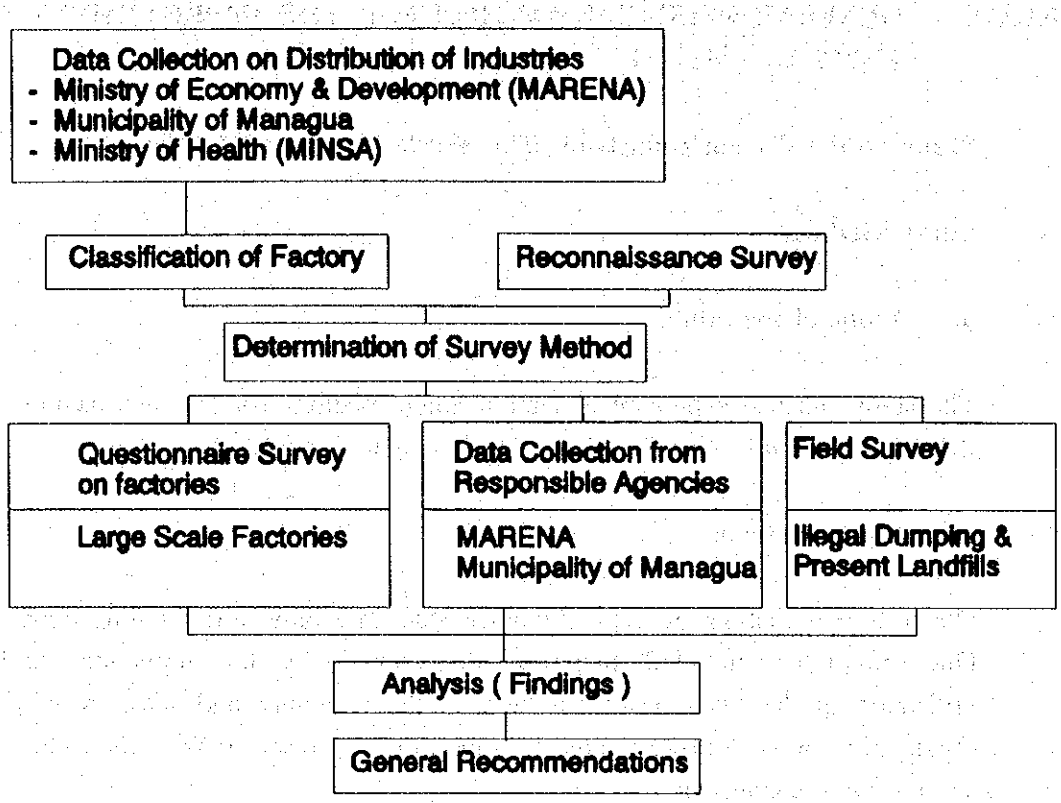


Figure N.1.1a The Present Industrial Solid Waste Management Study Flow Chart

N.1.2 Study Results

a. Data Collection from Responsible Agencies on Present ISWM

aa. Responsible Agencies

In Nicaragua, the responsible agencies on ISWM are MARENA, MINSA and the municipalities as shown in Table N.1.2a. Therefore, data on the following aspects were collected from MARENA and ALMA:

- laws and regulations
- administration and organization
- generation and discharge
- collection, processing, recycling and final disposal

b. Legislation and Enforcement

Regardless of the several problems in the improper handling and disposal of Industrial Solid Wastes in Nicaragua, specific legislations dealing with this subject were not established until October 1994.

As a matter of fact, laws related to Water Protection, Environmental Protection, Water Quality Standards and Guidelines concerning the disposal of hazardous wastes or industrial emissions[1] did not exist. In the absence of an Environmental Law, the Sanitation Code (Decree Nº 394) and the Sanitation Inspection Decree (Decree Nº 432) were used to regulate critical environmental issues. For example, a chlorine producing factory (Penwall) was closed down due to complaints and charges against mercury pollution.

Environmental standards and guidelines of international organizations (World Health Organization (WHO), United Nations Development Program (UNDP)) were also adopted by the country, in lieu of national laws. The application of these standards and guidelines did not work effectively in the country however.

Presently, various guidelines and regulations formulated by MARENA are in effect. A system that would determine whether specific projects or development works require Environmental Impact Assessment Studies is also under consideration.

According to the data observed by the truck scale, about 3,000 tons of industrial wastes are disposed annually at the Acahualinca landfill.

c. Present Situation of Industries

ca. Survey on Industrial Distribution

caa. Locations of Industries in the Study Area

Industries are concentrated in D2 to D6, and 96% of the factories in Managua are in these districts. Table N.1.2b enumerates these industries.

cab. Classification of Industries

Industries in Managua are mainly light industries (food & beverage, textile, wood & furniture production).

---

[1]Muñoz Muñiz, Juan Manuel; Estudio sobre Desechos Peligrosos en Nicaragua,Organización Panamericana de la Salud 1993

cac. Distribution of Factories by Number of Employees

Table N.1.2c shows the distribution of enterprises by number of employees. There are 72 factories with more than 50 employees, and this number only represents 3% of the total number of factories in Managua.

cb. Present Municipal Collection Services

The present municipal collection service charges these industries according to the following categories:

1. Enterprises with up to date account records
2. Large scale enterprises
3. Institutions renting containers from the Municipality

cba. Enterprises with up to date account records

The municipal waste collection fee department keeps a file on enterprises with account records (see Table N.1.2d). The 1,300 enterprises paying collection fees are regarded as enterprises with account records.

cbb. Large scale enterprises

There are 16 industries classified as large scale enterprises that do not pay collection fees to the Municipality in accordance with the executive decree (Decreto Ejecutivo). Table N.1.2e outlines these 16 industries.

Table N.1.2a Roles of Governmental Organizations in Water and Waste Management

	Ministry of Health (MINSA)	Ministry of Economy & Development (MEDE)	Ministry of Environment & Natural Resources (MARENA)	Nicaraguan Institute of Aqueducts and Sewerage (INAA)	Managua Municipality (ALMA)	Ministry of Agriculture (MAG)
Potable Water				Planning, Design, Construction, Maintenance		
Rainfall Drainage					Planning, Design, Construction, Maintenance	
Sewage (including nightsoil)				Planning, Design, Construction, Maintenance		
Industrial Waste	Hygiene & Cleaning		Under the management of MINSA		Supposed to carry out inspection, but no inspection is being carried out at present	Permission for Slaughter
Medical Waste	Under the management of MINSA					

Table N.1.2b Type of Industry by District in Managua

Type of Industry	District							Total
	D1	D2	D3	D4	D5	D6	D7	
6	20	88	90	126	120	102	0	546
7	23	46	43	103	96	95	0	406
8	3	27	10	34	14	15	0	103
9	14	33	36	56	24	36	1	200
10	-	36	23	53	22	20	0	154
11	7	47	36	65	27	31	1	214
12	4	2	5	8	2	7	0	28
13	5	8	21	26	17	22	0	99
14	5	36	19	39	26	21	0	146
15	-	12	6	30	9	14	0	71
16	1	14	6	35	11	10	0	77
17	-	-	1	4	2	2	0	9
18	-	14	4	17	5	4	0	44
Total	82	363	300	596	375	379	2	2,097

Source: Ministerio de Economía y Desarrollo (MEDE)

Note :
6. Food, Beverage & Tobacco
7. Textiles & Clothing
8. Leather & Footwear
9. Wood & Furniture
10. Paper, Printing & Publishing
11. Chemicals
12. Rubber & Plastics
13. Non-Metallic Products
14. Iron & Metal
15. Non-ferrous Metals & Fabricated Metal Products
16. Machinery
17. Electrical Facilities
18. Transport Equipment

Table N.1.2c Distribution of Enterprises by Number of Employees (April 1994)

District	Number of Employees				Total
	1 - 20	21 - 50	51 - 100	101 -	
D1	73	5	2	2	82
D2	335	18	3	6	363
D3	280	7	4	9	300
D4	550	24	11	11	596
D5	371	2	2	-	375
D6	343	14	12	10	379
D7	1	1	-	-	2
Total	1,954	71	34	38	2,097

Source : MEDE

Table N.1.2d Distribution of Enterprises with Account Records by District and Municipality Collection Fee

District	Collection fee			Total
	C$ 250	C$ 500	C$ 750	
D1	5	1	4	10
D2	128	22	43	193
D3	191	62	68	321
D4	293	54	64	411
D5	152	50	41	243
D6	60	12	27	99
D7	-	-	-	-
Total	829	201	247	1,277

Source: Collection Department, Municipality of Managua

Table N.1.2e List of Large Scale Enterprises

Enterprises	
Casa Pellas (Flor de caña)	CHEVRON
Coca cola	TEXACO
Pepsi cola	ESSO
Cervecería TOÑA	SHELL
Cervecería VICTORIA	TROPIGAS
INDUQUINISA	ESSO GAS
TANIC	Kola Shaler
Cementera	Fosforera

cbc. Institutions renting containers from the Municipality

There are 24 institutions renting containers from the municipality, and they are shown in Table N.1.2f.

Table N.1.2f Institutions renting containers from ALMA

Institutions	1	2	Unit of container	Unit Cost (C$/month)	Total (C$)
BANCO CENTRAL		●	4	500	2,000
CLUB RECREATIVE FUERZA AEREA		●	1	500	500
CASA MANTICA		●	8	400	3,200
COMERCIAL METROCENTRO		●	2	500	1,000
DELMOR	●		3	500	1,500
EMBOTELLADORA MILCA	●		1	12,000	12,000
HOSPITAL BAUTISTA		●	4	500	2,000
HOTEL INTERCONTINENTAL		●	8	400	3,200
HOTEL CAMINO REAL		●	4	500	2,000
HOTEL LAS MERCEDES		●	4	500	2,000
INAA		●	10	400	4,000
BANCO DE AMERICA		●	1	500	500
PLAZA JULIO MARTINEZ		●	1	500	500
LA PERFECTA	●		11	350	3,850
LA LOTERIA		●	2	500	1,000
MINISTERIO DE ECONOMIA		●	1	500	500
NABISCO CRISTAL	●		8	400	3,200
LA NESTLE	●		1	500	500
PETRONIC	●		2	500	1,000
ROBERTO TERAN		●	3	500	1,500
SUPERMERCADO LINDA VISTA		●	4	500	2,000
SUPERMERCADOS EXTRA (REDENTOR, BELLO HORIZONTE Y CIUDAD JARDIN)		●	7	400	2,800
TIP TOP	●		2	500	1,000
ZONA FRANCA	●		5	500	2,500
Total	8	16	96		

Note: 1 Industries
2 Institutions, Ministries or Commercial Businesses

All these institutions receive Municipal waste collection services.

cbd. Estimated non-paying industries

From the results mentioned above, the estimated number of industries not paying the collection fee is approximately 800 (see Table N.1.2g).

Table N.1.2g Estimated Number of Industries Paying Municipality Collection Service Fee

Classification		Number of Industries
Fee paying	Enterprises with account records	1,277
Fee exempt industry	Large scale enterprises	16
Institutions renting containers from Municipality		8
Non-paying industries		796
Total		2,097

Non-paying institutions are assumed to dispose industrial solid wastes in the past by the following methods:

- At the Acahualinca landfill site (this is possible because supervision is not strict at the site)
- Within their premises
- Illegal dumping along roads, in channels, etc.

The present disposal methods employed by these institutions however are quite difficult to identify.

d. Questionnaire Survey to Industries

Existing data on ISWM is limited and this study may be the first on industrial solid waste to be conducted in Nicaragua. Although the survey was conducted on institutions in the Study Area, the discharge amount and final disposal methods of ISW producers were not completely surveyed because the study was only given a

short period of time.

To cope with the limitation, 30 representative factories were interviewed to grasp the general prevailing conditions and to supplement the existing data provided by MARENA and the Municipality of Managua. Field surveys were also carried out on the illegal dumping sites in the Study Area.

db. Results of Questionnaire Survey on Factories

dba. Selection of Representative Factories

Large scale factories, potential producers of hazardous wastes were selected for an interview.

dbb. Results of Questionnaire Survey

The results of the survey indicate the factories' various waste handling methods at the municipal final disposal site. Some of these methods are recycling, incineration and self-disposal (see Table N.1.2h).

Table N.1.2h(1) Result of Questionnaire Survey on Industries

Industry	District	Number of Workers	Products	Solid Waste Generation			Waste Disposal Cost (C$/month)	Hazardous or Toxic Waste	Liquid Waste Treatment
				Waste Category	Quantity/ Month	Disposal Method			
01	none								
02	1	220	Sacks Strings	1. Ashes 2. Oil waste 3. Plastic waste 4. Paper waste	1. 0.40 m^3 2. 0.40 m^3 3. 9 ton 4. 12.50 m^3	1. Incineration 2. Acahualinca 3. Acahualinca 4. Acahualinca	1,200	None	None
03	2	140	Fuel and Lubricant	1. Sludge 2. Oil 3. Alkaline 4. Plastic 5. Paper 6. Wood 7. Rags 8. Metal 9. Glass 10.Construction 11.Others	1. 20 ton/year 2. 5 buckets 3. 3 buckets 4. 100 lbs 5. 500 lbs 6. 100 lbs 7. 200 lbs 8. 500 lbs 9. 100 lbs 10.500 lbs 11.50–100 gl	1. Sedimentation basin 2. Oven 3. Acahualinca 4. Acahualinca 5. Acahualinca 6. Acahualinca 7. Acahualinca 8. Acahualinca 9. Acahualinca 10.Acahualinca 11.Acahualinca	$ 4,200 (Annual)	Catalyst Asbestos	Sedimentation Basin
04	none								
05	2	123	Construction materials	1. Sludge 2. Paper 3. Wood 4. Rags 5. Vegetables 6. Others 7. Construction	1. 16 m^3/week 2. 0.202 m^3/week 3. 0.304 m^3/week 4. 0.404 m^3/week 5. 0.404 m^3/week 6. 0.404 m^3/week 7. 8.5 m^3/week	Acahualinca (self–disposal)	C$ 2000 (weekly)	None	None
06	2	117	Vegetable, Oil and spices	1. Sludge 2. Alkaline 3. Plastic 4. Paper 5. Rags 6. Others	1. 8 buckets 2. 8 buckets 3. 30 qq/month 4. 300 lbs 5. 300 lbs 6. 300 lbs	Acahualinca (self–disposal)	C$ 5000–O/M C$ 2000–Fuel and Repair of vehicle	Sludge	None
07	2	51	Collector and canner of liquified gas	1. Paper 2. Vegetables 3. Metal 4. Dross	1. 2 buckets/day 2. 2 buckets/day 3. 22 ton/6 months 4. 10–15 cylinder/month	Acahualinca (self–disposal)	None	None	None

Note: O/M : Operation and Maintenance

Table N.1.2h(2) Result of Questionnaire Survey on Industries

Industry	District	Number of Workers	Products	Solid Waste Generation			Waste Disposal Cost (C$/month)	Hazardous or Toxic Waste	Liquid Waste Treatment
				Waste Category	Quantity/Month	Disposal Method			
08	3	106	Sausage	1. ashes 2. oil 3. plastic 4. paper 5. rags 6. animals 7. vegetables 8. metal 9. construction 10.dust	1. 1/2 quintal 2. 50 lbs 3. 100 lbs 4. 200 lbs 5. 20 lbs 6. 70 lbs 7. 40 lbs 8. 10 lbs 9. – 10.1 bucket	Municipality Collection	C$ 6,450	None	None
09	4	154	Electricity Service	1. fuel 2. paper 3. rags 4. metal 5. construction	1. 5 gallons 2. 8 buckets 3. 8 buckets 4. 50 lbs/month 5. 6 qq/month	Acahualinca (self–disposal)	C$ 13,000	None	None
10	4	1,207	Alcoholic Beverages	1. paper 2. glass 3. others 4. bran	1. 15 buckets/week 2. 15 buckets/week 3. 7 buckets/week 4. –	1. Municipal Collection (inside the industry) 2. Municipal Collection (inside the industry)	C$ 5,000	None	Bran
11	4	200	Plastic bags	1. plastic 2. paper 3. metal 4. rags 5. others	1. 1,000 lbs/day 2. 1,500 – 2,500 lbs/day 3. 1,500 – 2,500 lbs/day 4. – 5. –	1. Recycle of plastic waste 2. Municipal Collection 3. Municipal Collection 4. Municipal Collection 5. Municipal Collection	C$ 4,000	Chemical substance	None
12	4	160	Drugs	1. ashes 2. paper 3. glass	1. 20 m^3/month 2. 6 buckets 3. 200–300 cm^3	1. Municipal Collection 2. Municipal Collection 3. Inside the premises	C$ 300	None	None
13	4	21	Papers and boxes	1. plastic 2. rubber 3. metal 4. dust	1. 1 ton 2. * 4 latas 3. 1 lata 4. –	1. Selling 2. Sold inside the industry 3. Sold inside the industry	Municipal Tax	None	None

Note: lata: * a squared can of medium capacity
qq: quintal (1 qq = 100 lbs = 45 kg)

Table N.1.2h(3) Result of Questionnaire Survey on Industries

Industry	District	Number of Workers	Products	Solid Waste Generation			Waste Disposal Cost (C$/month)	Hazardous or Toxic Waste	Liquid Waste Treatment
				Waste Category	Quantity/Month	Disposal Method			
14	4	325	Dairy products	1. fuel 2. sludge 3. oil 4. acid 5. alkaline 6. plastic 7. paper 8. vegetables	1. 28 lts/month 2. 2 buckets/week 3. 20 lts/month 4. 24 gal 5. 24 gal 6. 1200 lbs/month 7. 2 buckets/day 8. 2 baldes/day	Municipal Collection	C$ 20,000	Acid and Alkaline	
15	4	450	Cookie Factory	1. plastic 2. paper 3. vegetables	1. 55 container 2. 70 container 3. 55 container ($0.83\ m^3$)	Municipal Collection	C$ 3,000	None	None
16	4	50	Metallic Structures	1. plastics 2. metal	1. $2\ m^3$/month 2. 75–100 ton	Acahualinca (self-disposal & disposal within the premises)	None	None	None
17	2	22	Fuel and Lubricants	1. fuel 2. oil 3. alkaline 4. plastics 5. paper 6. rags	1. 50 gal 2. 700 gal 3. 20 gal 4. $5\ m^3$/month 5. 110 gal 6. 5 gal	Municipal Collection (sedimentation basin)	C$ 300–400	combustible liquid waste	None
18									
19									
20	5	18	batteries	1. acid 2. plastics 3. paper 4. metal 5. glass 6. dust	The factory didn't provide information	Acahualinca (self-disposal)	C$ 1,000	Sulfuric acid & lead	None

Table N.1.2h(4) Result of Questionnaire Survey on Industries

Industry	District	Number of Workers	Products	Solid Waste Generation			Waste Disposal Cost (C$/month)	Hazardous or Toxic Waste	Liquid Waste Treatment
				Waste Category	Quantity/Month	Disposal Method			
21	6	117	Soap	1. alkaline 2. plastics 3. paper 4. dust 5. others	1. 20 lts 2. – 3. 10 boxes 4. – 5. –	Acahualinca (self–disposal)	None	None	None
22	6	300	Alcoholic Beverages	1. alkaline 2. plastic 3. paper 4. wood 5. vegetables 6. metal 7. glass 8. construction	1. 600 gal/min 2. 20,000 boxes/year 3. 20 m^3 4. 15 m^3 5. 45 m^3 6. 47 tons/year 7. 200 tons/year 8. 40 m^3	Acahualinca (inside the industry)	C$ 4,500	Bran	None
23	DID NOT COOPERATE WITH THE STUDY								
24	6	60	Gas	Alkaline	10 tons	Municipal Collection	Municipal Tax	None	None
25	6	12	Basic chemical Substances (adhesives)	1. fuel 2. sludge 3. oil 4. alkaline 5. plastic 6. paper 7. metal 8. vegetables 9. rubber 10.dust 11.others	1. 10 gal 2. 6 buckets 3. 6 gal/six months 4. 300 lbs 5. 250 lbs 6. 400 lbs 7. 400 lbs 8. 260 lbs/month 9. 260 lbs 10.– 11.1,000 gal	Municipal Collection	None	None	None
26	6	NA	Cigarette Factory	1. plastics 2. paper 3. vegetables 4. metal 5. dust 6. others	1. – 2. 6 tons 3. 2 qq 4. 2qq 5. – 6. 1,000 gal	Municipal Collection	None	None	None

Table N.1.2h(5) Result of Questionnaire Survey on Industries

Industry	District	Number of Workers	Products	Solid Waste Generation			Waste Disposal Cost (C$/month)	Hazardous or Toxic Waste	Liquid Waste Treatment
				Waste Category	Quantity/Month	Disposal Method			
27	6	46	Paints, varnish and lacquer	1. fuel 2. sludge 3. oil 4. alkaline 5. plastic 6. paper 7. vegetables 8. metal 9. construction 10.dust 11.others	1. – 2. 15 buckets 3. 1000 gal 4. – 5. 24 lbs 6. 700 lbs 7. – 8. 5000 lbs 9. – 10.– 11.–	Municipal Collection	None	None	None
28	6	36	Processed seafood products	1. paper 2. animals 3. construction 4. others	1. 4–5 waste basket 2. 2,000–3,000 lbs/day 3. 3 m^3 4. 1,200 gal/day	Municipal Collection	None	None	None
29	6	298	Processed beef	1. ashes 2. oil 3. alkaline 4. paper 5. wood 6. animals 7. vegetables 8. metal 9. glass 10.construction 11.dung 12.corpses 13.dust 14.others	The factory didn't provide information	In the premises	None	Ammonia	None
30	6	12	Spices, ketchup, mustard	1. ashes 2. plastic 3. paper 4. rags 5. vegetables 6. metal 7. glass 8. others	1. – 2. 15 lbs 3. 40 lbs 4. 5 lbs 5. 50 lbs 6. 300 lts 7. 35 lbs 8. 300 gal	Burning of wastes in the premises	None	None	None

Table N.1.2h(6) Result of Questionnaire Survey on Industries

Industry	District	Number of Workers	Products	Solid Waste Generation			Waste Disposal Cost (C$/month)	Hazardous or Toxic Waste	Liquid Waste Treatment
				Waste Category	Quantity/Month	Disposal Method			
31	1	149	Cotton, gauze and bandage for hospitals	1. acid 2. plastic 3. paper 4. wood 5. rags 6. vegetables	1. 800,000 lts/month 2. 5–6 buckets 3. 5–6 buckets 4. 5–6 buckets 5. 5–6 buckets 6. 1 big can*	Municipal Collection (daily)	None	water with acid	None
32	1	50	Drugs	1. plastic 2. paper 3. vegetables 4. glass 5. others 6. dust	1. 75–100 bags 2. 20.20 m^3 3. 20.20 m^3 4. 20.20 m^3 5. 10–15 kg 6. 21,000 kg	Burning inside premises	Municipal Tax	Outdated drugs and liquid wastes	None

e. Field Survey

ea. Survey on Illegal Dumping Sites in the Study Area

eaa. Field Reconnaissance on Illegal Dumping

More than 200 illegal dumping sites supposedly exist in the Study Area.

- **Illegal dumping along roads in the Study Area**

  A survey was carried out on wastes illegally dumped along the main roads in the Study Area. Most of the wastes found were municipal solid waste, while the rest may be classified as industrial waste.

- **Illegal dumping in channels**

  Illegal dumping is widespread along channels and most of the wastes are municipal solid wastes, while a token few are industrial waste.

eab. Survey Results

- **Along the main roads in rural areas**

  The main roads in rural and urban areas are generally quite spacious with reserves a lot wider than paved carriageways. Municipal solid wastes are mainly illegally dumped in these areas.

- **Along the branch roads in rural areas**

  Municipal solid wastes are the kind of wastes mainly illegally dumped along the branch roads of rural areas, which are normally unpaved.

- **In the channels**

  The kind of wastes mainly observed to be illegally dumped along the channels are municipal solid wastes.

- **Near Managua International Airport**

  Traffic in roads on the east and south side of the international airport is light, and these areas are mainly used as illegal dumping sites for construction waste and glass and leather factory wastes. Factories in the vicinity illegally

dump their wastes because of the proximity of the area and the high cost of haulage of waste to the Acahualinca disposal site.

eac. Sewage Sludge

The sewage system in Managua covers 86 % of the urban area.

Articles used in the toilet cannot be flushed down due to structural problems. These used articles (toilet papers, etc.) are disposed as municipal wastes at the municipal landfill.

There are no sewage treatment plants in the Study Area. Sewage from the 16 sewers is discharged into Lake Managua without undergoing treatment.

ead. Construction Waste

Construction wastes are mainly dumped in vacant areas and sometimes debris are disposed of and abandoned at the end of residential blocks. There are, however, some construction projects directly transporting their debris to the Acahualinca disposal site.

Construction debris are illegally dumped in the east and south roads of the international airport where traffic is light.

eae. Secondhand Cars

Although Nicaragua exports secondhand cars to El Salvador or Costa Rica, some old vehicles are stored in garages or illegally abandoned in vacant areas.

eaf. Liquid Industrial Waste

Liquid industrial wastes are discharged into the public sewers without undergoing treatment.

eag. Corpse Transportation

The Ministry of Health (MINSA) is responsible for cadaver transportation. Sometimes stretchers are used to transport these cadavers to the cemetery due to hearse shortage.

eah. Cremation

Interment and not cremation is practiced in Nicaragua.

A private funeral company constructed the first crematorium with 3 chambers in Nicaragua in May 1994. Residents in the vicinity have been complaining about the pungent smell coming from the crematorium.

N.1.3 Findings

a. Laws and Regulations

Nicaragua has no laws on groundwater and environmental protection, and neither does it have water quality standards nor guidelines for the disposal of hazardous and industrial wastes.

Although the Environmental Standards and Guidelines of international organizations like WHO and UNDP are being enforced in the country in lieu of national laws, they are not compelling enough to cope with the conditions prevailing in Nicaragua.

The laws and regulations in effect in Nicaragua are very lenient. Penalties or punishments are not imposed.

b. Administration and Organization

Industrial Waste Management is associated with many government organizations. However, no particular investigations are carried out for the disposal or treatment of industrial wastes.

c. Generation

ALMA states that the annual amount of industrial waste disposed at the Acahualinca disposal site totals 13,000 m^3. There are no data that would substantiate the figure however.

d. Classification of Factories

Factories located in Managua are classified as either of the light industry category or factories of small scale enterprises.

e. Collection and Haulage

ALMA provides collection and haulage services for the industrial wastes of factories but with the exclusion of hazardous and toxic wastes. The collection fee charged by ALMA on factories are based on their sales taxes. There are factories, however, who do not pay the collection fee.

f. Compost made from Market Solid Waste

The Acahualinca final disposal site is constructed with a pilot composting plant which is being operated under the guidance of an expert from Amsterdam. Organic wastes from Market Oriental are used for the production of compost.

Approximately 5 tons of compost are produced every month.

g. Final Disposal

Industrial wastes are finally disposed of at the Acahualinca disposal site through the collection services of the municipality.

On the other hand, the disposal methods of non-paying institutions are quite difficult to determine. Some are presumed to use the Acahualinca disposal site, while others are presumed to dump their wastes illegally along the roads on the east and south sides of the Managua International Airport (Augusto César Sandino).

h. General Recommendations on ISWM

Industrial solid wastes are mostly disposed of at the Acahualinca final disposal site.

A separate landfill site should be constructed, on the other hand, for the disposal of hazardous industrial wastes, and this landfill site should be strictly managed and controlled to prevent accidents.

N.2 Study on Present Medical SWM

N.2.1 Method of the Study

a. Definition of Terms

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

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

Non-infectious wastes are disposed of at municipal landfills and are therefore included in the study of MSWM. The medical waste referred to in this chapter is limited to infectious wastes, which are enumerated in Table N.2.1a.

Table N.2.1a Types of Infectious Wastes

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

b. Scope of the Study

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

c. Study Methods

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

- data collection from agencies responsible for the present medical SWM (Ministry of Health (MINSA) and ALMA).

- distribution of questionnaires to medical solid waste producers.

- field survey

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

d. Study Flow

The study on medical solid waste management was conducted according to the process shown in the following figure.

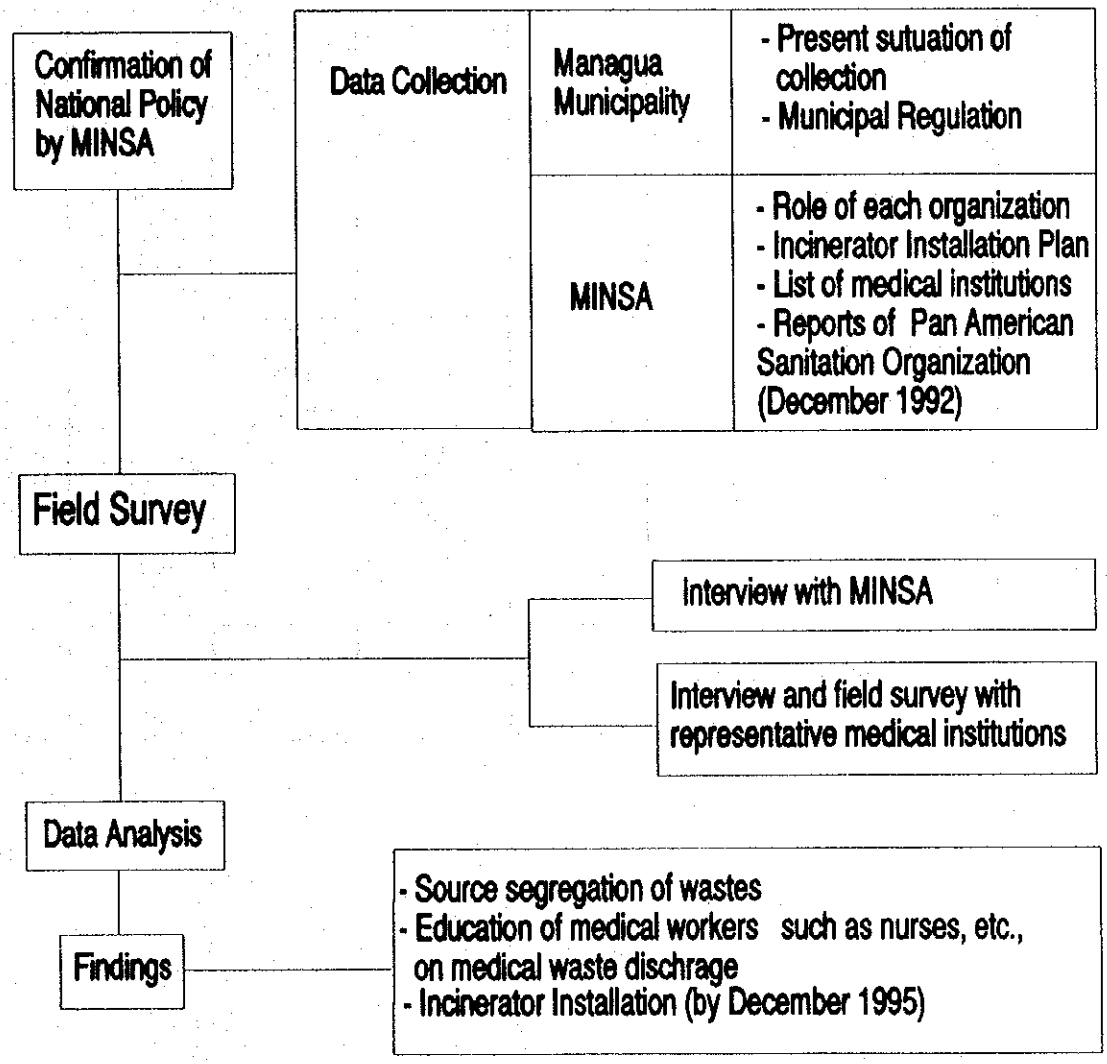


Figure N.2.1a Medical Waste Treatment Study Flow

N.2.2 Study Results

a. Role of Government Organizations

The role of government organizations in water and waste management in Nicaragua is summarized in Table 4.2.2a.

Table N.2.2a Role of Government Organizations in Water and Waste Management

	Ministry of Health (MINSA)	Ministry of Economy & Development (MEDE)	Ministry of Environmental & Natural Resources (MARENA)	INAA	Managua Municipality (ALMA)	Ministry of Agriculture (MAG)
Potable Water				INAA is responsible for potable water		
Water Drainage					The municipality is responsible for rainwater drainage	
Miscellaneous Drainage (including nightsoil)				INAA is responsible for other drainage		
Industrial Waste	Hygiene & Cleaning		MARENA is responsible for I.W		Responsible for Inspection but does not presently carry out inspections	Permission for Slaughter
Medical Waste	MINSA is in charge of medical waste					

b. Classification of Medical Institutions

Medical Institutions are classified into six categories as shown in Table N.2.2b.

Table N.2.2b Classification of Medical Institutions in Managua

	Jurisdiction		Services
	Government	Private	
1. Hospitals	●	●	medical treatment
2. Health Centers (C/S)	●		medical consultation
3. Health Service Points (PM) 4. Medical Service Points (PS)	● ●		medical consultation
5. Clinics		●	medical consultation
6. Pharmacies		●	dispatch prescription
7. Laboratories		●	analysis of specimens

ba. Hospitals

Hospitals provide better medical services than other institutions.

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

bb. Health Centers (Centro de Salud - C/S)

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

bc. Health Service Points (PM) and Medical Service Points (PS)

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

bd. Clinics

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

be. Pharmacies

Pharmacies are privately owned facilities and cannot carry out injections.

bf. Laboratories

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

c. Incinerators

ca. Historical Background

caa. Situation until middle of 1980

Incinerators were installed in two hospitals for the sole purpose of eliminating medical solid wastes. Operational problems however led hospitals to stop using incinerators by the middle of 1980 and resort to burying these hazardous wastes in their premises or in the cemetery, Carolina Calero in Ciudad Sandino.

cab. Hygiene and Public Cleansing Program for the City of Managua

In June, 1988, upon the request of the "Regional Commission for the Protection of Children", ALMA prepared a program on Hygiene and Public Cleansing which entails the provision of cleansing services to Hospitals and Health Care Centers.

The program also entails the provision of a daily domestic waste collection services to hospitals and Health Care Centers (C/S) of Managua, which shall be independent of the municipal collection services. The main objective of this service is to correct problems related to collection frequency which leads to the storage of wastes in hospitals for up to 4 days.

This program, however, does not touch on specific activities that ALMA has to develop for the control of medical solid wastes from hospitals.

The internal cleansing of hospitals is the responsibility of the Ministry of Health, while ALMA is in charge of hospital waste transport to the landfill in Acahualinca.

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

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

cad. Study on Management and Final Disposal of Solid Waste Generated in Managua in 1988

A study on the solid waste management and final disposal system of four hospitals in Managua (Manolo Morales, Bertha Calderón, Fernando Velez Paiz and Antonio Lenin Fonseca) was carried out in the latter half of 1988. The study was implemented as an academic requirement for students of education majoring in Environmental Engineering. The study concludes that problems concerning wastes generated in these hospitals were mainly concentrated in the waste handling, internal collection and final disposal aspects.

cae. Preliminary Diagnosis in the Cemetery of Ciudad Sandino in 1991

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

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

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

caf. Final Disposal in the former Hospital "El Retiro"

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

cag. Present Medical Solid Waste Disposal

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

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

d. National Policy

da. Introduction of Incinerators for Medical Solid Waste Management

The policy of the Ministry of Health (MINSA) concerning Medical Solid Waste Management is shown in Table N.2.2c. The policy entails the improvement of measures for the treatment of medical solid waste in the Municipality of Managua, which shall be later extended nationwide.

Table N.2.2c MINSA's Basic Policy on Medical Solid Waste Management

Solid Waste Management		
Stage	Location	Method
First	Managua	Introduction of Incinerator
Second	Nationwide	Introduction of Incinerator

db. Incinerator Installation Program in Managua Municipality

The European Union (EU) approved the plan to install incinerators in ALMA in November 1993. The plan is shown in Table N.2.2d.

Table N.2.2d Incinerator Installation Plan in Managua

Item	Description
Incinerator	Plant with three chambers
Owner	Private independent company
Capacity	100 kg/h per chamber, totalling 300 kg/h
Medical Institution	Private and public hospitals, clinics and laboratories. This will be possible once the law which grants the power to control and regulate private and public medical institutions to MINSA is approved.
Installation Schedule	1. Six months of prior investigation 2. Twelve months for construction, personnel training and installation. 3. Operation under guidance for 30 months followed by self-sustained undertaking.
Location	Not defined, as it will be an interinstitutional decision (MINSA, Municipality, INAA, etc.).
Collection	Collection frequency is not defined since prior investigation is required.
Haulage	A fleet of vehicles will be available (trucks with a refrigeration system). Route design is not yet established.

dc. Installation Program of Incinerators Outside Managua

The Ministry of Health (MINSA) submitted an application to the EU for the introduction of incinerators outside Managua Municipality in April 1994. MINSA intends to introduce incinerators in the towns listed in Table N.2.2e.

Table N.2.2e Areas Considered for the Installation of an Incineration Plant outside of Managua

Department	Principal town	Location of Incinerator Plant
Estelí	Estelí	Estelí, La Trinidad
Madriz	Somoto	Somoto
Nueva Segovia	Ocotal	Ocotal, Jalapa
Chinandega	Chinandega	Chinandega, Corinto
León	León	-
Managua	Managua	-
Carazo	Jinotepe	Jinotepe
Granada	Granada	Nandaime, Granada
Masaya	Masaya	Masaya
Rivas	Rivas	Rivas
Boaco	Boaco	-
Chontales	Juigalpa	Juigalpa
Matagalpa	Matagalpa	Matagalpa
Jinotega	Jinotega	Jinotega
Puerto Cabezas	Puerto Cabezas	Puerto Cabezas
Bulefields	Bluefields	El Rama, Bluefields
Río San Juan	San Carlos	-

e. Field Survey

ea. Distribution of Medical Institutions

The distribution of medical institutions is shown in Table N.2.2f. There are 13 hospitals and 33 Health Care Centers in Managua, and these medical institutions are concentrated in districts 2,3,4 & 5 where population is very dense.

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

eaa. Interview with Hospitals

Table N.2.2g summarizes the result of the interview carried out in all the medical institutions in Managua Municipality. Almost all of the medical institutions dispose medical solid waste through the solid waste collection services conducted by the

Municipality.

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

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

Table N.2.2h and Table N.2.2i show the results of the interview survey on C/S, PM and Clinics.

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

eac. Interview Survey with Pharmacies and Laboratories

Tables N.1.2j and k show the results of the interview carried out with pharmacies and laboratories. These institutions discharge solid waste through the collection services of the municipality.

ead. Collection Services of ALMA

Table N.2.2l shows the collection services of the municipality for 22 medical institutions.

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

eae. Incinerators in the Study Area

Table N.2.2m shows the limited number of incinerators in the Study Area. Only the incinerator of the hospital Aleman Nicaraguanse (Carlos Marx) is functioning properly, the rest are either out of order or rundown. Accordingly, only 4 – 5 hospitals incinerate their wastes; other hospitals burn their medical waste within their premises or dispose then at the Acahualinca disposal site through municipality Collection Service which mixes this waste type with general solid waste.

eaf. Necessity for Medical Solid Waste Management

Table N.2.2n shows the demands for medical solid waste management.

This interview identified numerous problems, the major one of which stems from the collection service quality (collection frequency and efficiency, container maintenance). The results of the interview also showed the education level of hospital workers.

Table N.2.2f Medical Institutions Distribution by District in the Municipality of Managua

District		1	2	3	4	5	6	7	Total	
Hospital	Government	0 (0)	5 (5)	2 (2)	0 (0)	2 (2)	0 (0)	0 (0)	9 (0)	13 (13)
	Government + Private	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	1 (0)	
	Private	0 (0)	0 (0)	1 (1)	1 (1)	0 (0)	1 (1)	0 (0)	3 (3)	
CS (Centro de Salud)	Government	3 (2)	5 (2)	4 (1)	11 (1)	5 (2)	4 (2)	1 (0)	33 (10)	
Clinic	Private	(0)	(1)	(2)	(2)	(2)	(0)	(0)	(7)	
PM (Health Service Point)	Government	5 (0)	5 (0)	13 (1)	5 (1)	16 (0)	20 (0)	0 (0)	64 (2)	
PS (Medical Service Point)	Government	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3 (0)	3 (0)	
Pharmacy	Private	(1)	(1)	(1)	(1)	(1)	(1)	(0)	320 (6)	
Laboratory	Private	(0)	(1)	(1)	(1)	(2)	(1)	(0)	(6)	
Total		(3)	(10)	(9)	(8)	(9)	(5)	(0)	(44)	

Note: The figures in parentheses show the number of medical institutions surveyed

Table N.2.2g Summary of Questionnaire Survey on Hospitals on Medical Solid Waste Management

District		2	2	2	2	2	3	3	3	4	4	5	5	6
Specialty		Rehabili-tation	General Medicine	Derma-tology	General Medicine	Psychiatric	Gynecology Obstetrics and Oph-thalmology	Pediatrics Gynecology obstetrics	General Medicine	General Medicine	General Medicine (Military Hospital)	General Medicine	Pediatrics	General Medicine
Name of Hospital		Aldo Chavarría	Carlos Roberto Huembes	Dermato-lógico	Lenin Fonseca	Psychiatric	Bertha Calderón	Fernando Vélez Paiz	Monte España	Bautista	Alejandro Dávila Bolaños	Manolo Morales	Manuel de Jesús Rivera	Alemán NicAraguense (Carlos Marx)
Owner		Gov	Gov	Gov	Gov	Gov	Gov	Gov	Private	Private	Private+ Gov	Gov	Gov	Private
Number of Outpatients/day		15	2,233	65	245	25	175		2	65		77	33	591
Beds		48	127	70	270	165	313	250	20	40	156	210	259	
Staff (Per-sons)	Doctors	4	68	21	175	20	55	133	70	50	65	170	115	72
	Assistants	40	282	68	249	106	259	266	12	–	400	307	544	248
	Administration	30	50	56	86	151	156	173	2	–	150	136	118	122
Medical Waste Gen-era-tion / day	Minor Sugery	–	2	–	1	–	10	–	5/month	–	–	15	–	15
	Major Surgery	–	5	–	14	–	12	–	15/month	–	–	9	7	16
	Parturition	–	5	–	–	–	66		5/month		–	–	–	30
Total														
Disposal Method		DM-1	DM-1 DM-6	DM-1	DM-1	DM-1 DM-5	DM-1 DM-2	DM-1 DM-7	DM-1	DM-1 DM-2 DM-8	DM-1 DM-2	DM-1	DM-1 DM-3 DM-4	DM-1 DM-2

Note: DM-1 Disposal through municipal solid waste collection services
DM-2 Wastes are incinerated in the hospital
DM-3 Wastes are burned at the hospital Premises
DM-4 Wastes are buried at the hospital Premises
DM-5 Wastes are dumped in a hole constructed within hospital premises
DM-6 Self-disposal to Acahualinca
DM-7 Disposal by hospital Alemán Nicaraguense
DM-8 Disposal of pathological waste at hospital Manuel de Jesus Revera

Table N.2.2h Summary of Questionnaire Survey on Health Centers (Centros de Salud) and Health Service Points (Puesto Médico) on Medical Waste Management

District		1	1	2	2	3	3	4	4	5	5	6	6
Specialty		CS	CS	CS	CS	CS	PM	CS	PM	CS	CS	CS	CS
Name of Health Center		Ciudad Sandino Zone Nº 4	Ciudad Sandino Zone Nº 7	Socrates Flores	La Morazán	Altagracia	Loma Linda	Francisco Buitrago	María Auxiliadora	Pedro Altamirano	Carlos Rugama	Silvia Ferrufino	Villa Venezuela
Owner		Gov.	Gov.	Gov.	Gov.	Gov.	Gov.	Gov.	Gov.	Gov.	Gov.	Gov.	Gov.
Number of Outpatients/day		60	24–32	40–45	300	180	15–20	200	30	180	120	250	300
Beds		0	1	0	0	0	0	0	1	0	0	0	0
STAFF	Doctors	6	18	16	13	20	1	30	1	42	21	16	31
	Assistants	20	30	15	45	15	1	30	0	131	80	28	25
	Administration	5	11	12	11	30	1	42	1	9	6	33	24
MW Generation	Minor Surgery	0	1	0	4	12	0	0	0	0	5	2	5
	Major Surgery	0	0	0	0	0	0	0	0	0	0	0	0
	Parturition	0	0	0	0	0	0	0	0	0	0	0	0
Total													
Disposal Method		DM1	DM1 DM3	DM1 DM3 DM4	DM1 DM3	DM1	DM1 DM3	DM1 DM3	DM1 DM3	DM1 DM3=DM5	DM1 DM3 DM4	DM1 DM3	DM1

Note: DM–1 Disposal through Municipal Solid Waste Collection Services
DM–2 Wastes are incinerated in the hospital
DM–3 Wastes are burned at the hospital premises
DM–4 Wastes are buried in hospital premises
DM–5 Wastes are dumped in a hole constructed within the hospital premises

CS: Centro de Salud
PM: Puesto Médico
MW: Medical Waste

Table N.2.2i Summary of Questionnaire Survey on Clinics on Medical Waste Management

District		2	3	3	4	4	5	5
Specialty		General Medicine	General Surgery	General Medicine	General Medicine	Gynecology	Pediatrics	Various Observation
Name of Clinic		Fertilidad El Carmen	Plaza España	Centro Médico	Don Bosco	IXCHEN	San Rafael	Tiscapa
Owner		Private	Private	Private	Private	Private	Private	Private
Number of Outpatients		40	15	20	4	100	40	100
Beds		0	6	0	0	5	0	0
STAFF	Doctors	15	26	4	2	6	2	12
	Assistants	7	3	2	2	5	0	12
	Administration	3	6	1	2	16	1	8
MW Generation	Minor Surgery	2	0	1/week	0	5	2	0
	Major Surgery	0	0	1/week	0	0	0	0
	Parturition	0	0	0	0	0	0	0
Total								
Disposal Method		DM-1	DM-1	DM-1	DM-1	DM-1	DM-1	DM-1

Note: DM-1 Disposal through Municipal Solid Waste Collection Service

Table N.2.2j Summary of Questionnaire Survey on Pharmacies on Medical Waste Management

District		1	2	3	4	5	6
Collection							
Name of Pharmacy		Fuente Médica	BORGEN	RIVERA	AMERICANA	LA SALUD	LA PALMITA
Owner		Private	Private	Private	Private	Private	Private
STAFF	Doctor	0	1	0	1	0	2
	Pharmacist	0	0	0	0	0	0
	Administration	3	3	1	4	1	1
MW Genera–tion	Syringe	None	None	None	None	None	None
	Medicine	Yes	Yes	Yes	Yes	Yes	Yes
Disposal Method		DM–1	DM–1	DM–1	DM–1 DM–6	DM–1	DM–1

Note: DM–1 Disposal through municipal solid waste collection service
DM–6 Self–disposal to Acahualinca

Table N.2.2k Summary of Questionnaire Survey on Laboratories on Medical Waste Management

District		2	3	4	5	5	6
Name of Laboratory		D'Trinidad	Bio-Análisis	Nicaraguense	Clínico Especializado	Clínico Patológico	Centro Nacional de Diagnóstico y Referencia
Owner		Private	Private	Private	Private	Private	Private
Number of Subjects		10	40	40	30	5	NO
Beds		0	0	0	0	0	0
STAFF	Doctor	1	2	1	0	0	7
	Assistant	7	1	0	1	2	87
	Administration	2	2	9	2	0	35
MW Generation	Liquid	Yes	Yes	Yes	Yes	Yes	Yes
	Syringe	Yes	Yes	Yes	Yes	Yes	Yes
	Pathological	Yes	Yes	Yes	Yes	Yes	Yes
Disposal Method		DM-1 LW-1	DM-1 LW-1	DM-1 LW-1	DM-1 LW-1	DM-1 LW-1	DM-1 LW-1

Note: DM-1 Disposal through Municipal Solid Waste Collection Service by Municipality
LW-1 Disposal of untreated liquid waste to public drainage system

Table N.2.21 Collection Service by Municipality for Medical Institutions

District	Medical Institutions	Collection Service							Interviewed Institutions
		Mon	Tue	Wed	Thu	Fri	Sat	Total	
2	Hospital Carlos Roberto Huembes	●		●		●		3	●
2	Hospital Psiquiátrico Nacional		●		●		●	3	●
2	Hosp. Rehabilitación Aldo Chavarría		●		●		●	3	●
2	Hospital Dermatológico		●		●		●	3	●
2	C/S Sócrates Flores		●		●		●	3	●
2	C/S Francisco Morazán		●		●		●	3	●
2	Hospital Lenin Fonseca	●	●	●	●	●	●	6	●
2	Policlínica central	●		●		●		3	
3	C/S Niños y M. Ayapal	●		●		●		3	
3	Hospital Bertha Calderón	●	●	●	●	●	●	6	●
3	Hospital Monte España	●		●		●		3	●
3	Centro Nac. Cruz Roja Nicaraguense	●				●		2	
3	Hospital Fernando Velez Paiz	●	●	●	●	●	●	6	●
4	C/S Roberto Clemente	●		●		●		3	
4	C/S Francisco Buitrago	●		●		●		3	
4	Oficinas INSSBI	●		●		●		3	
4	Hospital Bautista	●	●	●	●	●	●	6	●
4	Hospital Militar "Dávila Bolaños"	●	●	●	●	●	●	6	●
5	Hospital Manolo Morales	●	●	●	●	●	●	6	●
5	Hospital del Niño La Mascota	●	●	●	●	●	●	6	●
6	C/S Sivia Ferrufino	●					●	2	●
6	Hospital Alemán Nicaraguense (Carlos Marx)	●	●	●	●	●	●	6	●
Total		17	13	15	13	16	14		

Note : -C.S (Health Care Center) -No collection Service on Sundays

Table N.2.2m Incinerators for Infectious Waste in the Study Area

District		2	2	2	2	2	3	3	3	4	4	5	5	6
Hospital Name		Aldo Chavarría	Carlos Roberto Huembes	Dermato–lógico	Lenin Fonseca	Psiquiá–trico nacional	Bertha Calderón	Fernando Vélez Paiz	Monte España	Bautista	Alejandro Dávila Bolaños	Manolo Morales	Manuel de Jesús Rivera (La Mascota)	Alemán Nicaraguense (Carlos Marx)
Specialty		Rehabi–litation	General Medicine	Dermatol–ogy	General Medicine	Pychiatry	Gynecology+ Ophthalmolo–gist	Pediatrics Gynecology	General Medicine	General Medicine	General Medicine	General Medicine	Pediatrics	General Medicine
Owner		Gov.	Gov.	Gov.	Gov.	Gov.	Gov.	Gov.	Private	Private	Private+ Gov.	Gov.	Gov.	Private
Capacity							200 lbs/d	60 lbs/h				60lbs/h	30–45 lbs/h	60lbs/h
Average Incineration	kg/day							No detailed technical information		No information given		No detailed technical information		250 lbs/h
	hr/day						2 hrs (morning) 2 hrs (night)							2–3 hrs
Fuel Cost	C$/day						450 gal/month						C$195/day	C$50–C$60–/day
Average Ash Weight	C$/day						200 lbs/week							0.83 lbs/day
Installation Year		None	None	None	None	None	1975		None		None		1980	Jan 1994
Remarks					Pathological waste sent to other Hospitals		Ash is buried around the incinerator. 50 lbs of placentas are produced daily.	Not Functioning. Infectious Waste Sent to Hospital Aleman Nicalaguense		Functioning	Pathological waste sent to Hospital La Mascota	Not functioning	Not functioning	Functioning

Table N.2.2n Problems clarified through interviews with Medical Institutions

Problems	Remarks
1. Service Level	
1.1 Frequency of Collection	– Daily collection should be carried out to prevent the accumulation of wastes discharged – Fixed day collection is recommended
1.2 Separation of Waste	– Education programs should be implemented – Stop factories from discharging their wastes into hospital containers
1.3 Container	– Maintenance of containers – Increase number of containers – Larger containers necessary
1.4 Time of collection	– Fixed time collection – If fixed time collection is unattainable, a device for informing the arrival of the collection vehicle is necessary
2. Education	– lack of personnel and resources for collection of medical wastes – instructions on separate collection should be given

f. Legislation and Enforcement

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

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

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

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

N.2.3 Study Findings

a. Government Organization and Collection Service

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

b. Medical Waste Collection

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

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

c. Incinerator Installation Program

The European Union (EU) approved the program for the installation of incinerators in the Municipality of Managua for the treatment of Medical Waste, in December 1993.

The Ministry of Health completed the first detailed survey phase on the future establishment of an incineration system for one month, from November to December 1994, and will commence the second survey phase for another month in February of 1995.

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

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

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

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

N.2.4 General Recommendation on Medical SWM

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

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

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

ANNEX O

ENVIRONMENTAL EVALUATION


N
0
200m

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ANNEX O ENVIRONMENTAL EVALUATION ON ANPLS

O.1 Introduction

This report is a compilation of the results of the short term study carried out on subjects that have an impact on the environment for the formulation of the feasibility study previously stated in the MSWM Master Plan.

O.2 Background

A civil war which lasted for years has destloyed the social infrastructure and consequently worsened the economy of the Municipality of Managua (area : 330km^2, population : 1.1 million), in the Republic of Nicaragua. Furthermore, the rapid pace of increase in population has brought about an increasing complexity in the generation of solid waste and an actualization of environmental problems. The management of solid waste in the Municipality of Managua has become a critical problem. For example:

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

To overcome the above problems and to systematically improve the situation, the preparation of a Solid Waste Management (SWM) Master Plan for the Municipality of Managua is a very effective approach, technically as well as financially. However, this approach has not been practiced in the Municipality of Managua and further no SWM Plans have been prepared in the country.

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

O.3 Master Plan

O.3.1 Outline of MSWM Master Plan

a. Target Year

The master plan shall cover a period between 1995 to 2010. Upon consideration of the limited resources for SWM in the Municipality, the goal of the master plan shall be pursued in a stepwise manner.

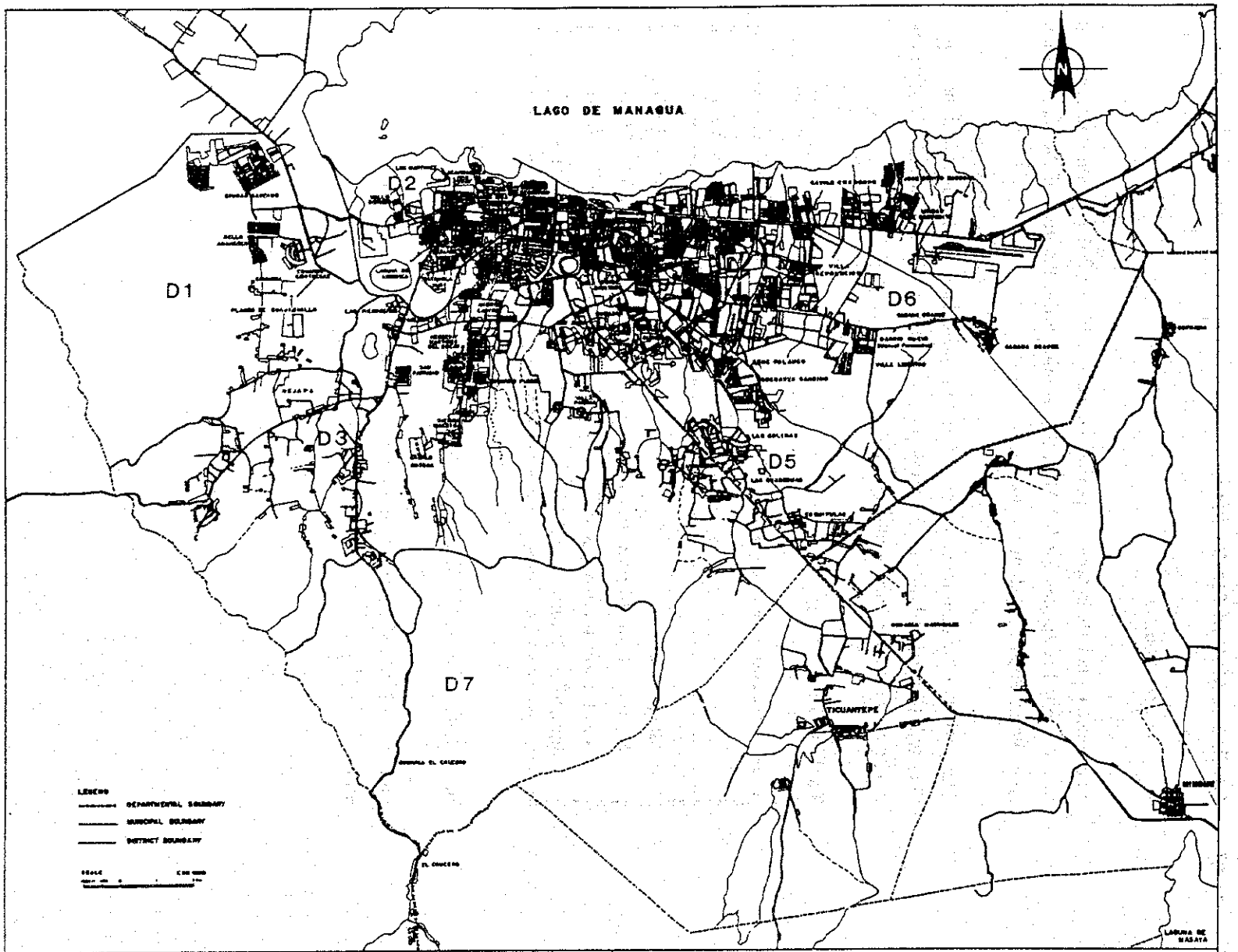
The period of the plan may be divided into the following three stages and the target year will be finalized during the study process with the Nicaraguan side. Study area is shown in Figure O.3.1a and O.3.1b.

Table O.3.1a 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. Outline of MSWM Master Plan

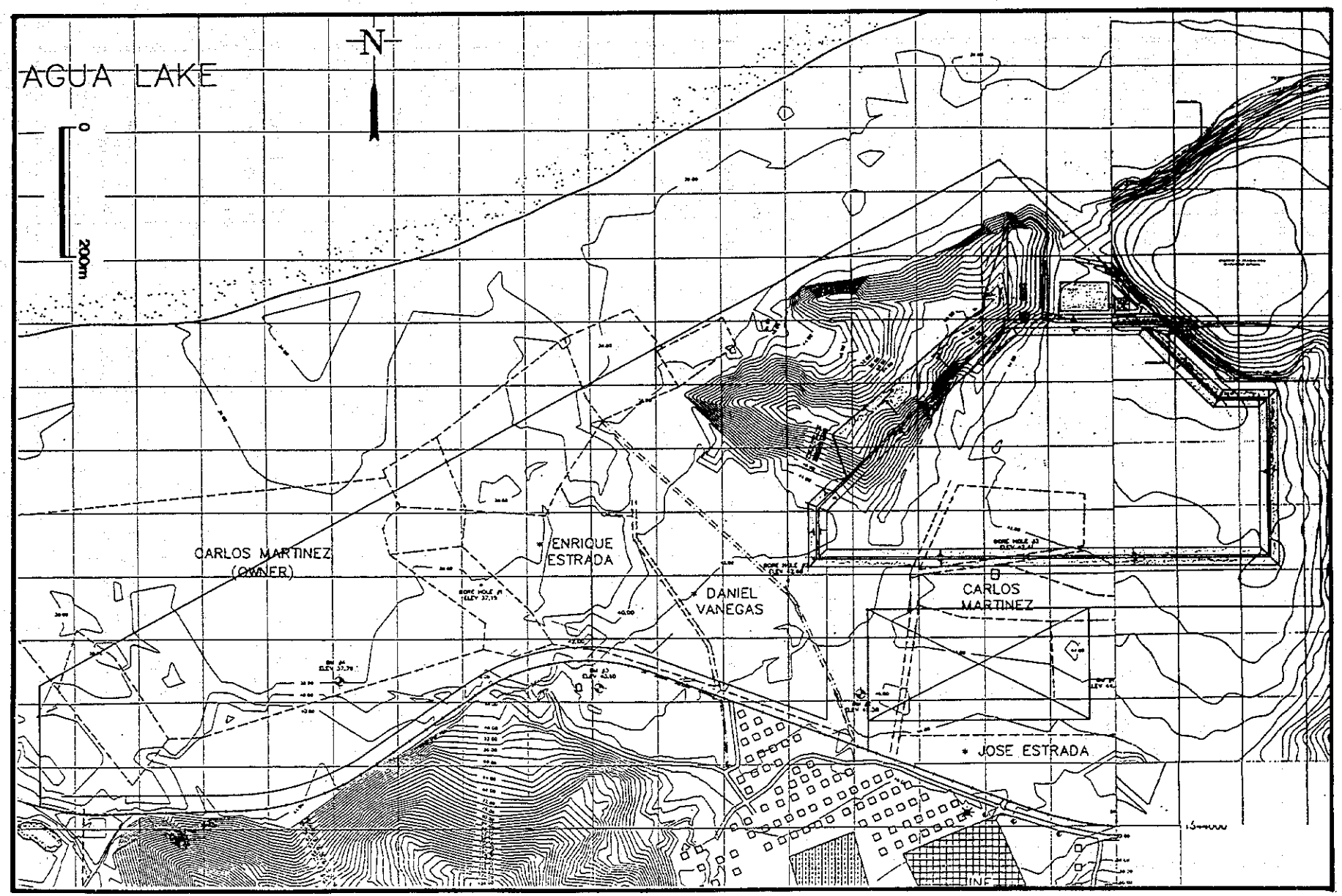
Outline of MSWM Master Plan on the technical system is shown in Table O.3.1b and Table O.3.1c.



THE STUDY ON WATER SUPPLY PROJECT IN MANAGUA

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure O.3.1a
Location map of study area



Fugure O.3.1b Locatio map of ANPLS

Table O.3.1b Outline of the Techinical System of The MSWM Master Plan

Item	Year	1995	2000	2010
1.	**GENERAL**			
	Total Population	1,127,605	1,452,900	2,069,347
	Urban Area Population	877,817	1,131,053	1,610,944
	Service Population	675,919	1,017,947	1,610,944
2.	**WASTE STREAM**			
	Generation	921.1 ton/day	1,280.4 tons/day	2,171.8 tons/day
	Self-disposal	198.1 tons/day	196.4 tons/day	223.3 tons/day
	Recycled Amount at Generation Sources	17.9 tons/day	26.2 tons/day	47.0 tons/day
	Collection	662.5 tons/day	758.6 tons/day	1,448 tons/day
	Recycled Amount (Recycling Material)	14.0 tons/day	20.1 tons/day	36.4 tons/day
	Direct Haulage	43.2 tons/day	299.2 tons/day	453.5 tons/day
	Final Disposal	692.3 tons/day	1,037.7 tons/day	1,865.1 tons/day
3.	**DISCHARGE & STORAGE**			
	Type of Containers			
	- 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
4.	**COLLECTION & HAULAGE**			
	Collection Ratio	77%	90%	100%
	Service Population and ratio	675,919(77.0%)	1,017,947(90.0%)	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(0%)
	Collection System			
	- Residential area (A)	Curb collection	Curb collection	Curb collection
	- Residential area (B)	Open heaping	Container/ Bell collection	Container/ Bell collection
	- Large generation sources	Container	Container	Container
	Collection Frequency			
	- Residential area (A)	Thrice a week	Thrice a week	Thrice a week
	- Residential area (B)	Irregular	Thrice a week	Thrice a week
	- Large generation sources	Everyday except holidays	Everyday except holidays	Everyday except holidays

Item	Year	1995	2000	2010
	Collection Vehicles			
	– Residential area (A)	Compactor trucks without public containers	Compactor trucks without public containers	Compactor trucks without public containers
	– Residential area (B)	Wheel loaders & dump trucks	Hoist trucks with containers/ Compactor trucks without public containers	Hoist trucks with containers/ Compactor trucks without public containers
	– Large generation sources	Compactor trucks with public containers/ Roll-on, Roll-off trucks	Compactor trucks with public containers	Compactor trucks with public containers
	Haulage System	Direct; by collection vehicles	Direct; by collection vehicles	Direct; by collection vehicles
	Main Equipment(Unit)			
	– Compactor($15.3m^3$)	47	55	86
	– Compactor with container	4	3	4
	– Hoist truck	(4) (Roll-on Roll-off Truck)	20	71
	– Container($1m^3$)	Approx. 250 units ($0.83m^3$)	157	154
	– Container($7m^3$)	Approx. 20 units ($15m^3$)	127	127
5.	**STREET SWEEPING**			
	Sweeping System	Manual sweeping	Manual sweeping	Manual sweeping
	Covered Road Length	331 km	350 km	350 km
	Main Equipment (Unit)	Combination of wheel loader and dump truck		
	– Open Truck	–	2	2
	– Container ($1m^3$)	–	116	116
6.	**PARK & GREEN AREA**			
	Cleansing System	Manual Sweeping	Manual Sweeping	Manual sweeping
	Cleansing Area	16.7 ha	45 ha	45 ha
7.	**INTERMEDIATE TREATMENT**	None	None to be introduced	None to be introduced

Item	Year	1995	2000	2010
8.	**FINAL DISPOSAL**			
	Landfill Method	Sanitary landfill Level 1: controlled tipping	Sanitary landfill Level 3	Sanitary landfill Level 4
	Disposal Site	Acahualinca	Acahualinca N.P.L.S	Acahualinca N.P.L.S
	Area of the Site	40 ha	100 ha	100 ha
	Landfill Owner	Municipality	Municipality	Municipality
	Distance from Main Generation Source	6.5 km	8.3 km	8.3 km
	Topography	Flat	Flat	Flat
	Service Area	Municipality	Municipality	Municipality
	Subject Waste	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		
	Working Hours	Park	Park	Park
	Main Equipment (Unit)	6:00 - 18:00	6:00 - 18:00	6:00 - 18:00
	- Bulldozer	2	5	8
	- Landfill Compactor	4	3	4
	- Wheeloader	0	1	1
	- Dump Truck	0	2	3
	- Motor Grader	0	1	1
	- Wheel Excavator	0	1	1
	- Water Tanker	2	1	1
	- Pick-up Truck	0	2	2
9.	**EQUIPMENT OPERATION & MAINTENANCE**			
	Vehicle Depot			
	- location	Los Cocos Workshop	Los Cocos Workshop	Los Cocos Workshop
	workshop			
	- location	Los Cocos Workshop	Los Cocos Workshop	Los Cocos Workshop
	- responsible organization	Public Cleansing Office(PCO)	PCO	PCO
	- number of personnel	37	43	43

Table O.3.1c Outline of the Institutional System of the MSWM Master Plan

Items \ Year	1995	2000	2010
1. GENERAL			
Total Population	1,071,868	1,452,900	2,069,347
Urban Area Population	834,427	1,131,053	1,610,944
Service Population	642,100	1,017,947	1,610,944
2. ADMINISTRATION AND ORGANIZATION			
Responsible Organization	Public Cleansing Office	Public Cleansing Office	Public Cleansing Office
Organization Chart	Refer to ANNEX F.3	Refer to M/R Chapter 7	Refer to M/R Chapter 7
Number of Personnel			
- Administration	Administration 19	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
TOTAL	**539 persons**	**687 persons**	**706 persons**
Type of Management			
- Collection & Haulage			
Area A	Municipality(PCO)	Municipality(50%), Concession(50%)	Concession(100%)
Area B	-	Municipality(PCO)	Municipality(PCO)
Large Generation sources	Municipality(PCO)	Municipality(PCO)	Municipality(PCO)
- Street Sweeping	Municipality(DO)	Municipality(PCO)	Municipality(PCO)
- Final Disposal	Municipality(PCO)	Municipality(PCO)	Municipality(PCO)
- Equipment O&M	Municipal(PCO)	Municipality(PCO)	Municipality(PCO)
- Public Relation Assistant	-	Municipality(PCO)	Municipality(PCO)
- Budget Control	-	Municipality(PC))	Municipality(PCO)

Items \ Year	1995	2000	2010
3. FINANCE			
Budget (million C$)			
– for the whole municipality	205.2	273.4	414.9
– for MSWM	17.6	69.6	80.3
Collection & Haulage	9.6	27.2	30.1
Public Cleansing Service	7.0	5.8	5.8
Disposal	0.7	34.3	42.1
Workshop	0.3	1.5	1.5
Promotion	0.0	0.8	0.8
– unit cost(C$/ton)			
Collection & haulage	56.2	98.2	56.9
Public Cleansing Service	1071.4	753.4	753.4
Disposal	2.8	90.4	61.8
Workshop	1.6	5.5	2.9
Promotion	0.0	2.7	1.6
State of Cadastre Registration	Incomplete		Completed
Fee Charging	Waste fee depends on	Completed	Waste fee is collected
– Collection area A	the frontal length of the premises (No collection service)	Waste fee is collected by the concessionaire; Waste fee and subsidy from Municipality;	by the concessionaire; Waste fee and subsidy from Municipality;
– Collection area B	Waste fee	Waste fee based on the volume of the waste;	Waste fee based on the volume of the waste;
– Large generation sources	no charge	Tipping fee based on the amount of the waste	Tipping fee based on the amount of the waste
– directly hauled to disposal site			
4. PRIVATIZATION	Not established	Semi-privatization	Semi-privatization
Method of Privatization	–	Concession	Concession
Work Share of Private Contractor	–	50% of Area A	100% of Area A
5. REGULATION & GUIDELINES	None		
For Littering		Public Cleansing Code	Public Cleansing Code
For Storage, Discharge and Collection		Solid Waste Management Code <SWM Code>	Solid Waste Management Code <SWM Code>
For Final Disposal		Solid Waste Management Code <SWM Code>	Solid Waste Management Code <SWM Code>
6. PUBLIC COOPERATION	None		
Responsible Organization		Public communications assistant	Public communications assistant
Method of Public Education		by using VIDEO set	by using VIDEO set

Note: M/R Main Report

O.3.2 Short Term Improvement Plan for Feasibility Study

Upon consideration of the contents of the optimum system for MSWM, the following priority projects were determined at the meeting for the discussion meeting of the IT/R on October 13th 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; and
- Promotion of public awareness, cooperation and participation

a. Collecton Area Expansion Strategies

The Collection system employed in collection area A, a well developed area, will be modified, except for the use of comoactor trucks. Cllection area is A is presently almost completely covered by collection services that expansion is not required. Services on Collection area B, however, should be extended.

The present collection system in area B is not suited to the envitonmental state of the area. The General Urbanization Plan of Managua classifies Area B into 2 categories: spontaneous and progressive settlement areas. The spontaneous settlement area has no vehiclular access road and constitutes 60% of Area B. The progressive settlement area is constructed with a road mainly for vehicular access and constitutes 40% of Area B.

Given these conditions, expansion of collection services in Area B will involve the use of the container collection system in the spontaneous settlement area and the bell collection system in the progressive settlement area.

Collection System

Collection Area A: Curb collection system
Collection Area B:

- Spontaneous Settlement: Container collection system
- Progressive Settlement: Bell collection system

The implementation of a container collection system in collection area B will require the following from the residents:

- Disposal of waste in the containers.
- Regular cleaning of the peripheral areas of the container.

- Inform the municipality if wastes other than household refuse is dumped, e.g. industrial and construction debris.
- Maintain a sanitary environment by sweeping streets and drains, picking up rubbish in public areas, avoid littering, etc.

b. Strategy for Leachate Control at the Acahualinca Newly Proposed Landfill Site (ANPLS)

ba. Background

ANPLS was selected because it will not affect groundwater quality, the drinking water source, regardless of its proximity to Managua Lake, the final destination of groundwater flow.

However, the quality of leachate originating from the present Acahualinda disposal site is worse than the quality of Managua Lake according to the water quality survey. Although the cause and effect relationship is unclear, it is quite definite that leachate is one of the factors that contanimate Managua Lake.

On the other hand, it is common knowladge that the concentration of sewage load in Managua Lake is considerably heavier than leachate from the landfill.

bb. Phased measures for leachate

Taking account of the above facts, the 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 followng phased measures for leachate control were proposed instead:

2000 year: Sanitary landfill Level 3
- the installation of liners for seepage control
- the installation of leachate collection, circulation and monitoring facilities.

2010 year: 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 th 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 prduction of the plant. Financially, this will minimize the capital required for the improvement of the water quality of Managua Lake.

c. Equipment Operation & Maintenance

The present **Los Cocos Workshop** which shall be under the Public Cleansing Office shall be improved in order to carry out preliminary maintenance of vehicles and equipments for cleansing service.

d. Public Cooperation

da. 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.

db. 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.

O.4 Existing Environmental Condition

O.4.1 Topography and Geography

a. Topography

The western part of Nicaragua is geologically and geographically divided into 3 distinct regions, namely the Pacific coastal plains, the Nicaraguan depression and the interior highlands. The study area is located in a part of the Nicaraguan depression.

The Nicaraguan depression is surrounded by the Pacific coastal plains and interior highlands, and is a belt-shaped lowland area extending from the northeast to the southwest. About half of the Nicaraguan depression is occupied by the Lake Managua (approximately 1,040km^2 and 38.2m deep) and Lake Nicaragua (approximately 8,200km^2 and 31.2m deep).

Along the southwest margin of this depression is a chain of new volcanoes extending from the northwest to the southeast. Most of these volcanoes are composed of compound volcanic conical hills and cinder cones, and the others are made up of calderas and remains of craters. Many of the volcanoes have crater lakes and are still active.

The study area is located to the south of Lake Managua, which is at the southwest margin of the Nicaraguan depression, and is surrounded by the mountain ranges of Managua bordering the municipalities. The whole study area extends from the southern to the northern slope. The urban areas are established on the gently sloping terrain along Lake Managua.

Several crater lakes are scattered in the area, one of which is Lake Asososca, the water supply source of Managua. Lake Asososca is within a volcanic chain extending north-south.

b. Geology

The geology of the study area is explained in Table O.4.1a and the geological distribution is outlined as follows:

ba. Middle las Sierras Group (TQps (M))

- distributed in the urbanized area
- made up of basaltic-andesitic compact agglomerate, tuffbrecia, tuff and

pyroclastic flow

bb. Upper Las Sierras Group (TQps (S))

- distributed in the southern part of the urbanized area, which is made up of gently undulating hills, and the western part of the mountains of Managua
- made up of basaltic–andesitic agglomerate, tuffbrecia, tuff, fossil, and tuffaceous sand and silt

bc. Masaya Volcanics (QvM)

- distributed in the area to the south of the Managua airport
- made up of pyroclastic flows and fall deposits

bd. Pleistocene Volcanics (QvP)

- distributed in the mountains at the western and southern parts of the study area
- made up of pyroclastic fall deposits, flow and lava

be. Holocene Volcanics (QvH)

- this group makes up the geology of volcanic chains where Asososca Lake is located
- made up of pyroclastic flows and fall deposits

bf. Alluvium Deposits (QaL)

- this group makes up the geology of the area to the north of the airport, which is located in the northern part of the study area
- made up of sand and clay sediments with pyroclastic materials and debris deposits

Table O.4.1a Geological Distribution in the Study Area

Geologic Age		Name of Geologiv Rock Units		Litholigy
Quanternary	Holocene	Alluvium Q a l		Sand and clay sediments with pyroclastic material, debris deposits.
		Holocene Volcanic Q v H		Basaltic-andesitic lavas.
				Phyloclastic flows and phyloclastic fall deposits.
	Pleistocene	Pleistocene Volcanics Q v P		Phyloclastic fall deposits with phyloclastic flows and lavas.
		Apoyo Volcanics Q v A		Phyloclastic fall deposits and flows (Pumice) with dacitic lavas.
		Masaya Group Volcanics Q v M		Basaltic lavas (Hard and porous-auto brecciated).
				Phyroclastic flows and phyloclastic fall deposits.
Tertiary	Pleistocene	Las Sierras Group	Upper Las Sierras group	Basaltic-andestic agglomerate, tuffbreccia tuff, fossil soil, tuffacedeous sand and silte.
			Middle Las Sierras group	Besaltic-andesitic compact ag-glomerate, tuffbreocia, tuff, phyroclactic flow.
		Plio-pleistocene Volcanics		Basaltic-andesitic lavas in near Masaya and Apoyo calderas.
	Pliocene (Eocene)	El Salto Formation & Other Teritiary Sedementary Rocks TPS		Tuffaceous sandstone & siltstone with fossil shells (Broen tuffaceous shales).

Source: The Study on Water Supply Project in Managua, JICA, 1993

O.4.2 Climate

The meteorological conditions of the study area were determined based on the 1991 meteorological survey carried out in Ingenio Julio Buitrago (IJB) along the Pacific coastal plains, the International Airport of Managua in the Nicaraguan depression, and Muy Muy in the interior highlands. The results are shown in Table O.4.2a.

a. Temperature

aa. Annual Average Temperature

IJB was observed to have the highest annual average temperature and Muy Muy the lowest.

In May, the temperature in all three areas was observed to be high. Temperature is low in November in IJB, and in December in Managua and Muy Muy (refer to Fig.O.4.2a).

Temperature in the study area is observed to decrease as you move further inland where the altitude is higher as seen from the annual average temperature of the three observation stations:

IJB: 4.3°C
Managua: 3.2°C
Muy Muy: 2.7°C

ab. Maximum Temperature

The hottest time of the year in IJB is in May where the temperature is recorded at 37°C. In Managua, it is in April and May at 36.4°C, and in Muy Muy, in June at 23.8°C.

ac. Minimum Temperature

The coolest time of the year is in December in IJB (18°C), and in January in Managua (17.8°C) and Muy Muy (16.2°C). As previously mentioned, temperature in the study area tends to decrease as you move further inland.

b. Annual Average Humidity

Annual average humidity, 69.3% in IJB, 74.2% in Managua, and 82% in Muy

Muy, tends to increase further inland. The lowest value was observed in March in all three stations. The highest value was observed in October in IJB and Managua, and from August to September in Muy Muy.

c. Precipitation

Although there are no actual rainfall data in IJB for August 1990, precipitation in this area is still assumed to be the highest. Accordingly, IJB has the highest annual precipitation, followed by Muy Muy and then Managua.

The annual precipitation of Managua is the lowest at about half the value of the 2 other observation stations. The rainy and dry seasons in all three areas start from May to November and December to April, respectively. Eighty two (82%) to ninety eight (98%) percent of rain falls in the rainy season (refer to Fig. O.4.2b).

d. Evaporation

Regardless of the insufficient data on IJB for August, the area is considered to have the highest evaporation value, followed by Managua and then Muy Muy. Evaporation in all three observation stations peaks in April and is at its lowest in October and November in IJB, November in Managua, and December in Muy Muy, respectively. Evaporation tends to fluctuate in a manner similar to annual temperature.

e. Wind Velocity

Wind velocity tends to decrease further inland as seen from the data on average annual wind velocity: 2.0m/sec in IJB, 1.1m/sec in Managua, and 0.5m/sec in Muy Muy. It is further observed to be faster in the dry season than in the rainy season in IJB and Managua. Wind velocity is slow all year round in Muy Muy (refer to Fig. O.4.2c).

f. Wind Direction

Easterly winds prevail throughout the year at all observation points.

g. Natural Conditions

Managua is located between the Pacific coastal plains and the interior highlands, therefore its climate is influenced by the nature of this two regions. The area has two seasons, dry and rainy, and has low rainfall.

The wind blows from the east with a velocity that is slower in the rainy season than in the dry season. Annual evaporation exceeds annual precipitation, thereby resulting in water shortage.

Table O.4.2a Meteorological Condition

METOROLOGICAL STATION:INGENIO JULIO BUITRAGO(I.J.B.)
ALTITUDE: 10m

ITEM		UNIT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
AIR TEMP.	MAXIMU	C	32.7	33.2	34.7	35.2	34.1	32.5	33.6	34.4	33.4	30.6	31	32	33.1
	MINIMUM	C	23.1	23.8	25	25.6	25.7	24.8	24	24.5	23.4	22.5	21.8	20.9	23.8
	MEAN	C	27.9	29.3	29.9	30.1	29.6	28.3	28.3	28.9	28	26.2	25.8	26	28.2
RELATIVE HUMIDITY		%	66	54	51	57	66	74	73	70	75	87	83	76	69.3
PRECIPITATION		mm/MON	0	0	0	34.7	353.1	69.9	36.1	-	132.8	608.3	338.4	0	1573.3
EVAPORATION		mm/MON	264.5	275.3	340.7	343.4	274.8	192.6	229.2	-	224.4	168	168	185.8	2666.7
WIND VELOCIT	MEAN	m/s	3.8	4	4.3	3	2.1	1.2	1.4	1.7	1.2	0.2	0.1	1.4	2
WIND DIRECTION			E	E	E	E	E	E	E	E	E	C	C	NE	E

METOROLOGICAL STATION:MANAGUA AIRPORT
ALTITUDE: 56m

ITEM		UNIT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
AIR TEMP.	MAXIMU	C	32.3	32.8	34.1	35.4	34.2	32.4	32.1	32.8	33.0	32.7	31.5	31.6	32.9
	MINIMUM	C	21.1	20.9	22.0	23.5	23.9	23.9	23.1	23.1	23.1	22.8	22.5	20.9	22.6
	MEAN	C	26.1	26.4	27.7	29.1	28.3	27.3	26.9	27.2	27.0	26.8	26.3	25.9	27.1
RELATIVE HUMIDITY		%	72	69	64	61	71	79	79	78	80	82	80	75	74.2
PRECIPITATION		mm/MON	1.2	1.1	0.0	3.8	92.0	114.1	104.1	113.8	85.1	100.9	132.3	8.6	757.0
EVAPORATION		mm/MON	183.6	159.4	234.0	264.6	146.9	151.2	133.6	164.0	152.0	141.2	133.0	137.7	2001.1
WIND VELOCIT	MEAN	m/s	1.6	1.5	1.7	1.6	1.3	1.1	1.0	0.8	0.7	0.2	0.3	0.8	1.1
WIND DIRECTION			NE	E	E	E	E	E	E	E	SE	SE	E	E	E

METOROLOGICAL STATION:MUY MUY
ALTITUDE: 320m

ITEM		UNIT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
AIR TEMP.	MAXIMU	C	27.5	28.0	29.3	31.4	31.4	28.7	29.0	28.7	29.8	30.1	28.4	27.5	29.2
	MINIMUM	C	19.7	19.5	20.2	21.2	21.8	21.9	21.4	21.5	21.2	20.7	20.9	20.0	20.8
	MEAN	C	23.6	24.0	25.3	25.6	25.5	24.4	24.3	24.1	24.1	24.5	23.8	22.9	24.3
RELATIVE HUMIDITY		%	78	74	69	73	79	88	86	88	88	86	85	84	82
PRECIPITATION		mm/MON	80.7	61.8	22.3	16.3	174.4	282.6	139.9	263.7	135.1	162.6	135.4	98.8	1573.6
EVAPORATION		mm/MON	84.7	-	167.3	192.1	153.8	110.9	123.5	102.8	110.9	129.5	87.3	80.0	1342.8
WIND VELOCIT	MEAN	m/s	0.2	0.2	0.2	0.2	0.1	0.9	0.1	0.1	0.7	0.6	0.8	1.5	0.5
WIND DIRECTION			NE	NE	NE	NE	E	E	E	E	E	SE	E	E	E

-;NO MEASURED

SOURCE:INETER(1992):METEOROLOGICAL YEARBOOK 1990.

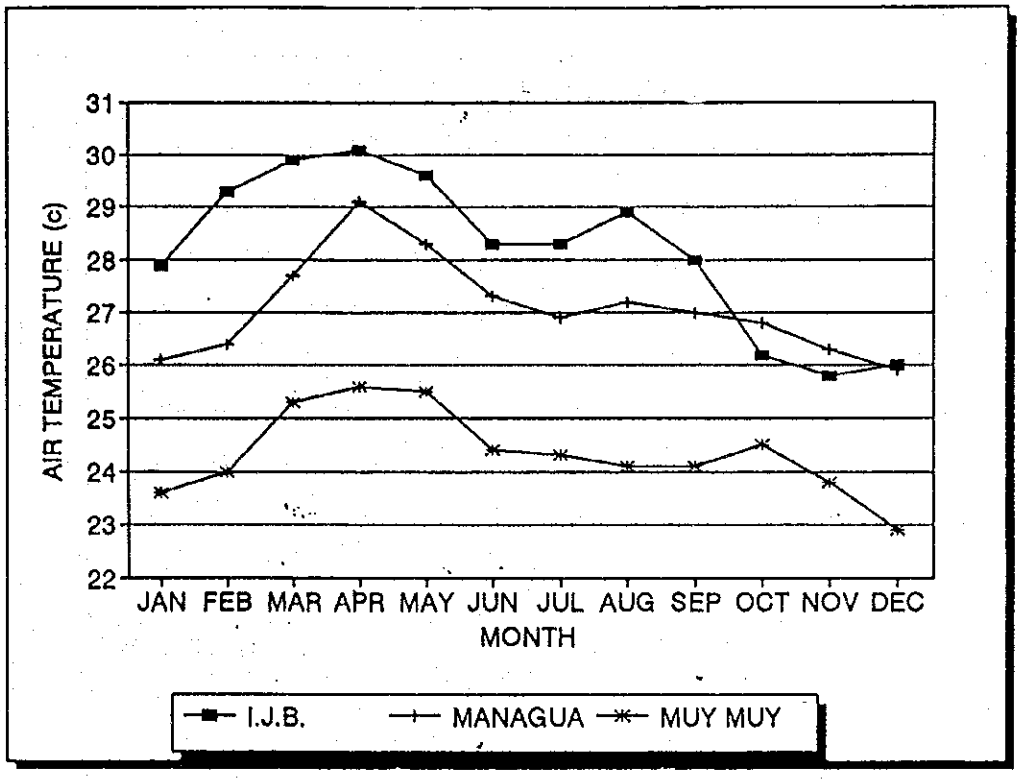


Figure O.4.2a Air Temperature

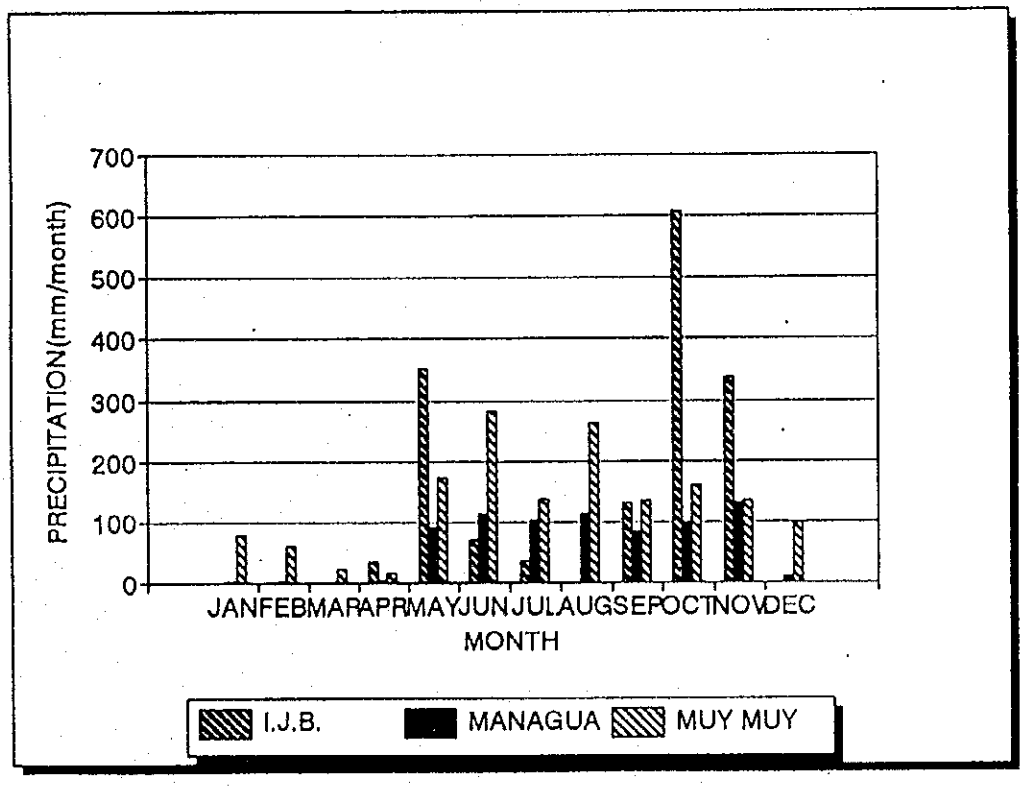


Figure O.4.2b Precipitation

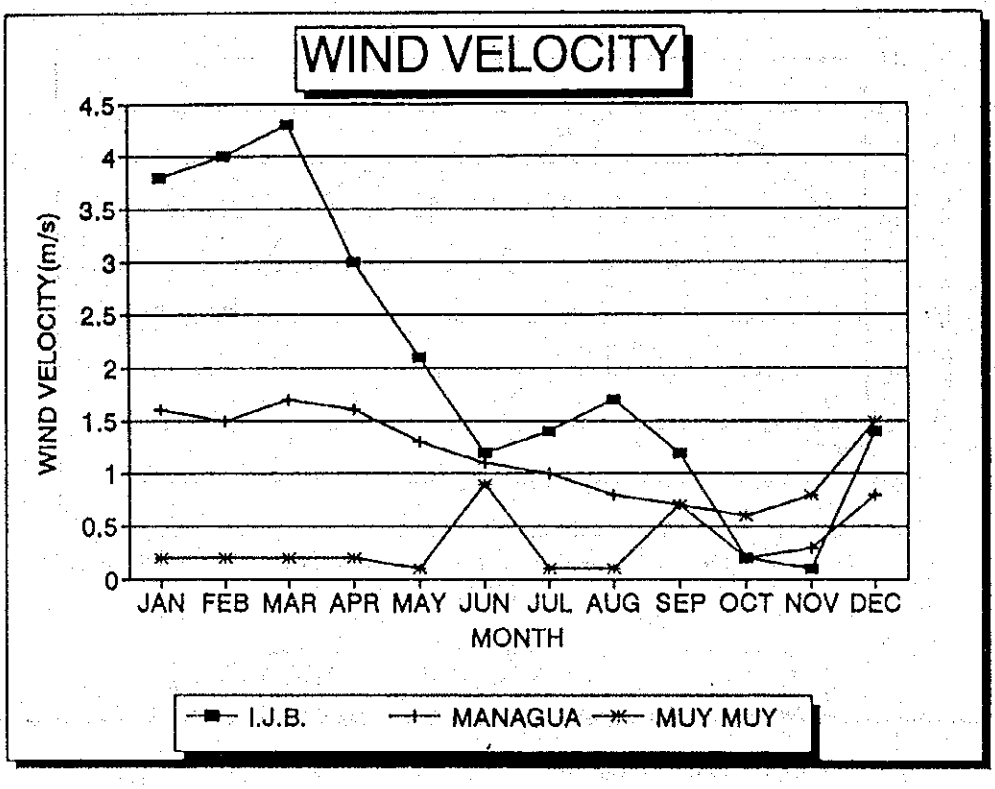


Figure O.4.2c Wind Velocity

O.4.3 Groundwater (Hydrology)

a. Surface Water

In the Kokusai Kogyo (1993) report[1], the water system of the study area was divided into 5 catchment areas, which are detailed in Figure O.4.3a. Catchment areas I (120km²) and II (222km²) directly face the lake as they extend from the mountain slope. Masatepe and La Concepcion are located within catchment areas III (136km²), IV (183km²) and the catchment area (219km²) of Lake Masaya, which extend toward the La Mocuana River.

Managua Lake, the second largest lake in Nicaragua, is located to the north of Managua City. Surface water and groundwater flow into the lake from the south. To the east is Tipitapa River which connects Lake Managua to Lake Nicaragua, the biggest lake in Central America. There is hardly no flow from Lake Managua to Lake Nicaragua because of the decrease in the water level of the former.

To the south of the study area is Asososca Lake, the drinking water resource of the city of Managua for years. At present, the water of the lake services more than 30% of the population.

To the east of the airport, in the northeast of the city, is a huge spring water resource located at a height of 50 – 60m above sea level. The total volume of water discharged from this spring is assumed to make up the estimated base flow in the upstream basin which includes Masaya Caldera.

La Mocuana River is the only perennial river in the study area and is dependent on spring water discharge. However, a survey on the river's water level conducted in 1991–1992 showed a discharge of 1.0 –1.40m³/sec. An observation of the discharge in the dry and rainy seasons shows that the entire spring water resource area has an average discharge of at least 1.35m³/sec.

With the exception of the La Mocuana river, the rivers in the study area are all intermittent. Runoff collected upstream during rainfall periods usually produces only 2 – 3 hour discharge into the lake.

[1] Kokusai Kogyo (1993) report : The Study on Water Project in Managua, Main Report

b. Groundwater

ba. Groundwater Level

The Managua groundwater basin is basically divided into: a) recharge basin of the Managua and Carazo mountains, b) basin reserve and the flow zone of the low lying plateau, and c) area where water from Lake Managua is discharged. It is further divided into the western, central, and eastern sub-basins because of the impermeable upper basement rock layer (El Salttion, Brito Formation) forming the basement of the groundwater basin, the geological and lithofacies formation, and fault and fracture zones of volcanic groups. Figure O.4.3a shows the water level in the groundwater basin and the groundwater flow mechanism.

The western area of the groundwater basin is basically a cone shaped catchment area from which water flows into Lake Managua. However, the huge pumping pressure in Lake Asososca alters the course of groundwater flow.

In the eastern groundwater basin, the flow moves eastward towards Lake Masaya, passing the Masaya Caldera where the flow path changes to the north. The springs in the low lying Sabana Grande (50 – 60m above sea level) are located at the eastern boundary of the groundwater basin area.

As has been shown above, Asososca Lake is an important water source for the city of Managua. However, groundwater pumping from the 1970s led to the continuous decline in water level. In spite of the reduction in pumping volume in the 1990s, the water level of Asososca dropped to 35.0m above sea level in contrast to Managua Lake's 36.5m.

The discharge of domestic drainage from the factories and towns in the lake shore pollutes the Managua Lake. The continuous decline in the water level of Asososca Lake is also feared to result in the intrusion of contaminated water into Managua Lake. The water level of Asososca Lake is usually influenced by rainfall and pumping volume. Although the lake showed signs of recovering its water level after pumping was reduced in 1989, it is still lower than the water level of Managua Lake due to limited rainfall for the past several years.

bb. Groundwater Quality

The quality of groundwater pumped up from the wells used in the study is considered suitable for drinking. As illustrated in the Trilinear Diagram in Figure O.4.3b, the concentration of samples extracted upstream becomes diluted as they move downstream (from Ca+Mg to Na+K).

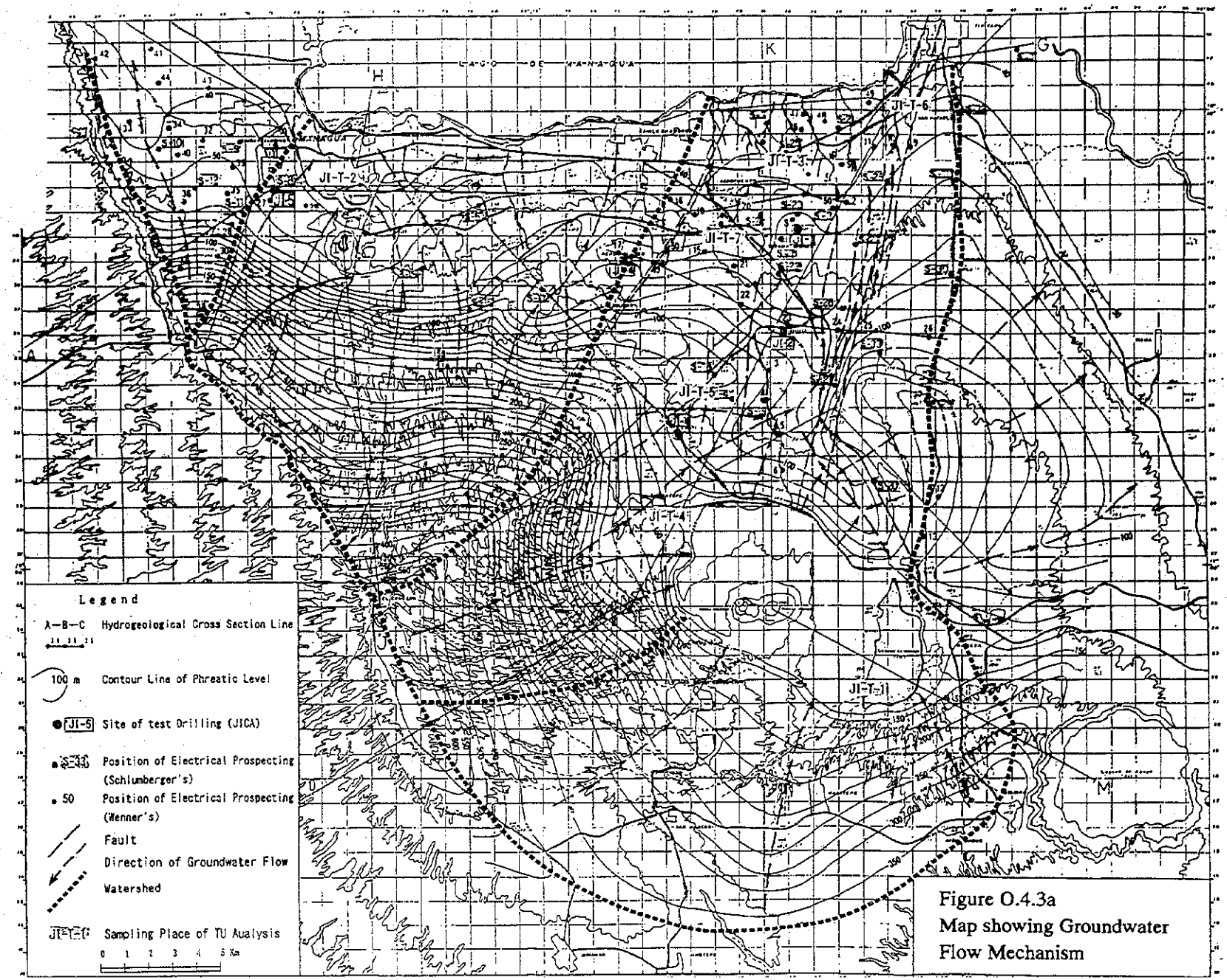
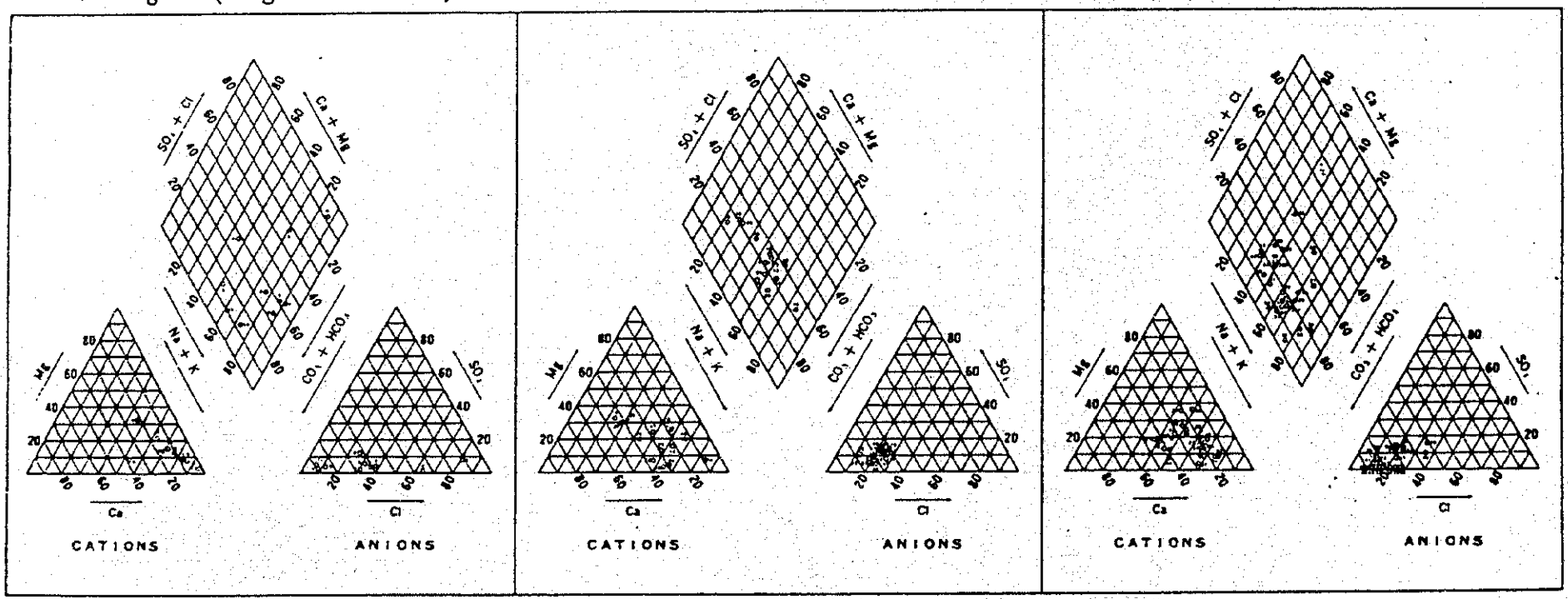


Figure O.4.3a
Map showing Groundwater Flow Mechanism

Trilinear Diagram (Diágrama Tri-lineal)



River, Spring, lakes | Western & Central Hydrogeological Basin | Eastern Hydrogeological Basin

Figure O.4.3b The Trilinear Diagram

O.4.4 Air Quality

Air quality in the Acahualinca present disposal site was surveyed using parameters such as suspended particulate matter (SPM) and dust fall. The survey is outlined below.

Survey Period:

- 1st Survey Period – 26 May 1994 to 2 June 1994
- 2nd Survey Period – 5 to 12 December 1994

The survey results are shown in Table O.4.4a below.

Table O.4.4a Result of Air Quality Survey

Survey Period	Dust Fall (mg/cm^2/30 days)	SPM (ug/m^3)
1st Period	0.77	130
2nd Period	0.187	154

The values of PANAIRE (Pan-american Net of Sampling by Air Contamination) used as reference in the survey were 0.50 mg/cm^2/30 days for Dust Fall and 100 ug/m^3 for SPM. Although the table above only shows the 2nd survey results for dustfall, the value is lower than the value of PANAIRE.

O.4.5 Water Quality

The results of the water quality analysis carried out in the surrounding area of the present Acahualinca disposal site are shown in Tables O.4.5a and O.4.5b. The analysis is outlined below.

Survey Period:

- 1st Survey Period: 2,3, 17 June 1994
- 2nd Survey Period: 23, 24 and 30 November 1994

The survey results are shown in Tables 5.5a and 5.5b, and are summarized below:

- Cd, Cr+6, and PCB were not detected from any of the samples used in the 2 survey periods.

- The parameters surveyed to have higher concentration than the guidelines of Nicaragua and WHO for drinking water quality are as follows:

  1st Survey Period: SO4--2, Cl-, Pb, As, Hg
  2nd Survey Period: So4--2, Pb, As, Hg, Cu, Na+, K+, Ca, Mg++

Table O.4.5a Maximum and Minimum Values for Water Quality Analysis (1st Survey)

Type of water		Water Temperature °C	pH	COD mg/lit	BOD mg/lit	$SO4^{-2}$ mg/lit	Cl^- mg/lit	T-N mg/lit	Pb mg/lit	As mg/lit	Cd mg/lit	Cr^{+6} mg/lit	Hg mg/lit	PCB mg/lit	Cu mg/lit
Leachate	Maximum	36	8.1	2273.3	132	2900	1357	112	0.14	0.04	n.d	n.d	0.4	n.d	0.06
	Minimum	30	7.3	136	20	625	110	6	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Wells	Maximum	33	7.9	1593	72	1525	229	47.8	0.12	0.02	n.d	n.d	0.27	n.d	0.057
	Minimum	29	7.3	25	4	140	63.4	0.34	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Boring holes	Maximum	35	7.9	979.2	48	3800	833	50.1	0.02	0.03	n.d	n.d	0.39	n.d	0.103
	Minimum	28	7	72.8	16	625	90	0.47	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Lakes	Maximum	32	9.5	1190	70	900	394	33.6	0.1	0.05	n.d	n.d	0.4	n.d	0.166
	Minimum	28.5	7	98	20	250	39.4	3.1	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Standard	CAPRE	–	–	–	–	25–250	250	–	0.01	0.01	0.01	–	0.001	–	1–2
	WHO	–	–	–	–	250		–				–		–	1

n.d : not detected

Table O.4.5b Maximum and Minimum Values for Water Quality Analysis (2nd Survey)

Type of Water		Water Temperature °C	pH mg/lit	COD mg/lit	BOD5 mg/lit	T-N mg/lit	SS mg/lit	DO mg/lit	CN mg/lit	SO4 mg/lit	Cl^- mg/lit	Pb mg/lit	As mg/lit
Leachate	Maximum	31	8.3	464	120	37.22	254.5	5.6	0	957.22	656.88	0.8	0.32
	Minimum	28	7.4	57	6	1.512	25.77	0	0	260.02	270.48	0.03	0.08
Wells	Maximum	27.5	8	226	60	28.23	27.3	2.8	0	1035.8	260.82	0.11	0.49
	Minimum	26.5	7.25	0	0	0.075	1.76	1.4	0	160	36.71	0.03	0.17
Water Ways	Maximum	32	7.68	906	260	27.1	209	4	0	878.7	695.52	0.12	0.51
	Minimum	28.5	7.31	306	40	0.63	26	0.4	0	795.2	67.62	0.012	0.01
Boring holes	Maximum	-	8.7	201	48	2.96	1594	4	0	859.07	193.2	0.08	0.22
	Minimum	-	7.9	57	6	0.004	71.33	2	0	83.5	154.56	0.04	0.09
Lakes	Maximum	27.5	9.3	362	80	5.3	196	8	0	716.7	347.76	0.23	0.63
	Minimum	26	7.1	136	12	3.192	11.88	0.4	0	95	32.84	0.04	0.12
Standard	CAPRE	-	6.5-8.5	-	-	-	-	8	-	25-250	250	0.01	0.01
	WHO	-		-	-	-	-	n.d	-	250			

Type of Water		Cd mg/lit	Cr^{+6} mg/lit	T-Hg mg/lit	PCB mg/lit	Cu mg/lit	HCO^{3-} mg/lit	Na^+ mg/lit	K^+ mg/lit	Ca^{++} mg/lit	Mg^{++} mg/lit
Leachate	Maximum	0	0	10	n.d	2.53	1724	420.1	55.8	302.6	180.06
	Minimum	0	0	5.59	n.d	1.15	496	143.4	17.36	32.87	23.571
Wells	Maximum	0	0	6.14	n.d	6.36	376	85.32	23.9	132.67	22.113
	Minimum	0	0	3.94	n.d	2.27	217	42.95	6.96	25.25	6.1722
Water Ways	Maximum	0	0	7.79	n.d	3.57	276	230.4	22.5	130.3	28.43
	Minimum	0	0	3.94	n.d	1.5	130	59.91	9.02	18.84	3.21
Boring holes	Maximum	0	0	8.34	n.d	1.126	296.52	85.17	11.92	58.6	10.09
	Minimum	0	0	3.38	n.d	0.9	118.4	35.85	5.2	18.036	3.16
Lakes	Maximum	0	0	10	n.d	3.053	494	395.2	44.4	32.064	24.84
	Minimum	0	0	4.49	n.d	0.48	156	21.59	6.53	10.12	1.17
Standard	CAPRE	0.01	-	0.001	-	-	-	25	10	100	30
	WHO		-		-	1.0	-	200	-	n.d	n.d

O.4.6 Noise

Noise in the area surrounding the present Acahualinca disposal site and noise created by the traffic of transportation vehicles in the national highway were analysed and the results are shown below.

Survey Period:
Traffic Noise – the survey was carried out for 24 hours, from 8 am of May 19 to 7:10 am of May 20, at an interval of 10 minutes.

Noise in the environment – the survey was carried out for 24 hours, from 8 a.m of May 23 to 7:10 of May 24. The results of the survey are shown in Tables O.4.6a and O.4.6b, and are summarized below.

- traffic noise ranged from 45.1 to 77.5 (dB) (Leq); these values fluctuate in accordance with traffic volume.
- traffic noise exceeds the guideline of WHO, 55 (dB), both in the afternoon and at night.
- environmental noise fluctuates daily and ranges from 43.5 to 57.7 (dB) (Leq).

Table O.4.6a Result of Traffic Noise Survey

Date : 19-20 Nay 1994

Place : El Triunfo Street

Hour	Noise Level (dB(A))					volume of traffic
	Leq	L5	L50	L95	L(max)	
08:00-08:10	75.1	80.8	71.8	64.0	91.2	141
09:00-09:10	75.3	80.4	70.5	62.8	94.4	112
10:00-10:10	73.4	78.6	69.9	60.8	90.6	113
11:00-11:10	72.8	78.4	70.1	62.1	88.5	149
12:00-12:10	73.6	79.6	69.3	60.5	92.8	107
13:00-13:10	71.6	77.7	67.0	57.8	88.9	95
14:00-14:10	70.6	75.9	66.3	56.1	87.0	111
15:00-15:10	72.6	78.2	68.0	57.5	90.8	107
16:00-16:10	74.6	80.2	69.6	60.4	93.2	106
17:00-17:10	75.1	80.0	68.4	59.7	94.4	93
18:00-18:10	77.5	82.1	69.2	61.9	101.5	89
19:00-19:10	73.2	76.1	66.4	62.8	95.0	64
20:00-20:10	68.0	73.4	62.9	57.0	86.9	36
21:00-21:10	67.2	72.8	60.8	52.9	85.9	50
22:00-22:10	66.0	72.2	60.7	51.7	82.1	36
23:00-23:10	61.1	67.9	54.9	47.5	80.4	14
24:00-24:10	53.1	58.2	46.1	42.5	77.9	5
01:00-01:10	61.3	65.9	45.6	39.5	94.4	5
02:00-02:10	49.7	55.4	42.1	40.7	70.9	1
03:00-03:10	45.1	49.3	43.2	40.3	64.7	0
04:00-04:10	56.7	62.4	45.6	40.9	75.6	7
05:00-05:10	66.9	71.5	56.1	46.7	90.1	16
06:00-06:10	68.0	74.3	61.5	50.4	88.3	37
07:00-07:10	71.7	77.2	67.6	58.5	87.7	90

Note:

Leq	:	Equivalent continuous sound pressure level
L5	:	95% value of noise level on integral frequency curve of measured noise level
L50	:	50% value of noise level on integral frequency curve of measured noise level
L95	:	5% value of noise level on integral frequency curve of measured noise level
L(max)	:	Max value of measured noise level
Volume of traffic	:	The volume of traffic of section C

Table O.4.6b Result of Environmental Noise Survey

Date : 23-24 May 1994
Place : Acahualinca

Hour	Noise Level (dB(A))				
	Leq	L5	L50	L95	L(max)
08:00-08:10	57.7	59.9	44.8	38.4	82.2
09:00-09:10	57.5	53.2	39.6	36.1	86.2
10:00-10:10	43.5	48.8	38.5	35.5	72.2
11:00-11:10	47.9	54.2	43.5	39.1	69.7
12:00-12:10	47.2	51.5	43.0	39.2	74.8
13:00-13:10	44.0	46.3	41.2	37.6	69.2
14:00-14:10	51.3	48.0	42.1	37.8	78.1
15:00-15:10	52.0	56.2	45.9	41.8	81.4
16:00-16:10	50.9	52.5	41.8	38.2	81.9
17:00-17:10	56.3	62.5	48.1	42.5	76.5
18:00-18:10	53.1	58.0	47.1	42.8	76.2
19:00-19:10	51.1	56.6	45.6	41.9	74.4
20:00-20:10	45.7	48.0	40.3	38.0	72.8
21:00-21:10	45.2	47.2	39.5	35.9	68.7
22:00-22:10	46.8	48.6	38.6	35.6	73.6
23:00-23:10	45.8	49.5	39.9	36.0	69.2
24:00-24:10	52.0	57.6	39.8	36.1	80.7
01:00-01:10	56.0	57.6	46.0	38.7	86.0
02:00-02:10	45.0	49.0	38.2	34.5	73.7
03:00-03:10	49.2	48.2	37.1	33.3	80.6
04:00-04:10	57.3	61.3	41.5	35.8	83.3
05:00-05:10	50.3	54.5	38.5	33.8	74.6
06:00-06:10	48.8	54.0	39.3	35.1	73.0
07:00-07:10	48.7	52.6	39.9	36.0	78.2

Note:
- Leq : Equivalent continuous sound pressure level
- L5 : 95% value of noise level on integral frequency curve of measured noise level
- L50 : 50% value of noise level on integral frequency curve of measured noise level
- L95 : 5% value of noise level on integral frequency curve of measured noise level
- L(max) : Max value of measured noise level

O.4.7 Traffic Volume

The route used by the transportation vehicles heading towards the present Acahualinca disposal site was surveyed to determine traffic volume. The results of the survey are as outlined below.

Survey Period: the survey was carried out from May 19 to 20, 1994 for 24 hours, from 8 am until 8 am.

The results of the survey showed the traffic volume at every section of the intersection, which is shown in Table O.4.7a and outlined below.

- maximum traffic volume at sections is 9,121 vehicles/day
- maximum volume of collection vehicles is 148 vehicles/day
- the traffic of collection vehicles takes place in the morning.

Table O.4.7a Results of Traffic Volume Survey

Hour	Section A						Section B						Section C						Section D					
	S.V.	L.V.	W.C.V.	Total	Rate of L.V.	Rate of W.C.V.	S.V.	L.V.	W.C.V.	Total	Rate of L.V.	Rate of W.C.V.	S.V.	L.V.	W.C.V.	Total	Rate of L.V.	Rate of W.C.V.	S.V.	L.V.	W.C.V.	Total	Rate of L.V.	Rate of W.C.V.
	veh/h	veh/h	veh/h	veh/h	%	%	veh/h	veh/h	veh/h	veh/h	%	%	veh/h	veh/h	veh/h	veh/h	%	%	veh/h	veh/h	veh/h	veh/h	%	%
06:00-07:00	322	94	13	431	14.8	2.4	188	30	7	205	14.8	3.4	381	112	16	709	13.8	2.3	31	6	7	38	13.4	3.1
07:00-08:00	316	87	28	883	14	4.2	133	41	13	208	19.8	7.3	349	109	38	686	13.9	5.3	47	3	21	73	6.8	39.8
08:00-09:00	324	87	14	805	11.1	3.3	191	41	18	230	16.4	7.3	338	96	38	864	14.9	4.8	29	13	36	78	13.4	46.7
09:00-10:00	323	71	13	806	12.2	3	183	43	14	222	19.4	6.3	335	108	21	884	16.3	3.2	40	7	23	73	9.7	34.7
10:00-11:00	484	72	7	873	12.8	1.2	188	34	13	215	15.8	6	323	88	14	636	13.8	2.2	25	9	24	48	13.1	38.2
11:00-12:00	447	88	3	519	13.3	0.6	130	49	8	187	26.2	4.3	457	111	8	576	19.3	1.4	24	11	13	48	27.9	27.1
12:00-13:00	308	83	3	397	13.9	0.8	188	36	3	297	17.4	2.4	369	113	3	884	16.3	0.4	23	6	3	32	19.8	9.4
13:00-14:00	308	87	3	382	14.7	0.5	200	42	4	249	16.9	1.6	350	109	2	881	16.9	0.3	34	4	1	39	10.3	2.6
14:00-15:00	361	88	6	649	13.1	0	174	28	0	208	13.9	0	389	120	2	714	16.8	0.3	20	4	3	26	15.4	7.7
15:00-16:00	498	66	3	564	11.3	0.4	191	29	3	223	13	1.3	542	88	0	630	14	0	41	5	1	47	10.6	2.1
16:00-17:00	380	37	0	387	9.3	0	117	33	0	150	22	0	389	67	0	456	14.7	0	20	3	0	23	20	0
17:00-18:00	305	25	0	329	7.9	0	95	19	0	114	16.7	0	330	46	0	376	12.2	0	11	1	0	12	8.3	— 0
18:00-19:00	111	14	0	125	11.2	0	88	12	0	81	14.8	0	129	24	1	153	15.7	0.7	10	0	1	11	0	9.1
19:00-20:00	148	20	0	168	11.9	0	48	9	0	57	14	0	163	28	0	188	13.8	0	12	0	0	12	0	0
20:00-21:00	98	11	0	107	10.3	0	37	5	0	42	11.9	0	117	18	0	135	12	0	9	2	0	11	18.2	0
21:00-22:00	36	2	0	80	3.3	0	31	4	0	35	10	0	70	5	0	75	6.7	0	9	1	0	10	10	0
22:00-23:00	28	0	0	28	0	0	10	1	0	11	9.1	0	30	1	0	36	2.8	0	2	0	0	3	0	0
23:00-24:00	12	2	0	14	14.3	0	4	0	0	4	0	0	13	2	0	15	13.3	0	1	0	0	1	0	0
24:00-01:00	13	0	0	13	0	0	6	0	0	6	0	0	19	0	0	19	0	0	0	0	0	0	0	0
01:00-02:00	15	2	0	17	11.8	0	3	0	0	3	0	0	18	2	0	20	10	0	0	0	0	0	0	0
02:00-03:00	36	5	0	41	12.2	0	15	3	0	18	16.7	0	36	5	0	41	12.2	0	2	1	0	3	33.3	0
03:00-04:00	88	20	0	88	22.7	0	26	15	0	41	36.6	0	83	30	0	113	26.5	0	3	1	0	4	16.7	0
04:00-05:00	191	33	4	247	21.1	1.6	80	25	0	85	29.4	0	223	79	8	304	24.7	2	9	4	2	15	26.7	13.3
05:00-06:00	417	73	4	491	15.3	0.8	129	29	1	159	18.2	0.6	462	101	3	568	17.8	0.9	19	5	2	26	19.2	7.7
Total	6829	1061	90	8080	13.1	1.5	2300	527	88	2965	17.8	3	7310	1465	144	9121	16.1	1.6	433	89	120	657	13.5	20.5

S.V.:SMALL VEHICLE

L.V.:LARGE VEHICLE

W.H.V.:WASTE COLLECTION VEHICLE

O.4.8 Biological Environment

Nicaragua is mostly made up of forest lands, which vary in elevation and are largely divided into 4 regions in terms of temperature, rainfall pattern, topography and geology. These regions are presented in Figure O.4.8a as Ecosystem 1 (Pacific Ocean area), Ecosystem 2 (central northern area), Ecosystem 3 (central area), and Ecosystem 4 (Atlantic Ocean area). The project area, Managua city, is located within Ecosystem 1 (Pacific Ocean area).

As shown in Figure O.4.8b, the surrounding area of Managua City is classified into: a) a very hot and dry area with medium to small size deciduous leaved trees, b) a very hot and mild humid area with medium to small size deciduous leaved trees, c) a cool and humid area with medium size deciduous leaved trees. Area a) is located in the lowlands along Managua Lake, while area b) is located south of the city of Managua, at an elevation of 50 – 200m, in the surrounding area of the lake where the temperature is slightly cool. The third area, c), is located at an elevation of 200 – 500m. The various biological species in these areas are described in the compiled data (refer to attachment of ANNEX O).

Figure O.4.8c shows the areas in Nicaragua restricted for development. Table O.4.8a shows the 4 divided areas of Managua City and its surroundings. The proposed final disposal site is not located within any of the areas restricted for development.

Table O.4.8a The Areas in Managua City and its Surrounding Restricted for Development

No.	Area Name	Area Mea-sure-ment (ha)	Legal Number	Designated Year, Month and Day	Targets
9	Peninsula de Chiltepe	1,800	#1320	9/8/1983	Tropical trees, crater lake, ecological system of animals
10	Laguna de Tiscapa	40	#42.91	11/4/1991	Landscape, water resources
11	Laguna de Asososca	140	#42.91	11/4/1991	City drinking water supply resource,landscape
12	Laguna de Nejapa	220	#42.91	11/4/1991	Landscape, water resources

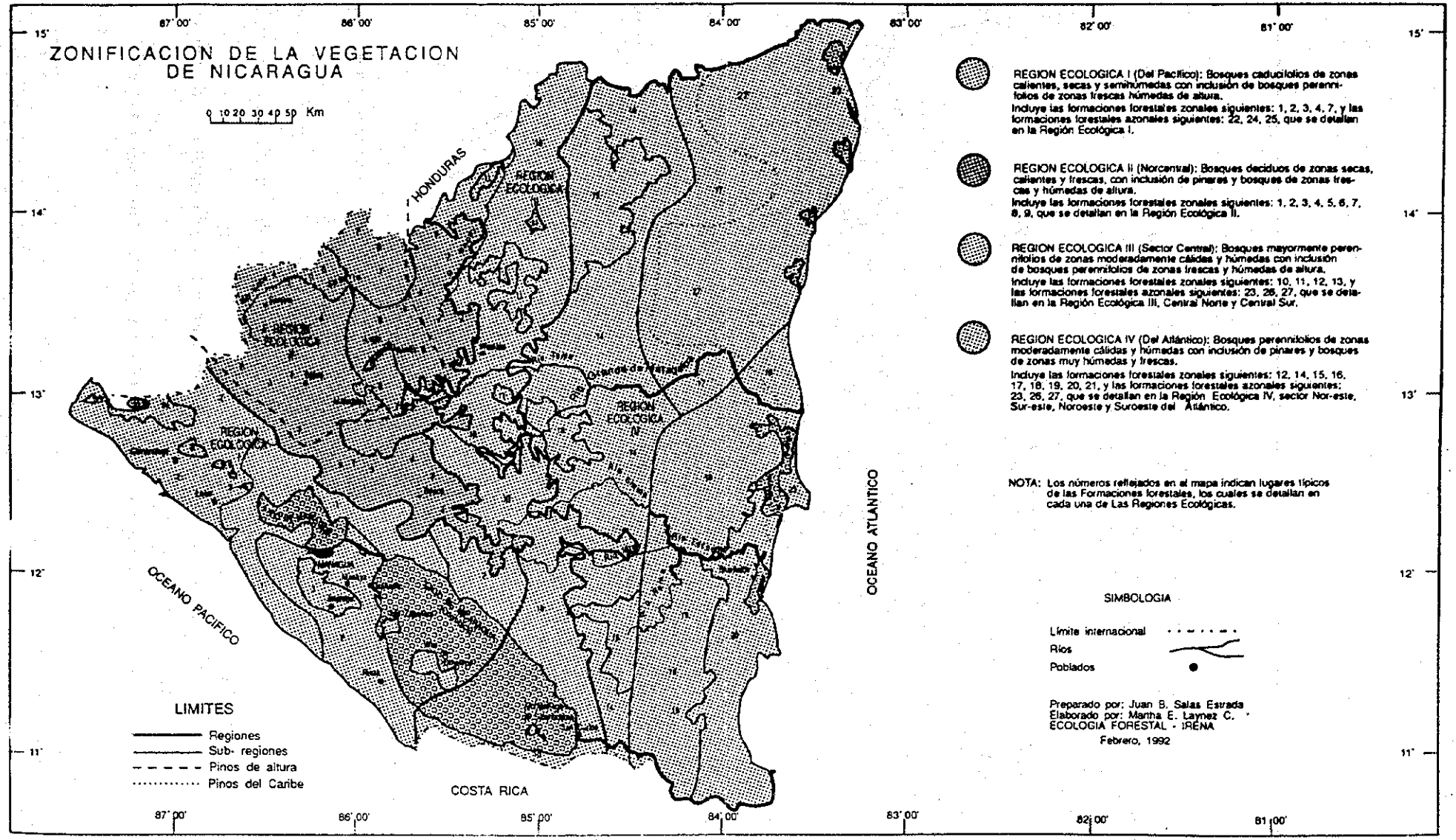


Figure O.4.8a Vegetation map in Nicaragua

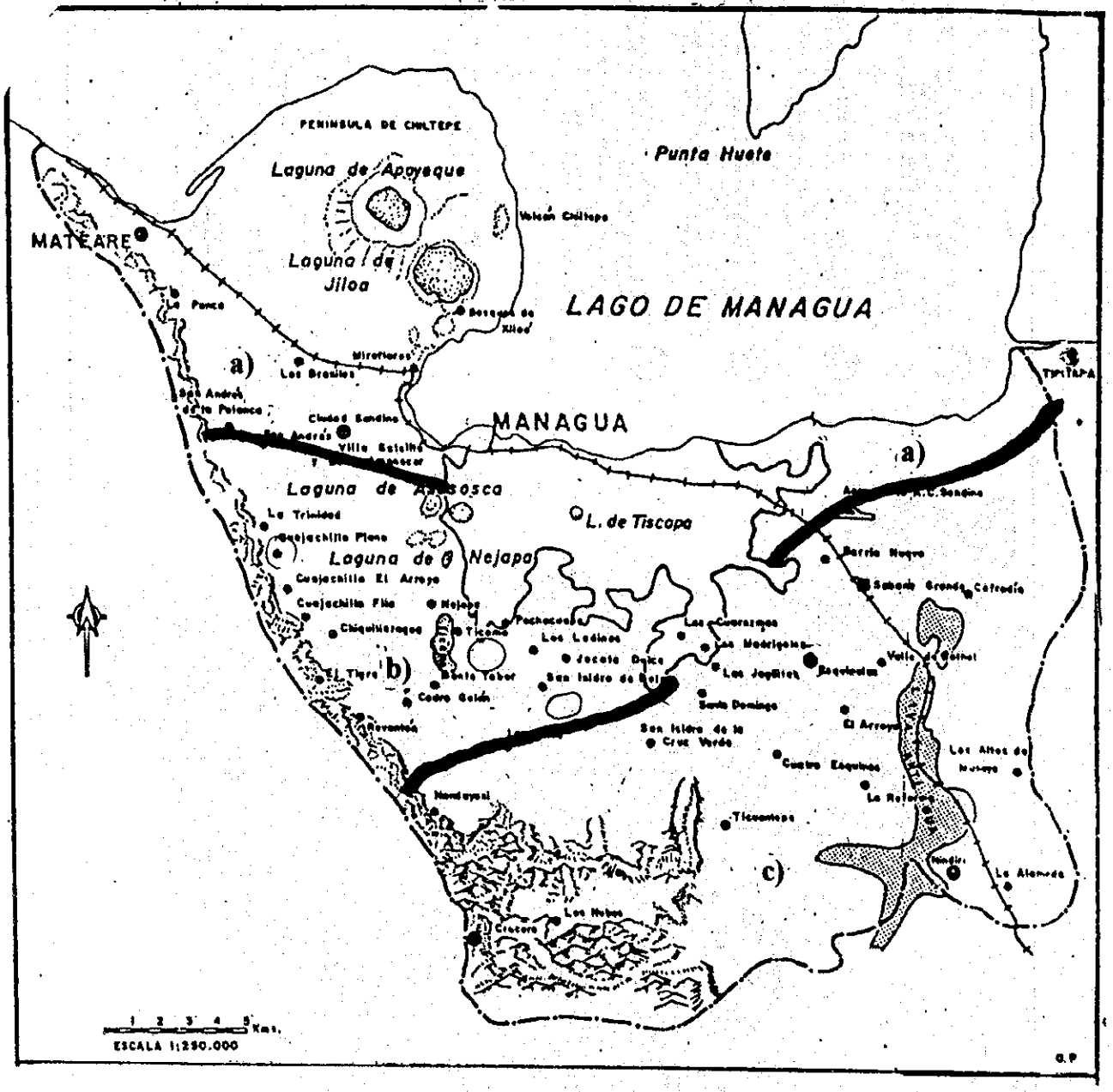


Figure O.4.8b Map of vegetal formation in Managua

a) Very hot and dry forest area with medium to small size deciduous leaved trees

b) Very hot and mild humid forest area with medium to small size deciduous leaved trees

c) Cool and humid forest area with medium size deciduous leaved trees

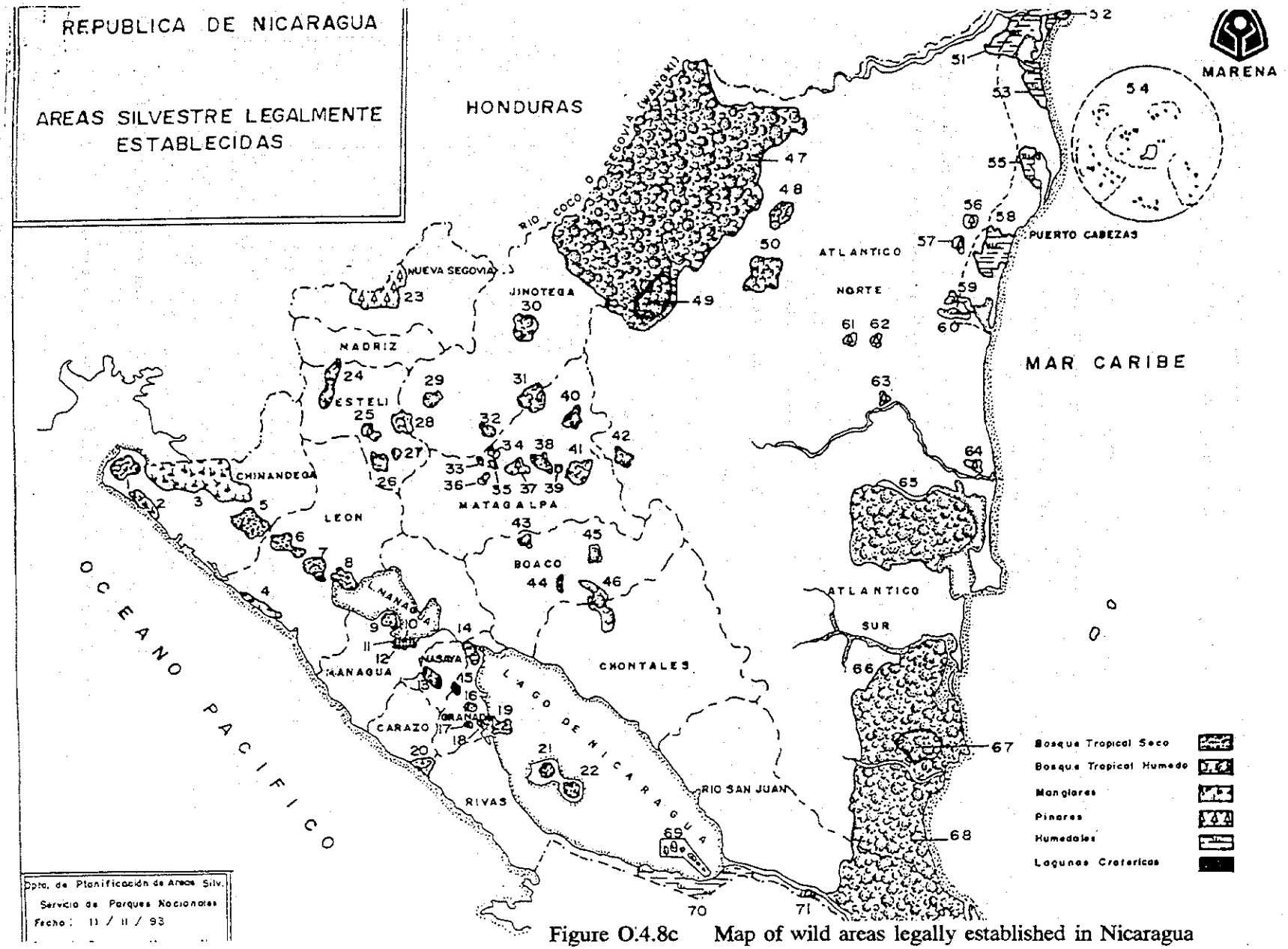


Figure O.4.8c Map of wild areas legally established in Nicaragua

O.4.9 Population of the Study Area

The Study Area covers the whole area under the administration of the Municipality of Managua (ALMA), and is composed of 7 districts: D1, D2, D3, D4, D5, D6 and D7.

The municipal area covers 540 km2, while the city (urbanized area) extends over 250 km2. The value used here to represent the present population of the municipality of Managua is an estimate. The last national census was taken in 1971, before the 1972 earthquake which destroyed the central area of the city.

The 1994 population of the municipal area is based on electoral registration data given by CSE and arranged by the Study Team together with the population data provided by the Planning Head Office of ALMA.

Based on these data, the municipality of Managua is estimated to have a population of about 1.07 million in 1994. The population of the urban and rural areas is estimated at 834 thousands and 237 thousands, respectively. Almost 78% of the population live in the urban area, while 22% live in the rural area. The most densely populated districts are D4 and D2 with 12,325 persons/km^2 and 7,222 persons/km^2 respectively. D1 and D7 are the least densely populated with 1538 persons/km^2 and 62 persons/km^2, respectively (refer to Table O.4.9a).

Table O.4.9a Present Population, Density, Household (1994)

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

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

1) 31.6% of rural population was added to district D1
2) Part of district D7; population based on CSE data was divided into D3 & D5 rural population
3) Population provided by ALMA was used for district D7

O.4.10 Land Use

Land use conditions presented herein includes the urban area of Managua (refer to Figure O.4.10a), where the development of low rise buildings is occurring at a rapid pace. According to the Town Planning Head Office of ALMA, 58% of the urban area is for residential use. Commercial and service facilities are also constructed within the residential housing area. The number of housing settlements (especially spontaneous settlements) has increased considerably in recent years, adversely affecting the environment and the majority of the population.

The city is divided into six industrial zones, mainly along North Avenue and the access road to Leon. Industries were established along North Avenue during the centro-American Common Market due to accessibility, proximity to the airport, and easy disposal of waste into the lake. Although 80% of Nicaragua's industries are in Managua, these industries only cover 4% of the urban land of the latter.

Service areas refer to institutional buildings, e.g., health, administration, schools, transportation and storage, and occupies the second land use category(17.7%). Some of these establishments are constructed along the main roads, while some are scattered here and there due to a lack of a central configuration in the city. Vacant areas occupy 8.8% of the total urban land, green areas 1.23% and recreation 0.44%.

Table O.4.10a Land Use Area

LAND USE	Total Urbanized Area	
	Area (ha)	Area (%)
Housing	5,495.16	58.01
Industry	386.00	4.07
Commercial	196.75	2.08
Service	1,678.56	17.71
Sport	41.65	0.44
Green Area	116.27	1.23
Military	148.24	1.56
Vacant	830.68	8.77
Agriculture	254.68	2.69
Road	265.29	2.80
Others	60.30	0.64
Total	9,473.58	100

Source: Town Planning Head Office, ALMA

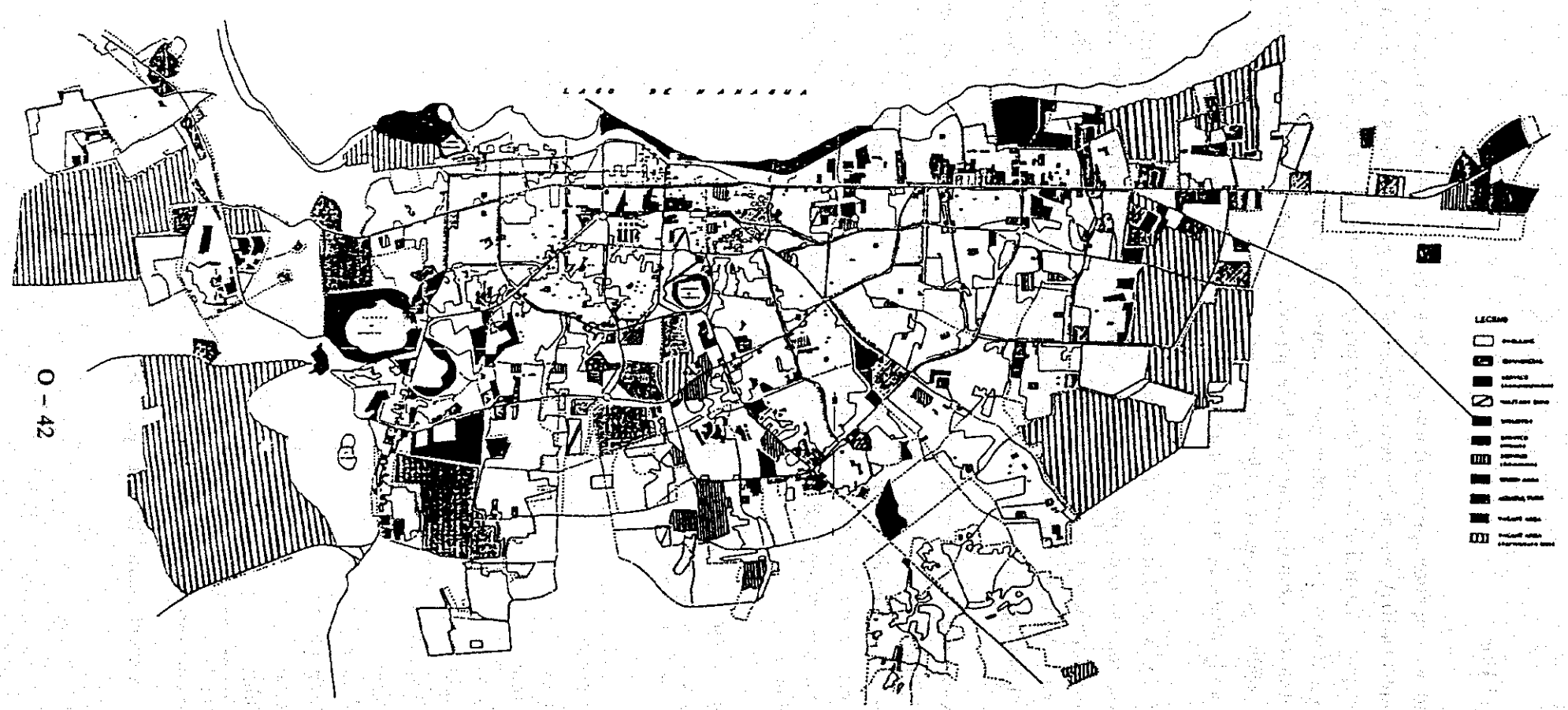


Figure O.4.10a Land Use in the Urban Area

O.4.11 Employment

The employment condition in Managua is shown in Table O.4.11a.

Table O.4.11a Indicators of Employment in Nicaragua and Managua

(Unit : person)

	Nicaragua		Managua	
	1991	1992	1992	1993
Total Population	3,999,200	4,130,700		920,737
Economically Active Population	1,386,300	1,445,400		375,870
Employment	1,192,100	1,211,100		321,745
Primary Sector	415,400			16,087
Secondary Sector	227,400			64,349
Manufacturing	188,200			41,827
Construction	30,200			22,200
Mining	9,000			322
Tertiary Sector	549,300			241,309
Commerce	195,500			86,871
Transport & Communication	42,600			21,477
Finance	24,700			10,618
Electricity,gas & water supply	10,300			4,102
Other services	276,200			118,241
Unemployment	194,200	234,300		54,125
Underemployment	722,000	781,200		163,503
Percentage of Unemployment (%)	14.0	16.2	18.8	14.4
Percentage of Underemployment (%)	52.0	54.0	35.7	43.5

Source: ALMA

FIDEG Condiciones de Vida de la Poblacion Urbana de Managua

BCN Informe Anual 1992

INEC Compendio Estadistico 1987-1991

The figures in the Table pointed out the following:

- Unemployment and underemployment rate in 1993 is lower than the national figures. The FIDEG survey showed a different figure, 18.0%, for unemployment.
- The situation in 1993 was worse than in 1992.

O.4.12 Industries

Although it is difficult to get any statistics on the industries of Managua, particularly data on the volume of production and sales, it is said that about 80.7% of the manufacturing industries of Nicaragua are in Managua. According to the data given by MEDE, a total of 2,097 manufacturing industries are established in Managua, 60 of which have more than 50 employees.

The various manufacturing industries are as follows:

- Food, Beverage & Tobacco
- Textiles & Apparel
- Chemical & Chemical Product
- Wood & Furniture, and
- Paper, Printing & Publishing

The large international corporations located in Managua are as follows: Casa Pellas, Coca Cola, Pepsi Cola, Cerveceria Tona, Induquinisa, Cerveceria Victoria, Tanic, Cementera, Chevron, Texaco, Esso, Tropigas, Shell, Esso Gas, Kola Shaler and Fosforera.

O.5 Evaluation and Environmental Protection Measures

O.5.1 Evaluation Method

Each project, except for the promotion of public awareness, cooperation and participation, was evaluated in terms of their environmental impact based on the items set up by using the Matrix for Scoping of JICA.

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

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

O.5.2 Evaluation of the Project for the Improvement of the Collection and Public Area Cleansing System

a. Assessment Method

The habitat factors subject to EIA were determined by forming a matrix showing their relationship with the environmental impact factors of the project, based on the details of the Project and the surrounding environmental condition. Matrix is shown in Table O.5.2a.

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

b. Project Outline

ba. Collection Area Expansion

The 1994 collection rate was 76%. The target collection rate for 2000 is 90% and 100% for 2010.

bb. Establishment of Public Cleansing System

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

bc. Establishment of Adequate Operation and Maintenance System

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

Table O.5.2a Matrix of environmental impacts and factors

	Air Quality	Water Quality	Soil Contamination	Noise	Vibration	Land Subsidence	Offensive Odor	Meteorology	Topographical and Geological Feature	Soil Erosion	Ground Water	Hydrological Situation	Flora and Fauna	Landscape	Resettlement	Economic Activities	Traffic and Public Facilities	Split of Community	Water right and Right of Common	Public Health condition	Waste	Disaster	Sunny Condition	Radio wave condition	Traffic safety	Damage by wind
Operation of New Collection Vehicles				*	*																					
Construction of New Waste Disposal Site							*																			

Note: * Not significant adverse environmental impact

c. Determination of Habitat Factors and Environmental Impacts Factors

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

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

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

ca. Air pollution:

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

cb. Noise:

The small number of collection vehicles to be operated in this area will not effect considerable noise.

cc. Vibration:

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

cd. Offensive Odor:

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

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

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