

**eb. Phased measures for leachate**

Taking account of the above facts, adequate anti-contamination measures for Managua Lake should be incorporated in the Master Plan.

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: Sanitary Landfill Level 3**

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

**Year 2010: Sanitary Landfill Level 4**

- the installation of leachate treatment facilities

As previously mentioned, the measures for the improvement of the lake water quality will be focused on sewage treatment, because sewage concentration is higher than leachate making the effect of the latter minimal in comparison. Therefore, the most cost effective way to treat contaminated water entering the lake would be to construct a sewage plant, and to treat the waste leachate at the same plant, since its reduced volume will not affect the capacity or production of the plant. Financially, this will minimize the capital required for the improvement of the water quality of Managua lake.

**I.1.2 Target Year and Population**

**a. Target Year**

The master plan shall cover the period between 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.

The period of the plan may be divided into the following three stages and the target year will be finalized during the study process with the Nicaraguan side.

Table I.1.2a Target Year

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

**b. Population Forecast in the Study Area**

Population is the most essential factor in the formulation of the Study for the improvement of SWM and the physical development plan for the municipality of Managua.

Population projections are basic data for development planning and estimation of future solid waste generation amount for the improvement of SWM. Population statistics, which is directly related to the solid waste collection coverage, was carefully discussed with ALMA which decided to adopt the Study Team's present population base to project future population and plans on SWM.

The future district population and urbanized area are projected as shown in Table I.1.2a.

A population growth of 5.2% was assumed from 1994 to 2000 and 3.6% for the period between 2000 - 2010. Given these growth rates, the population of Managua municipality is projected to increase 1.4 times the present population by 2000 and 1.9 times by 2010, reaching a total of 2,069 million inhabitants.

Table I.1.2b District Population Projection by Target Year

District	1994		2000		2010	
	Total	Urban	Total	Urban	Total	Urban
D1	92,890	63,556	125,911	86,149	179,333	122,701
D2	134,696	134,696	182,578	182,578	260,044	260,044
D3	195,410	134,833	264,875	182,764	377,258	260,308
D4	204,711	204,711	277,483	277,483	395,215	395,215
D5	209,045	144,241	283,357	195,516	403,582	278,471
D6	220,855	152,390	299,365	206,562	426,382	294,204
D7	14,261	0	19,331	0	27,532	0
<b>Total</b>	<b>1,071,868</b>	<b>834,427</b>	<b>1,452,900</b>	<b>1,131,052</b>	<b>2,069,347</b>	<b>1,610,943</b>

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

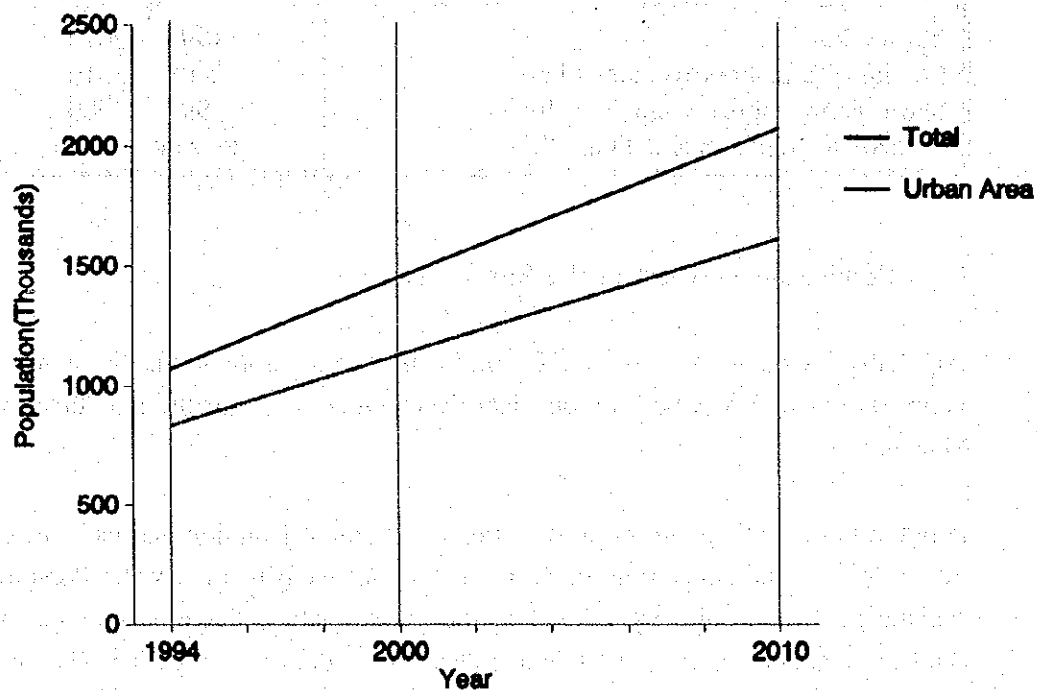


Figure I.1.2a Population Growth in the Study Area

### I.1.3 Future Waste Amount and Composition Forecast

#### a. Forecast Conditions

##### aa. Types of waste

The different types of waste in this study are:

##### i. MSW

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

**ab. Target Years for the Forecast**

The target years for the forecast of waste amount and composition are as follows:

2000 : The target year for the first priority project.

2010 : The target year for the master plan.

**ac. Factors Affecting Waste Increase and Composition**

The following factors will have an influence on the future generation of waste and its composition:

- Social welfare and the financial capacity of individual consumers/families
- Industrial technology
- Importation

Forecasting is difficult to conduct in Nicaragua due to the lack of previous data on waste amount and composition. Economically, the wastes of Nicaragua should identify with the developing state of the country (e.g., GDP growth).

**b. Forecast on Future Waste Amount**

**ba. Forecast Methodology**

For the type of wastes to be forecast, the following assumptions were made:

**baa. Household waste**

Waste generation will be projected as follows:

$$[\text{Waste generation}] = [\text{Generation Rate}] \times [\text{Population}]$$

**baaa. Increase in generation rate**

To determine the relationship between GDP and the generation of waste, increase in welfare services was taken into account. Although a direct connection is not anticipated, some aspects indicating further analysis may be identified.

GDP increase is expected to have a large impact on the generation of waste per capita of developing countries than of developed countries. Also, at a certain welfare level, increase in GDP remarkably changes the composition of waste.

Japan has fine statistics enabling the analysis of the relationship between GDP and waste generation in a developing economy (1963 – 1970) and a developed economy (1975 – 1988). Data in the years 1970 – 1975 are excluded due to fluctuations resulting from the implementation of a new waste disposal and public cleansing law and economic recession and instability caused by the oil crisis. Based on data for the period between 1963–1970, a developing economy can be characterized as follows:

- Average increase in waste generation per capita: 5.789 %/year
- Average increase in GNP \*: 10.438 %/year

\* GNP was used due to unavailability of GDP.

Based on these figures, we assume that the changes in GDP affect waste generation as it renders the developing economy flexibility (60–55 of GDP – change in %).

The GDP of Nicaragua (taken from the 1994 constant) is supposed to develop as follows:

1994		+ 3.0%
1995 – 1998	gradually to	+ 5.0%
1999 – 2000		+ 5.0%
2001 – 2005		+ 4.5%
2006 – 2010		+ 4.0%

Annual rise in GDP would result in increased waste generation due to improved welfare services. And the increase in waste generation per capita per year is, estimated as:

**Table I.1.3a GDP Growth Rate and Increase in Generation Ratio**

Year	GDP Growth Rate	Increase in Generation Ratio
1994	3.0	-
1995	3.5	1.925
1996	4.0	2.200
1997	4.5	2.475
1998	5.0	2.750
1999	5.0	2.750
2000	5.0	2.750
2001	4.5	2.475
2002	4.5	2.475
2003	4.5	2.475
2004	4.5	2.475
2005	4.5	2.475
2006	4.0	2.200
2007	4.0	2.200
2008	4.0	2.200
2009	4.0	2.200
2010	4.0	2.200
Average	-	2.389

The table indicates a constant increase of 2.4% in waste generation per capita per year in the planning period 1995 – 2010.

**baab. Increase in population**

Population change is the factor that directly influences waste generation the most. The estimated annual population growths in the Study Area planning period are tabulated in Table I.1.2b.

**bab. Commercial, market, institutional and hospital waste**

Present generation amount of waste is forecast to increase in accordance with GDP growth rate.

**bac. Street sweeping and park & green area wastes**

The present generation rate of street sweeping and park and green area wastes is forecast to be fixed. These waste amounts will increase in accordance with the expansion of areas covered by street sweeping and public area cleansing services.

**bad. Other waste**

Other wastes, i.e., industrial waste, directly hauled waste and illegally dumped

waste, will increase in accordance with GDP growth rate.

**bb. Waste Amount Forecast**

The forecast on MSW and other waste will be made based on the above-mentioned assumptions. The household waste generation ratio in the Study Area was roughly estimated based on the 1994 generation ratio, and tabulated in Table I.1.3b. The results of the forecast are shown in Table I.1.3c.

Table I.1.3b Forecast on Household Waste Generation Ratio

	Unit	1994	2000	2010
Household Waste	g/person/day	664	769	969

Table I.1.3c Forecast on Waste Generation Amount

(unit: ton/day)

Generation Source		1994	2000	2010
MSW	Household Waste: Area A	369.6	580.1	1,041.2
	Household Waste: Area B	184.5	289.7	519.8
	Commercial Waste: Restaurants	25.4	33.1	50.3
	Commercial Waste: Others	0.4	0.4	0.4
	Market Waste	26.0	33.9	51.4
	Institutional Waste	2.3	2.9	4.0
	Hospital Waste	6.3	8.3	12.5
	Street Sweeping Waste	16.5	17.4	17.4
	Park & Green Area Waste	1.4	3.8	3.8
	Directly Hauled Waste	33.6	43.4	65.8
Sub-total		666.0	1,013.0	1,766.6
ISW	Industrial Waste	8.9	11.6	17.5
	Directly Hauled Waste	5.1	255.8	387.7
	Illegally Dumped Waste (from RIDS)	188.0	-	-
	Sub-total	202.0	267.4	405.2
Total		868.0	1,280.4	2,171.8

Note: Industrial waste amount is limited to Municipal collection.

Illegally dumped waste amount is limited to Municipal collection.

Illegally dumped waste was forecast using directly hauled waste figures.

**c. Forecast on Waste Composition**

**ca. Forecast on Waste Composition**

A change in the composition of waste is expected due to the marketing of new products and a different consumption pattern.

Table I.1.3d compares the results of the WAC survey on household waste and MSW composition with the 1991 data of Rio de Janeiro, Brazil, by the Applied Research Center of COMLURB (Rio de Janeiro Municipal Public Cleansing Company), 1987 data of Penang, Malaysia, 1972 data of Tokyo, Japan, and the 1993 data taken in Asuncion, Paraguay.

Table I.1.3d Comparison of MSW Composition Data

(unit: %)

	Managua, Nicaragua 1994		Penang ** Malaysia 1987	Tokyo Japan 1972	Rio de Janeiro 1991	Asuncion Paraguay 1993
	Household Waste from WACS	MSW * from WACS				
<b>1. Combustibles</b>	<b>75.09</b>	<b>76.22</b>	<b>88.1</b>	<b>89.0</b>	<b>79.1</b>	<b>72.8</b>
Kitchen Waste	34.86	34.80	32.8	25.9	33.9	37.4
Paper	5.37	7.07	25.5	35.6	27.1	10.2
Textile	1.87	1.94	3.4	3.2	2.7	1.2
Plastic	3.88	4.00	11.2	6.9	12.7	4.2
Grass and Wood	27.11	26.35	14.4	-	2.0	19.2
Leather and Rubber	2.00	2.06	0.8	0.8	0.7	0.6
Others	-	-	-	16.6	-	-
<b>2. Non-Combustibles</b>	<b>24.91</b>	<b>23.78</b>	<b>12.0</b>	<b>11.0</b>	<b>20.4</b>	<b>27.2</b>
Metal	1.69	1.77	2.6	3.7	3.1	1.3
Glass	2.91	2.91	1.4	7.3	2.2	3.5
Ceramic and Stone	8.07	7.60	0.2	-	0.4	2.5
Others(soils, etc.)	12.24	11.50	7.8	-	14.7	19.9
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>99.5</b>	<b>100</b>
Apparent Specific Gravity (kg/m <sup>3</sup> )	200	200	190	N.A	209	215

Note: WACS : Waste Amount and Composition Survey  
 \* : The figure shows the composition of MSW  
 \*\* Source : "Solid Waste Management Study for Pulau Penang and Seberang Perai Municipalities, August 1989, JICA"

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

- Increase in the ratio of combustibles and decrease in non-combustibles.
- Decrease in the ratio of kitchen waste and increase in paper and plastics.
- Decrease in the ratio of grass and wood and increase in metal and glass.
- Decrease in apparent specific gravity.

Referring to Table I.1.3d, the waste composition structure in 2010 is set as follows:

- Paper and plastic ratios will increase up to 11% and 7%, respectively.
- Ratio of grass and wood will decrease down to 23% due to less vegetation



in the urban area.

- Ratio of soil (others) will decrease down to 9% due to increase in paved roads.
- Only minor changes are observed in other items.

Table I.1.3e shows the forecast MSW composition in the Study Area.

Table I.1.3e Forecast MSW Composition

(unit: %)

Composition	1994	2000	2010
<b>1. Combustibles</b>	<b>76.22</b>	<b>78</b>	<b>80</b>
Kitchen Waste	34.80	35	35
Paper	7.07	9	11
Textile	1.94	2	2
Plastic	4.00	5	7
Grass and Wood	26.35	25	23
Leather and Rubber	2.06	2	2
<b>2. Non-Combustibles</b>	<b>23.78</b>	<b>22</b>	<b>20</b>
Metal	1.77	2	2
Glass	2.91	3	3
Ceramic and Stone	7.60	7	6
Others (Soils, etc.)	11.50	10	9
<b>Total</b>	<b>100.0</b>	<b>100</b>	<b>100</b>

Note: MSW here excludes street sweeping and bulky wastes.

**cb. Forecast on Calorific Value**

**cba. LCV of the physical composition of each waste category**

The following calorific values were measured in the WACS:

- for combustibles mixed from 8 generation sources, i.e. residential areas (high, middle and low income), markets, commercial areas (restaurants and others), institutions and road;
- for each combustible item from the middle income residential area.

The calorific value of wastes differs according to physical composition and how much moisture, combustible and ash it contains and the ratio of combustible waste and ash depends on the physical changes that take place. Table I.1.3f shows our survey data on mixed combustibles and the 1972 data on Japan.

Table I.1.3f Comparison of the Three Contents and LCV

	1994 JICA Study		Japan (1972)
	Household	MSW	
Moisture content (%)	37.27	37.42	54.1
Combustible content (%)	27.97	28.64	31.4
Ash content (%)	34.76	33.94	14.5
Lower Calorific Value Measured (kcal/kg)	1,045	1,092	1,165

The above 1994 data obtained by the JICA Study Team are weighing average figures of mixed wastes, taking the waste generation ratio by each category into account. The moisture content of each data ranges between 10% - 50%. The lower calorific value was determined by taking into account the possibility that the physical composition may vary, because the moisture content is forecast to remain constant.

The higher calorific value (HCV) in dry base of each combustible component of waste from the middle income residential area was also measured and used to calculate the lower calorific values (LCV's) shown in Table I.1.3g.

Table I.1.3g HCV in Dry Base and LCV in Wet Base of Each Combustible Waste

	Higher Calorific Value in Dry Base (kcal/kg)	Lower Calorific Value in Wet Base (kcal/kg)
Kitchen Waste	3,640	780
Paper	4,440	2,630
Textile	4,390	1,880
Plastic	9,280	6,690
Grass & Wood	3,320	1,450
Leather & Rubber	5,680	4,600

The LCV of wastes was calculated by the following formula:

$$LCV = (RGa^{*1} * 780 + RPa^{*2} * 2,630 + RT^{*3} * 1,880 + RPl^{*4} * 6,690 + RGr^{*5} * 1,450 + RL^{*6} * 4,600) / 100$$

RGa<sup>\*1</sup>; Ratio of kitchen waste in wet weight (%)  
 RPa<sup>\*2</sup>; Ratio of paper in wet weight (%)

- RT<sup>3</sup>; Ratio of textile in wet weight (%)
- RPl<sup>4</sup>; Ratio of plastic in wet weight (%)
- RGr<sup>5</sup>; Ratio of grass and wood in wet weight (%)
- RL<sup>6</sup>; Ratio of leather and rubber in wet weight (%)

**cbb. Lower calorific value forecast**

Using the above mentioned formula, the future LCV of MSW is estimated by multiplying the LCV in Table I.1.3g by the ratio of the future physical composition shown in Table I.1.3e.

In case a separate collection system will not be introduced, the LCV of mixed waste is estimated as shown in Table I.1.3h.

**Table I.1.3h Forecast on Lower Calorific Value**

Year	Lower Calorific Value (kcal/kg)
	Mixed
1994	1,238
2000	1,336
2010	1,494

**d. Future Waste Stream**

**da. Forecast Conditions**

**daa. Source recycling**

The rate of food waste recycled (about 3% of the generation amount) at generation sources will be maintained till 2010.

**dab. Self-disposal (collection service area)**

Since the same kind of housing style (detached houses) will still be common in the future, the self-disposal rate (about 13% of the generation amount) is estimated to remain the same until 2010. Consequently, the self-disposal amount is calculated by the formula below.

$$SA = GA \times 0.13$$

SA: Self-disposal amount (ton/day)

GA: Generation Amount  
0.13: Self disposal rate as percentage of generation amount

**dac. Self-disposal (non-collection service area)**

Self-disposal amount in non-collection area is calculated using the following formula:

$$SA(\text{non}) = GA(\text{non}) \times 0.13$$

SA(non) : Self-disposal amount in non-collection area (ton/day)  
GA(non) : Generation amount in non-collection area (ton/day)

**dad. Discharge**

The waste discharge amount is obtained using the following formula:

$$DA = WGA - SRA - SA - SA(\text{non})$$

DA : Discharge amount (ton/day)  
WGA : Waste generation amount (ton/day)  
SRA : Source recycling amount (ton/day)

**dae. Recycling other than at sources**

Recycling will be popularized and its importance will be further acknowledged as the GDP growth rate escalates.

**daf. Other waste**

Other wastes hauled to the disposal site will increase in accordance with the GDP growth rate.

**dag. Landfill**

The landfill amount is calculated by the formula below.

$$LA = DA - RA + OWA$$

LA: Landfill amount (ton/day)  
RA: Amount of recycling other than at sources (ton/day)  
OWA: Other waste amount (ton/day)

**dah. Apparent specific gravity**

Apparent specific gravity of waste after compaction at the final disposal site is 0.8.

**db. Future Waste Stream**

The future waste streams are presented in Table I.1.3i and Figure I.1.3a.

**Table I.1.3i Waste Stream in Managua**

Category		Unit	Year		
			1994	2000	2010
MSW	a.Generation	ton/day	871.0	1,013.0	1,766.6
	b.Self Disposal	ton/day	185.2	196.4	223.3
	c.Recycling at Generation Source	ton/day	16.7	26.2	47.0
	d.Collection	ton/day	433.5	747.0	1,430.5
	e.Directly Hauled MSW	ton/day	36.6	43.4	65.8
ISW	f.ISW collected by the Municipality	ton/day	8.9	11.6	17.5
	g.ISW from RIDS	ton/day	188.0	0.0	0.0
	h.Directly Hauled ISW	ton/day	5.1	255.8	387.7
i.	Recycling	ton/day	12.8	20.1	36.4
j.	Waste amount at Final Disposal Site per day	ton/day	656.3	1,037.7	1,865.1
k.	Waste amount at Final Disposal Site per year (jx365)	ton/year	239,550.0	378,761.0	680,762

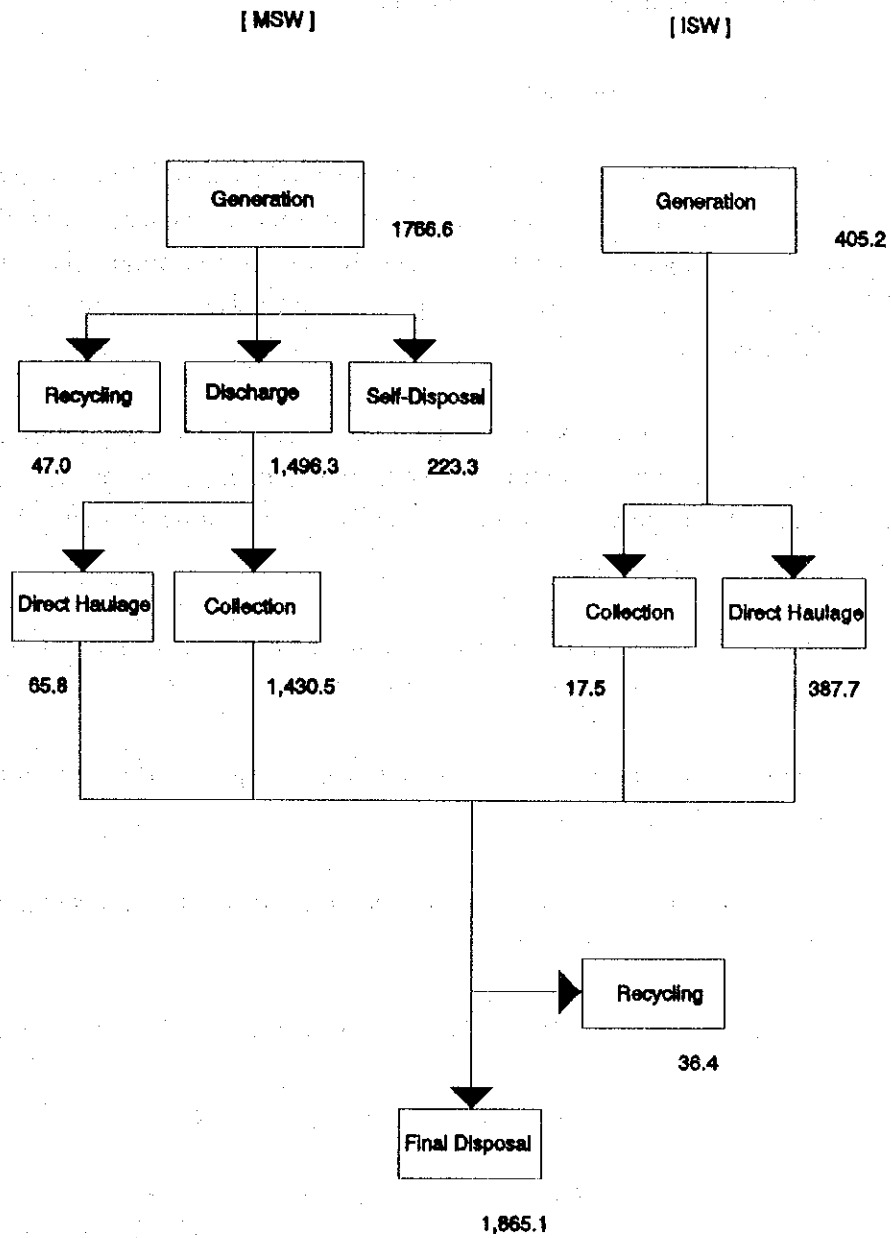


Figure I.1.3a Waste Stream in 2010 in the Study Area (unit : ton/day)

## **I.1.4 Other Preconditions**

### **a. Economic and Financial Conditions**

#### **aa. Economic Growth Rate**

It is very difficult to forecast the future economy of Nicaragua because the country is presently changing its economic structure to a market economy. Further, even the use of trend figures of economic variables to describe future scenarios is too risky because for a long period of time the country has been under a controlled regime and civil war.

The formulation of the SWM Master Plan necessitates forecasting future economic figures to estimate waste volume and economic capability, factors relevant to the estimation of the required SWM cost. Therefore, the following assumptions on the future GDP and GRDP were made:

- The actual GDP growth rate will increase to more than 3.5% as the population increase rate exceeds 3%.
- The positive changes in the economy of Nicaragua in 1994 will bring about a 2% to 3% growth rate.
- The development plans for Nicaragua will aim for a 5% economic growth rate in the 1994 - 1995 period.

Based on the above assumptions, the GDP growth rate forecast is as follows:

Year	GDP (growth/year)
1994	3.0%
1995	3.5%
1996	4.0%
1997	4.5%
1998-2000	5.0%
2001-2005	4.5%
2006-2010	4.0%

In 1992, Managua made up 50% of the GDP, a contribution estimated to increase to 55% by the year 2000. This figure will be adopted until the year 2010 in the Study.

The estimated increase is attributable to the belief that urbanization will attract migrants from rural areas and encourage the convergence of tertiary industries in Managua City.

Based on the above reasons, the main GDP and GRDP figures per annum were calculated as shown in Table I.1.4a.

Table I.1.4a Master Plan Framework

	Unit	1992	1994	1995	2000	2005	2010
GDP	mill.US\$	1,686.0	1,724.4	1,784.8	2,245.4	2,798.2	3,404.5
Share of Managua	%	50.0	51.3	51.9	55.0	55.0	55.0
GRDP in Managua	mill.US\$	843.0	883.8	925.9	1,235.0	1,539.0	1,872.5
Population of Managua	thousands	971.3	1,071.9	1,127.6	1,452.9	1,733.9	2,069.3
GRDP per capita	US\$	867.9	824.5	821.1	850.0	887.6	904.9

**ab. City Finance and Family Income Estimates**

The budget of the city of Managua and the income of families in the city are assumed to be proportional to the GRDP growth rate; increase in city budget is proportional to the total GRDP growth and increase in family income is proportional to the GRDP growth per capita.

Table I.1.4b Financial State of Managua Municipality and Family Income

	Unit	1992	1994	1995	2000	2005	2010
Budget of Managua	mill.US\$	33.5	33.1	34.7	46.2	57.6	70.1
Family Income	US\$/month	389.6	370.1	368.6	381.6	389.4	406.2

**b. Conditions for Cost Estimation**

All cost estimates are conducted taking the following into account:

- The prices and foreign exchange rate are based on the January 1995 rate.

$$\text{US\$ 1.00} = \text{C\$ 7.1183}$$

- Inflation is not taken into account.



- Local laborers whose wages are under C\$ 25,000/year are not obliged to pay income tax, but 12.5% social security charge is deducted from the wage.
- Prices for equipment not available in Nicaragua reflect Japanese price levels. These will be presented in CIF prices in C\$.

Unit prices for earthworks, concrete works, buildings, etc., were based on the information given by the Ministry of Construction, Managua Municipality and private construction companies.

Table I.1.4c presents unit prices available in Nicaragua in June 1995.

Table I.1.4c Unit Prices Available in Managua

DESCRIPTION	UNIT	PRICE
1. Salary, including 12.5% Social Securities Charge		
- manager	C\$/pers	4,666
- engineer	C\$/pers	3,033
- mechanic	C\$/pers	1,604
- driver & clerk	C\$/pers	1,410
- worker	C\$/pers	992
2. Earthworks		
- Excavation and Compaction: hauling distance = 0 to 50 m	C\$/m <sup>3</sup>	30
- Excavation, haulage and compaction		
0 - 1km	C\$/m <sup>3</sup>	34
1 - 5km	C\$/m <sup>3</sup>	44
5 - 10km	C\$/m <sup>3</sup>	54
10 - 15km	C\$/m <sup>3</sup>	64
3. Drainage Works		
- Underground drain including excavation, supply & placing of gravel	C\$/m	40
- Underground drain with perforated pipe, including excavation, supply & placing of perforated pipe (D=diameter) and filter material		
D = 100 mm	C\$/m	180
D = 150 mm	C\$/m	240
D = 300 mm	C\$/m	440
- Open ditch w=3.0m, including excavation and shaping	C\$/m	290
- Open ditch reinforced concrete w=3.0m, including all works	C\$/m	2,600
- Concrete pipe D=600mm, including excavation, foundation, supply & placing concrete pipe and back fill	C\$/m	770
- Concrete pipe culvert D=1,200mm, including excavation, foundation, supply and placing concrete pipe and back fill	C\$/m	2,200
4. Pavement works		
- 5 cm asphalt concrete	C\$/m <sup>2</sup>	130
- 20 cm mechanical stable gravel	C\$/m <sup>2</sup>	
- 20 cm course gravel	C\$/m <sup>2</sup>	
5. Concrete works, including material and form works		
- Reinforced concrete	C\$/m <sup>3</sup>	1,400
- Concrete	C\$/m <sup>3</sup>	850
6. Building works		
- Garage - a steel structure with steel cladding; including foundation and concrete floor	C\$/m <sup>2</sup>	1,300
- Office building - of reinforced concrete; including all works	C\$/m <sup>2</sup>	2,300
7. Miscellaneous works		
- Fence - consists of 2m high galvanized wire mesh erected on galvanized steel posts each 2.5 m in diameter.	C\$/m	270
- Gate - 8 m wide	C\$/set	3,600
- Tree height = 2.5 - 3.0 m, including excavation, planting and all works	C\$/piece	40
- Turfing - consists of supply of turf and soil and all works necessary	C\$/m <sup>2</sup>	10
8. Materials		
- Diesel Oil	C\$/lt	1.89
- Gasoline	C\$/lt	4.00
- Gravel	C\$/m <sup>3</sup>	94.30
- Sand	C\$/m <sup>3</sup>	8.28
- Clay	C\$/m <sup>3</sup>	7.50
- Cement	C\$/45 kg	25.59
- Concrete		
150 kg/cm <sup>2</sup>	C\$/m <sup>3</sup>	534.75
210 kg/cm <sup>2</sup>	C\$/m <sup>3</sup>	570.85
- Reinforced bar	C\$/kg	4.43
- Electric Power	C\$/kwh	0.51

## I.2 Outline of MSWM

### I.2.1 Outline of Technical System

The outline of the technical systems of the MSWM Master Plan is shown in Table I.2.1a.

Table I.2.1a Technical Systems of the MSWM Master Plan

Item	Year	1995	2000	2010
<b>1. GENERAL</b>				
Total Population		1,127,605	1,452,900	2,069,347
Urban Area Population		877,817	1,131,053	1,610,944
Serviced Population		675,919	1,017,947	1,610,944
<b>2. WASTE STREAM</b>				
Generation		921.2 tons/day	1,280.4 tons/day	2,171.8 tons/day
Self-disposal		198.1 tons/day	196.4 tons/day	223.3 tons/day
Recycled Amount at Generation Sources		17.9 tons/day	26.2 tons/day	47.0 tons/day
Collection		662.5 tons/day	758.6 tons/day	1,448 tons/day
Recycled Amount (Recycling Material)		14.0 tons/day	20.1 tons/day	36.4 tons/day
Direct Haulage		43.2 tons/day	299.2 tons/day	453.5 tons/day
Final Disposal		692.3 tons/day	1,037.7 tons/day	1,865.1 tons/day
<b>3. DISCHARGE &amp; STORAGE</b>				
Type of Containers				
- Residential area A		Nylon sacks or plastic bags	Nylon sacks or plastic bags	Nylon sacks or plastic bags
- Residential area B		Open heaping	Communal containers/ Nylon sacks or plastic bags	Communal containers/ Nylon sacks or plastic bags
- Large generation sources (commercial areas, markets, hospitals, institutions, etc.)		Communal containers	Communal containers	Communal containers
- Street sweeping, parks & green areas		Open heaping	Communal containers	Communal containers
<b>4. COLLECTION &amp; HAULAGE</b>				
Collection Ratio		77 %	90 %	100 %
Service Population and ratio		675,919(77.0%)	1,017,947(90%)	1,610,944(100%)
- in Area A(%)		585,504(66.7%)	754,412(66.7%)	1,074,449(66.7%)
- in Area B(%)		90,415(10.3%)	263,535(23.3%)	536,444(33.3%)
Non-service Population and ratio		201,898(23.0%)	113,105(10%)	0(0%)

<b>Collection System</b> - Residential area (A) - Residential area (B) - Large generation sources	Curb collection Open heaping Container	Curb collection Container/Bell collection Container	Curb collection Container/Bell collection Container
<b>Collection Frequency</b> - Residential area (A) - Residential area (B) - Large generation sources	Thrice a week Irregular Every day except holidays	Thrice a week Thrice a week Every day except holidays	Thrice a week Thrice a week Every day except holidays
<b>Collection Vehicles</b> - Residential area (A) - Residential area (B) - Large generation sources	Compactor trucks without public containers Wheel loaders & dump trucks Compactor trucks with public containers/Roll-on, Roll-off trucks	Compactor trucks without public containers Hoist trucks with containers/Compactor trucks without public containers Compactor trucks with public containers	Compactor trucks without public containers Hoist trucks with containers/Compactor trucks without public containers Compactor trucks with public containers
<b>Haulage System</b>	Direct; by collection vehicles	Direct; by collection vehicles	Direct; by collection vehicles
<b>Main Equipment (Unit)</b> - Compactor(15.3m <sup>3</sup> ) - Compactor with container - Hoist truck - Container (1m <sup>3</sup> ) - Container (7m <sup>3</sup> )	47 4 (4) (Roll-on Roll-off Truck) Approx.250 units(0.83m <sup>3</sup> ) Approx.20 units(15 m <sup>3</sup> )	55 3 20 157 127	86 4 71 154 127
<b>5. STREET SWEEPING</b> Sweeping System Covered Road Length Main Equipment (Unit) - Open Truck - Container (1m <sup>3</sup> )	Manual sweeping 331 Km Combination of wheel loader and dump truck - -	Manual sweeping 350 Km - 116	Manual sweeping 350 Km 2 116
<b>6. PARK &amp; GREEN AREA</b> Cleansing System Cleansing Area	Manual sweeping 16.7 ha	Manual Sweeping 45 ha	Manual sweeping 45 ha

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

## I.2.2 Outline of Institutional System

The outline of the Institutional System of the MSWM Master Plan is shown in Table I.2.2a.

Table I.2.2a Outline of the Institutional System of the MSWM Master Plan

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

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

### I.3 Phased Implementation Plan

#### I.3.1 Examination of 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.

The plan was divided into the following three stages and the target year was finalized during the meeting concerning the Inception Report which was carried out with the Nicaraguan Coordinating Committee.

Table I.3.1a 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. Target in each Implementation Period**

The targets established for each implementation period are shown in Table I.3.1b.

Table I.3.1b Target and Implementation Period

Targets		Implementation Period
1.	<b>Immediate Improvement Plan</b> - To improve collection efficiency - To establish the system for collection area expansion - To establish the system for the sanitation of the area - To sanitize the present Acahualinca disposal site - To execute public education programs on sanitation	Present - 1996
2.	<b>Short Term Improvement Plan</b> - To attain 90% collection service - To start sanitary landfill with leachate circulation (Level 3) - To improve workshop - To establish sanitary education program	1997 - 2000
3.	<b>Medium Term Improvement Plan</b> - To attain 100% collection service - To start sanitary landfill with leachate treatment (Level 4)	2001 - 2010

**b. Concrete Measures**

**ba. Concrete Measures to attain the Targets of the Immediate Improvement Plan**

Table I.3.1c shows the concrete measures to be taken in order to attain the targets of the Immediate Improvement Plan. The affectivity of these measures were confirmed in the pilot projects conducted during the 3rd field survey in Nicaragua and their affectivity was confirmed.



**Table I.3.1c Concrete Measures to attain the Targets of the Immediate Improvement Plan**

Targets (Improvement)		Concrete Measures	
1.	To improve collection efficiency	-	By using data obtained from truck scale
2.	To establish the system for collection area expansion	-	Through organization of community and promotion of District Office
		-	Establishment of waste fee collection system by community in squat areas
3.	To establish the system for the sanitation of the area	-	Through organization of community associations and promotional activities by the District Office;
		-	Establishment of funds to improve area condition, i.e. roads and drains
4.	To sanitize the present Acahualinca disposal site	-	Construction of dike
		-	Improvement of approach road
		-	Transfer of techniques, i.e., daily waste covering,
		-	construction of gas removal facility
5.	To execute public education programs on sanitation	-	Education program on sanitation using videos and booklets
		-	Promotional activities by the District Office and Environmental Protection Head Office

**bb. Concrete Measures to attain the Targets of the Short Term Improvement Plan**

Table I.3.1d shows the concrete measures for the attainment of the short term improvement plan targets.

**Table I.3.1d 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 the 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 the 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

**bc. Concrete Measures to attain the Targets of the Medium Term Improvement Plan**

Table I.3.1e shows the concrete measures for the attainment of the medium term improvement plan targets.

**Table I.3.1e 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 the leachate treatment facilities
		-	Operation of sanitary landfill (Level 4)

The construction of a sewage treatment plant would enable the treatment of leachate, therefore, minimize the capital required for the plan to improve the water quality of Managua lake.

**I.3.2 Phased Implementation Plan**

To accomplish the targets of each phase, the concrete measures above mentioned should be carried out step by step taking into account the financial situation, the share the citizens' have to carry, and the concerned project itself.

The phased implementation plan for the MSWM Master Plan of the municipality of Managua is summarized and illustrated in Figure I.3.2a, I.3.2b.

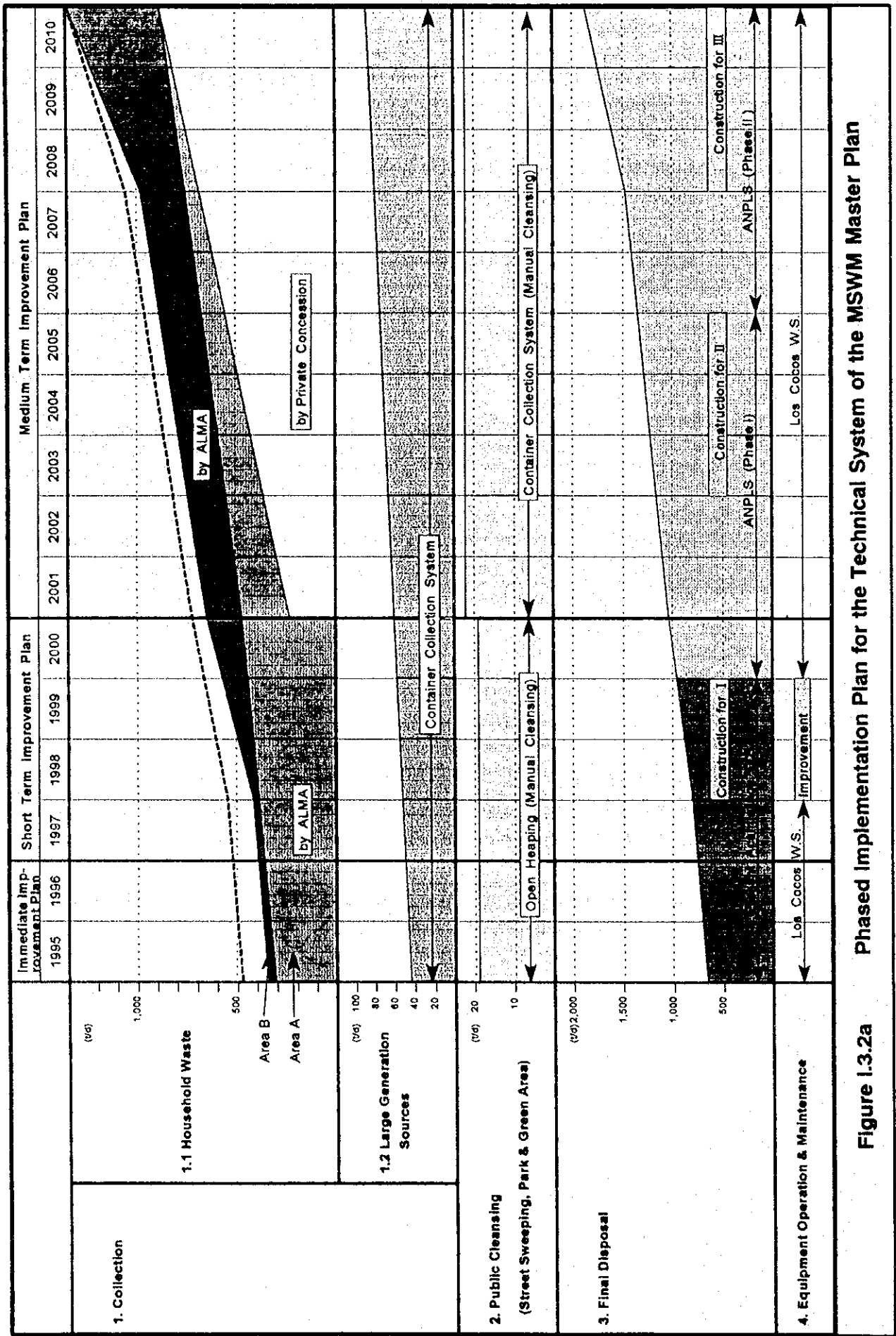


Figure I.3.2a Phased Implementation Plan for the Technical System of the MSWM Master Plan

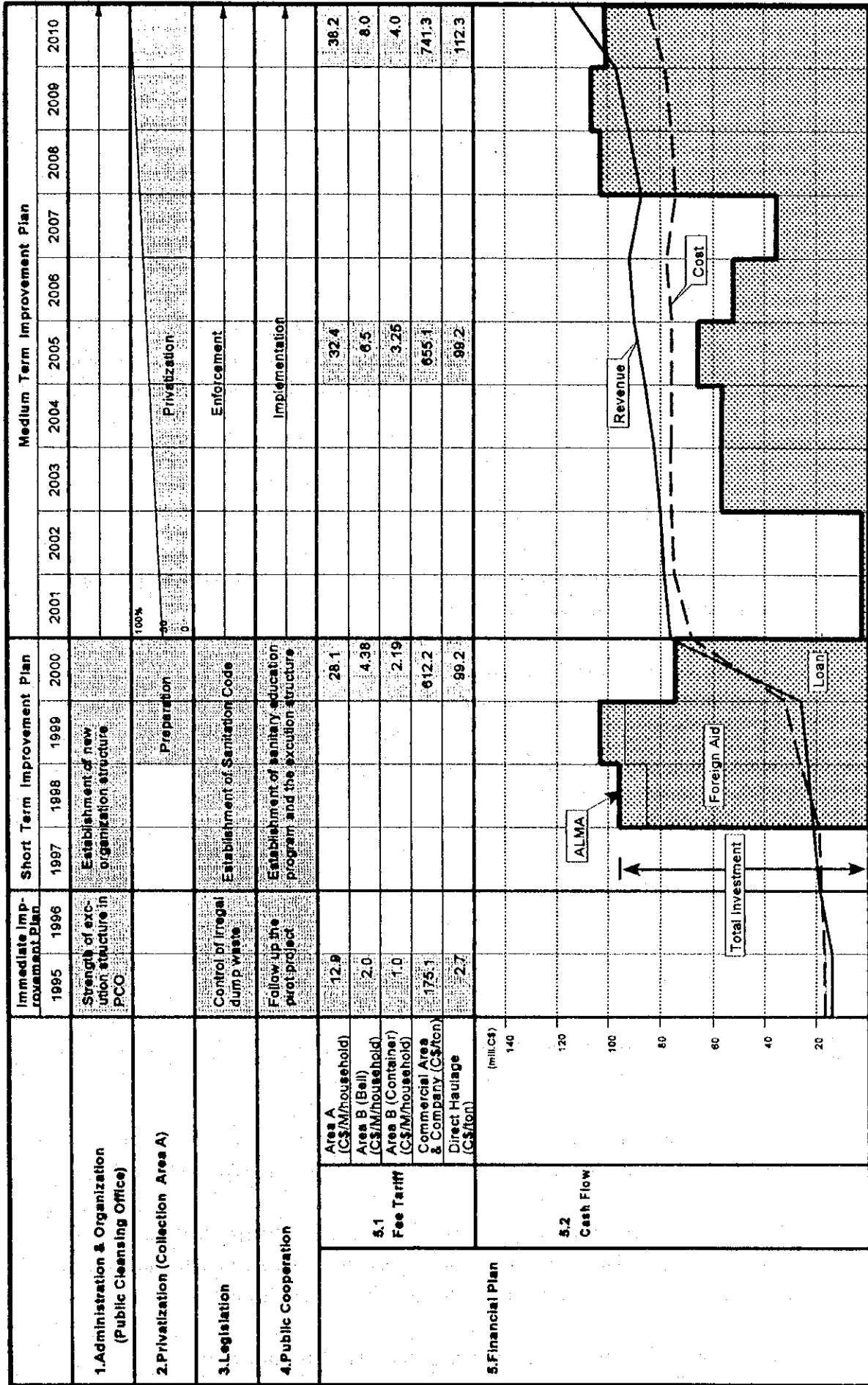


Figure I.3.2b Phased Implementation Plan for the Institutional System of the MSWM Master Plan

## **I.4 Technical System**

### **I.4.1 Discharge and Storage**

#### **a. Source Separation**

A **mixed discharge system** is suitable in exchange for either a processing facility, recycling plant or composting plant, all of which are not feasible. On the other hand, a separate discharge system will be recommended if either of these are feasible.

#### **b. Type of Storage Equipment**

**Nylon sacks or plastic bags** are suitable as waste storage equipment in residential areas as they are cheap, easy to handle and recyclable.

Communal containers shall be introduced in the non-collection areas (e.g. urban fringes) due to shortage in vehicular access routes. They shall be introduced in large waste generation sources as well, to improve collection efficiency. These containers will be used in public areas covered by cleansing services, such as street sweeping, to maintain cleanliness.

### **I.4.2 Collection and Haulage**

#### **a. Collection System**

The present **curb collection system** is a highly efficient form of collection and is considered appropriate for well developed areas like area A.

On the other hand, the container or bell collection system will be provided for area B because of the area's poor infrastructure (roads and electric cables).

The present **container collection system** is a highly efficient and inexpensive collection system which is considered appropriate for large generation sources such as commercial areas, markets, hospitals, institutions and factories.

Consequently, the following collection systems shall be provided:

**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

**b. Collection Method**

A **mixed collection system** is considered suitable in exchange for either a processing facility, recycling plant or composting plant, all of which are not feasible. On the other hand, a separate collection system will be recommended if these facilities are feasible.

**c. Collection Time**

**Day collection will be carried out since traffic condition in the Study Area will not affect the efficiency of the waste collection work.**

**d. Type of Collection Vehicle**

**The use of a compactor** is recommended for the curb collection system in collection area A and bell collection system in collection area B, because of its efficiency.

In consideration of the access road problems in area B, however, the **detachable container type** is recommended as well. Detachable containers are also recommended for large waste generation sources and areas covered by public cleansing services, in order to increase collection efficiency and maintain cleanliness.

**e. Haulage System**

**The motor vehicle haulage system without a transfer station** is recommended for the Study Area, in account of the favorable road network and the short distance from the main generation sources to the disposal site (20km).

### **I.4.3 Intermediate Treatment**

Upon consideration of the different intermediate treatment systems and the present MSWM in the Study area, these intermediate treatment systems were omitted for the following reasons:

#### **a. Incineration**

- The cost estimate was more than 26.3 US\$/ton. The highest sanitary landfill cost, including leachate treatment, in this study was estimated at 8.6 US\$/ton.
- There are enough candidate sanitary landfill sites for future disposal operations.

#### **b. Composting**

- The market for compost from municipal solid waste is very limited in the Study Area.
- Other fertilizers of good quality derived from animal excrement are easily obtained in the region.
- Due to high production cost, the sale price should be subsidized to make compost from municipal solid waste competitive in fertilizer markets.
- Composting requires considerable amount of money for transportation and labor.
- Less volume reduction.
- Possibilities of toxic heavy metals and secondary pollution in case of mixed collection.

#### **I.4.4 Street Sweeping**

##### **a. Sweeping System**

**Manual street sweeping** should be implemented in the Study Area to counter-act high unemployment ratio.

##### **b. Main Equipment**

**Detachable container type** is recommended to increase collection efficiency and maintain cleanliness.

#### **I.4.5 Park and Green Area Cleansing**

##### **a. Cleansing System**

**Manual cleansing** is considered suitable in areas with high unemployment ratio.

##### **b. Main Equipment**

**Detachable container type** is recommended to increase collection efficiency and maintain cleanliness.

#### **I.4.6 Final Disposal**

**Sanitary landfill with leachate treatment (Level 4)** shall be provided to avoid contaminating groundwater, the drinking water source, and lake Managua.

#### **I.4.7 Equipment Operation & Maintenance**

The present **Los Cocos Workshop** of the Public Cleansing Office shall be improved for the maintenance of vehicles and equipment for cleansing services.



## **I.5 Institutional System of the MSWM Master Plan**

### **I.5.1 Institutional Requirements**

There are no policies established concerning Solid Waste Management In Nicaragua, either at the national or municipal levels. As a result, all projects, plans and proposals in this field are incoherent or usually canceled, conditions further exacerbated by the extreme lack of financial resources.

The formulation of a national policy on Solid Waste Management is very important, therefore, to provide guidelines to the municipal level in the decision making arena concerning the formulation of legislations, standards, training programs and financial support strategies.

In the absence of a national policy, the city of Managua shall determine its own policies and goals using this Master Plan as main reference.

Concerning the institutional system, the following steps are briefly recommended:

- i) Formulation of Basic Legislation and Standards concerning Solid Wastes
- ii) Development of the technical capabilities of the personnel in charge of the Municipal Solid Waste Management.
- iii) Definition of the institutional model(s) to be chosen and implemented

#### **a. Legislation**

The establishment of proper and sound legislations 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.

The section delegated with the above responsibilities shall define the duties not only of the citizenry, but also of the municipal government. It shall also specifically determine violations of the Code, rating their magnitude, establishing the corresponding fines to be imposed, and most importantly, assign somebody to supervise these duties. Prior to the enforcement of the Code, an education program will be carried out to inform the public of their rights and duties.

The effect of the enforcement of the Sanitation Code Program will be evaluated jointly by the municipality of Managua, the Health Ministry and the National Police, and the results shall be used as bases for the preparation of the Public Cleansing Code.

**b. Training Program**

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

The officials and managers of the Public Cleansing Office of the Department of Public Works, as well as those of the Territorial Administration, are not trained professionally on Solid Waste Management techniques. The implementation of a training program is necessary therefore.

The number of personnel to be trained and the type of courses to be offered will be determined before commencing the training program, as well as the people to supervise the program and the courses.

The organization and planning of this training program should be consigned to an institution specializing in this field.

Accordingly, INATEC (Instituto Tecnológico Nacional) was initially recommended. INATEC is an autonomous but government affiliated institution in Nicaragua administered by 4 members: 2 representatives of a private enterprise and 2 representatives of the workers. INATEC deals either with formal training as with assistance programs such as the creation and development of micro enterprises among the poor inhabitants of the country, professional rehabilitation projects, housing construction, etc. The training program for Solid Waste Management is recommended not only for the city of Managua but nationwide.

Finally, established professionals are also recommended to attend the specialized courses on Solid Waste Management offered in other Latin American countries and elsewhere by the Pan American Health Organization, the chapter on Solid Waste of The Inter-American Environmental and Sanitation Association and other specialized institutions.

### **c. Definition of the Institutional Model**

The Managuan authorities have expressed the possibility of formulating a policy that would allow the privatization of public services. Actually, the General Planning Head Office has already produced a document ("Privatization Possibilities") that would privatize several of the services provided by the municipality<sup>1</sup>.

This document stresses the advantages that the municipality of Managua will obtain from the privatization of its public services, and gives preference to the privatization of Solid Waste Management services.

Ahead are several of the alternatives proposed for the institutional model of the present system.

## **1.5.2 Institutional Models for Solid Waste Management in Managua**

### **a. Introduction**

The most common Solid Waste Management institutional model is the municipal organization (Service, Division, Office, etc.) which is either directly subordinate to the Municipality's Department of Public Works, the Department of Public Services or the Department of Health.

In Managua, and in all of Nicaragua, private solid waste management enterprises do not exist. For the past 20 years, however, new approaches on how to cope with the growing complexity of Solid Waste Management in large metropolitan areas have been conceived in Latin America, consequently leading to the establishment of the many existing different institutional models. The same situation is perceived to take place in Nicaragua, and the starting point will probably be at the country's capital city, Managua.

Several of the new institutional models are non-governmental organizations ranging from micro to macro private enterprises, an omen reflecting the growing interest of such organizations in this field. Increase in community participation, which is evident in different ways, can be observed as well. Since these institutional models are profit-oriented, they generally provide better and efficient services in comparison to municipal services. Nevertheless, the selection of an institutional model would all depend on tradition, availability of resources, political environ-

---

<sup>1</sup>Privatización de la prestación de servicios públicos - División General de Planificación, Managua, Nov.1994

ment, etc., prevalent at a certain time and place. Managua, therefore, shall pick the one best suited to its resources and needs.

Presented hereafter are varieties of institutional models existing in Latin American cities to provide the Managuan authorities with a selection to determine which fits the present situation best, always bearing in mind that the main goal to be achieved is the improvement of the services provided to the population for the environmental enhancement of the city.

**b. Basic Models**

The arrangement of six different basic institutional models to manage Municipal Solid Wastes is possible through the following:

- i) Delegation of SWM services to a Division, Section or Department of the Municipality along with the use of government resources, e.g., vehicles, equipment and labor;
- ii) Consignment of SWM services to a company or juridical foundation affiliated with the Municipality;
- iii) Delegation of the supervision of SWM services to a Division, Section or Department of the Municipality who shall basically consign collection and street sweeping services to a private company;
- iv) Mixed system – consignment of SWM services management to a company affiliated with the Municipality. This company then contracts part of the services to private companies;
- v) Private Concessions – a private enterprise is granted the right to provide the services and charge the population accordingly.
- vi) Free market – a system where private enterprises provide services without any government interference.

The eccentric qualities of these institutional alternatives are discussed hereafter.

**ba. SWM Services entirely under Municipal Administration**

This is the most traditional institutional form of Solid Waste Management, delegated with various responsibilities and resources. It accounts for around 60%

of all organizations in large cities in the American region.

Only this model is used in the several Nicaraguan municipalities where Solid Waste Management Services are provided. The participation of private enterprises is only evident in the maintenance of the collection trucks and provision of tools and supplies.

In some small communities where garbage collection trucks are unavailable, the municipality often rents a truck with a driver on a daily or monthly basis to collect the refuse, and collection is carried out with the help of municipal employees.

Municipal Solid Waste services under this institutional model are not only limited to garbage collection, clearing and sweeping of streets and public spaces (including markets) and solid waste treatment and disposal, but also enforcement of ordinances (related to Solid Waste Management), parks and garden maintenance (trimming of trees, weed removal), among others. Sometimes the Solid Waste Management institution is also responsible for vector control, painting of street signs and their maintenance, and the manufacture of equipment and tools, such as brooms and carts. The Municipality of Managua for example makes its own carts for street sweeping activities.

In order to comply with all these tasks, the institution usually employs a large task force, owns a fleet of vehicles, equipment and a maintenance workshop. These kind of institutions also operate under a very limited budget and many bureaucratic constraints.

In small municipalities, the fleet of vehicles and workshop do not always belong to the Solid Waste Management institution, but are rather properties of the Municipality. The supervision of municipal fleet in Managua is the responsibility of the Vehicle & Equipment Repair and Maintenance Workshops under the jurisdiction of the Equipment Maintenance & Recovery Head Office.

The difficulties these institutional model encounter involves the procurement of tools, spare parts of vehicles and equipment, and supplies and the limitations imposed by the organizational structure and guidelines governing municipal employees. These limitations are particularly important when dealing with recruitment, lay-off and promotional activities.

The participation of private enterprises in this system is limited to support activities such as heavy maintenance of vehicles and equipment, engineering design and supply of part-time employees.

**bb. Municipal Authority (or Enterprise)**

This institutional form for dealing with Solid Waste Management is probably the most common at present in large and medium Latin American cities under several different structures. This institutional form was applied in Managua ever since the Sandinista Administration (until 1990) to basically do away with bureaucracy often present in government business transactions.

This institutional form may vary from one having direct municipal connections such as the case of autarchies, to an almost completely independent body, such as a corporation where the ownership is shared by the municipality, public institutions and private bodies, be they individuals or enterprises, major stockholders or not.

Juridical foundations, government-run companies and institutions (organized from the partnership of a group of municipalities and public enterprises) represent the other forms this institutional model may take.

Solid Waste Management under this institutional model is very advantageous as it renders flexibility to the administration (and the operational aspect) of relevant everyday tasks and responsibilities. The procedures involved in the procurement of necessary materials and equipment are taken care of speedily and the formulation of an employment policy virtually different from that of a public administration is possible.

**bc. Municipal administrations employing private enterprises**

The consignment of Solid Waste Management services to private enterprises by municipal governments is usually restricted to refuse collection and street sweeping activities on a fixed basis, ranging most commonly from 4 to 6 years.

Municipal authorities seldom take this immediate course of action to upgrade the SWM system even amidst municipal crisis or when no longer able to cope with the growing work load that results from urban growth. However, this would free the municipality from making further investments in equipment and vehicles that are usually required to improve collection services.

This institutional model delegates the operational responsibility to the private enterprise. The ultimate responsibility to the population, however, remains with the municipality which controls and monitors the services. What mainly obstructs the use of this option in Managua is the absence of funds needed to pay consignment services. Furthermore, there are enough equipment in Managua for collection services, at least in urban areas anyway. Some very large cities tend to hire

management companies to control and supervise work done by several of the private companies consigned by the municipality.

**bd. Mixed System**

Under mixed systems are several different arrangements, the most common being the independent municipal body hiring private companies to carry out Solid Waste Management services.

The various arrangements of this institutional model are given below:

**bda. Consignment of collection services, street cleansing, waste treatment and disposal**

Autonomous or independent municipal organizations can also consign, partially or wholly, solid waste management services to private enterprises. Partial consignment usually enables comparison between the efficiency and efficacy of private and public services.

**bdb. Contracting out transportation activities.**

Solid Waste Management services rely basically on transportation, therefore, hiring is sometimes limited to trucks, the drivers and the maintenance staff. This system is often used when shortage in vehicle and equipment fleet is acknowledged to be related to the affectivity or ineffectivity of Solid Waste Management.

The difficult problems that usually evolve in privatization (e.g., dismissal of refuse collectors) is avoided in this arrangement.

**bdc. Contracting out management services**

Due to the usual lack of managerial ability in government bodies, the hiring of people to supervise the technical and operational aspect of the services is the only means to upgrade collection performance. However, responsibilities, first and foremost, should be precisely defined along with the area of jurisdiction, to avoid any political problem.

**be. Concession**

Concession can be defined as : "something conceded by a government or a controlling authority, as a grant of land, a privilege, or a franchise". In this case it is the privilege to provide public services to a part or to the whole city.

The concessionaire is given jurisdiction over a certain area and gets to directly charge refuse producers according to the quality and quantity of waste collection services provided. This type of solid waste management was not applied in Latin America until recently, but the application is different from the United States and Canada where it is widely practiced.

In comparison with other forms of management, this is more unique because the operational and financial aspect of the SWM system is entirely handed over to the private enterprise. The government still controls and supervises the system and is still ultimately responsible for collection services due to its significance to public health.

The service population under this management pays directly to the organization providing the services.

The government selects the service providers based on the price charged to the consumers and technical performance. Public authorities grant concession to a particular enterprise over a defined area for a limited period of time. This is what is known to be a temporary limited monopoly.

#### **bf. Free Market**

The Free Market model is characterized by the absence of any government intervention, except for guidelines and legislations concerning health. The government does not interfere with the quality or quantity of the services provided to the clients and the prices charged.

This model is seldom used when dealing with industrial or heavy commercial waste, when dump trucks are hired by large refuse producers to collect their wastes.

In small communities where the local government is financially weak, an entrepreneur may start carrying out services on its own, providing clients with collection services for a fee.

#### **c. Conclusions**

This Master Plan proposes an Institutional System for the city of Managua in conformity to the general policy expressed by the authorities of the municipality and taking into account the technical system proposed besides the several alternative models presented.



Accordingly, a new institutional model shall be prepared in a way as to incorporate private participation, based on the following assumptions:

- i) Privatized services will be available for concession in city areas where the standard of living, from high to medium high (area A), is indicative of the inhabitants' capability to pay garbage collection and public cleansing services.
- ii) The concessionaire will be allowed to rent municipal collection trucks on a monthly basis but will give priority to hiring municipal employees dismissed in the reorganization process.
- iii) Since a private enterprise will not be able to recover its initial investment in poor areas (area B), services will be provided by the municipality for a subsidized price. This price will not cover the full costs but may be enough to pay a micro-enterprise, regardless of any sign of development in the community.
- iv) The disposal operations shall be financed by users of the sanitary landfill through the payment of tariff at the landfill entrance.
- v) The collection of industrial and bulky wastes shall be carried out separately for a special tariff to provide the municipality with a source of income.
- vi) The same shall apply to hospital waste collection.
- vii) The municipality is assumed to have the desire to consign street sweeping services based on its general policy for public services of the kind. Lack of funds may, however, hamper the municipality's desire to hire a private firm for the services. Furthermore, raising taxes to cover the cost of the services is not feasible at present.
- viii) Therefore until the municipality can cope with this burden, street sweeping services will be shared by the territorial districts administration and the Public Cleansing Office.
- ix) The Public Cleansing Office, the Beautification Office and the Department of Municipal Services of the Territorial Districts are recommended to coordinate fully with each other.

According to the above conditions, a general Institutional System covering the several activities related to Solid Waste Management in the city is proposed. A matrix concerning this system model is shown in Table I.5.2a.

This model will embody the following guidelines:

- i) The Municipality of Managua will remain in charge of the Solid Waste Management activities through the PCO (Public Cleansing Office) which will be partly in charge of the operational activities and also the control and supervision of the activities carried out by private enterprises.
- ii) The PCO will be directly in charge of refuse collection in poor city areas (areas not capable of paying the full cost of services provided), collection of industrial, heavy commercial refuse (including market wastes) and hospital waste – services that essentially provide the revenues of the Municipality and PCO as well.
- iii) PCO will also conduct disposal operations (at the Acahualinca landfill) as it might become a potential PCO source of revenue.
- iv) Vehicle and equipment operation and maintenance will be conducted by the municipal workshops. The Los Cocos workshop, in this model, will be placed under the jurisdiction of PCO. Other maintenance work that cannot be accommodated in this workshop will be delegated to private workshops or the Central Workshop.
- v) Collection services for Area A (where residents can fully afford collection services) will be carried out by private concession. This also includes the collection of refuse fee. The total amount of fee collected shall be able to cover the operation cost, including taxes, profits, etc., and the rental fee for the use of municipal trucks and other equipment. The rental fee will be used to subsidize the cost of the collection services in area B.

The street sweeping services and waste transportation services to the landfill site in this area will be carried out by PCO.

- vi) Street sweeping activities and transportation services in areas not under concession shall remain the responsibility of the Territorial Districts. The same sector is particularly responsible for areas (10% of the city) not covered by any collection service at all.
- vii) The micro enterprise's way of supplementing collection activities in AREA B may be used in the future. Although the same situation may happen, changes may still take place depending on the willingness of the residents to take the initiative and support the organization of a group of workers.

viii) The plan on this model's money flow (revenues only) is presented in Figure I.5.2a.

Table I.5.2a Proposed General Arrangement of Institutional Model Alternatives

Models	Activities		Household and Light Commercial Waste Collection			Industrial and heavy Commercial (Markets)	Hospital Wastes Collection	Street Sweeping Collection	Disposal Operations	Maintenance
			Rich	Medium	Poor					
Public Service	Municipal Organization Alone	Public Cleansing Office			Major Part	Yes	Yes	Area A	Yes	Major Part
		Territorial District						Area B		
		Municipal Authority (Company)								
Mixed System		Municipal Authority W/Services Contracted Out								
Private Service		Micro Enterprise			Minor Part					
		Concession	Yes	Yes						
		Free Market								Minor Part

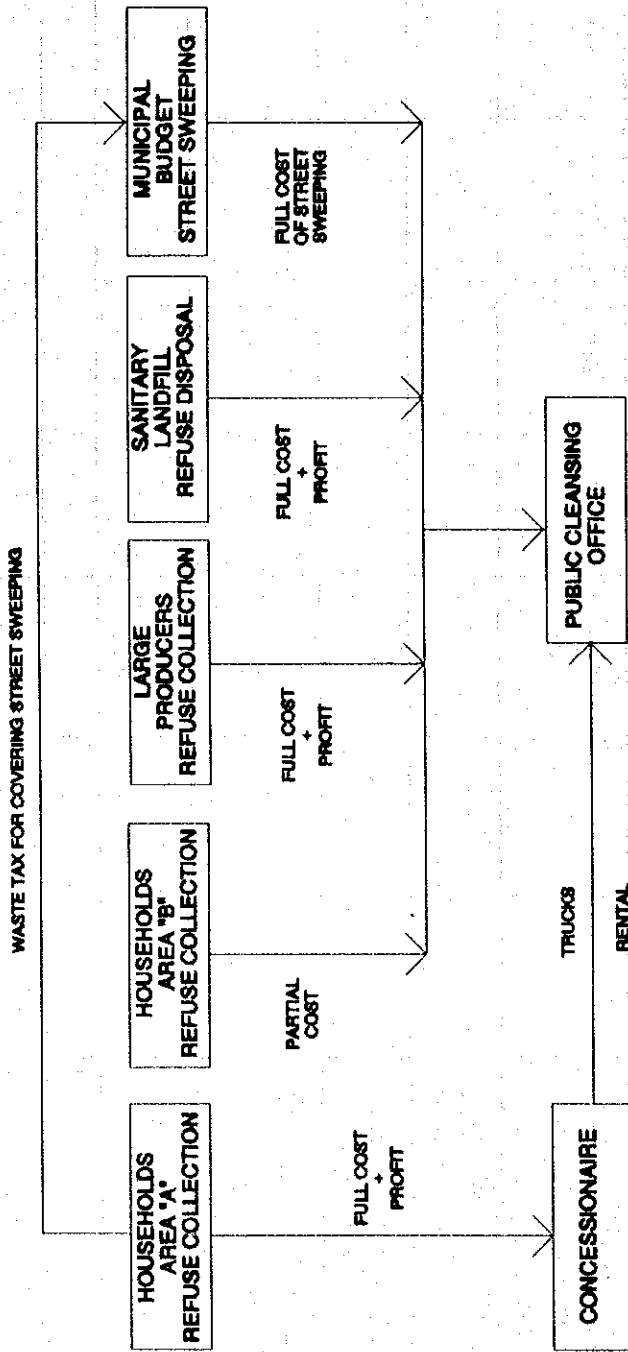


Figure 1.5.2a Managua SWM Revenue Flow

**d. Recommendations**

**da. Urgent needs**

Regardless of the proposed institutional changes, the existing system can be improved through the following measures:

- Better definition of responsibilities of the Districts, the Municipal Works Head Office and the Beautification Office
- Better coordination in the street sweeping and dump removal activities of the Public Cleansing Office and district administrations
- Expedite maintenance of vehicles and equipment; hiring a private workshop on a permanent basis to take care of major repair works of most needed equipment and vehicles.

**db. Public Cleansing Department New Organizational Chart**

According to the institutional system suggested, the organizational structure shown in Figure I.5.2b is proposed for the Public Cleansing Office.

The main responsibilities and duties of the units in this organization are:

**General Director** Supervision of all PCO activities, and their necessary representation

**Public Relations Assistant** Management of all environmental education programs as well as press relations and the media.

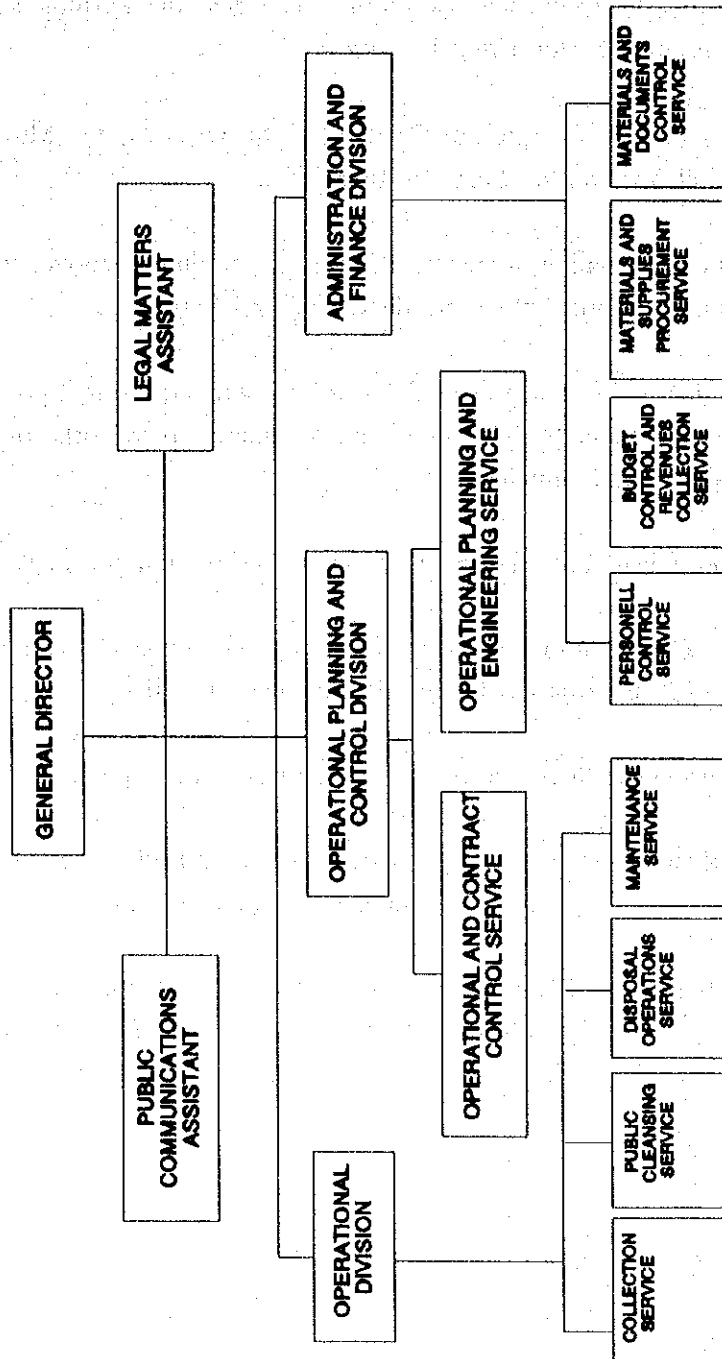


Figure I.5.2b Proposed Organizational Chart of Public Cleansing Office

<b>Legal Matters Assistant</b>	Supervision of all legal problems connected to the PCO, including those with employees. Acts as the director's advisor on legal matters.
<b>Operational Division</b>	Supervision of all operations (collection, disposal and street cleansing) in areas not included in the concession. The head of this division also represents the General-Director when necessary
<b>Operational Planning and Control Division</b>	Supervision of all the planning, control and engineering activities
<b>Administration and Finance Division</b>	In charge of all matters concerning personnel, materials, budget and revenues
<b>Collection Service</b>	Responsible for refuse collection in Area "B".
<b>Public Cleansing Service</b>	Responsible for cleansing of public areas in area "A".
<b>Disposal Operations Service</b>	Responsible for operations at the Acahualinca Sanitary Landfill
<b>Maintenance Service</b>	Responsible for the activities developed at the Los Cocos workshop as well as the supervision and control of repairs in private shops.
<b>Personnel Control Service</b>	Responsible for the daily attendance of the employees, personnel records as well as internal relations in the PCO
<b>Budget Control and Revenues Collection Service</b>	Responsible for control of revenues and expenses, collection of disposal fee at the Acahualinca Sanitary Landfill, collection of fees for the collection of industrial, large commercial and hospital wastes, and responsible for the rental fee paid by the concessionaire.
<b>Materials and Supplies Procurement Service</b>	Responsible for the general acquisition of parts,



supplies and materials for operational, administrative and maintenance services.

### **Materials and Documents**

#### **Control Service**

Responsible for storage and distribution of supplies and materials and for the control of document flow within the PCO

#### **dc. Tender requirements for the concession**

Application for concession of refuse collection activities involves the following processes:

##### **i Submission of a Municipal Ordinance to the Municipal Council stating:**

- objectives of the concession contract
- rules and guidelines for granting the concession (public bid)
- description of the services under concession
- geographical area and term of concession
- rules and criteria for defining tariff prices for the clients
- benefits to the municipality and to the city
- national and municipal legislation supporting the concession

##### **ii Setting up a commission to establish the administrative and technical activities for the concession contract bid, basically concerning:**

- tender specifications model for the concession contract
- model contract between the municipality and the concessionaire
- conditions for the hiring of municipal employees dismissed in the privatization process
- proposed time schedule of the concession contract

##### **iii Organize a technical and administrative staff for the supervision and control of services provided under the concession contract. This staff shall pay special attention to:**

- service schedule and frequency
- maintenance of equipment
- maintenance and safety of workers
- income and taxes paid by the concessionaire

### **I.5.3 Revenue Sources**

Basically the expenses for the cleansing services in the city of Managua are supposed to be covered by fees imposed for waste collection and landfill. In 1993, however, out of 15,000,000 cordobas spent for cleansing services, only 34 % was collected – 5,100,000 cordobas. The rest of the expenses was allocated from the general finances of the Municipality of Managua.

The collection of 8,700,000 cordobas was estimated for 1994. Although the target collection amount was 20,000,000 cordobas, the collection of the said estimate will be able to cover about 50 % of the cleansing expenses, including the estimated costs for streets and parks cleansing.

It is therefore desirable to secure an independent financial resource for the cleansing services proposed in the Master Plan for the year 2010. But, in so doing, the following should be considered:

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

#### **a. Establishment of a Beneficiary Pay Principle**

##### **aa. Beneficiary Pay Principle**

Cleansing services are indispensable to a comfortable urban life. Ironically, however, the expenses of the cleansing services escalate as improvement in service level brings about increase in waste discharge.

An appropriately implemented solid waste management system, with the cooperation of the residents, will help control waste generation, which in turn will contribute to the curtailment of the expenses of the cleansing services.

A "beneficiary pay principle" will promote the payment of fees set according to the volume of waste discharged. However, the huge discrepancy in the income of the people of Managua City is a factor that could make fee collection incredibly difficult if the amount imposed is based on the volume of waste discharged. This particular principle would be a burden to the low income household group.

**ab. The Economic Condition of the Residents**

Only a maximum of 17 % of the whole household population in Managua City receiving waste collection services paid waste fees until October 1994. In the "Residential Area", only about 73 % paid, while only a maximum of 2 % of the household population in other areas of collection area A paid fees. Residents in collection area B did not pay the collection fee nor the local tax imposed.

According to the Public Opinion Survey (POS), both high and middle income groups allocate about 1.0 - 1.3 % of the monthly family income for collection fees. Given this condition, the collection fee for household waste was as examined below.

**aba. Collection Area A**

In accordance with the "beneficiary pay principle", a waste collection, haulage, treatment and disposal fee will be collected from household waste dischargers of Collection Area A.

**abb. Collection Area B**

The bell collection system using container trucks or compactors will be implemented in this area. Partial charges will be imposed in consideration of the improvements in the environment that will result from the implementation of this system, i.e., prevention of illegal dumping and the elimination of RIDS (registered illegal dumping sites). The expenses for this service will be mainly subsidized by the Municipality of Managua.

However, to heighten resident awareness about the importance of waste problems, residents are obliged to carry their wastes to where the containers are located. The partial imposition of charges aforementioned (primary collection cost) will be carried out also as a means of heightening the awareness of the residents concerning environmental problems.

**abc. Payers**

SWM costs and clients are summarized in Table 3.4.3a.

**Table I.5.3a SWM costs and clients**

	Collection Cost	Disposal Cost	Supervision & Management Cost
Residents - Collection Area A	Residents	Private Concession (Residents)	Private Concession (Residents)
- Collection Area B	Municipality Residents (Partial)	Municipality	Municipality
Commercial & Business Activities - General Collection	Companies	Companies	Companies
- Collection of Large Quantities	Companies	Companies	Companies
- Direct Haulage		Companies	Companies
Streets & Parks	Municipality	Municipality	Municipality

**ac. Fee Collection System**

About 80 % of the fees presently collected is from large generation sources such as industries, commercial areas, markets and offices, while less than 23% comes from households. On the other hand household waste makes up 80% of the total amount of waste collected. In 1992 when the collection of waste taxes was made by incorporating the amount in electric bills and telephone bills, about three quarters of the amount was collected from households.

Accordingly, the establishment of an impartial fee collection system is desirable.

Fee collection can be carried out in several ways, either directly or indirectly, as shown in Table I.5.3b.

The present collection system does not only take up plenty of time, but does not also offer incentives for the discharge of less waste volume. In order to encourage many residents to pay, new methods should be applied and overall collection efficiency should be improved.

The proposed collection system is shown in Table I.5.3c.

Table I.5.3b Comparison of Collection Methods

	Standard	Advantages	Disadvantages
<p><b>Direct Collection</b></p> <p>Collection fees (current system)</p> <p>Waste collection fee</p>	<p>Present system (frontal length of houses facing access road.)</p> <p>Volume of waste</p>	<ul style="list-style-type: none"> <li>- Easily collectible along with property tax</li> <li>- Disparity in service levels is easily reflected in the imposed fee</li> </ul>	<ul style="list-style-type: none"> <li>- Imposed fee is not in proportion to the volume of waste discharged</li> <li>- Disparity in service levels is not reflected in the imposed fee</li> <li>- Municipality income gets relatively lower than expenses due to inflation</li> <li>- expensive collection fee</li> <li>- Requires the establishment of a new fee collection system</li> <li>- The fee imposed on low income groups increases</li> <li>- Measurement of waste volume is difficult</li> </ul>
<p><b>Indirect Collection</b></p> <p>Addition of the amount to the electric bill</p> <p>Addition of the amount to community fees</p>	<p>Consumption of electricity, etc.</p> <p>Per household</p>	<ul style="list-style-type: none"> <li>- Cost of fee collection is inexpensive</li> <li>- Cost of fee collection is inexpensive</li> </ul>	<ul style="list-style-type: none"> <li>- Creates dissatisfaction as the collection fee imposed does not meet the quality of the cleansing services</li> <li>- The fee imposed is not in proportion to the volume of waste discharged</li> </ul>

Table I.5.3c Fee Collection System

Beneficiaries	Fee Collection System	Collection Method
<p><b>Residents</b></p> <p>Collection Area A</p> <p>Collection Area B</p>	<p>Waste collection fee</p> <p>Addition of amount to community fees</p>	<ul style="list-style-type: none"> <li>- Collectors are presently employed, but in the future, payments will be made through banks or at the office.</li> <li>- A representative of the community directly makes the payment at the office.</li> </ul>
<p><b>Large Generation Sources</b></p> <p>General Collection</p> <p>Collection of Large Quantities</p> <p>Direct Transport of Waste</p>	<p>Waste Collection fee</p> <p>Collection fee (based on the volume of the wastes)</p> <p>Tipping fee (based on the weight of the waste)</p>	<ul style="list-style-type: none"> <li>- Payments through the bank or at the office</li> <li>- Payments through the bank or at the office</li> <li>- Payments directly at the disposal site</li> <li>- Payments through the bank or at the office</li> </ul>

The money flow of the fee collection system is summarized in Figure I.5.3a.

For efficient fee collection, the following are considered to be of extreme importance: appropriate disposition of staff and the use of highly advanced technology, e.g., computerized data base.

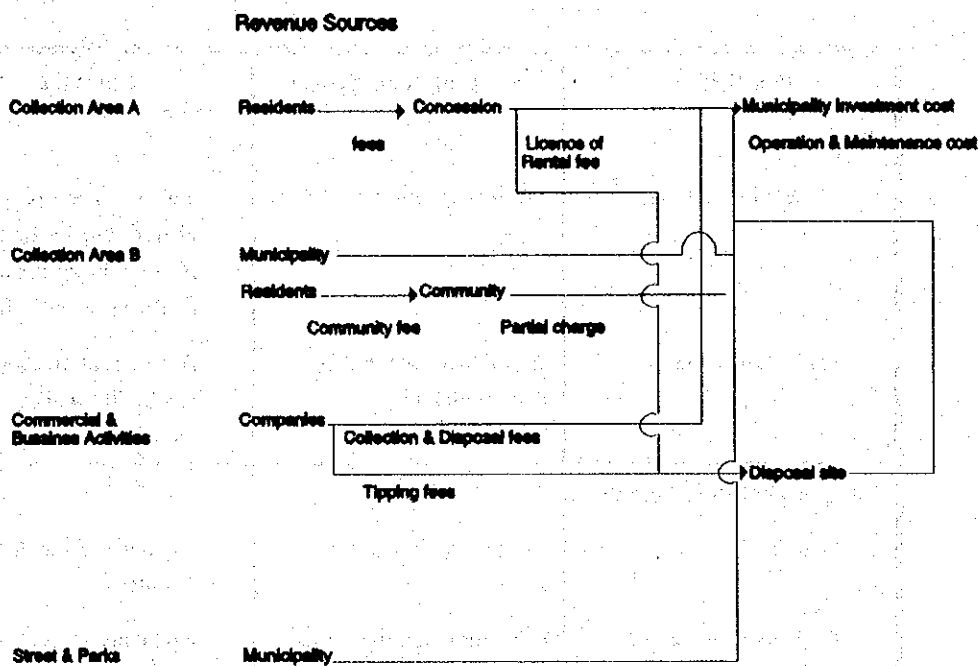


Figure I.5.3a Money Flow System of Fee Collection

**b. Appropriate Imposition of Fee and Budget Allocation**

The establishment of independent financial sources should be promoted in a step by step basis and will be pursued in the Master Plan under the following three phases:

- To ensure that by the year 1999 the whole cost for disposal, including depreciation costs, will be covered through tipping fees, and the whole cost for collection of large waste quantities from companies will be covered through collection fees. On the other hand, fee collection will be extended to the entirety of Collection Area A.
- To introduce private concession in Collection Area A by the year 2000 and to ensure that the whole cost for collection, haulage and disposal, including depreciation costs, will be covered through fees on waste collection.
- To ensure that by the year 2010 the whole cost for collection, haulage, treatment and disposal, including depreciation costs, will be covered through fees on waste collection and disposal.

The municipality of Managua should appropriate the budget necessary for each phase in order to maintain the sanitary landfill, streets and parks and extend collection areas.

#### **I.5.4 Public Cooperation**

##### **a. Background**

In order to gain acceptance for the proposed solid waste system, the formulation of a public education program is imperative. The need for a sanitary and efficient system should be made clear to the public.

Individual instruction may be conducted by the city council after its members are acquainted with the problems of and possible solutions for SWM.

The most effective public cooperation is attained voluntarily through informative, educational and persuasive measures. If residents are involved, they are more likely to be motivated and cooperative.

##### **b. Attainment of Public Cooperation**

Public cooperation can be obtained through the following:

- Public relations and communication.
- Good relations through effective SWM.
- Public education.
- Handling complaints.

##### **c. Items for Attaining Public Cooperation**

###### **ca. Public Relations and Communications**

Public relations are methods and activities that should be employed by the Municipality to promote a favorable relationship with the public.



Residents are to be informed about SWM i.e. magnitude of the problem, costs, organization of the system, collection schedules and their deviations, rules for collection and penalties, new methods of waste disposal, etc..

The information should be presented attractively and in a manner designed to obtain full cooperation. A system of communication must be implemented to familiarize, interpret, and clarify solid waste services to those who use them.

Public approval and goodwill ensue from the realization that public services are rendered efficiently and that public employees are competent, willing and pleasant.

It is essential for the citizens to be aware of the sincere desire of the public officials to render good services at a low cost. Through such understanding, the need for municipal regulations and citizens' cooperation will be recognized.

**cb. Good Relations Through Effective SWM**

All municipal employees are obliged to be courteous and polite to the public who are in effect customers. Solid waste collectors, in particular should be more polite as they have more direct contact with residents than those working in other sections. This calls for proper training of the employees to conduct waste collection and thus eliminating complaints and promoting better public relations. The employees should look presentable, be courteous and answer in clear and definite terms whatever queries are put to them. The language and the tone of voice used by the workers should be considerate.

**cc. Public Education**

The carelessness and thoughtlessness of citizens and their disregard for even the simplest rules of cleanliness and sanitation, is reflected in littered streets, alleys, parks, vacant lots, and even private premises. This tends to produce an untidy appearance throughout the community and a general lowering of public morale.

While ordinances, rules, regulations, and penalties have their rightful place in a solid waste management plan, their enforcement leaves much to be desired. It has been found that as a part of the public communication program, a much easier and more sensible solution is to secure public cooperation through education campaigns.

Citizen groups, such as the church, chamber of commerce, Women's Institute, Boy Scouts etc., also aid public education programs to ultimately achieve a cleaner city. Prominent members of society, including both professional and business leaders are invited to assist in such programs.

Public education through the media is valuable, especially at the start of a new solid waste collection system or when existing services are modified. Periodic news releases in the local papers and television showing the various phases of the collection and disposal service, photographs of good and bad practices, and similar information prepared in an attractive and popular style help to increase public awareness of what has to be done to provide a good refuse collection service and arouse interest in maintaining a clean city.

Seasonal clean-up campaigns will provide opportunities for public communication and cooperation. In these campaigns the residents are persuaded to get rid of junk which has accumulated in premises, garages as well as litter in backyards.

Education programs for school children is another option; it is a good policy; is essential for developing ethics on waste treatment among the future residents of the community.

Public education concerning refuse collection and disposal should be considered a long term activity, organized by the cooperative effort of public officials and citizen groups.

Clean-up campaigns include sanitation parades, decoration with pro-cleanliness posters, and trash baskets, insinuations for the public to keep their city clean.

A campaign strategy can be approached in the following manner:

- determine the extent of the problems and causes
- establish the goals and objectives of the campaign based on the problems identified
- determine persons, groups, associations, equipment or facilities necessary for the achievement of the objective
- develop a plan to enlist support for the project
- employ the plan to reach specific aims
- intensive propaganda throughout the media and personal persuasion to gain the objectives
- as each goal is reached, commend those involved and proceed to the next one

Public education should be related to enforcement; prosecution often is reserved for cases involving habitual violations which could result in health hazards and public nuisances. However, every effort should be made to remind residents of their obligations to cooperate with the Municipality in the operation of the solid waste management program.

#### **cd. Handling Complaints**

The number of complaints are often indicators of how successful the city's cleansing services are conducted: positive criticisms often pave the way towards an improved implementation of these services.

The correct procedure of handling complaints involves four principal stages:

- Receiving the complaint.
- Assignment of responsibility for investigation and correction.
- Follow up.
- Notification of correction.

The attitude of the public relations officer directly receiving complaints must be of extreme politeness as those filing the criticism are often unhappy and have a tendency of being irritable. Clear lines of authority should be established for complaints especially for some which are not of routine nature and require assessments from higher authorities and should automatically be brought to the attention of the relevant officials. When this procedure is conducted correctly, the public will soon realize the efforts of the Municipality in trying to look after their interests.

#### **d. Public Cooperation for the Area B Container Collection System**

In squat areas, community participation is an important issue for the successful implementation of the collection system.

In these areas the residents are forced to live without basic public services, and the lack of waste collection service creates many registered illegal dump sites in various places. The residents of these areas have economic limitations; malnutrition is common especially in infants and access to preventive medicine is low. In addition, basic knowledge of public health is low in squat areas due to lack of

education.

Generally speaking, providing collection services to these areas is not a top priority as other matters must be attended to such as legalization of land tenure, improvement of housing facilities, drinking water, electricity, reducing unemployment etc..

However, it is advisable to combine the collection project with another equally important one, thereby forming an attractive package.

The collection system should have a service level economically sustainable to the residents because the success of the project heavily depends on public participation which determines payment of fees.

The implementation of a container collection system will be opposed by residents too used to open heaping practices. However, this can be avoided by the manner in which the project is introduced. The acceptance of the project will greatly rely in the involvement of community leaders. These leaders should be educated so they can help introduce changes, rather than use mediators not familiar with the local situation. The involvement of the leaders is believed to largely motivate participation.

Effective community participation comes about when health workers and engineers interrelate with the people, providing information comprehensive to them. The detailed explanation of activities is believed to motivate the public to participate fully.

To achieve this purpose, a meeting should be held with the community leaders to discuss the details of the project and the benefits of public health and sanitation. The district development committee should be approached concerning the possible forming of a task force made up of leaders and officials involved in health and education activities, and independent groups and church organizations.

The social status of women should be given special consideration as well since these are the family members usually responsible for household solid waste management, the payment of fees and the general health of the family.

This committee reviews and decides on what development activity is necessary for the district. Health education should be carried out through the mass media and special programs. Officers from the Municipality and Ministry of Health should supervise these programs, explain and clarify any incomprehensible point and create a better working environment with increased public involvement.

## I.6 Financial Plan

### I.6.1 Basic Concept

The financial plan to attain the targets of the MSWM Master Plan was examined according to the process shown in Figure I.6.1a.

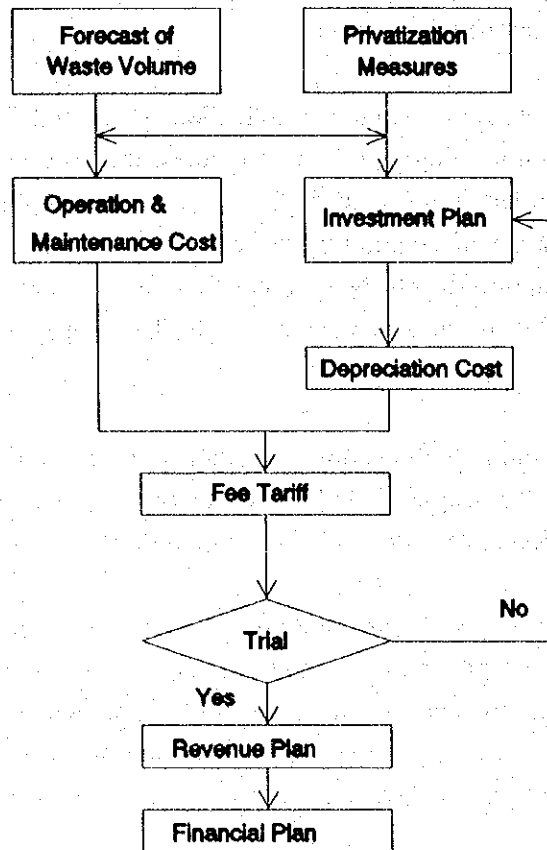


Figure I.6.1a Financial Planning Process

## I.6.2 Expenditure Plan

MSWM cost covers O&M, depreciation and investment costs.

### a. Major Assumptions

In order to estimate the MSWM cost, the following assumptions were established:

#### aa. O&M Cost

- O&M cost for 1995, 2000 and 2010 were estimated as follows based on the 1995 unit cost;

Table I.6.2a MSWM O&M Cost

	Total Cost (million C\$)			Unit Cost (C\$/ton)		
	1995	2000	2010	1995	2000	2010
Collection	9.59	14.04	22.85	56.2	50.7	43.2
Public Area Cleansing	7.02	5.26	5.26	1074.5	679.8	679.8
Final Disposal	0.68	5.99	12.32	2.7	15.8	18.1
Workshop	0.27	1.02	1.02	1.6	3.7	1.9
Promotion	0.00	0.67	0.74	0.0	2.4	1.4
Total	17.57	26.98	42.19	102.9	97.4	79.8

- The annual operation and maintenance cost, e.g., costs for fuel and lubricant, maintenance fee and personnel expenses, was calculated considering the partial privatization of collection services.
- The operation and maintenance cost of collection services of private concessionaires is assumed to be 30% cheaper than the Municipality's.
- 50 % and 100% of the waste collection services in collection area A is assumed to become privatized by 2000 and 2010, respectively.

#### ab. Depreciation cost

- The depreciation costs of equipment and facilities were determined by dividing the investments by the life span defined in Table 8.1.1c.

**ac. Investment Plan and resources**

- It is assumed that the investment for collection services will be financed from 1998 to 2000 to cope with the whole collection volume in 2000. After 2001, the Municipality will purchase collection vehicles in accordance with the yearly increase in waste amount. Private companies will also purchase collection vehicles for efficient collection and haulage services. In this estimation, the collection activities of private companies are assumed to be 30% more efficient than that of the municipality).

- The assumed investment for the disposal site is divided into the following 3 stages:

1998-1999      Initial earthworks necessary to set up the sanitary landfill and earthworks for a disposal area that can accommodate about half of the Master Plan waste volume.

2003-2005      The earthworks for a disposal area that will accommodate the other half of the Master Plan waste amount.

2008-2010      Construction of section III in ANPLS with a capacity of holding 2.1 mill. cubic meter of waste for three years after 2010. Also leachate treatment facilities will be installed to upgrade the sanitary landfill to level 4.

- It is assumed that the initial purchase cost from 1998 to 2000 of collection vehicles for the expansion of collection services in Collection Area B will be financed through foreign subsidies. The replacement of vehicles (27 compactors) granted before this study will be financed by the Municipality. After 2001, the Municipality of Managua and Concessionaires will finance the cost for the repair of collection vehicles and the purchase of new ones.

- The construction cost of the sanitary landfill in the first phase will be divided between the foreign counterpart and the Municipality of Managua. The share of the foreign counterpart is assumed to be 80%, including the cost for the purchase of heavy equipment.

- Loans will be made under the following conditions to finance the purchase cost of collection vehicles for Area A and commercial areas.

Repayment terms - 10 years with a 3 year grace period

Interest - 8 % per year

- The Municipality of Managua will finance the equipment for street cleansing and the maintenance of parks and green areas.

**b. Expenditure Plan**

The O&M, depreciation and investment costs were estimated and summarized in Table I.6.2b.

**I.6.3 Revenue Plan**

**a. Revenue Sources**

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

- establishment of a "Beneficiary Pay Principle"
- imposition of fees in accordance with the economic standing of the residents
- appropriate allocation of budget from the general budget of the Municipality.

The revenue sources and money flow system of fee collection are shown in Figure I.6.3a.

The partial payment of fees 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).



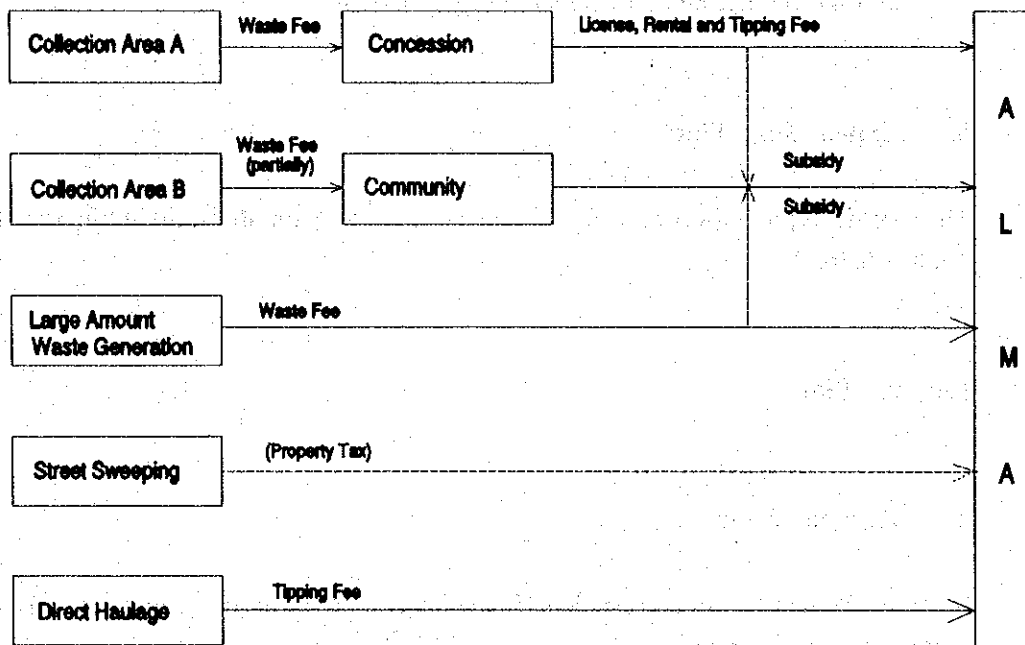
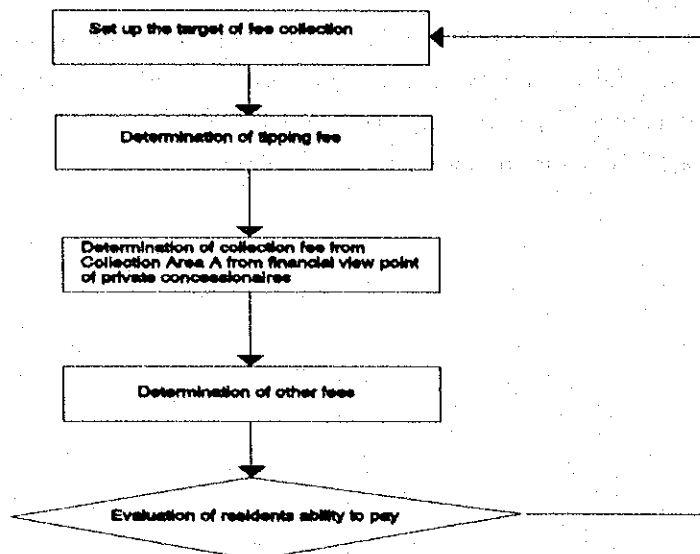


Figure I.6.3a Revenue Sources and Money Flow System of Fee Collection

**b. Fee Tariff**

The fee tariff will be determined by the following steps:



**The first step: Set up the target collection fee**

- The collection rate will be drastically increased from 10 – 95% within four or five years. The target collection rate in 2000 and 2010 is set at 95%.

**The second step: Determination of tipping fees**

- Tipping fees will be imposed to cover the whole costs from 2000 to 2006 needed to maintain the sanitary landfill, including the operation and maintenance costs, depreciation costs and management costs. Loan interests will be taken into account after 2007.

**The third step: Determination of collection fee**

- In this trial calculation, the total cost from 2001 to 2010 is taken into account, including the operation costs, tipping fees, rental fees of vehicles, license fee, loan interests (12.5 % in real term) and taxes. Although the services offered by private companies are efficient, they are more expensive than the services offered by the Municipality.

**The fourth step: Determination of other fees**

- The fees imposed on Collection Area B will be the same amount to be imposed during the collection experiment.
- A unit cost will be established for fee collection in commercial areas and companies, in consideration of the future fee collection system which will be based on discharged waste volume.

The fee tariff estimated from above mentioned trial calculation was shown in Table I.6.3c. The fee collection ratio established and used as a basic assumption for calculation is shown in Table I.6.3d.

**Table I.6.3a Fee Tariff**

Description		1995	2000	2005	2010	1995	2000	2005	2010
Waste Fee	Collection Area A (C\$/month/meter)					(C\$/month/household)			
	Residential (A)	3.00	6.57	7.56	8.92	64.3	140.8	161.9	191.1
	Residential (B)	2.00	4.38	5.04	5.94	23.8	52.1	59.9	70.7
	Traditional	1.00	2.19	2.52	2.97	10.0	21.9	25.2	29.7
	Popular	0.75	1.64	1.89	2.23	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 Col- lection	1.00	2.19	3.25	4.00				
	Commercial & Companies (C\$/ton)								
	Collection	175.1	612.2	655.1	741.3				
Tipping Fee	Direct Haulage	2.7	99.2	99.2	112.3				

\* : Waste fee includes the tipping fee

**Table I.6.3b Fee Collection Ratio (%)**

	1994	2000	2010
Collection Area A			
- Residential (A)	52	95	95
- Residential (B)	55	95	95
- Traditional	10	95	95
- Popular	10	95	95
Collection Area B			
- Bell Collection	0	50	95
- Container Collection	0	50	95
Commercial & Companies	100	100	100

**c. Revenue Plan**

The revenue plan was examined based on the fee tariff and is shown in Table I.6.3c.

**d. Financial Plan**

The financial plan was made based on the expenditure and revenue plan and is shown in Table I.6.3c.

Table I.6.3c Financial Plan (Managua Municipality)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
<b>1. Expenditure (mill. C\$)</b>																	
1.1	O&M Cost	17.57	18.27	19.06	21.19	22.81	23.41	23.68	28.86	24.37	24.63	24.27	24.01	23.20	24.04	25.14	29.46
1.2	Investment	0.00	0.00	0.00	110.77	117.18	47.14	2.10	2.00	58.81	58.13	67.83	52.43	34.51	102.89	106.30	100.19
	Sub-total (1)	17.57	18.27	19.06	131.96	139.99	70.55	25.78	25.86	83.18	82.76	92.10	76.44	57.71	126.93	131.44	129.65
<b>2. Cost</b>																	
2.1	O&M Cost	17.57	18.27	19.06	21.19	22.81	23.41	23.68	23.86	24.37	24.63	24.27	24.01	23.20	24.04	25.14	29.46
2.2	Depreciation Cost	0.00	0.00	0.00	4.71	9.77	46.15	46.43	46.79	47.43	47.93	47.50	50.75	48.83	50.25	52.24	54.17
2.3	Interest etc.	0.00	0.31	0.00	0.00	0.00	0.00	3.77	3.77	3.23	2.69	2.15	1.62	1.08	0.54	0.00	
	Sub-total (2)	17.57	18.58	19.06	25.89	32.58	69.56	73.88	74.42	75.57	75.79	74.47	76.91	73.64	75.37	77.92	83.63
<b>3. Revenue</b>																	
3.1	Waste Fee	8.04	12.54	14.75	17.13	19.49	45.87	47.02	45.76	45.86	45.89	49.62	49.26	48.78	49.78	50.84	59.20
3.2	Revenue from Private Concession	0.00	0.00	0.00	0.00	0.00	11.59	12.88	14.22	15.65	17.13	23.13	25.25	19.61	22.00	24.67	40.99
3.3	ALMA Budget	7.02	7.02	7.02	10.50	14.37	19.21	19.97	20.76	21.60	22.47	18.04	18.63	19.05	20.26	21.72	13.24
	Sub-total (3)	15.06	19.56	21.77	27.63	33.66	76.68	79.86	80.74	83.11	85.49	90.80	93.14	87.44	92.05	97.23	113.43
4.	Balance = (3)-(2)	-2.50	0.98	2.71	1.73	1.28	7.12	5.97	6.32	7.54	9.70	16.33	16.23	13.79	16.68	19.31	29.80
<b>5. Investment Resources</b>																	
5.1	Foreign Aid	0.00	0.00	0.00	85.38	93.41	47.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.2	Loan	0.00	0.00	0.00	0.00	0.00	47.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.3	ALMA Capital Budget	0.00	0.00	0.00	25.39	23.76	0.00	2.10	2.00	12.22	11.54	21.24	52.43	34.51	19.06	22.47	16.36
5.4	Reserved Fund	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	46.59	46.59	0.00	0.00	0.00	83.84	83.84	83.84
5.5	Sub-total	0.00	0.00	0.00	110.77	117.18	47.14	2.10	2.00	58.81	58.13	67.83	52.43	34.51	102.90	106.31	100.20

## **I.7 Phased Implementation Plan**

### **I.7.1 Examination of 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.

The plan was divided into the following three stages and the target year was finalized during the meeting concerning the Inception Report which was carried out with the Nicaraguan Coordinating Committee.

Table I.7.1a 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. Target in each Implementation Period**

The targets established for each implementation period are shown in Table I.7.1b.

**Table I.7.1b Target and Implementation Period**

Targets		Implementation Period
1.	<b>Immediate Improvement Plan</b>	Present - 1996
1.1	<b>Technical Improvement</b> <ul style="list-style-type: none"> <li>- To improve collection efficiency</li> <li>- To establish the system for collection area expansion</li> <li>- To establish the system for the sanitation of the area</li> <li>- To sanitize the present Acahualinca disposal site</li> <li>- To execute public education programs on sanitation</li> </ul>	
1.2	<b>Institutional Improvement</b> <ul style="list-style-type: none"> <li>- Settlement of the new section in PCO to follow up the pilot projects</li> <li>- Increasing the waste fee collection ratio</li> <li>- Starting the planning and control process</li> <li>- Establishment of a training program for staff</li> <li>- Establishment of supervision structure for illegal dump waste</li> <li>- Initiation of administrative improvements</li> </ul>	
2.	<b>Short Term Improvement Plan</b> <ul style="list-style-type: none"> <li>- To attain 90% collection service</li> <li>- To start sanitary landfill with leachate circulation (Level 3)</li> <li>- To improve workshop</li> <li>- To establish sanitary education program</li> </ul>	1997 - 2000
3.	<b>Medium Term Improvement Plan</b> <ul style="list-style-type: none"> <li>- To attain 100% collection service</li> <li>- To start sanitary landfill with leachate treatment (Level 4)</li> </ul>	2001 - 2010

**b. Concrete Measures**

**ba. Concrete Measures to attain the Targets of the Immediate Improvement Plan**

Table I.7.1c shows the concrete measures to be taken in order to attain the targets of the Immediate Improvement Plan. The affectivity of these measures were confirmed in the pilot projects conducted during the 3rd field survey in Nicaragua.

**Table I.7.1c 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 an 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 and promotion of 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 Settlement of the new section in PCO (Public Cleansing Office) to follow up the pilot projects</p> <p>2.2 Increasing the waste fee collection ratio</p> <p>2.3 Starting the planning and control process</p> <p>2.4 Establishment of a training program</p> <p>2.5 Establishment of supervision structure for illegal dump waste</p> <p>2.6 Initiation of administrative improvements</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 Managua municipal authorities.</p>

**bb. Concrete Measures to attain the Targets of the Short Term Improvement Plan**

Table I.7.1d shows the concrete measures for the attainment of the short term improvement plan targets.

**Table I.7.1d 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 the 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 the leachate circulation facilities
		-	Operation of sanitary landfill (Level 3)
3.	To strengthen the maintenance capability	-	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

**bc. Concrete Measures to attain the Targets of the Medium Term Improvement Plan**

Table I.7.1e shows the concrete measures for the attainment of the medium term improvement plan targets.

**Table I.7.1e 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 the leachate treatment facilities
		-	Operation of sanitary landfill (Level 4)

**I.7.2 Phased Implementation Plan**

For the accomplishment of the targets of each phase the concrete measures mentioned above shall be carried out step by step taking into account the financial situation, the citizens' share in the collection service expenses and the concerned project itself.

The phased implementation plan to achieve the MSWM Master Plan of the municipality of Managua is summarized and illustrated in Figure I.3.2a, I.3.2b.



1

1

1

# ***ANNEX J***

---

***FEASIBILITY STUDY OF  
THE PRIORITY PROJECTS***



## CONTENTS

	Page:
J.1 Preliminary Design of Technical System .....	J - 1
J.1.1 Design Conditions .....	J - 1
J.1.2 Improvement of the Collection and Public Cleansing System .....	J - 6
J.1.3 Construction of the Acahualinca Newly Proposed Landfill Site .....	J - 19
J.1.4 Improvement of the Present Los Cocos Workshop .....	J - 69
J.1.5 Promotion of Public Awareness, Cooperation and Participation .....	J - 82
J.1.6 Summary of Preliminary Design for the Priority Projects .....	J - 83
J.2 Institutional System .....	J - 86
J.2.1 Administration and Organization .....	J - 86
J.2.2 Privatization .....	J - 88
J.2.3 Regulations and Enforcement .....	J - 89
J.2.4 Training of Personnel .....	J - 89
J.3 Estimation of Project Cost .....	J - 91
J.3.1 Conditions on Cost Estimation .....	J - 91
J.3.2 Project Cost .....	J - 93
J.3.3 Project Cost .....	J - 96
J.4 Project Evaluation .....	J - 97
J.4.1 Evaluation Method .....	J - 97
J.4.2 Evaluation of Improvement Project for the Collection and Public Area Cleansing System .....	J - 100
J.4.3 Construction Project of the Acahualinca Proposed Landfill Site .....	J - 105
J.4.4 Improvement Project for Los Cocos Workshop .....	J - 111
J.4.5 Promotion Project of Public Awareness, Cooperation and Participation .....	J - 115
J.4.6 Overall Financial Evaluation .....	J - 117
J.5 Implementation Plan .....	J - 123
J.5.1 Project Implementation Bodies .....	J - 123
J.5.2 Implementation Schedule .....	J - 123
J.5.3 Financial Plan .....	J - 123

## LIST OF TABLES

		Page:
Table J.1.1a	Design Conditions .....	J - 3
Table J.1.1b	Key Assumptions for Design .....	J - 3
Table J.1.1c	Life Span of Equipment and Facilities .....	J - 4
Table J.1.2a	Waste Discharge Amount in 2000 .....	J - 6
Table J.1.2b	Proposed Storage System .....	J - 7
Table J.1.2c	Proposed Collection System .....	J - 8
Table J.1.2d	Daily Collection Amount by Collection System in 2000 .....	J - 9
Table J.1.2e	Collection Time and Amount of Compactor trucks (15.3 m <sup>3</sup> ) and Hoist trucks (7.0 m <sup>3</sup> ) per trip .....	J - 10
Table J.1.2f	Required Number of Vehicles in 2000 .....	J - 12
Table J.1.2g	Required Number of Drivers and Collectors .....	J - 13
Table J.1.2h	Length and Waste Amount for Street Sweeping .....	J - 14
Table J.1.2i	Area and Waste Amount for Park and Green Area Cleansing ...	J - 15
Table J.1.3a	Estimated Daily Waste Disposal Amount and Required Capacity of ANPLS .....	J - 22
Table J.1.3b	Calculation of Percolation Coefficient .....	J - 42
Table J.1.3c	Permeability Test Data of ANPLS .....	J - 46
Table J.1.3d	Equipment Required for the Operation of ANPLS .....	J - 51
Table J.1.3e	Manpower Disposition for the Acahualinca Newly Proposed Landfill Site .....	J - 60
Table J.1.3f	Construction Cost by Phase in the Acahualinca Newly Proposed Landfill Site .....	J - 67
Table J.1.3g	Estimated Quantities for O&M of Disposal Site .....	J - 68
Table J.1.6a	Proposed Equipment .....	J - 84
Table J.1.6b	Summary of Manpower Schedule .....	J - 85
Table J.3.1a	Executing Bodies of MSWM .....	J - 91
Table J.3.1b	Summary of Life Years .....	J - 91
Table J.3.1c	Rate of Annual Maintenance Costs .....	J - 92
Table J.3.2a	Procurement Schedule of Equipment by priority project .....	J - 93
Table J.3.2b	Investment Schedule of ALMA by Priority Project .....	J - 94
Table J.3.2c	Summary of O & M Cost .....	J - 95
Table J.3.3a	Initial investment Cost of the Priority Projects .....	J - 96
Table J.4.1a	Economic and Financial Evaluation Methods .....	J - 99
Table J.4.1b	Revenue and Expenditure Items of the Cash Flow for the Financial Evaluation .....	J - 99
Table J.4.1c	Economic Evaluation .....	J - 100
Table J.1.4d	Machines and tools to be acquired for the Improved Los Cocos Workshop in 2000 .....	J - 75
Table J.4.3a	Project Outline .....	J - 107

Table J.4.6a	Results of the Economic and Financial Evaluation of the Priority Projects .....	J - 117
Table J.4.6b	Revenue and Expenditure of the project for the Improvement of the Collection System, including Workshop Improvement and Promotion of Public Cooperation .....	J - 120
Table J.5.3a	Financial Sources for Investment .....	J - 123

## LIST OF FIGURES

	Page:	
Figure J.1.1a	Waste Stream Diagram of Managua in 2000 .....	J - 5
Figure J.1.3a	Location of the Acahualinca Newly Proposed Landfill Site .....	J - 20
Figure J.1.3b	Landfill Methods .....	J - 51
Figure J.1.3c	Organization Chart of the ANPLS in 2000 .....	J - 59
Figure J.1.3d	Master Development Layout Plan of ANPLS till 2010 .....	J - 65
Figure J.1.3e	Master Development Layout Plan of ANPLS till 2010 .....	J - 66
Figure J.1.4a	Proposed Layout of Los Cocos in 2000 .....	J - 76
Figure J.1.4b	Improvement Plan for Workshop Building (1) .....	J - 77
Figure J.1.4c	Improvement Plan for Workshop Building (2) .....	J - 78
Figure J.4.6a	Share of Waste Fee in Residential Income .....	J - 121
Figure J.4.6b	Share of SWM in Municipal Budget .....	J - 121
Figure J.4.6c	Reserved Fund / Total Debt .....	J - 122
Figure J.5.3a(1)	Implementation Schedule .....	J - 125
Figure J.5.3a(2)	Implementation Schedule .....	J - 126



## **ANNEX J FEASIBILITY STUDY OF PRIORITY PROJECTS**

### **J.1 Preliminary Design of Technical System**

#### **J.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 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 J.1.1a Design Conditions

Items	Basic Concept
Target Year	2000
Target Area	Urban area under the Managua Municipality
Population	1,452,900
Service Population	1,131,052
Collection Waste Amount	759 tons/day
Street Sweeping Length	350 km
Disposal Amount	1,038 tons/day
Sanitary Landfill Level	Level-3
Distance to landfill from Generation Source	8.3 km
Waste Stream	Figure J.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 J.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. Street Sweeping</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 J.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 its 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 J.1.1a.

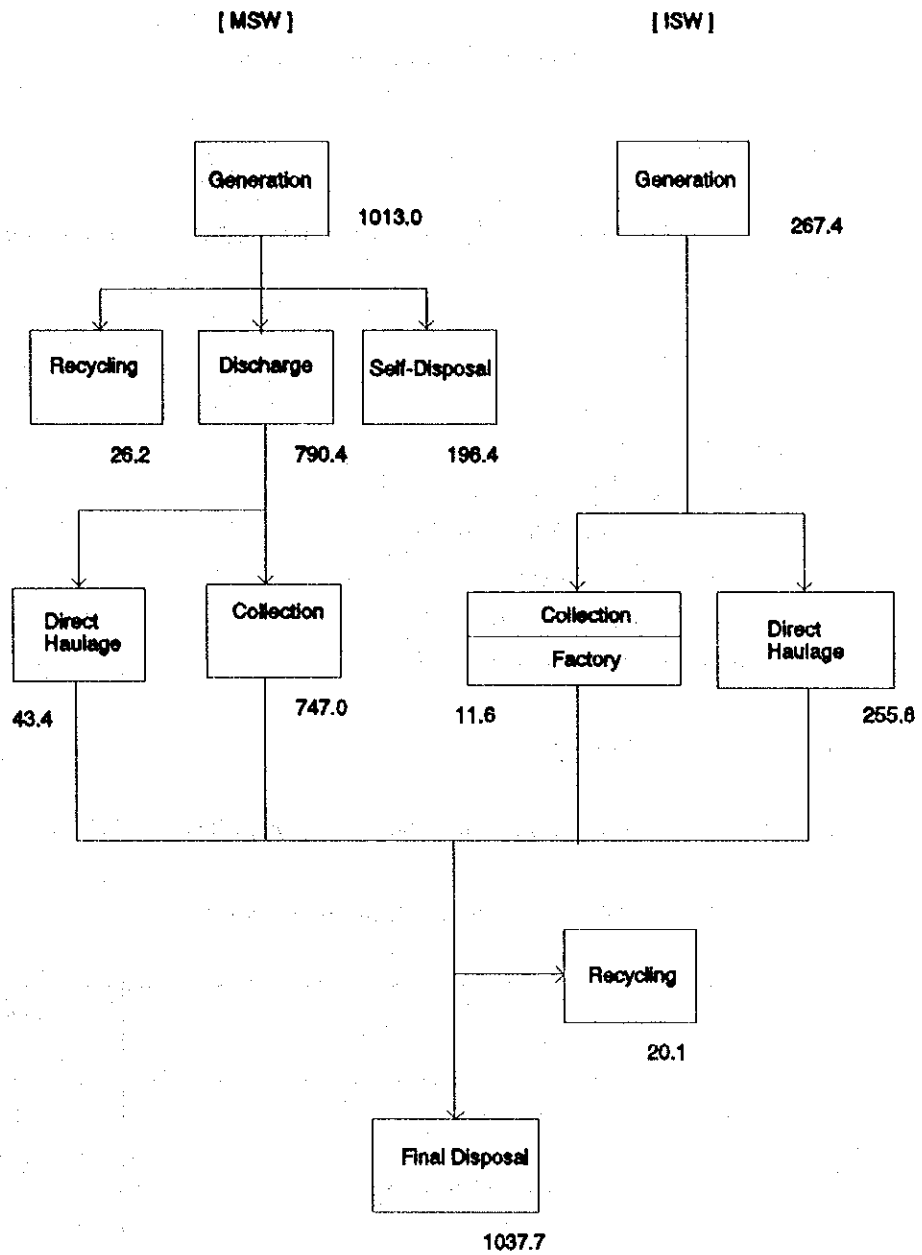


Figure J.1.1a Waste Stream Diagram of Managua in 2000

## J.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 J.1.2.1a.

Table J.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
Total		758.7

**ac. Storage system**

**aca. Storage system**

The proposed storage system is summarized in Table J.1.2.1b below.

Table J.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,

1.0m<sup>3</sup> Container: 270

7.0m<sup>3</sup> Container: 131

using the formula  $Q_c = Q_w \times 7/Q_d/E/ASG$  (unit),

where,

$Q_c$  : Number of containers required (unit)

$Q_w$  : Waste collection amount (ton/day)

$Q_d$  : Number of working days per week = 6 (days)

$E$  : Rate of efficiency = 0.8

$ASG$  : Apparent Specific Gravity = 0.22 (t/m<sup>3</sup>)

**ad. Collection system**

**ada. Collection system**

The proposed collection system is summarized below.

Table J.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**

**i. Assumptions**

For the estimation of the required number of collection vehicles, the following assumptions were made:

- Daily collection amount(Q): see Table J.1.2.1c
- Working hours: 8 hours/day
- Transportation speed: 20 km/hr
- Unit collection time:
  - .Compactor trucks 23 min/ton
  - .Compactor trucks with container 23 min/ton
  - .Hoist trucks 9 min/ton
- Operation rate of vehicles: 90 %

- Efficiency rate of containers: 80 %
- Loading amount of a collection vehicle:

.Compactor =  $15.3 \text{ m}^3 \times 0.9 \times 0.45 \text{ ton/m}^3 = 6.20 \text{ tons/vehicle}$

.Hoist truck =  $7.0 \text{ m}^3 \times 0.8 \times 0.22 \text{ ton/m}^3 = 1.23 \text{ tons/vehicle}$

- Daily collection amount

The established annual work days total 297 days, and the calculated daily municipal collection amount is shown hereafter.

The calculation of the daily collection amount was made by collection system. The daily amount for collection by  $15.3\text{m}^3$  compactor trucks was divided into two assuming that 50% of household waste will be collected by the private sector. The daily amount for collection by  $15.3\text{m}^3$  compactors with  $1.0\text{m}^3$  containers was divided into three in consideration of the different routes established for the collection of commercial and industrial waste, hospital waste, and street sweeping waste.

Table J.1.2d Daily Collection Amount by Collection System in 2000

unit: ton/day

	Daily Collection Amount	Remarks
Compactor trucks ( $15.3\text{m}^3$ )	340.0	
	239.8	50% of Area-A by Private Sector
	579.8	
Compactor trucks ( $15.3\text{m}^3$ ) 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	

## ii. Collection time and amount per trip

With the Time & Motion (T & M) study conducted in May 1994 and data obtained during the 4 month-observation period using the truck scale at Acahualinca disposal site, the average time appropriated to each work and the amount of waste collected by a  $15.3 \text{ m}^3$  compactor truck and  $14.0 \text{ m}^3$  compactor truck were determined and, based on the analysis of the above data, the collection time and



amount per trip for the proposed 15.3 m<sup>3</sup> compactor trucks and hoist trucks attached with a 7.0 m<sup>3</sup> container were calculated and shown below.

Table J.1.2e Collection Time and Amount of Compactor trucks (15.3 m<sup>3</sup>) and Hoist trucks (7.0 m<sup>3</sup>) per trip

unit: minute

Type of Vehicle	Collection	Haulage	Dumping	Others	Required Time per trip	Amount of Waste per trip
Compactor trucks (15.3 m <sup>3</sup> )	140 23 min/ton	40	15	30	225	6.88 tons
Compactor trucks (15.3 m <sup>3</sup> ) with container lift	140 23 min/ton	40	15	30	225	6.88 tons
Hoist trucks (7 m <sup>3</sup> )	10 9 min/ton	40	15	30	73	1.80 tons

### iii. Calculation of haulage distance

The haulage distance from the collection area to the final disposal site was determined as 8.3km using the present topographic map on a scale of 1:50,000.

### iv. Calculation of required vehicles

The number of vehicles required per collection amount was determined by using the formula below, based on the above-mentioned assumptions, and presented in Table 1.2.c. A spare vehicle is added to every 10 vehicles required, to obtain the total number of vehicles for Asuncion and AMUAM.

#### <Compactor trucks without containers>

$$Q_{rv} = 1.1 \times Q_{wd}/Q_{ucd}$$

$$Q_{ucd} = Q_{uct} \times (8/Tt/60)$$

$$Tt = T_{uc} \times Q_{uct} + 2 \times (L1/S1) \times 60 + T_d + T_o$$

where,

Q<sub>rv</sub>: Required number of vehicles (unit)

Q<sub>wd</sub>: Daily waste collection amount (ton/day)

Q<sub>ucd</sub>: Unit collection amount per vehicle per day (ton/day)

Q<sub>uct</sub>: Unit collection amount per vehicle per trip (ton) = 6.88 tons/trip

Tt: Required time per trip (minute)

**Tuc:** Unit collection time (minute/ton) = 23 minutes/ton  
**L1:** Distance from collection area to the landfill (km)  
**S1:** Transportation speed (km/hour) = 20 km/hour  
**Td:** Dumping time (minutes) = 15 minutes  
**To:** Other work time (minutes) = 30 minutes

**<Compactor trucks with container lift>**

**Qrv** =  $1.1 \times Qwd / Qucd$   
**Qucd** =  $Quct \times (8 / Tt / 60)$   
**Tt** =  $Tuc \times Quct + 2 \times (L1 / S1) \times 60 + Td + To$

where,

**Qrv:** Required number of vehicles (unit)  
**Qwd:** Daily waste collection amount (ton/day)  
**Qucd:** Unit collection amount per vehicle per day (ton/day)  
**Quct:** Unit collection amount per vehicle per trip (ton) = 6.88 tons/trip  
**Tt:** Required time per trip (minute)  
**Tuc:** Unit collection time (minute/ton) = 23 minutes/ton  
**L1:** Distance from collection area to the landfill (km)  
**S1:** Transportation speed (km/hour) = 20 km/hour  
**Td:** Dumping time (minutes) = 15 minutes  
**To:** Other work time (minutes) = 30 minutes

**<Hoist trucks>**

**Qrv** =  $1.1 \times Qwd / Qucd$   
**Qucd** =  $Quct \times (8 / Tt / 60)$   
**Tt** =  $Tuc \times Quct + 2 \times (L1 / S1) \times 60 + Td + To$

where,

**Qrv:** Required number of vehicles (unit)  
**Qwd:** Daily waste collection amount (ton/day)  
**Qucd:** Unit collection amount per vehicle per day (ton/day)  
**Quct:** Unit collection amount per vehicle per trip (ton) = 1.80 tons/trip  
**Tt:** Required time per trip (minute)  
**Tuc:** Unit collection time (minute/ton) = 9 minutes/ton  
**L1:** Distance from collection area to landfill (km)  
**S1:** Transportation speed (km/hour) = 20 km/hour  
**Td:** Dumping time (minutes) = 15 minutes  
**To:** Other work time (minutes) = 30 minutes

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

Table J.1.2f 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

**v. Other equipment to be required for collection works**

It is necessary for the collection vehicles and road maintenance equipment to 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, including spare vehicles).

Table J.1.2g Required Number of Drivers and Collectors

Position	Number of employees	Remarks
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 ratio in the Study Area
- poor road conditions such as relatively narrow streets, low asphalt and concrete pavement rate, poor condition of storm water 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. Calculation of required equipment and workers**

**i. Proposed sweeping length and amount of waste to be swept**

The target length of streets to be swept and the amount of waste to be swept is shown in Table J.1.2h.

Table J.1.2h Length and Waste Amount for Street Sweeping

street length	350 km
waste amount	17.4 tons/day

**acb. Required number of equipment**

The calculation of the number of containers required to store swept waste is shown in the previous section and presented in Table J.1.2.2c.

The required number of vehicles for 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.

**acc. Required number of sweepers**

The required number of sweepers is calculated in accordance with the following assumptions and is shown in Table J.1.2.2c:

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

**b. Park and Green Cleansing**

**ba. Cleansing system**

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

**bb. 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.

**bc. Calculation of required equipment and workers**

**bca. 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 J.1.2i.

Table J.1.2i Area and Waste Amount for Park and Green Area Cleansing

Area	45 km
Waste amount	3.8 tons/day

**bc. Required number of equipment**

The required number of vehicles for collection of park and green waste is calculated in the manner shown in the previous section and is presented in Table J.1.2f. A pickup was added to the proposed number of vehicles for inspection and supervision.

**bcc. Required number of cleaners**

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

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

Table J.1.2j Required Number of Equipment and Employees for Public Cleansing Service in 2000

	Required Number	Remarks
1. Collection Equipment		
- Compactor trucks (15.3m <sup>3</sup> ) with container lift	2 units	Street sweeping
- Hoist trucks	1 unit	Park & Green Cleansing
- Pickups	2 units	Supervision
2. Employees (Position)		
- Manager	1 unit	
- Foreman	6 units	
- Driver	5 units	
- Worker (collector)	8 units	
- Sweeper	234 units	
- Cleaner	113 units	
- Clerk	2 units	

**c. Recycling**

**ca. Introduction**

"Recycling" is the reutilization of non-valuable materials as resources or refers to the collection and reproduction of these for effective reuse. Recycling reduces the waste generation 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 therefore to avoid conflict with the present private sector.

**cc. Planned Recycling Activities**

**cca. Administrative support for private recycling businesses**

**i. Introduction**

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 generated 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.

**ii. Method**

- The municipality shall bring about a demand for recycled paper by imposing the use of recycled paper in all government institutions.
- The municipality shall provide private recycling companies with public spaces for installation of containers, collection stations for reusable materials, etc., free of charge.
- The municipality shall provide opportunities to private recycling companies to advertise free of charge.
- Promotion of recycling activities outside the municipal landfill in order to prohibit scavenging inside.

**cb. Promotion of public cooperation initiated by the administration**

**i. Introduction**

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.

**ii. Method**

- To organize promotional and educational events for MSWM
- To invite citizens and students to MSWM facilities.

**cc. Introduction of on-site composting of household waste**

**i. Introduction**

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 generation amount.

**ii. Method**

An on-site composting container will be installed in householders' yards for the discharge of kitchen wastes for decomposition. Compost may be utilized as a soil conditioner in the householder's yard as well.

On-site composting requires:

- the sorting of organic wastes in the kitchen
- the provision of a standard model closed compost container for each household, or several for each block of flats

The microbiological process in decomposting is accelerated by adding water to the container so as to keep dry matter content around 300 – 500 kg per ton of waste. The contents of the container should be mixed occasionally for aeration, a handling technique that also accelerates compost formation with substantial microbial heat production. Mixing also prevents the generation of offensive odor.