipment, labor and materials are estimated and presented in Table 10.1.3e.

Table 10.1.3e Estimated Quantities for O & M of the Disposal Site

Item	Description	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Machinery (unit)	Bulldozers (21 ton)	5	5	5	6	6	6	6	7	7	8	8
	Landfill Compactors (20 ton)	3	3	3	3	3	3	3	4	4	4	4
	Wheel Loader(1.2m <sup>3</sup> )	1	1	1	1	1	1	1	1	1	1	1
	Dump Trucks(10 ton)	2	2	2	2	2	2	2	2	2	2	2
	Motor Grader(130 PS)	1	1	1	1	1	1	1	1	1	1	1
	Wheel Excavator(0.7m <sup>3</sup> )	1	1	1	1	1	1	1	1	1	1	1
	Water Tank(5m <sup>3</sup> )	1	1	1	1	1	1	1	1	1	1	1
	Pick-ups	2	2	2	2	2	2	2	2	2	2	2
Employee (Person)	Manager	1	1	1	1	1	1	1	1	1	1	1
	Foreman	2	2	2	2	2	2	2	2	2	2	2
	Truck Scale Operator	3	3	3	3	3	3	3	3	3	3	3
	Machine Operator	16	16	16	17	17	17	17	19	19	21	21
	Mechanic	1	1	1	1	1	1	1	1	1	1	1
	Worker	5	5	5	5	5	5	5	5	5	5	5
	Clerk	2	2	2	2	2	2	2	2	2	2	2
	Security	1	1	1	1	1	1	1	1	1	1	1
Material (t.S)	Insecticide	1	1	1	1	1	1	1	1	1	1	1
	Fuel & Lubricant	1	1	1	1	1	1	1	1	1	1	1
	Others	1	1	1	1	1	1	1	1	1	1	1
Utilities (t.S)	Water and Electricity	1	1	1	1	1	1	1	1	1	1	1

Table 10.1.3f Estimated O & M Costs for the Disposal Site

Item	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Disposal Operation Service	2.95	2.95	2.95	2.55	2.55	2.55	2.55	3.07	3.07	3.29	3.29
Fuel & Lubricant	0.34	0.34	0.34	0.37	0.37	0.37	0.37	0.44	0.44	0.48	0.48
Maintenance	0.99	0.99	0.99	1.01	1.01	1.01	1.01	1.04	1.04	1.07	1.07
Personnel Expenses	2.31	2.44	2.57	2.71	2.86	3.02	3.17	3.33	3.59	3.86	4.16
Landfill Works	-	-	-	-	-	-	-	-	-	-	3.29
Landfill Treatment	5.99	6.12	6.25	6.64	6.79	6.95	7.10	7.89	8.14	8.71	12.30
Sub-total in mill. CI	0.84	0.86	0.88	0.93	0.95	0.98	1.00	1.11	1.14	1.22	1.73
(Sub-total in mill. US\$)	0.51	0.51	0.51	0.55	0.55	0.55	0.55	0.64	0.64	0.63	0.63

## 10.1.4 Improvement of the Present Los Cocos Workshop

### a. Design Conditions

#### aa. Introduction

Proper vehicle and equipment maintenance system is the key to a sound solid waste management and can be realized through the formulation and provision of manuals. The maintenance system, however, can be effectively implemented with the provision of the right tools and facilities.

In Managua, the maintenance of MSWM vehicles and equipment is carried out at the Los Cocos workshop, which is located in a poorly structured building and equipped with limited tools and equipment, some of which are rundown or malfunctioning. Given these conditions, it goes without saying that the workshop renders very sloppy services.

Several suggestions are made therefore to improve workshop conditions and human and material resources.

#### ab. Design Conditions

The MSWM vehicle and equipment operation and maintenance works are conducted in accordance with the following work share.

Table 10.1.4a MSWM Vehicle and Equipment Operation and Maintenance Works

Use of Equipment	Work Items	Operation	Maintenance & Repair
1. Collection		ALMA, Private Sector	ALMA
2. Final Disposal		ALMA	ALMA
3. Administration		ALMA	ALMA

Consequently, this chapter also deals with the improvement plan for the present Los Cocos workshop.

**b. Improvement Plan**

**ba. Lay-Out Modifications and Enlargements of the Present Los Cocos Workshop**

**Table 10.1.4b Required Number of Machines and Tools for Welding Section**

Machines and Tools	Welding Section	Mechanic Section
- Welding Machine	2	-
- Bench Electric Grinder	1	-
- Wood Bench	1	-
- Metallic Bench	1	-
- Machinist Vise	2	-
- Oxy-Acetylene Welding	1	-
- Tool Box	2	2

Some of the machines and tools to be acquired for the mechanical repair section are as follows:

**Table 10.1.4c Required Number of Machines and Tools for the Mechanical Repair Section**

Item	Quantity
- Bench	3
- Metallic Bench	1
- Bench Electric Grinder	1
- Machinist Vise n 8	2
- Compressed Air outlet	2
- Hydraulic Hanger	1
- Universal Drilling Machine	1

**bb. Proposed Area to be Paved for Washing, Lubrication and Inspection**

**Table 10.1.4d Proposed Area to be Paved in 2000**

Present Situation	Proposal
Surface Area: 651.36 m <sup>2</sup>	204.00 m <sup>2</sup> - new construction and one pit for the greasing section
	69.40 m <sup>2</sup> - enlargement of the present shed to house the mechanical repair section
	30.00 m <sup>2</sup> - cloakroom and bathroom - new constructions

**bc. Enlargement of the Present Shed for the Container Construction and Maintenance in Los Cocos and New Lay-Out**

Presently, all the collection type containers are repaired and only a few are built in this section. Some vehicle repair services are also done in this section.

When the street sweeping operations will be handed over to the Public Cleansing Office, this section shall also be improved in order to render maintenance services to the litter carts that are currently being made in this shop.

The container construction and maintenance section shall also be enlarged in order to accommodate the body repair and painting activities which are not made today.

For this purpose, the area (120 m<sup>2</sup>) alongside the painting boxes and the area for the body repair works shall be paved in concrete.

**Table 10.1.4c Improvement Plan of Container Construction and Maintenance Section**

Section	Present (m <sup>2</sup> )	Year 2000 (m <sup>2</sup> )
- Offices	82.50	82.50
- Welding and Smithy	108.48	269.60
- Painting	59.00	90.00
- Paved area	0.00	120.00
Total	249.98	562.10

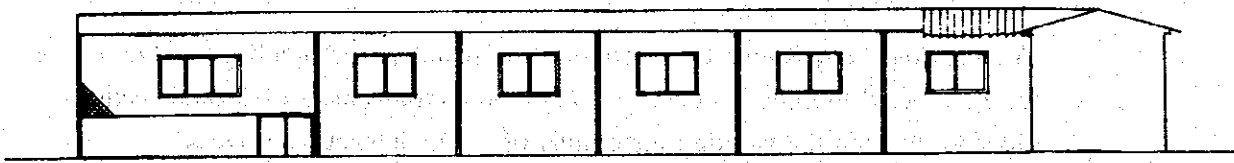
**bd. Construction of a New Shed in Los Cocos and New Lay-Out**

The previous suggestions for improving the maintenance buildings at Los Cocos were restricted to minor extensions and to the rearrangement of several sections in order to upgrade the working conditions of the maintenance services.

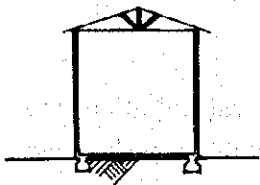
For the year 2000 though, a new shed for maintenance of vehicles and equipments shall be constructed. This new shed will be constructed in Los Cocos, near the present one, taking advantage of the current constructions used by the administrative offices and the greasing section. Also the construction of a new pit for lubrication, inspection, etc. shall be carried out.

The other areas occupied by the mechanical repair section, vulcanization and welding sections shall be demolished. The area located between the new shed and the old one shall be paved with concrete and will be used as an access for vehicles to the shed and for temporary parking of vehicles undergoing quick repair services.

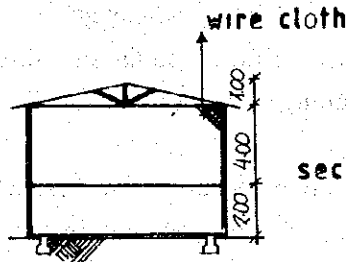
Several new machines and tools shall be acquired for these workshops sections for maintenance services. These machines and tools are listed in ANNEX J.



façade



section BB



section CC

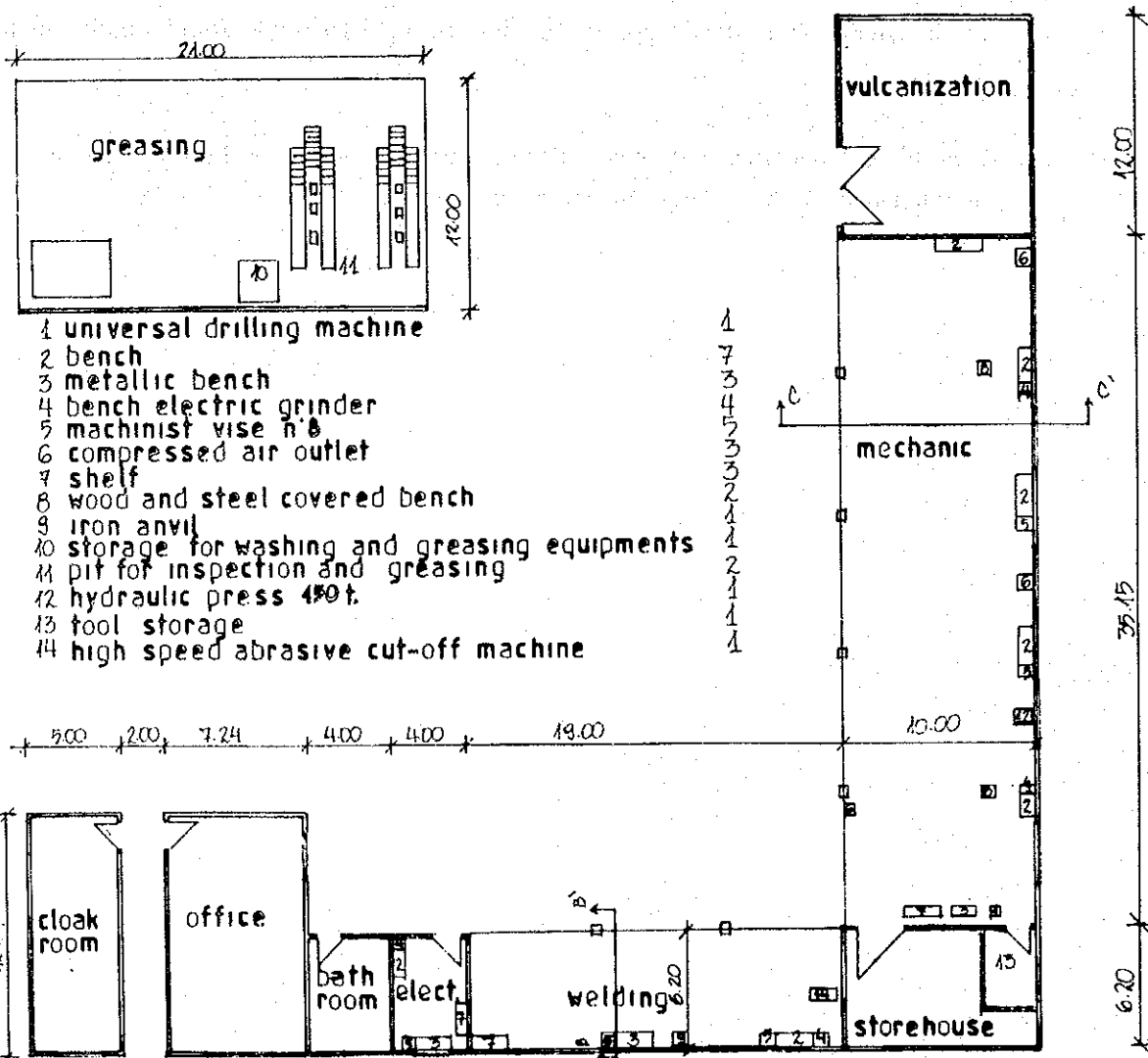


Figure 10.1.4a Proposed Workshop Building in Los Cocos

## be. Maintenance Staff Requirements

Required number of maintenance staff is summarized in the table below.

Table 10.1.4f Required Number of Personnel for Los Cocos Workshop

Section	1995	2000
- Administration	2	3
- Mechanical Repair	16 <sup>(1)</sup>	18
- Vulcanization	6+1 <sup>(3)</sup>	6
- Greasing	4+3 <sup>(2)</sup>	6
- Electrical Repair	4	4
- Welding	3	3
- Body repair & painting	4	3
Total	39+4	43

- Notes:
- (1) 8 mechanics and 8 helpers
  - (2) 3 workers more in the greasing section after the construction of the paved area and the services expansion
  - (3) for better tire repair services

## 10.1.5 Promotion of Public Awareness, Cooperation and Participation

### a. Introduction

Public awareness, cooperation and participation are necessary to realize the target defined in the Master Plan. These are very important not only for the MSWM activities but also for the citizen themselves, for improvement of the sanitary environment.

The activities for promotion of public awareness, cooperation and participation shall be done by the municipality. The public communications assistant, which is a proposed section to be established in the municipal organization as described in the institutional proposal, shall be the section to fulfill this task. Required equipment and staff to carry out these activities are proposed herein.

### b. Required Equipment

The activities for the promotion of public awareness, cooperation and participation shall be carried out all over the project area. Since a large part of the household

population have no TV sets, a 4-wheel drive station wagon with a video is proposed to carry out these activities.

**c. Required Number of Staff**

**Table 10.1.5a Required Number of Staff**

	<b>Position</b>	<b>Required Number of Staff</b>
-	Manager	1
-	Assistant manager	1
-	Driver	1
-	Worker	3
-	Clerk	1

**10.1.6 Required Number of Equipment and Manpower for the Priority Projects**

**a. Required Number of Equipment**

The number of equipment which were planned to be used for MSWM operation based on the analysis carried out in section 10.1, are summarized in Table 10.1.6a.



Table 10.1.6a Summary of Proposed Equipment by Priority Project

Items	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
<b>1. Collection and Public Cleansing Service</b>													
<b>1.1 Collection Service</b>													
- Compactors 15.3m <sup>3</sup>	5	10	55	55	55	55	55	50	45	24	24	24	24
- Compactors 15.3m <sup>3</sup> + container lift	1	3	3	3	3	3	3	3	4	4	4	4	5
- Hoist Trucks for 7.0m <sup>3</sup> container	10	20	20	21	22	23	25	26	27	29	34	39	45
- Containers 1.0m <sup>3</sup>	135	270	270	276	283	290	297	305	312	319	327	335	344
- Containers 7.0m <sup>3</sup>	65	131	131	139	147	155	163	172	182	191	223	258	297
- Dump Trucks 8m <sup>3</sup>	3	6	6	6	6	6	6	6	6	6	6	6	6
- Wheel Loaders 0.7m <sup>3</sup>	1	3	3	3	3	3	3	3	3	3	3	3	3
- Motor Graders 103 PS	0	1	1	1	1	1	1	1	1	1	1	1	1
- Pickups	3	6	6	6	6	6	6	6	6	6	6	6	6
<b>1.2 Public Cleansing Service</b>													
- Compactors 15.3m <sup>3</sup> + Container lift	1	2	2	2	2	2	2	2	2	2	2	2	2
- Hoist Trucks for 7.0m <sup>3</sup> Container	1	1	1	1	1	1	1	1	1	1	1	1	1
- Pickups	1	2	2	2	2	2	2	2	2	2	2	2	2
<b>2. Disposal Operations Service</b>													
- Bulldozers 21tons	0	5	5	5	5	6	6	6	6	7	7	8	8
- Landfill Compactors 20tons	0	3	3	3	3	3	3	3	3	4	4	4	4
- Wheel loaders 1.2m <sup>3</sup>	0	1	1	1	1	1	1	1	1	1	1	1	1
- Dump Trucks 10m <sup>3</sup>	0	2	2	2	2	2	2	2	2	2	2	2	2
- Motor Graders 130PS	0	1	1	1	1	1	1	1	1	1	1	1	1
- Wheel Excavators 0.7m <sup>3</sup>	0	1	1	1	1	1	1	1	1	1	1	1	1
- Water Tanks 5m <sup>3</sup>	0	1	1	1	1	1	1	1	1	1	1	1	1
- Pickups	0	2	2	2	2	2	2	2	2	2	2	2	2
<b>3. Maintenance Service</b>													
- Mobile Workshop	0	1	1	1	1	1	1	1	1	1	1	1	1
- Maintenance Equipment in Los Cocos	0	1	1	1	1	1	1	1	1	1	1	1	1
<b>4. Public Communications Assistants</b>													
-Station Wagon with VIDEO	1	1	1	1	1	1	1	1	1	1	1	1	1

**b. Manpower Schedule**

The manpower needed to conduct the MSWM operations based on the analysis results in section 10.1 are summarized in Table 10.1.6b.

**Table 10.1.6b Summary of Manpower Schedule by Priority Project**

Items	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
<b>1. Collection and Public Cleansing Service</b>													
<b>1.1 Collection Service</b>													
- Manager	1	1	1	1	1	1	1	1	1	1	1	1	1
- Foremen	6	6	6	6	6	6	6	6	6	6	6	6	6
- Driver	25	74	78	79	79	80	80	80	80	57	62	66	71
- Worker (collector)	61	34	194	195	193	194	190	188	186	113	118	120	123
- Clerk	3	3	3	3	3	3	3	3	3	3	3	3	3
<b>1.2 Public Cleansing Service</b>													
- Assistant Manager	1	1	1	1	1	1	1	1	1	1	1	1	1
- Foreman	6	6	6	6	6	6	6	6	6	6	6	6	6
- Driver	3	5	5	5	5	5	5	5	5	5	5	5	5
- Worker (Collector)	5	8	8	8	8	8	8	8	8	8	8	8	8
- Street Sweeper	225	230	234	234	234	234	234	234	234	234	234	234	234
- Park Cleaner	104	104	113	113	113	113	113	113	113	113	113	113	113
- Clerk	2	2	2	2	2	2	2	2	2	2	2	2	2
<b>2. Disposal Operations Service</b>													
- Manager	1	1	1	1	1	1	1	1	1	1	1	1	1
- Foreman	2	2	2	2	2	2	2	2	2	2	2	2	2
- Truck-scale Operator	3	3	3	3	3	3	3	3	3	3	3	3	3
- Machine Operator, Driver	4	9	16	16	16	17	17	17	17	19	19	21	21
- Mechanic	1	1	1	1	1	1	1	1	1	1	1	1	1
- Worker	5	5	5	5	5	5	5	5	5	5	5	5	5
- Clerk	2	2	2	2	2	2	2	2	2	2	2	2	2
- Security	1	1	1	1	1	1	1	1	1	1	1	1	1
<b>3. Maintenance Service</b>													
- Manager	1	1	1	1	1	1	1	1	1	1	1	1	1
- Mechanic	3	10	18	18	18	18	18	18	18	18	18	18	18
- Driver	0	1	1	1	1	1	1	1	1	1	1	1	1
- Worker	14	14	21	21	21	21	21	21	21	21	21	21	21
- Clerk	2	2	2	2	2	2	2	2	2	2	2	2	2
<b>4. Public Communications Assistants</b>													
- Manager	1	1	1	1	1	1	1	1	1	1	1	1	1
- Assistant Manager	1	1	1	1	1	1	1	1	1	1	1	1	1
- Driver	1	1	1	1	1	1	1	1	1	1	1	1	1
- Worker	3	3	3	3	3	3	3	3	3	3	3	3	3
- Clerk	1	1	1	1	1	1	1	1	1	1	1	1	1

## **10.2 Institutional System**

### **10.2.1 Administration and Organization**

#### **a. Administration**

The administration of the solid waste management system in Managua by the year 2000 will remain in the hands of the municipality, regardless of the proposed participation of the private sector in a significant segment of the municipal solid waste management activities.

Being universally acknowledged as a public health concern, urban solid wastes management shall always be administered by public officials.

In the case of Managua, the system will continue to be controlled by the municipal government basically through the Public Cleansing Office, which is under the Public Works and Maintenance Head Office.

Although some activities related to collection or street cleansing may be executed by other government agencies or private enterprises, the ultimate responsibility and authority shall remain, all the time, with the Public Cleansing Office.

It is very important to take note that the cleanliness of a city is the result of the combined efforts of many individuals and institutions. Therefore, the participation and cooperation of various government bodies, private concerns and non-governmental associations involved in solid waste problems are essential for the accomplishment of a clean and healthy city.

The public cleansing operations will remain in the hands of the Municipality of Managua and will be exclusively carried out by PCO from the year 2000, including the street sweeping activities presently conducted by the district offices.

#### **b. Organization**

The organization of the municipal solid waste management system in Managua will be based on the following structure:

**Table 10.2.1a Municipal Solid Waste Management System**

<b>Responsible Institution</b>	<b>Organizational Role</b>
<b>National Government (MINSA, National Police)</b>	<ul style="list-style-type: none"> <li>- Legislation and Enforcement</li> <li>- Control of Illegal Dumping of Waste</li> </ul>
<b>Municipality (Dep. of Environmental Education, District Offices etc.)</b>	<ul style="list-style-type: none"> <li>- Public Sanitary Education</li> <li>- Promotion for Sanitary Improvement</li> <li>- Property Tax Collection</li> </ul>
<b>Public Cleansing Office</b>	<ul style="list-style-type: none"> <li>- Waste Collection (Area B, Large Generation)</li> <li>- Street Sweeping</li> <li>- Final Disposal</li> <li>- Vehicle and Equipment Maintenance</li> <li>- Planning and Control</li> <li>- Fee Collection</li> <li>- Management of environmental education program</li> </ul>
<b>Private Concessionaires</b>	<ul style="list-style-type: none"> <li>- Waste Collection (Area A)</li> <li>- Fees Collection</li> </ul>
<b>Citizens</b>	<ul style="list-style-type: none"> <li>- Establishment of community organization for sanitation</li> <li>- Participation in public education program</li> <li>- Monitoring illegal dumping activities in the area</li> <li>- Primary Collection (Area B)</li> <li>- Fees and Taxes Payment</li> </ul>

The Public Cleansing Office organizational structure is as presented in Figure 7.2.2a of the Master Plan.

This structure shall be fully operational by the year 2000, with all positions occupied by appropriate public officials.

## **10.2.2 Privatization**

The role of the private sector in the MSWM in Managua will be intensified as privatization is becoming a trend not only in Managua but also in other Latin American cities.

In the case of Managua, the private sector will be mainly responsible for the collection of refuse produced in collection area "A"; collection in this area by the year 2000 will be wholly serviced by concessionaires. The concessionaires will be granted the collection of household waste in the most affluent sections of Managua as well as the fee collection of the households serviced.

Concession as a privatization measure was selected basically due to the following three reasons:

- There is a surplus of collection trucks in Managua as a result of foreign donations
- Concession will provide the Public Cleansing Office with income by leasing equipment to the concessionaire.
- The Municipality is very inefficient in tax and fee collection. This is not expected to happen with the concessionaire.

The role of the private collectors working on the secondary collection system that is being designed for collection area "B" is also important to the privatization of services. Although these workers are not usually recognized as formal entrepreneurs and part of the private sector, they are, in fact, vital components of the collection organization and should be given recognition.

The private sector is also capable of supplying other activities such as:

- Vehicles and equipment supply along with their respective spare parts and accessories
- Vehicles and equipments maintenance and repair (when they cannot be made in the Los Cocos workshop)
- Materials, goods and utilities supply
- Purchase and processing of recycled materials
- Participation in public environmental campaigns

Finally, it should also be stressed that the public sector, represented by the citizens and enterprises, will be the ultimate entity accountable for funding the MSWM system through the payment of fees and taxes.

### **10.2.3 Regulations and Enforcement**

It is forecast that Managua will have sanitary codes or guidelines in effect by the year 2000.

The sanitation code shall characterize what is considered "urban solid waste", and set government responsibilities and duties as well as those of the citizens. It shall also set fines for those that do not comply with their obligations and state an appeal procedure for those who do not agree to the fines imposed to them.

It is advisable also that the Municipality of Managua acknowledge what is being done at the national level by MARENA - the Ministry of National Resources and the Environment, with regard to solid waste legislation, in order to integrate and harmonize national and municipal legislations.

The enforcement activities, should be carried out by a trained group of public officials which shall be supervised by the Public Cleansing Office.

An effort shall also be sought in order to involve and integrate other government agencies in the enforcement activities such as those that have been done with the National Police and the Health Inspectors of the Health Ministry.

It is important to note that the enforcement program assures the people that the government sector is complying with their responsibilities and duties. By this time the citizens of Managua are more environmentally aware as a result of the public environmental education programs carried out.

#### **10.2.4 Training of Personnel**

Employees from all department levels should be exposed to training activities on a regular basis.

Depending upon the opportunities and efforts the administration provides, some of the employees shall have had some kind of training by the year 2000.

Universities do not offer solid waste management as a course in the under graduate area but rather as special short courses usually for post-graduates. Latin American and United States institutions offer some of these short courses. Officials in charge of the Public Cleansing Office in Managua should be encouraged to take these courses.

These short courses usually offer packages of subjects that best fit the needs of the applicants. In the case of Managua, special emphasis shall be placed on solid waste legislation and ordinances, operational control management, planning efficient routes design, special handling of hazardous wastes and medical wastes.

Workshop personnel should also be made to take courses on vehicles and equipment maintenance and repair. These courses shall be supplied primarily by the dealers and suppliers of the vehicles and equipment in use at the Public Cleansing Office.

Further details about these courses can be found in the chapter on Vehicles and Equipment Maintenance.

Public officials should also be encouraged to participate in seminars and conferences on solid waste management. The knowledge and the ability to make a comparison of experiences and practices in other cities and institutions greatly benefits the managers in charge of the solid waste collection and disposal.

### 10.3 Estimation of Project Cost

#### 10.3.1 Conditions on Cost Estimation

##### a. Executing Bodies

Cost estimation was executed based on the proposed executing bodies presented in Table 10.3.1a.

Table 10.3.1a Executing Bodies of MSWM by Priority Project

Projects	Fund Raising and Repayment	Construction and Procurement	Operation
1. Collection Service 1-1. Collection	ALMA	ALMA	ALMA Private Comp.
1-2. Street Sweeping	ALMA	ALMA	ALMA
2. Construction of ANPLS	ALMA	ALMA	ALMA
3. Improvement of Los Cocos Workshop	ALMA	ALMA	ALMA
4. Promotion of Public Awareness	ALMA	ALMA	ALMA

**b. Equipment Life Span**

The following figures were used for equipment replacement planning and cost estimation.

**Table 10.3.1b Equipment Life Span**

Category	Item	Life Span	Salvaged Value
Equipment	Heavy Equipment	7	10 %
	Container	5	0 %
Machinery	Truck Scale, etc.	15	0 %
Building	Site Office, etc.	15	0 %
Civil Works	Ordinary civil works	30	0 %
	Section consumed by disposal	disposal period	0 %

**c. Maintenance Cost**

Maintenance costs taken into account for cost estimation are presented in Table 10.3.1c.

**Table 10.3.1c Rate of Annual Maintenance Costs**

Category	Item	Rate of Maintenance Cost
Equipment	Compactor Trucks, (15.3 m <sup>3</sup> )	5 %
	Compactors with lift	5 %
	Hoist Trucks (7.0 m <sup>3</sup> )	5 %
	Containers (1 m <sup>3</sup> )	2 %
	Containers (7 m <sup>3</sup> )	2 %
	Dump Trucks (10 m <sup>3</sup> )	5 %
	Water Tanks (5 m <sup>3</sup> )	5 %
	Pickups	5 %
	Bulldozers 21 tons	10 %
	Landfill Compactors	10 %
	Wheel loaders	10 %
	Motor Graders	10 %
	Excavators	10 %
	Mobile Workshop	5 %
	Station Wagon	5 %
Workshop	Building	0 %
	Building	0 %
	Equipment	2 %



**d. Fuel and Lubricant**

Fuel and lubricant cost was assumed at C\$0.82/km based on current operations.

**e. Contingency**

Fifteen percent (15%) of the investment was taken into account as price contingency and physical contingency.

**f. Proposed Manpower and Equipment Schedule**

The Proposed number of equipment and manpower for each project are shown in Figures 10.1.6a, 10.1.6b.

**10.3.2 Project Cost**

**a. Investment Cost**

**aa. Procurement Schedule of Equipment**

Procurement schedule was planned in accordance with the results of the preliminary design. The Municipality of Managua will procure not only the compactor trucks (15.3m<sup>3</sup>) to be used for municipal collection work but also those for collection by concessionaires; this will be done only in the initial stage. At the end of the equipment's life (7 years), the private sector shall procure the equipment.

Table 10.3.2a Procurement Schedule of Equipment by Priority Project

Items	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
<b>1. Collection &amp; Public Cleaning Service</b>													
<b>1.1 Collection</b>													
- Compactors 15.3m <sup>3</sup>	5	5	45	0	0	0	0	0	0	24	0	0	0
- Compactors 15.3m <sup>3</sup> + container lift	1	2	0	0	0	0	0	1	3	0	0	0	1
- Hoist Trucks for 7.0m <sup>3</sup> container	10	10	0	1	1	1	2	11	11	2	6	6	7
- Containers 1.0m <sup>3</sup>	135	135	0	6	7	142	142	8	13	14	150	150	17
- Containers 7.0m <sup>3</sup>	65	66	0	8	8	73	74	9	18	17	105	109	48
- Dump Trucks 8m <sup>3</sup>	3	3	0	0	0	0	0	3	3	0	0	0	0
- Wheel Loaders 0.7m <sup>3</sup>	1	2	0	0	0	0	0	1	2	0	0	0	0
- Motor Graders 103 PS	0	1	0	0	0	0	0	0	1	0	0	0	0
- Pickups	3	3	0	0	0	0	0	3	3	0	0	0	0
<b>1.2 Public Cleaning Service</b>													
- Compactors 15.3m <sup>3</sup> with Container lift	1	1	0	0	0	0	0	1	1	0	0	0	0
- Hoist Trucks for 7.0m <sup>3</sup> Container	1	0	0	0	0	0	0	1	0	0	0	0	0
- Pickups	1	1	0	0	0	0	0	1	1	0	0	0	0
<b>2. Disposal Operations Service</b>													
- Bulldozers 21ton	0	5	0	0	0	1	0	0	5	1	0	1	1
- Landfill Compactors 20 tons	0	3	0	0	0	0	0	0	3	1	0	0	0
- Wheel loaders 1.2m <sup>3</sup>	0	1	0	0	0	0	0	0	1	0	0	0	0
- Dump Trucks 10m <sup>3</sup>	0	2	0	0	0	0	0	0	2	0	0	1	0
- Motor Graders 130PS	0	1	0	0	0	0	0	0	1	0	0	0	0
- Wheel Excavators 0.7m <sup>3</sup>	0	1	0	0	0	0	0	0	1	0	0	0	0
- Water Tanks 5m <sup>3</sup>	0	1	0	0	0	0	0	0	1	0	0	0	0
- Pickups	0	2	0	0	0	0	0	0	2	0	0	0	0
<b>3. Maintenance Service</b>													
- Mobile Workshop	0	1	0	0	0	0	0	0	1	0	0	0	0
- Maintenance Equipment in Los Chicos	0	1	0	0	0	0	0	0	0	0	0	0	0
<b>4. Public Communication Activities</b>													
- Station Wagon with VIDEO	1	0	0	0	0	0	0	1	0	0	0	0	0

ab. Estimation of Investment Schedule

Table 10.3.2b Investment Schedule for ALMA by Priority Project

unit: mill.C\$

Item	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
<b>1. Improvement of Collection and Public Cleaning System</b>													
1.1 Collection	15.8	19.0	75.4	2.0	2.0	10.2	11.4	18.1	24.6	29.3	19.1	19.4	14.2
1.2 Public Cleaning	2.6	1.5	-	-	-	-	-	2.6	1.5	-	-	-	-
Sub-total in mill.C\$	18.4	20.5	75.4	2.0	2.0	10.2	11.4	20.7	26.1	29.3	19.1	19.4	14.2
(Sub-total in mill.US\$)	2.58	2.88	10.6	0.28	0.28	1.43	1.60	2.91	3.67	4.11	2.68	2.73	1.99
<b>2. Construction of ANPLS</b>													
1.1 Construction	71.6	51.2	-	-	-	46.6	46.6	46.6	-	-	83.8	83.8	83.8
1.2 Landfill Equipment	-	25.8	-	-	-	2.1	-	-	25.8	5.1	-	3.0	2.1
Sub-total in mill.C\$	71.6	77.0	-	-	-	48.7	46.6	46.6	25.8	5.1	83.8	86.8	85.9
(Sub-total in mill.US\$)	10.06	10.81	-	-	-	6.84	6.55	6.55	3.62	0.72	11.78	12.20	12.10
<b>3. Improvement Low Coste Workshop</b>													
1.1 Construction	5.2	3.6	-	-	-	-	-	-	-	-	-	-	-
1.2 Equipment	-	2.7	-	-	-	-	-	-	0.5	-	-	-	-
Sub-total in mill.C\$	5.2	6.3	-	-	-	-	-	-	0.5	-	-	-	-
(Sub-total in mill.US\$)	0.73	0.88	-	-	-	-	-	-	0.08	-	-	-	-
<b>4. Promotive public awareness, cooperative and participation</b>													
Sub-total in mill.C\$	0.7	-	-	0.1	-	-	0.2	0.5	-	0.1	-	-	0.2
(Sub-total in mill.US\$)	0.10	-	-	0.02	-	-	0.02	0.08	-	0.02	-	-	0.02
<b>Total Cost in mill.C\$</b>	<b>95.9</b>	<b>105.8</b>	<b>75.4</b>	<b>2.1</b>	<b>2.0</b>	<b>58.9</b>	<b>58.2</b>	<b>67.8</b>	<b>52.4</b>	<b>34.5</b>	<b>102.9</b>	<b>106.2</b>	<b>100.3</b>
<b>Total Cost in US\$</b>	<b>13.47</b>	<b>14.57</b>	<b>10.6</b>	<b>0.30</b>	<b>0.28</b>	<b>8.27</b>	<b>8.17</b>	<b>9.54</b>	<b>7.37</b>	<b>4.85</b>	<b>14.46</b>	<b>14.93</b>	<b>14.11</b>

Table 10.3.2c Annual Investment Plan by Priority Project

unit: mill.C\$

Priority Projects	1998	1999	2000	2001	2002	2003	2004
1. Collection Improvement	18.382	20.522	75.423	1.990	2.002	10.177	11.391
- Foreign portion Area B	15.774	19.029	0.000	1.716	1.649	6.631	6.530
- Foreign portion Area A & LGS	2.608	1.493	75.423	0.274	0.353	3.546	4.861
2. ANPLS Construction	71.619	76.959	0.000	0.000	0.000	48.636	46.591
- Foreign portion for construction	61.357	40.904	0.000	0.000	0.000	38.803	38.803
- Foreign portion for equipment	0.000	25.793	0.000	0.000	0.000	2.045	0.000
- Local portion for construction	10.262	10.262	0.000	0.000	0.000	7.788	7.788
3. Workshop Improvement	5.216	6.287	0.000	0.000	0.000	0.000	0.000
- Foreign portion for construction	4.774	3.182	0.000	0.000	0.000	0.000	0.000
- Foreign portion for equipment	0.000	2.663	0.000	0.000	0.000	0.000	0.000
- Local portion for construction	0.442	0.442	0.000	0.000	0.000	0.000	0.000
4. Public Promotion	0.680	0.000	0.000	0.110	0.000	0.000	0.150
- Foreign portion	0.680	0.000	0.000	0.110	0.000	0.000	0.150
5. Total	95.897	103.768	75.423	2.100	2.002	58.813	58.132
- Foreign portion	85.193	93.064	75.423	2.100	2.002	51.025	50.344
- Local portion	10.074	10.704	0.000	0.000	0.000	7.788	7.788

Priority Projects	2005	2006	2007	2008	2009	2010
1. Collection Improvement	20.703	26.091	29.247	19.056	19.458	4.161
- Foreign portion Area B	14.710	15.033	7.957	15.245	17.441	12.181
- Foreign portion Area A & LGS	5.993	11.058	21.290	3.811	2.017	1.980
2. ANPLS Construction	46.591	25.793	5.154	83.836	86.845	15.881
- Foreign portion for construction	38.803	0.000	0.000	65.980	65.980	65.980
- Foreign portion for equipment	0.000	25.793	5.154	0.000	3.009	2.045
- Local portion for construction	7.788	0.000	0.000	17.856	17.856	17.586
3. Workshop Improvement	0.000	0.540	0.000	0.000	0.000	0.000
- Foreign portion for construction	0.000	0.000	0.000	0.000	0.000	0.000
- Foreign portion for equipment	0.000	0.540	0.000	0.000	0.000	0.000
- Local portion for construction	0.000	0.000	0.000	0.000	0.000	0.000
4. Public Promotion	0.540	0.000	0.110	0.000	0.000	0.150
- Foreign portion	0.540	0.000	0.110	0.000	0.000	0.150
5. Total	67.834	52.424	34.511	102.892	106.303	100.192
- Foreign portion	60.046	52.424	34.511	85.036	88.447	82.336
- Local portion	7.788	0.000	0.000	17.856	17.856	17.856

b. O & M Cost

Table 10.3.2d Summary of O & M Costs by Priority Project

unit:mill.C\$

Item	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
<b>1. Improvement collection and public cleaning system</b>											
1.1 Collection service	10.47	10.59	10.64	10.76	10.85	10.64	10.90	8.29	8.88	9.41	10.12
1.1.1 Fuel & lubricant	1.85	1.88	1.90	1.93	1.96	1.98	2.00	2.03	2.19	2.33	2.52
1.1.2 Maintenance	4.33	4.39	4.43	4.51	4.62	4.42	4.28	3.90	3.58	3.87	4.28
1.1.3 Personnel expenses	4.29	4.32	4.29	4.32	4.27	4.25	4.23	2.97	3.11	3.20	3.32
1.2 Public cleaning service	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26
1.2.1 Fuel & lubricant	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
1.2.2 Maintenance	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
1.2.3 Personnel expenses	4.96	4.96	4.96	4.96	4.96	4.96	4.96	4.96	4.96	4.96	4.96
Sub-total in mill.C\$	15.73	15.85	15.90	16.02	16.11	15.9	15.76	13.55	14.14	14.67	15.38
(Sub-total in mill.US\$)	2.21	2.23	2.23	2.25	2.26	2.23	2.21	1.90	1.99	2.06	2.16
<b>2. Disposal operation</b>											
2.1 Fuel & lubricant	2.35	2.35	2.35	2.55	2.55	2.55	2.55	3.07	3.07	3.29	3.29
2.2 Maintenance	0.34	0.34	0.34	0.37	0.37	0.37	0.37	0.44	0.44	0.48	0.48
2.3 Personnel expenses	0.99	0.99	0.99	1.01	1.01	1.01	1.01	1.04	1.04	1.07	1.07
2.4 Landfill works	2.31	2.44	4.37	2.71	2.86	3.02	3.17	3.33	3.59	3.86	4.16
2.5 Landfill treatment	-	-	-	-	-	-	-	-	-	-	3.29
Sub-total in mill.C\$	5.88	6.12	6.25	6.64	6.79	6.95	7.10	7.89	8.14	8.71	12.30
(Sub-total in mill.US\$)	0.84	0.86	0.88	0.93	0.95	0.98	1.00	1.11	1.14	1.22	1.73
<b>3. Maintenance service</b>											
3.1 Fuel & lubricant	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
3.2 Maintenance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
3.3 Personnel expenses	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Sub-total in mill.C\$	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
(Sub-total in mill.US\$)	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
<b>4. Promotion public awareness, cooperation and participation</b>											
4.1 Fuel & lubricant	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
4.2 Maintenance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.3 Personnel expenses	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
4.4 Video and print	0.17	0.80	0.18	0.18	0.21	0.21	0.21	0.23	0.23	0.23	0.23
Sub-total in mill.C\$	0.67	0.89	0.69	0.69	0.71	0.71	0.71	0.74	0.74	0.74	0.74
(Sub-total in mill.US\$)	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
<b>Total Cost in mill.C\$</b>	<b>23.41</b>	<b>23.68</b>	<b>23.96</b>	<b>24.37</b>	<b>24.63</b>	<b>24.27</b>	<b>24.01</b>	<b>23.20</b>	<b>24.04</b>	<b>25.14</b>	<b>29.46</b>
<b>(Total Cost in mill.US\$)</b>	<b>3.29</b>	<b>3.33</b>	<b>3.35</b>	<b>3.42</b>	<b>3.46</b>	<b>3.41</b>	<b>3.37</b>	<b>3.26</b>	<b>3.38</b>	<b>3.53</b>	<b>4.14</b>

### 10.3.3 Project Cost

Initial investment cost by priority project is summarized in Table 10.3.3a.

Table 10.3.3a Cost of the Initial investment Cost by priority Project

unit:mill.C\$

Project	Executing Bodies	Description	Total Amount (mill.C\$)	Local Portion (mill.C\$)	Foreign Portion (thn.USD)
Improvement of Collection System	ALMA	Total Investment Cost	114.33	47.12	9,439
		Sub-total	110.23	47.12	8,863
		- Collection Service * Procurement of equipment for collection service Compactor, Compactor with lift, Hoist Truck, Container 1.0m <sup>3</sup> and 7.0m <sup>3</sup> , Dump Truck, Wheel loader, Motor Grader, Pickup			
		Sub-total	4.10	-	576
		- Public Cleansing Service * Procurement of equipment for public cleansing works Compactor with lift, Hoist Truck			
Construction of ANPLS	ALMA	Total Investment Cost	148.57	20.52	17,989
		Sub-total	122.78	20.52	14,366
		- (Land Acquisition 93ha.) - Construction of ANPLS (Phase I) * Capacity 2,600,000 m <sup>3</sup> * Design life year 6 years * Target landfill operation Level 3 * Facilities: Site office, Garage, Trackscale, Fence, Dike, Leachate circulation facilities, etc.	(not included)		
		Sub-total	25.79	-	3623
		- Equipment * Procurement of equipment for landfill operation Bulldozer, Landfill compactor, Wheel Loader, Dump truck, Motor Grader, Wheel excavator, Pickup			
Improvement of Los Cocos Workshop	ALMA	Total Investment Cost	11.50	0.88	1,492
		sub-total	8.84	0.88	1118
		- Construction of Workshop Building * Facilities: Enlargement of maintenance shed, Container shed, Pavement			
		Sub-total	2.66	-	374
		- Equipment * Procurement of maintenance equipment Maintenance machine and tools, Mobil workshop			
Promotion of Public Awareness, Cooperation and Participation	ALMA	Total Investment Cost	0.68	-	46
		- Equipment * Procurement of equipment for public education Station wagon with video set			
Total Projects Cost			275.08	68.52	28,966

Note: Costs based on the price in January 1995.

## **10.4 Project Evaluation**

### **10.4.1 Evaluation Method**

#### **a. Outline of the Project**

The following projects were selected as priority projects for the short term improvement plan of the MSWM in Managua.

- i. Improvement of the collection and public area cleansing system
  - Extension of collection service area
  - Establishment of public cleansing system
  - Establishment of adequate operation and maintenance system
  - Provision of collection equipment
- ii. Construction of sanitary landfill at the proposed site in Acahualinca
  - Land expropriation
  - Construction of approach road
  - Construction of enclosure dike
  - Installation of leachate circulation system
  - Provision of landfill equipment
- iii. Improvement of the present Los Cocos workshop
  - Construction of workshop building
  - Provision of maintenance equipment
- iv. Promotion of public awareness, cooperation and participation
  - Provision of promotional tools and equipment

The social, environmental and financial effects of the projects were evaluated.

**b. Social Evaluation**

The social evaluation of each project was conducted on the basis of the following factors:

- creation of jobs
- improvement of the public health in the study area
- appropriateness of technology
- improvement of technical level
- impacts on cleansing service workers
- recovery of degraded areas
- conformity with the city structure
- equality of service level

**c. Environmental Evaluation**

The effects of the projects, except for the promotion of public awareness, cooperation and participation, on the environment were evaluated using the assessment items set up in the "Environmental Guidelines for Development Studies, Volume VI, Municipal Solid Waste Management, 1994, JICE".

The habitat factors subject to EIA were determined by forming a matrix showing their relationship with the environmental impact factors of the project, based on the details of the Project and the surrounding environmental condition.

The preliminary surveys and assessments carried out were substantial but few, in light of the fact that they were taken for the basic plan.

**d. Economic and Financial Evaluation**

The methods used to evaluate the of economic and financial impacts are shown in Table 10.4.1a



Table 10.4.1a Economic and Financial Evaluation Methods

Projects	Financial evaluation	Economic evaluation
1. Improvement of Collection and Public Area Cleansing System	Quantitative evaluation	Quantitative evaluation Qualitative evaluation
2. Construction of ANPLS	Quantitative evaluation	(Cost minimum) Qualitative
3. Improvement of Los Cocos Workshop	to be evaluated along with the project for the Improvement of collection and public area cleansing system	Quantitative evaluation Qualitative evaluation
4. Promotion of Public Awareness, Cooperation and Participation	to be evaluated along with the project for the Improvement of collection and public area cleansing system	Quantitative evaluation Qualitative evaluation
5. Overall Evaluation	Continuity of the MSWM (financial share of the municipality and citizens)	

**e. Financial Evaluation**

The revenue and expenditure items of the cash flow for the project's financial evaluation are outlined in Table 10.4.1b.

Table 10.4.1b Revenue and Expenditure Items of the Cash Flow for Financial Evaluation

Items	Sources	Execution Body	ALMA's Revenue	ALMA's Expenditure
Collection & Haulage	Collection Area A	ALMA	-Waste Fee	-Investment and O&M of Vehicles
		Private	-License Fee -Rental Fee -Tipping Fee (Partial)	-Investment and maintenance cost of Vehicles
	Collection Area B	ALMA	-Waste Fee(partial)	-Investment and O&M of Vehicles
	Large Generation Sources	ALMA	-Waste Fee	-Investment and O&M of Vehicles
	Street Sweeping	ALMA	-(Property Tax)	-Investment and O&M of Vehicles
Final Disposal		ALMA	-Tipping Fee*	-Investment and O&M of Facilities, Vehicles and Equipment

\* Tipping fees are collected as part of waste fee from Area A, large generation sources. Companies and shops carrying

out direct haulage are charged a fee at the disposal site.

## f. Economic Evaluation

Table 10.4.1c shows the benefits and the costs for project evaluation.

Table 10.4.1c Benefit and Cost Items for Project Economic Evaluation

Evaluation	Improvement of Collection Services	Final Disposal Site	Workshop Improvement	Promotion of Public Cooperation
Benefits (B)	curtailment of cost for removal of illegally dumped waste*		curtailment of investment and O&M costs because services provided by concessionaires are 30% more efficient than the municipality's*	curtailment of street sweeping services cost*
	promotion of public participation  improved living environment, improved public health and sanitation, attracts tourists, higher land market values	better sanitary environment, improved public health and sanitation, groundwater preservation, prevent waste scattering	help improve the efficiency of collection services in area A	increase in area B residents willingness to pay reduction of drain cleansing fee, fee for disposal of illegally dumped waste, fee for the cleansing of streets and public and green area
Cost (C)	investment, O&M costs	investment, O&M costs	investment, O&M costs	preparation of pamphlets and videos, personnel costs, transportation costs, material costs

\* These were analyzed quantitatively.

Table 10.4.1d shows the factors used to convert financial costs to economic costs.

Table 10.4.1d Conversion Factor from Financial Cost to Economic Cost

Item	Conversion factor	Assumption
Import goods		
collection vehicles	85%	Custom duty 5%, domestic taxes 10%
video set	80%	Custom duty 10%, domestic taxes 10%
spare parts	90%	Custom duty 0%, domestic taxes 10%
light heavy oil	99%	Custom duty 1%, domestic taxed 0%
Labor		
unskilled	60%	Income level of semi-unemployed people
Equipment ownership cost	90%	Heavy equipment (import goods) 60% Heavy oil 25%, personnel expenses (skilled) 15% (weighing average)

Note: Average Shadow Exchange Rate (SER) was estimated at 1.06 in 1991 and 1.05 in 1992 despite the data available. SER was disregarded in the Study because only almost 1.0 was calculated in 1994.

## **10.4.2 Project for the Improvement of Collection and Public Area Cleansing System**

### **a. Social Evaluation**

The ultimate objective of the improvement of the collection system is to create a clean living environment in the urban area of Managua City to safeguard public health.

This objective will be reached basically through:

- improvement of the solid wastes collection services
- extension of collection area
- improvement of the street sweeping activities
- improvement of the refuse disposal operations

Aside from the objectives, this project is also estimate to bring about the following:

- Creation of jobs, technical as well as unskilled ones
- Improvement of the public health in the area; health condition of residents is directly linked to the cleanliness of public spaces and effectiveness of refuse collection services.
- Improvement of the technical level of Nicaraguan professionals, mostly engineers, but also includes technicians.
- Improvement of working conditions for unskilled laborers, primarily on matters related to safety and hygiene.
- Recovery of degraded areas making them useful to the community, as in the case of the existing municipal landfill.
- General improvement in landscape, be it in the urbanized areas or open green spaces.

Evaluation is rather difficult, since many social benefits have a strong psychological component that is sometimes impossible to measure. Qualitatively, the improvement of collection system is feasible because it will bring about the above mentioned results.

**b. Environmental Evaluation**

**ba. Assessment Method**

The habitat factors subject to EIA were determined by forming a matrix showing their relationship with the environmental impact factors of the project, based on the details of the Project and the surrounding environmental condition.

The preliminary surveys and assessments carried out were substantial but few, in light of the fact that they were taken for the basic plan.

**bb. Project Outline**

**bba. Collection Area Expansion**

The 1994 collection rate was 77%. The target collection rate for 2000 is 90% and 100% for 2010.

**bbb. Establishment of Public Cleansing System**

Aside from waste collection, roads and drains will be cleaned and constructed, respectively, for the sanitation of the study area.

**bbc. Establishment of Adequate Operation and Maintenance System**

The vehicles to be assigned for collection services will be chosen properly and maintenance works will be adequately carried out to smoothly implement collection activities.

**bc. Determination of Habitat Factors and Environmental Impacts Factors**

The following are the two environmental impact factors determined from the above data:

- Operation of new collection vehicles for the new collection area
- Construction of a new waste disposal site

The habitat factors that may come about with the operation of new collection vehicles are air pollution with the emission of exhaust gas, noise and vibration, and bad odors may be generated with the construction of a new waste disposal site.

**bca. Air Pollution:**

The target maximum collection frequency in the new collection area, which is predominantly a residential area, is thrice a week and the number of collection vehicles assigned to this area will be limited to a few. Conclusively, these vehicles will only emit a small amount of exhaust gas which will not be enough to cause significant air pollution.

**bc. Noise:**

The small number of collection vehicles to be operated in this area will not produce significant noise levels.

**bcc. Vibration:**

The small number of collection vehicles to be operated in the area will not cause extreme vibration.

**bcd. Bad Odors:**

The new collection area is predominantly a residential area, whereby the container and bell collection system will be implemented.

The areas assigned for container arrangement are presently heaped with waste. The placing of containers will therefore eliminate heaping practices, and with a twice or thrice a week collection, further improvement can be attained.

Bell collection is a system that entails the ringing of a bell to inform the residents of the arrival of the collection vehicle for their wastes. This particular system prevents the accumulation of waste.

To a great extent, these collection systems will prevent the generation of bad odor in the collection area.

Consequently, these 4 habitat factors were not considered for EIA.

**bd. Environmental Survey and Assessment**

Originally, environmental surveys and assessments are carried out for the two environmental impact factors aforementioned. But since they will not considerably bring about the 4 habitat factors given above, none will be carried out. Conclusively, MSWM is considered to have none of the given impacts.

**be. Environmental Protection Measures**

MSWM is assessed to have no adverse impact on the environment. However, this assessment was made assuming that the residents will carry the collection system out exactly as planned. To successfully uphold this assessment, environmental protection measures in the form of education programs that would completely inform the residents of the waste disposal plan and objectives should be adopted therefore.

**c. Economic and Financial Evaluation**

**ca. Economic Evaluation**

**caa. Quantitative Evaluation**

The curtailment of collection costs for illegally dumped waste in area B will be considered a tangible benefit of the collection improvement project. Accordingly, the reduction of the collection cost of waste dumped illegally along streets, parks and channels will be considered a benefit.

- As a result of the time comparison between street cleansing work and collection works for illegally dumped waste, one fourth of present unit cost for street and park cleansing is used to determine the unit benefit for the collection of waste dumped illegally.
- The economic internal rate of return (EIRR) is estimated at 24.1% if the investment and O&M costs for new collection services necessary for residents in area B are regarded as costs. This figure proves the economic feasibility of the project.

**cab. Qualitative Evaluation**

The following items are the subjects for qualitative evaluation:

- Improvement of public health
- Contribution to prevention of the generation of dengue fever, malaria, cholera etc. through elimination of waste heaping practice
- Promotion of public participation in cleansing services
- Promotion of tourism  
(improvement of sanitary condition and beautification of Managua is related to tourism)
- Rise of land costs

(improvement of sanitary condition and beautification of the area is associated to the rise of land cost due to rapid infrastructure improvement.)

**cb. Financial Evaluation**

Cleansing costs of area B will be mainly taken from waste fees from area A residents, which shall be collected based on the "beneficiary pay principle", because area B residents have a limited capability to pay. The rest will be covered by large generation sources, and ALMA.

R/E (Revenue/Expenditure) is 0.80 at a discount rate of 0%, if initial investment costs are excluded in the revenues.

Assuming that initial investment costs are financed by grant aid from foreign countries and regarded as revenues, the Financial Internal Rate of Return (FIRR) will be 9.8%, thereby concluding the project as financially feasible.

**10.4.3 Project for the Construction of the Acahualinca Proposed Landfill Site**

**a. Social evaluation**

From the social standpoint, the project has the following benefits:

- i Creation of jobs, technical as well as unskilled ones
- ii Improvement of the public health in Acahualinca present disposal site; health condition of residents is directly related to the cleanliness of public spaces.
- iii Improvement of the technical level of Nicaraguan professionals, engineers mostly, but also includes technicians.
- iv Improvement of working conditions of unskilled personnel, basically on matters related to safety and hygiene.
- v Recovery of degraded areas making them useful to the community, as in the case of the Acahualinca landfill.
- vi General improvement in landscape, be it in the urbanized areas or open green spaces.

The quantitative evaluation of social benefits is rather difficult since many have strong psychological components that are almost impossible to measure tangibly. The construction of the Acahualinca Newly Proposed Landfill Site is feasible because it is relevant to the sanitation and beautification of the final disposal site.

**b. Environmental evaluation**

**ba. Assessment Methods**

The habitat factors subject to EIA were determined by forming a matrix showing their relationship with the environmental impact factors of the project, based on the details of the project and the surrounding environmental condition.

The preliminary surveys and assessments carried out were substantial but few, in light of the fact that they were taken for the basic plan.

**bb. Project Outline**

The construction of the final disposal site will be carried out in 4 phases and the areas to be reclaimed per construction phase are shown in Table 10.4.3a.

Table 10.4.3a Project Outline

	Construction Period (year)	Landfill Period (year)	Landfill Area (ha)	Buffer Zone (ha)	Total Area (ha)	Capacity (m <sup>3</sup> )
Phase I	1998 – 1999	2000 – 2005	18.8	5.9	24.7	2,600,000
Phase II	2003 – 2005	2006 – 2010	21.7	6.6	28.3	3,000,000
Phase III	2008 – 2010	2011 – 2013	15.2	4.8	20.0	2,100,000
Phase IV	2011 – 2013	2014 – 2016	15.2	4.8	20.0	2,100,000
Total			70.9	22.1	93.0	9,800,000

**bba. Land Expropriation**

Land directly adjacent to the shoreline will not be included in the acquisition.

**bbb. Construction of Approach Road**

- i The road used by the present Acahualinca disposal site will be extended for future use.
- ii The road will be widened to 8 m and extended for another 1km, from the present truck scale to the landfill site.



### **bbc. Construction of Enclosure Dike**

- i A dike will be constructed in each phase.
- ii The dike will be 6m high with a banking gradient of 1 : 2.
- iii Turfing will be carried out on the dike slope.

### **bbd. Installation of Leachate Circulation System**

- i A (sheet) lining will be placed inside the dike.
- ii A leachate collection pipe will be installed at the area where the lining is placed.
- iii Collected leachate will be circulated within the disposal site by using a pump.
- iv Daily waste covering will be carried out to prevent scattering, generation of harmful insects and bad odor.
- v Soil in street sweeping wastes will be used for waste covering.
- vi Gas release pipes will be installed to accelerate aerobic decomposition for the immediate stabilization of the landfill site.
- vii Final waste covering material will be extracted from the small hilly area within the disposal site.

### **bbe. Provision of Landfill Equipment**

To adequately carry out landfill works, a bulldozer, landfill compactor, wheel loader, dump truck, motor grader, wheel excavator, water tanker and a pickup will be provided.

### **bc. Determination of Habitat Factors and Environmental Impact Factors**

Given the details aforementioned, the following were determined as the environmental impact factors (a) during the landfill works and (b) after the landfill works:

#### **(a). During the Landfill Works:**

Generation of bad odors from leachate discharge –

The leachate circulation system pond may emit bad odors

Extraction of soil for waste covering –

The extraction of soil from the small hilly area within the disposal site will alter the landscape

**(b). After the Landfill Works**

**Leachate Discharge -**

Discharge of water coming from the leachate treatment facilities into Lake Managua

Conclusively, bad odors, landscape and water quality are the habitat factors determined by this study.

**bd. Environmental Survey and Assessment**

**bda. Bad odors**

Regarding bad odors, the qualitative environmental impact assessment is conducted considering predominant winds as well as the location of the proposed leachate circulation pond, which is a source of bad odors, and of houses to be avoided.

The leachate circulation pond will be constructed at the northernmost part of the final disposal site where the nearest residences are approximately 250 meters to the southeast. There is also a village 600 meters south of the area. The wind blows from the east, so that the construction of the circulation pond in this site will barely affect the said residents.

**bdb. Landscape**

A qualitative evaluation is carried out regarding the effect on the surrounding landscape based on present land use in the vicinity of the proposed final disposal site.

Peninsula de Chiltepe is the only scenic spot near the proposed landfill site.

The small hill within the proposed landfill site will be exploited for waste covering and dike construction material. Although this hill will disappear after completing the disposal site, it will have little effect on the surrounding landscape.

**be. Environmental Protection Measures**

As forementioned, it is judged that these activities will have little impact on the surrounding environment. Nevertheless, the following protection measures are necessary to minimize whatever impact they are to bring about:

**bea. Bad Odors**

The generation of bad odors can be further minimized by the proper operation of leachate circulation system and avoidance of storing leachate for long periods of time.

**beb. Landscape**

The following are proposed as environmental protection measures:

- daily covering of waste to restrict waste exposure
- turfing on the slope to create an area in harmony with nature

**c. Economic and financial evaluation**

**ca. Economic Evaluation (Qualitative Evaluation)**

Sanitary landfill level 3 should be at the very least carried out to protect the environmental conditions of Lake Managua. This landfill level introduces the use of a leachate circulation system.

The use of a sheet lining to upgrade the leachate treatment system will require additional expenses as compared to a system without lining. Nevertheless, the following advantages are expected from its use:

- Prevent the contamination of Lake Managua
- Improve public health
- Preservation of groundwater quality as potable water

The following effects are expected from daily waste covering activities and the construction of a buffer zone:

- Prevent waste scattering
- Sanitary improvement of the disposal site's surrounding environment

The management and operation of the final disposal site under independent fund reserves would inevitably raise the tipping fee. If the tipping fee is higher than expected, people tend to dump waste illegally. Therefore, indirect support for the operation through new legislation is necessary to prevent illegal dumping.

**cb. Financial Evaluation (Quantitative Evaluation)**

If the foreign portion of the initial investment for the construction of the new landfill site is financed by a grant aid from a foreign country, it will be financially feasible with an FIRR of 29.6%. If the project is financed by loans, however, the FIRR will only be 1.5%.

Nevertheless, R/E is estimated at 0.83 at a discount rate of 0% based on the financial evaluation of the Acahualinca Newly Proposed Landfill Site, from 2011 to 2016, taking into account the construction of leachate treatment facilities for landfill level 4.

Regarding the final disposal site after 2011, a feasibility study should be carried out again should a waste treatment plan is to be constructed.

**10.4.4 Improvement Project for Los Cocos Workshop**

**a. Social Evaluation**

The main objective of the improvement of the Los Cocos workshop is to keep the rate of operation of equipment used for MSWM high by strengthening its maintenance capability.

The project is also considered to bring about the following benefits to the community:

- Creation of jobs, technical as well as unskilled.
- Improvement of the technical level of Nicaraguan professional engineers mostly, but also includes technicians.
- Improvement of working conditions of unskilled personnel basically in matters related to safety and hygiene.
- Support the improvement project of the collection system, and sanitary landfill operation in ANPLS

The quantitative evaluation of most of these outcomes is rather difficult since many of them have a strong psychological component which is quite impossible to measure. Qualitatively, the improvement of the Los Cocos workshop is feasible because it will greatly contribute to the establishment of a reliable collection service.

**b. Environmental Evaluation**

**ba. Assessment Method**

The habitat factors subject to EIA were determined by forming a matrix showing their relationship with the environmental impact factors of the project, based on the details of the Project and the surrounding environmental condition.

The preliminary surveys and assessments carried out were substantial but few, in light of the fact that they were taken for the basic plan.

**bb. Project Outline**

**bba. Construction of Workshop Building**

- A one story workshop will be constructed at the building site.
- The building site will not be subject to any extension or expansion work.

**bbb. Provision of Maintenance Equipment**

The following equipment and their respective quantity will be provided by the year 2010:

Bulldozer (21 tons)	8
Landfill Compactor (20 tons)	4
Wheel Loader (1.2m <sup>3</sup> )	1
Dump Truck (10 tons)	2
Motor Grader (130 PS)	1
Wheel Excavator (0.7m <sup>3</sup> )	1
Water Tanker (5m <sup>3</sup> )	1
Pickup	2

**bc. Determination of Habitat Factors and Environmental Impact Factors**

Based on the details aforementioned, the environmental impact factors are [operation of construction vehicles] and [transport of construction materials] during construction work, and [increased repair and maintenance services due to increase in machineries and equipment] after the completion of construction work.

The habitat factors that may be influenced by these impact factors are air quality, noise, vibration, traffic safety.

**bca. Air Quality**

The operation of construction vehicles, vehicles for material transport and equipment maintenance may pollute the air.

Since this activity involves the construction of a new workshop at the existing workshop site, only a small number of construction vehicles will be used for the preparation of the site. Construction vehicles will not affect air quality therefore.

**bc. Noise**

The operation of a small number of vehicles will not produce loud irritable noises.

**bcc. Vibration**

The operation of a small number of vehicles will not produce damaging vibrations.

**bcd. Traffic Safety**

Increase in vehicular traffic may affect traffic safety conditions especially since there are a lot of houses within the vicinity of Los Cocos. The effect will be minimal however, since the project will only cause a slight increase in traffic volume.

Conclusively, these habitat factors were not subject to EIA.

**bd. Environmental Survey and Assessment**

Originally, environmental surveys and assessments are carried out for the environmental impact factors aforementioned, but since they will not seriously bring about the given habitat factors, none will be carried out.

Conclusively, this project will not have a significant impact on the surrounding environment.

**be. Environmental Protection Measures**

The traffic volume increases when the amount of waste generation increases. Accordingly, the following environmental protection measures are proposed:

- To assign a traffic regulator at the entrance and exit of Los Cocos to assure traffic safety;

- To educate vehicle drivers and heavy equipment operators on safe driving and operation;
- To select equipment with due consideration of the environment, to reduce air pollution, noise generation and vibration which may come about.

**c. Economic and financial evaluation**

**ca. Economic Evaluation**

**caa. Quantitative Evaluation**

The improvement of the workshop will lengthen the life span and improve the operation rate of collection vehicles.

The realization of the proposed improvement of Los Cocos workshop is indispensable to reduce collection expenses of a private collection company. At the same time, it will guarantee a reliable collection service and achieve the improvement of the collection service.

The quantitative evaluation of the project for the improvement of Los Cocos workshop regards as benefits the reduction in investment and O&M costs which will contribute to increased service efficiency brought about by privatization.

Collection efficiency by privatization will be improved step by step between 2000 and 2010. Finally, a benefit of C\$ 6.0 million in 2010 can be expected, which is a 30% improvement over the 1994 figure.

As a result, with an EIRR of 12.5% (investment and O&M costs were taken as expenditures) the project is judged financially feasible.

**cab. Qualitative Evaluation**

The improvement of the Los Cocos workshop is expected to raise the operation efficiency of ALMA's collection vehicles and street sweeping services.

Moreover, the provision of a collection service at regular intervals will increase the residents' willingness-to-pay.

**cb. Financial Evaluation**

The R/E until 2010 is only 0.82 at a discount rate of 0%, assuming that investment

is financed by foreign grant aid; this figure can be regarded as revenue.

As discussed in the economic evaluation, the improvement of the workshop is essential for the smooth operation of cleansing services in Managua. Therefore, this project is financially feasible when evaluated jointly with the collection and public area cleansing system improvement projects.

#### **10.4.5 Project for the Promotion of Public Awareness, Cooperation and Participation**

##### **a. Social Evaluation**

Word of mouth communication of ideas and comments will undoubtedly remain our most effective form of education. For this reason, demonstration of certain new methods of solid waste management is particularly valuable.

The ultimate objective of above projects is to create a clean living environment in the urban area of Managua City, to safeguard public health. These projects were selected to achieve the targets indicated in the Master Plan, as projects to be done by 2000.

Promotion of public awareness, cooperation and participation itself is not a direct measure for MSWM improvement, but it is expected to give the following effects:

- Prevention of illegal dumping
- Improvement of the public health in the area; health condition of residents is assumed to be directly related to the cleanliness of public spaces and effectiveness of refuse collection services.
- Recovery of degraded areas making them useful to the community, as in the case of the existing municipal landfill.
- Establishment of an MSWM under the supervision of the citizens and municipality.
- Establishment of waste fee collection system for a sound financial MSWM

The public promotion project, together with the other 3 projects, will benefit the community with its objectives and the above mentioned results.

##### **b. Environmental Evaluation**

An environmental impact assessment was not carried out for the "Promotion of



Public Awareness, Cooperation and Participation" project because it only involves the provision of audio visual tools (television, video machine, booklets) for environmental and sanitary public education.

**c. Economic and Financial Evaluation**

**ca. Economic Evaluation**

**caa. Quantitative Evaluation**

The project for the promotion of resident participation and cooperation will curtail the cleansing costs through the reduction of the amount of waste illegally dumped along streets, parks and channels, as well as raise the efficiency of collection services in Collection Area B. It will also help reduce the solid waste collection and disposal expenses by reducing waste discharge volume.

Quantitative evaluation was carried out accounting the increase of willingness-to-pay in Area B as a benefit due to the reduction of illegally dumped waste collection costs.

The implementation costs of the public promotion project equal 0.8% of the benefits brought about by the reduction in illegally dumped waste collection costs.

Considering the above benefits and costs for the preparation of promotional pamphlets and video programs, including personnel, transportation and material costs, the project is financially feasible with an EIRR of 34.0%.

**cab. Qualitative Evaluation**

Since public participation and cooperation will be promoted in the generation sources, including Area B, the following effects are expected:

- Increase in Willingness-to-Pay
- Promotion of Recycling Activities
- Attraction of tourists

**cb. Financial Evaluation**

This project is impossible to evaluate financially because it does not have any direct revenues. Nevertheless, the implementation of this project is considered feasible when evaluated along with the collection service improvement and public

area cleansing projects.

#### 10.4.6 Overall Financial Evaluation

The results of IRR are summarized in Table 10.4.6a, which concluded the necessity of the four projects.

Table 10.4.6a Summary of EIRR and FIRR

unit: %

Projects	EIRR	FIRR	
		by project	3 combined projects
1. Collection Improvement	24.1	9.8	9.0
2. Improvement of Los Cocos	12.5	-	
3. Promotion of Public Education	34.0	-	
4. Construction of ANPLS	-		29.6

##### a. Overall Evaluation of the 3 Projects Proposed for Area B

Assuming the initial investment is financed by a foreign grant aid, the projects for improvement of collection services, Los Cocos workshop and promotion of public participation and cooperation activities are judged financially feasible, with a 9.0% FIRR.

##### b. Financial Evaluation of Private Companies for Concession

The FIRR of private companies is estimated at 7.7% considering that the services of concessionaires will be 30% more efficient than ALMA's and that they will be granted tipping fee discounts of 60% for the period 2000-2004 and 30% for the 2005-2009 period.

##### c. Area A Financial Capability

The generation sources in Area A are financially capable of paying the imposed collection fees, which will also partly subsidize the cleansing service for Area B.

It is estimated that the collection fees will be within 1% of the household income

of in Area A until 2009. (Refer to Figure 10.6.4a).

The leachate treatment facilities will be upgraded to level 4 in the year 2010 for the new landfill site, slightly rising the collection fees imposed on the residents. Therefore, it is necessary to review the project's financial evaluation after 2011 as indicated in the financial evaluation for the ANLPS construction project.

**d. Municipal Financial Capability**

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

In this case, cleansing costs shared by ALMA will decrease gradually from C\$ 19.2 in 2000 to C\$ 13.2 million in 2010. As a result, cleansing costs in relation to ALMA's budget will go from 7.6% in 1998, the highest value, to 3.4% in 2010 (Refer to Figure 10.4.6b). Conclusively, this proves that ALMA can sustain MSWM expenses on its own.

If a loan covers most of the initial investment costs, the waste collection fees will be used to repay it. ALMA will then be obliged to obtain another loan to finance the second and third investments, thereby incurring a total debt of C\$ 300 million (refer to Figure 10.4.6c).

Table 10.4.6b shows the revenue and expenditure plan of the 3 projects.

Table 10.4.6b Revenue and Expenditure of Collection System Improvement Project including Workshop Improvement and Promotion of Public Cooperation

unit: mill.€

	Revenue						Expenditure			Discount Rate	
	Residents of Area B	Residents of Area A	Large Generation Sources	Subsidy from ALMA	Maintenance Fee from Private Concession	Sub-total	Investment	O&M cost	Sub-total	Revenue	Expenditure
1998	0.0			20.5		20.6	21.0	2.5	23.5	20.6	23.5
1999	0.1			25.6		25.7	26.0	3.5	29.5	23.6	27.1
2000	0.5	3.0	3.0	3.0	1.2	10.6	0.0	5.3	5.3	8.9	4.5
2001	0.6	3.1	3.1	3.1	1.2	11.0	1.7	5.5	7.2	8.5	5.6
2002	0.7	3.2	3.2	3.2	1.2	11.4	1.8	5.8	7.6	8.1	5.4
2003	0.8	3.3	3.3	3.3	1.2	11.9	7.2	6.0	13.2	7.7	8.6
2004	1.0	3.4	3.4	3.4	1.2	12.4	7.1	6.4	13.4	7.4	8.0
2005	1.7	2.6	2.6	5.2	1.2	13.2	14.8	6.6	21.4	7.2	11.7
2006	1.9	2.7	2.7	5.4	1.2	13.8	15.0	6.7	21.7	6.9	10.9
2007	2.1	2.7	2.7	5.3	0.0	12.8	8.0	6.2	14.2	5.9	6.5
2008	2.7	3.0	3.0	6.1	0.0	14.9	15.4	7.2	22.6	6.3	9.5
2009	3.4	3.5	3.5	7.1	0.0	17.5	17.4	6.4	23.9	6.8	9.2
2010	5.1	3.7	3.7	7.4	0.0	19.9	12.2	7.5	19.7	7.1	7.0
2011						0.0	(41.5)		(41.5)	0.0	(13.5)
Total	20.7	34.1	34.1	98.4	8.4	195.8	105.7	79.1	184.8	125.0	125.0

R/E 1.000067

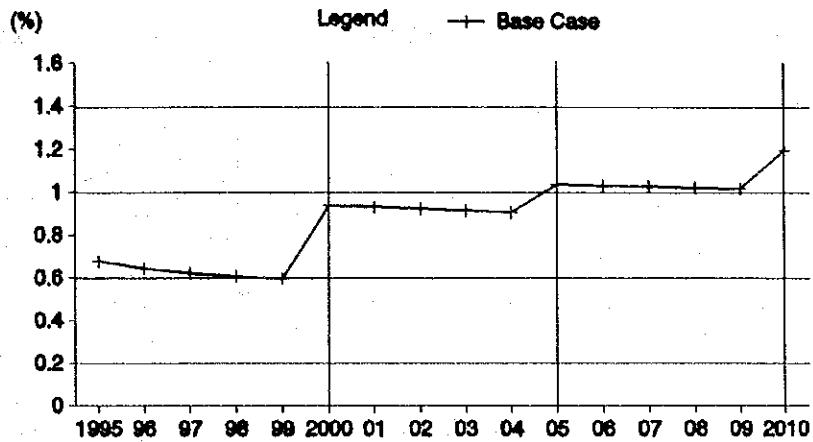


Figure 10.4.6a Share of Waste Fee in Residential Income unit: %

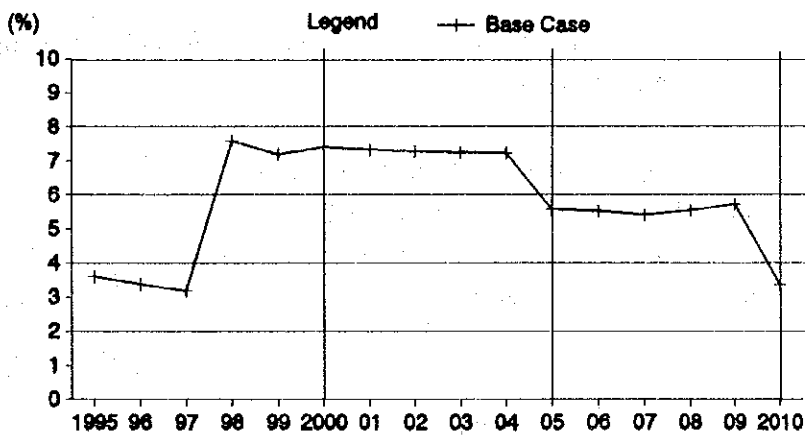


Figure 10.4.6b Share of SWM in Municipal Budget unit: %

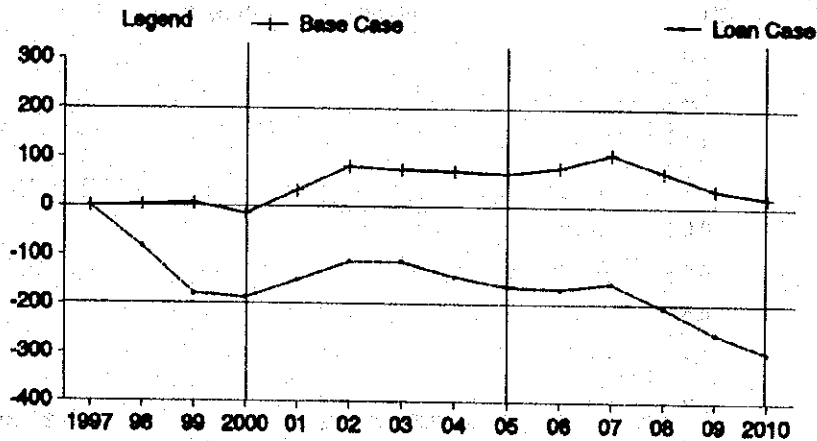


Figure 10.4.6c Reserved Fund / Total Debt unit: mill.x10<sup>2</sup>C\$

## 10.5 Implementation Plan

### 10.5.1 Project Implementation Bodies

ALMA will be the government body in charge of the implementation of the following 4 projects:

- a. Improvement of Collection System
- b. Construction of the ANPLS
- c. Improvement of Los Cocos Workshop
- d. Public Promotion

### 10.5.2 Implementation Schedule

The proposed implementation schedule of the 4 projects is shown in Figure 10.5.2a.

### 10.5.3 Financial Plan

#### a. Financial Sources for Investment

Table 10.5.3a Financial Sources for Investment

unit: mill.C\$

	1998	1999	2000	Total
Total Investment	95.89	103.77	75.42	275.08
Foreign Aid	85.19	93.07	-	178.26
Loan	-	-	75.42	75.42
Municipality	10.70	10.70	-	21.40

#### b. Objects of Foreign Aid

The objects of foreign aid are listed below. However, foreign aid is also assumed to cover the cost for the procurement of equipment required by 2000 when the new collection system starts and the foreign portion of the construction cost.

Equipment:	Collection vehicles for Area B, large generation sources and street sweeping
	Equipment for landfill works
	Equipment for workshop
	Equipment for public promotion
Construction	Construction of the ANPLS
	Construction of workshop

#### c. Objects of Loan

It was assumed that the procurement cost for the equipment to be replaced in 2000 and additional equipment required to cope with increase in waste volume will be covered by a loan because the municipality will not be able to afford the tremendous amount of money required.

The provision from private companies will not be taken into account because these companies are very small in scale at present. Therefore, the following loan conditions were assumed.

**Loan condition: Repayment period** 10 years  
**Interest** 8 % per year

**d. Objects of ALMA**

The municipality of Managua will procure the remaining number of equipment. It will also supply the budget equivalent to the local portion of the costs for the construction of the ANPLS and Los Cocos workshop.



Projects	1996	1997	1998	1999	2000
<b>1. Collection Improvement</b>					
<b>1.1 Procurement of Equipment</b>					
(1) Preparation					
(2) Detailed design			-		
(3) Tender			-		
(4) Manufacturing of equipment					
(5) Delivery of equipment				-	
(6) Operation					
<b>Investment total</b>			<b>32.03</b>	<b>35.17</b>	<b>47.13</b>
<b>2. Construction of ANPLS</b>					
<b>2.1 Disposal Site Construction</b>					
(1) Preparation					
(2) Land acquisition					
(3) Detailed design			-		
(4) Tender			-		
(5) Construction					
(6) Operation					
<b>Sub-total</b>			<b>61.39</b>	<b>61.39</b>	
<b>2.2 Procurement of Equipment</b>					
(1) Preparation					
(2) Detailed design			-		
(3) Tender			-		
(4) Manufacturing of equipment					
(5) Delivery of equipment				-	
(6) Operation					
<b>Sub-total</b>				<b>25.79</b>	
<b>Investment cost total</b>			<b>61.39</b>	<b>87.18</b>	

Figure 10.5.3a(1) Implementation Schedule unit: mill.C\$

Projects	1996	1997	1998	1999	2000
<b>3. Improvement of Los Cocos Workshop</b>					
<b>3.1 Construction of Building</b>					
(1) Preparation					
(2) Detailed design					
(3) Tender					
(4) Construction					
(5) Operation					
<b>Sub-total</b>			<b>4.42</b>	<b>4.42</b>	
<b>3.2 Procurement of Equipment</b>					
(1) Preparation					
(2) Detailed design					
(3) Tender					
(4) Manufacturing of equipment					
(5) Installation of equipment					
(6) Operation					
<b>Sub-total</b>				<b>2.66</b>	
<b>Total</b>			<b>4.42</b>	<b>7.08</b>	
<b>4. Promotion of Public Participation</b>					
<b>4.1 Procurement of Equipment</b>					
(1) Preparation					
(2) Detailed design					
(3) Tender					
(4) Manufacturing of equipment					
(5) Delivery of equipment					
(6) Operation					
<b>Total</b>			<b>0.68</b>		

Figure 10.5.3a(2)

Implementation Schedule

unit: mill.C\$

# **CHAPTER 11**

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## **CONCLUSIONS AND RECOMMENDATIONS**



## CHAPTER 11 CONCLUSIONS AND RECOMMENDATIONS

*This chapter details the conclusions of the study and recommendations to the Managua Municipality in order to achieve the goal with certainty.*

### 11.1 Conclusions

#### 11.1.1 MSWM Master Plan

##### a. 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.**

##### b. Technical System

##### ba. Collection System

The following collection systems shall be provided for collection area expansion and provision of efficient collection services to the entire city of Managua.

Area A:	Curb collection system using compactor trucks
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

##### bb. Public Area Cleansing

Street sweeping and park and green area cleansing activities should be manually carried out in the Study Area to counteract high unemployment rate.

Container collection is recommended for public area cleansing to increase collection efficiency and maintain cleanliness of the city.

**bc. Construction of Sanitary Landfill in ANPLS (Acahualinca Newly Proposed Landfill Site)**

The installation of water treatment facilities in ANPLS for leachate control is desirable, but because of the enormous capital it would require the following phased-measures for leachate control were proposed instead:

Year 2000 - 2009 : Sanitary Landfill Level 3

- installation of liners for seepage control
- installation of leachate collection, circulation and monitoring facilities

Year 2010 - : Sanitary Landfill Level 4

- installation of leachate treatment facilities

**bd. Equipment Operation & Maintenance**

The present Los Cocos Workshop shall be improved in order to carry out preliminary maintenance of vehicles and equipment for cleansing services to be carried out by the Public Cleansing Office.

**c. Institutional System**

**ca. Administration and Organization**

The Municipality of Managua will remain in charge of the Solid Waste Management activities through the PCO (Public Cleansing Office).

The following roles are mainly incorporated in the proposed new organization of PCO:

- waste collection services in Area B
- operation of ANPLS
- proper O & M and preliminary maintenance of vehicles and equipment for cleansing services
- street sweeping service
- management of all environmental education programs

- control of revenue and expenditure for cleansing services

**cb. Privatization**

According to the policy of the municipality, the privatization of the following MSWM aspects, which should be managed by the municipality, is proposed.

**Table 11.1.1a Proposed Privatization System**

Generation sources	Executing Agency	Revenue sources for ALMA
Collection Area A	Private (Concession)	-License Fee -Rental Fee -Tipping Fee
Collection Area B	ALMA	Waste Fee (partial)
Large Generation Sources	ALMA	Waste Fee
Street Sweeping	ALMA	(Property Tax)
Direct Haulage	-	Tipping Fee

In order to realize the goal, expansion of service, through privatization, in Collection Area A (mainly high and middle income households) will be realized as follows:

- Year 2000: 50% of households in Collection Area A
- Year 2010: 100% of households in Collection Area A

**cc. Legislation**

The establishment of proper and sound legislation on solid waste management is an urgent need in Managua, since there are no sanitation codes particularly dealing with this subject. The Public Cleansing Code shall basically define the different types of wastes produced in the city and determine the responsibility and means for storage, transportation, treatment and disposal of each waste category.

**cd. Training Program**

A much needed training program shall be prepared for all levels of management in the Public Cleansing Office.

**ce. Public Cooperation**

In order to gain acceptance for the proposed solid waste system, a public education program should be established. The need for a sanitary and efficient system should

be made clear to the public.

**cf. Financial Plan**

In order to secure an independent financial resource for the 2010 cleansing services proposed in the Master Plan, the following should be considered:

- Establishment of a "Beneficiary-Pay Principle"
- Imposition of fees in accordance with economic standing of the residents
- Appropriate allocation of budget from the general budget of the Municipality.

The financial source and money flow of the fee collection system are shown in Figure 11.1.1a. The fee tariff estimated for each waste generation sources is shown in Table 11.1.b.

The partial payment of fee will be imposed even on Area B, which is basically economically impoverished, in accordance with the Beneficiary Pay Principle. The remaining cleansing expenses will be covered by the Municipality, Area A and Large Generation Sources (cross subsidy).

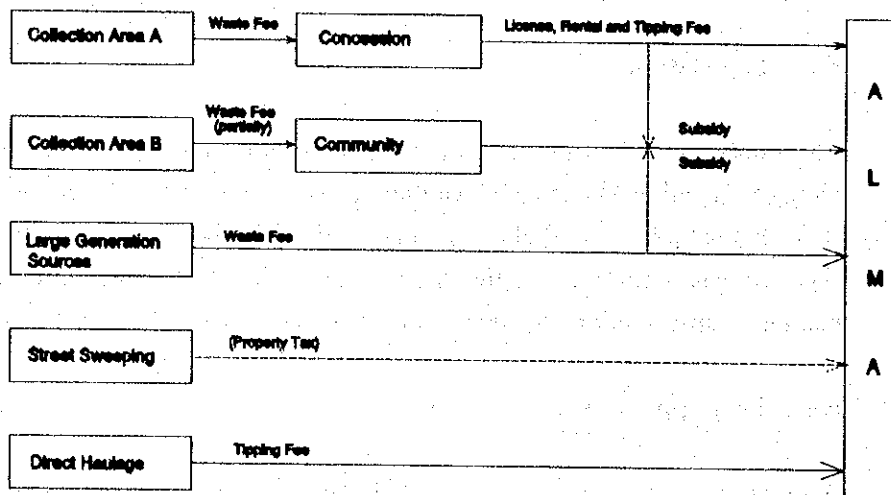


Figure 11.1.1a Financial Source and Money Flow of the Fee Collection System



Table 11.1.1b Fee Tariff

Description		1995	2000	2005	2010
Waste Fee *	Collection Area A (C\$/month/household)				
	Residential (A)	64.3	140.8	161.9	191.1
	Residential (B)	23.8	52.1	59.9	70.7
	Traditional	10.0	21.9	25.2	29.7
	Popular	7.5	16.4	18.9	22.3
	Collection Area B (C\$/month/household)				
	Bell Collection	2.00	4.38	6.50	8.00
	Container Collection	1.00	2.19	3.25	4.00
	Large Generation Sources	175.1	612.2	655.1	741.3
Tipping Fee	Direct Haulage	2.7	99.2	99.2	112.3

\* Waste fee includes tipping fee

### 11.1.2 Phased Implementation Plan

The Master Plan shall cover a period of 15 years, from 1995 to 2010. Upon consideration of the limited resources of the municipality for SWM, the goal of the Master Plan shall be pursued in a stepwise manner.

Table 11.1.2a Target Years

Plan	Period
Master Plan	1995 - 2010
- Medium Term Improvement Plan	2001 - 2010
- Short Term Improvement Plan for Feasibility Study	1997 - 2000
- Immediate Improvement Plan	present - 1996

#### a. Immediate Improvement Plan (present-1996)

Table 11.1.2b shows the concrete measures to be taken in order to attain the targets of the Immediate Improvement Plan.

**Table 11.1.2b Concrete Measures to attain the Targets of the Immediate Improvement Plan**

Targets (Improvement)	Concrete Measures
<p><b>1. Technical Improvement</b></p> <p>1.1 To improve collection efficiency</p> <p>1.2 To establish the system for collection area expansion</p> <p>1.3 To establish the system for the sanitation of the area</p> <p>1.4 To sanitize the present Acahualinca disposal site</p> <p>1.5 To execute public education programs on sanitation</p>	<ul style="list-style-type: none"> <li>- By using data obtained from truck scale</li> <li>- Through organization of community associations and promotional activities by the District Office</li> <li>- Establishment of waste fee collection system by community in squat areas</li> <li>- Through organization of community associations and promotional activities by the District Office;</li> <li>- Establishment of funds to improve area condition, i.e. roads and drains</li> <li>- Construction of dike</li> <li>- Improvement of approach road</li> <li>- Transfer of techniques, i.e., daily waste covering,</li> <li>- construction of gas removal facility</li> <li>- Education program on sanitation using videos and booklets</li> <li>- Promotional activities by the District Office and Environmental Protection Head Office</li> </ul>
<p><b>2. Institutional Improvement</b></p> <p>2.1 Set up a new section in PCO (Public Cleansing Office) to follow up pilot projects</p> <p>2.2 Increase waste fee collection ratio</p> <p>2.3 Commencement of planning and control processes</p> <p>2.4 Establishment of a training program</p> <p>2.5 Establishment of supervision structure for illegally dumped waste</p> <p>2.6 Initiation of administrative improvement works</p>	<p>These activities can be carried out by the existing municipal staff, provided that training is supplied and proper support is given by the Managuan municipal authorities.</p>

**b. Short Term Improvement Plan (1997-2000)**

**ba. Selection of Priority Projects**

The Master Plan consists of various projects, some of which will be selected as priority projects to be carried out in 2000. A Feasibility Study will be conducted on the priority projects. The following are the priority projects proposed by the Study Team and approved by the Coordinating Committee.

- Improvement of collection and public area cleansing system

- Construction of the sanitary landfill at the proposed site in Acahualinca
- Improvement of the present Los Cocos workshop for maintenance of cleansing equipment
- Promotion of public awareness, cooperation and participation

**bb. Feasibility Study for the Priority Projects**

**bba. Project Cost**

**i. Initial Investment Cost**

The costs of the initial investment were estimated as shown in Table 11.1.2c. Investment period is for 2 years from 1998 to 1999.

Table 11.1.2c Estimated Project Costs by Priority Project

unit : mill.C\$

Projects	Main Contents of the Projects	Project Cost	
1.Collection Improvement	Compactor truck (15.3m <sup>3</sup> ) :10 Units Hoist truck (7m <sup>3</sup> ) :21 Units Compactor truck with container :5 Units Container (1m <sup>3</sup> ) :270 Units Container (7m <sup>3</sup> ) :131 Units	114.33	
2.Construction of ANPLS	Construction (Phase I)	122.78	148.57
	Equipment(Bulldozer, Landfill compactor, etc.) :16 Units	25.79	
3.Improvement of Los Cocos Workshop	Construction	8.84	11.50
	Equipment (Maintenance machine, etc.)	12.66	
4.Promotion of Public Education	Equipment (Station wagon, video set)	0.68	

**ii. Operation & Maintenance (O&M) Cost**

The O&M cost consists of depreciation cost, fuel and lubricant cost, maintenance cost and personnel expenses, and is shown in Table 11.1.2d.

**Table 11.1.2d O&M Cost of the Priority Projects**

unit: mill.C\$

Project	2000	2005	2010
1. Improvement of Collection System	15.73	15.59	15.40
2. Construction of ANPLS	5.99	6.95	12.30
3. Improvement of Los Cocos Workshop	1.02	1.02	1.02
4. Promotion of Public Participation	0.67	0.71	0.74
Total Portion and Maintenance Cost	23.41	24.27	29.46

**bbb. Project Evaluation****i. Social evaluation**

Each project was evaluated socially in terms of the jobs they will create, improvement in public health, appropriateness of technology, etc. The results should that the four projects are feasible from a social view point.

**ii. Environmental evaluation**

The environmental evaluation of each project, except the promotion of public awareness, cooperation and participation, was carried out using the assessment items set up in the "Environmental Guidelines for Development Studies, Volume VI, Municipal Solid Waste Management, 1994, JICE". This evaluation also concluded that the four projects are feasible.

**iii. Economic and Financial Evaluation**

The Economic and Financial IRR of the four projects are shown in Table 11.1.2e. The FIRR of the projects for the improvement of the workshop and promotion of public cooperation which was calculated along with the collection services improvement is 9.0%.

The evaluation of the construction of the disposal site, however, showed an R/E of more than 1, in spite of a 0 discount rate, because the construction of the facility, which is for public use, will be kept at a minimum cost.

If the initial investment cost is financed by subsidies from the central government or grant aid from foreign countries, part of the collection fees will be reserved internally as funds, which will allow ALMA to shoulder the budget for the second

and third investments.

In this case, the cleansing costs of ALMA will gradually decrease from C\$ 19.2 to C\$ 13.2 million in 2010. As a result, the cleansing costs in relation to the municipal budget will go from 7.6% in 1998, the highest value, to 3.4% in 2010.

In conclusion, ALMA can financially sustain MSWM services.

Table 11.1.2e EIRR and FIRR by Project

Unit: %

Projects	EIRR	FIRR	
		by project	3 combined project
1.Collection Improvement	24.1	9.8	9.0
2.Improvement of Los Cocos	12.5	-	
3.Promotion of Public Education	34.0	-	
4.Construction of ANPLS	-	29.6	

The residents of Area A are considered financially capable of paying the fees imposed, which will partially subsidize the cleansing service for Area B. The collection fee is estimated to be only equivalent to about 1% of the household income of residents in Area A until 2009.

**bc. Concrete Measures for Short Term Improvement Plan**

Table 11.1.2e shows the concrete measures for the attainment of the short term improvement plan targets.

**Table 11.1.2f Concrete Measures to attain the Targets of the Short Term Improvement Plan**

Targets	Concrete Measures
1.To attain 90% collection service	- Provision of cleansing equipment of good quality - Improvement of collection and public area cleansing system
2.To start sanitary landfill with leachate circulation (Level 3)	- Construction of the Acahualinca newly proposed landfill site (ANPLS) - Installation of leachate circulation facilities - Operation of sanitary landfill (Level 3)
3.To improve workshop	- Improvement of present Los Cocos workshop for maintenance of cleansing equipment
4.To establish public education programs on sanitation	- Promotion of public cooperation and participation using materials on sanitation

**c. Medium Term Improvement Plan (2000-2010)**

Table 11.1.2g shows the concrete measures for the attainment of the medium term improvement plan targets.

**Table 11.1.2g Concrete Measures to attain the Targets of the Medium Term Improvement Plan**

Targets	Concrete Measures
1.To attain 100% collection service	- Provision of cleansing equipment of good quality
2.To start sanitary landfill with leachate treatment (Level 4)	- Installation of leachate treatment facilities - Operation of sanitary landfill (Level 4)

**d. Phased Implementation Plan**

The phased implementation plan to achieve the MSWM Master Plan for the Municipality of Managua is summarized and illustrated in Figures 7.3.2a and 7.3.2b.

## **11.2 Recommendations**

### **a. Community Organization for Area Sanitation**

The establishment of an organization in the community was proven to be necessary not only for the execution of collection services but also for the sanitation of the squat areas as well.

In order to promote this activity, the section who shall be made responsible and at the same time constitute the present staff of PCO (Public Cleansing Office), DO (District Offices) and DEE (Department of Environmental Education) should be set up in the municipality.

The section will mainly have the following roles:

- Educate the community
- Execution of sanitary education programs
- Coordinate with responsible municipal offices

### **b. Leachate Treatment in ANPLS**

The installation of leachate treatment facilities in ANPLS was proposed for 2000. The main factor that contaminates the water quality of Lake Managua is sewage water from the city.

The formulation of a master plan for the construction of sewage system in Managua City has commenced. In the plan, the study team recommends the construction of a sewage plant as the most cost effective means of treating waste water inflowing to the lake. It also recommends leachate treatment in the same plant as the reduced volume will have no adverse impact on the capacity or production of the plant.

This combined utilization of the sewage plant will minimize the capital required for the improvement of waste quality flowing into Lake Managua.

### **c. Acquisition of Proposed Landfill Site**

The proposed landfill site is a private land. Accordingly, the Study Team requested the Nicaraguan counterparts to carry out any means possible to acquire the land for

**ANPLS construction.**

Based on the environmental study carried out by the Study Team, the proposed area is the most suitable area in Managua for the construction of the future landfill site, which should be as spacious as possible.

**d. Composting**

In the Study, the composting system was not introduced as a component of the optimum technical system of the Master Plan mainly because of a small market for compost products derived from MSW. Nevertheless, the municipality experimented on the manual production of composts under the guidance of a Dutch expert.

Composting is a very effective means of MSW volume reduction and source recovery, a practice which consequently extends the life span of the final disposal site.

Therefore, the Study Team recommended the continuous implementation of composting activities to the municipality, regardless of its present state of unprofitability, in order to accumulate data necessary to eventually perpetuate the activity.

**e. Recycling**

The recycling system was not introduced as a component of the optimum technical system of the Master Plan mainly because of a limited market for recycled goods. The MSWM system is also not adequately established yet for the introduction of recycling activities.

Nevertheless, recycling is expected to play a very important role in future MSWM with regard to the reduction of waste generation amount and prevention of the wasteful use of natural resources. The municipality, therefore, should promote recycling activities in cooperation with the central government.

**f. Methane Gas Recovery**

The recovery of methane gas in ANPLS is not included as a technical system component of the Master Plan mainly due to the reason stated hereafter.



The anaerobic condition of a landfill site usually produces methane gas, but deteriorates leachate quality. To improve leachate quality, a semi-aerobic landfill structure with a liner is proposed in the Master Plan.

A study of gas production condition in the present disposal site would necessitate investigations on the quality and quantity of gas produced, including test boring activities which are not included in the scope of the study.

**g. Privatization**

The municipality expressed the need to privatize MSWM in accordance with central government policies.

Accordingly, the Study Team carried out studies to determine the most adequate and feasible privatization model in terms of curtailment of the Municipality's MSWM budget and the waste collection fee.

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.

**h. Financial Source**

It would be 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 therefore, or with donations from bilateral and multilateral agencies. ALMA must therefore strive to acquire such sources to successfully implement the projects.

**i. Classification of the Priority Projects**

All priority projects are feasible and necessary to achieve the targets of the Master Plan. However, since the financing for the execution of the projects depends on foreign aid, the Nicaraguan side is requested to classify the projects in order of importance.



# **CHAPTER 12**

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## **GENERAL RECOMMENDATIONS FOR THE IMPROVEMENT OF MEDICAL SWM AND INDUSTRIAL SWM**



## CHAPTER 12 GENERAL RECOMMENDATIONS FOR THE IMPROVEMENT OF MEDICAL SWM AND INDUSTRIAL SWM

### 12.1 Study on Present Medical SWM

#### 12.1.1 Method of the Study

##### a. Definition of Terms

The study defines "Medical Solid Waste" as wastes resulting from the medical activities of medical institutions. The study classifies this waste type as:

- Infectious waste
- Non-infectious waste (includes non-medical wastes)

Non-infectious wastes are disposed of at municipal landfills and are therefore included in the study of MSWM. The medical waste referred to in this chapter is limited to infectious wastes, which are enumerated in Table 12.1.1a.

Table 12.1.1a Types of Infectious Wastes

Types of Waste	Example
Non-solid substances e.g., blood	Blood, blood serum, blood plasma, body fluid (sperm, tissues fluid, etc.), blood preparation
Pathologic wastes	Organs, tissues
sharp equipment stained with blood	Injection needles, scalpels, test tubes, Petri dishes, glass scrapes, etc.
Test equipment, culture medium used for testing and inspections in relation to pathogenic bacteria	Test tubes, culture medium, petri dishes used for testing and inspections
Equipment used for dialysis treatment	Tubes, filters, etc.
Other equipment stained with blood	Disposable items such as gloves for testing and inspection, sanitary cotton, gauze, bandage

### **b. Scope of the Study**

The study intends to prepare general recommendations for the improvement of Medical SWM (infectious wastes) in the Study Area by conducting a rapid diagnosis.

### **c. Study Methods**

Due to time limitations, a quick study was carried out for a month. One should bear in mind, therefore, that there are certain limitations to the use of the study results in view of the reability and accuracy of the data obtained. The following were carried out for the quick study of the present medical SWM:

- data collection from agencies responsible for the present medical SWM (Ministry of Health (MINSA) and ALMA)
- distribution of questionnaires to medical solid waste producers
- field survey

The above mentioned activities were conducted for a month, from April to May 1994.

## **12.1.2 Study Results**

### **a. Classification of Medical Institutions**

Medical Institutions are classified into six categories which are enumerated below.

#### **aa. Hospitals**

Hospitals provide better medical services than other institutions.

There are 13 hospitals in Managua, 7 of which conduct major operations. 9 of these hospitals are state owned, 3 are private hospitals and 1 is partly private and partly government run.

#### **ab. Health Centers (Centro de Salud - C/S)**

Centro de Salud is a government-run health center providing simple medical consultation services, have no beds and do not accept inpatients. Their services are

restricted to minor surgeries.

**ac. Health Service Points (PM) and Medical Service Points (PS)**

Health and Medical Service Points are state owned institutions providing medical checkups. These institutions operate at different hours; Health Service Points are open for longer hours than Medical Service Points.

**ad. Clinics**

Clinics are private health institutions that do not normally have inpatients and are without beds therefore. The medical services offered in clinics are very limited.

**ae. Pharmacies**

Pharmacies are privately owned facilities and cannot carry out injections.

**af. Laboratories**

Laboratories are privately owned facilities used to analyze various medical specimens.

**b. Incinerators**

**ba. Historical Background**

**baa. Reports on Sanitary Control in Hospitals Prepared in the late 1980's**

Reports on sanitary control in hospitals were formulated during the late 80's by the Regional Office of the Ministry of Health [Region III, Managua ("Department of Managua")]. The reports contain specific information concerning the management and final disposal of solid wastes, pointing out the existence of sanitary problems in the solid waste management and final disposal systems of all hospitals in Managua.

**bab. Study on Management and Final Disposal of Solid Waste generated in Managua in 1988**

A study on the solid waste management and final disposal system of four hospitals in Managua (Manolo Morales, Bertha Calderón, Fernando Velez Paiz and Antonio Lenin Fonseca) was carried out in the latter half of 1988. The study was

implemented as an academic requirement for students majoring in environmental engineering. The study concludes that problems concerning wastes generated in these hospitals were mainly concentrated in the waste handling, internal collection and final disposal aspects.

**bac. Preliminary Diagnosis in the Cemetery of Ciudad Sandino in 1991**

In November 1991, the Department of Environment, which is under ALMA, carried out a study entitled "Preliminary Diagnosis in the Cemetery of Ciudad Sandino", the site used by public and private hospitals of Managua for the disposal of infectious wastes.

According to the study, the uncautious burying of these infectious wastes is what affects the immediate environment most. Improperly buried wastes are usually easily exhumed by domestic animals (dogs, cats) and jeopardize the health of the people within the vicinity.

Until the middle of 1992 medical wastes were disposed at the cemetery in Ciudad Sandino.

**bad. Final Disposal in the former Hospital "El Retiro"**

"El Retiro" used to be a hospital which was utilized for a while as a final disposal site for hospital wastes. The place used to operate on weekdays but was however closed down due to complaints from neighbors.

**cae. Present Medical Solid Waste Disposal**

Although infectious wastes are presumed to be disposed of in "El Retiro", the segregation of medical wastes is considered to be inadequately carried out.

At present, most medical solid wastes are handled in a manner similar to that of municipal solid waste. They are being collected daily by collection units and disposed of without any prior treatment in the municipal landfill of Managua at Acahualinca. This form of management puts the population of Managua at a very high risk.



**c. National Policy**

**ca. Introduction of Incinerators for Medical Solid Waste Management**

The policy of the Ministry of Health (MINSA) concerning medical solid waste management entails the improvement of measures for the treatment of medical solid waste in the Municipality of Managua, which shall be later extended nationwide.

**cb. Incinerator Installation Program in Managua Municipality**

The European Union (EU) approved the plan to install incinerators in ALMA in November 1993. The plan is shown in Table 12.1.2a.

Table 12.1.2a Incinerator Installation Plan in Managua

Item	Description
Incinerator	Plant with three chambers
Owner	Private independent company
Capacity	100 kg/h per chamber, totalling 300 kg/h
Medical Institution	Private and public hospitals, clinics and laboratories. This will be possible once the law which grants the power to control and regulate private and public medical institutions to MINSA is approved.
Installation Schedule	<ol style="list-style-type: none"><li>1. Six months of prior investigation</li><li>2. Twelve months for construction, personnel training and installation.</li><li>3. Operation under guidance for 30 months followed by self-sustained undertaking.</li></ol>
Location	Not defined, as it will be an interinstitutional decision (MINSA, Municipality, INAA, etc.).
Collection	Collection frequency is not defined since prior investigation is required.
Haulage	A fleet of vehicles will be available (trucks with a refrigeration system). Route design is not yet established.

**d. Field Survey**

**da. Distribution of Medical Institutions**

There are 13 hospitals and 33 Health Care Centers in Managua, and these medical institutions are concentrated in districts 2,3,4 & 5 where population is very dense.

Due to low population density, only 1 health care center is established in district 7.

**daa. Interview with Hospitals**

Almost all of the medical institutions dispose medical solid waste through the solid waste collection services conducted by the Municipality.

This survey also established the lack of an infectious solid waste management system in the Municipality.

**dab. Interview with C/S (Health Care Center) PM and Clinics**

These medical institutions only offer medical consultations and do not receive inpatients, therefore, almost all of them have no beds. They discharge medical waste through the solid waste collection services provided by ALMA.

**dac. Interview Survey with Pharmacies and Laboratories**

These institutions discharge solid waste through the collection services of the municipality.

**dad. Collection Services of ALMA**

The collection services of the municipality enforces 3 types of collection frequency: 6 days/week for 8 hospitals, 3 days/week for 12 medical institutions, and 2 days for 2 medical institutions.

**dae. Incinerators in the Study Area**

Only the incinerator of the Hospital Aleman Nicaraguense (Carlos Marx) is functioning properly, the rest are either out of order or rundown. Accordingly, only 4 - 5 hospitals incinerate their wastes; other hospitals burn their medical waste within their premises or dispose of it at the Acahualinca disposal site though the municipality collection service, mixing it with several other solid wastes.

**e. Legislation and Enforcement**

There are no municipal or national legislations specifically dealing with medical wastes.

Today, wastes are generally either disposed of at the Acahualinca landfill or burned or dumped within hospital grounds. Only the incinerator of Hospital Aleman Nicaraguense is in good condition.

Legislations on health and sanitation, like the Sanitary Code, Sanitary Inspection Guidelines and the Municipal Law, are general and vague and are not compelling enough to cope with the most pressing issues prevailing in Managua.

A project shared by all Central American countries was however organized to develop a "Regional Program for the Collection and Treatment of Hospital Solid Waste" in the six capital cities of Central America. This project was financed by the European Union and one of its objectives is to develop adequate legislations on solid waste management.

**12.1.3 Study Findings**

**a. Government Organization and Collection Service**

MINSA is the sole organization responsible for the management of medical wastes. Nevertheless, medical wastes segregation is never carried out and ALMA has been collecting the municipal solid wastes of medical institutions.

**b. Medical Waste Collection**

As previously mentioned, there are no government organizations providing waste collection services to the medical institutions of Managua, forcing most of these institutions to burn refuse at their premises or dispose medical wastes at the final disposal site through municipal collection services.

Furthermore, the staff of medical institutions are unaware of the importance of segregating medical waste from municipal solid waste, indirectly putting the health of collection workers and scavengers at the disposal site at risk as both wastes are collected, hauled and disposed at the Acahualinca landfill site.

**c. Incinerator Installation Program**

EU approved the program for the installation of incinerators in ALMA for the treatment of Medical Waste, in December 1993.

MINSA completed the first phase of a detailed survey on the future establishment of an incineration system, November to December 1994, and will commence the second phase of the survey in February of 1995.

**d. Necessity of Education Programs for the Staff of Medical Institutions**

Although municipal collection services are theoretically provided only for refuse, the municipality also collects domestic waste mixed with medical waste. The mixed condition of the wastes only proves the negligence in the part of the waste producers.

The use of incinerators to treat waste would require careful waste segregation considering the consequences that could seriously result from non segregation.

A one month staff education program was carried out nationwide from January to February 1995 in accordance with the incinerator installation program.

**12.1.4 General Recommendation on Medical SWM**

MINSA will introduce the medical waste incineration system to all the medical institutions in Managua in December 1995. In accordance to this, education programs prepared by EU were carried out with the staff of medical institutions in November 1994.

The incineration of infectious waste can only be made possible if medical institutions abide by the collection system established for medical waste.

ALMA and medical institutions should promote this system, in order to ensure the good sanitary conditions.