ec. Triaxial Compression Test

The triaxial unconsolidated undrained test (UU) was carried out. The results of the calculations of the specific values of the test carried out as well as unitary Stress Strain Curves in % - Stress are shown in the report "INFORME DE ESTUDIO GEOTECNICO" prepared by the Study Team.

ed. Consolidation Test

The "Time-Settlement" curves were drawn for each test carried out. The curves show the data from the extensometer reading as well as the recording time for every increase or decrease in load. Moreover, the data was calculated to prepare the curve, "Pressure-Vacuum Relationship.

Based on the compressibility curve of each sample, the pre consolidation load was determined following the empirical method. The results of the consolidation test are shown in the table below.

Table D.1.2b Consolidation Test Result

	Asososca Lake	Las Brisas Well	Borehole No. 1	Borehole No. 2	Borehole No. 3	Borehole No. 4	Borehole No. 5	Managua Lake
Maximum Recorded Level	36.5		37.48	37.37	35.77	39.43	35.89	
Minimum Recorded Level	36.22		37.08	36.65	35.77	36.31	35.88	
Average Level[5]	36.35	37.10	37.18	36.87	35.77	38.90	35.88	35.77
Dynamic Level		28.87						

Note: The average level is calculated by adding all levels divided by the reading frequency.

D.1.3 Environmental Survey on Present Landfills

The environmental survey was conducted to determine the present environmental condition of the disposal site. The environmental survey consists of water quality survey, sediment survey, ambient survey, noise survey, traffic volume survey and land use survey.

a. Water Quality and Sediment Survey

aa. Objectives of the Survey

The objectives of the water quality and sediment survey are to determine the present quality of:

- leachate discharged from the existing final disposal site,
- ground water near the existing disposal site,
- lake water near the existing disposal site and,
- lake sediment near the existing disposal site.

ab. Location of Sampling Points

The samples were taken from selected areas within the existing disposal site.

Location of the sampling points are shown in Figure D.2.1a.

ac. Analysis Items

The following items were analyzed:

- with regards to public health: Pb, As, Cd, Cr^{+6} , Hg, PCB, Cu
- others
  pH, COD, BOD, Total Nitrogen(T-N), SO_4^{-2} . Cl^-
- sediment
  Cu, Zn, Cd, As, SS, P, Pb, Hg

ad. Analysis Method

The water and sediment quality analyze were carried out in accordance with the "Standard Methods for the examination of water and wastewater including bottom sediments and sludges", 18th edition, New York, APHA-AWWA-APCF.

APHA : American Public Health Association
AWWA : American Water Works Association
WPCF : Water Pollution Control Federation

ae. Dates of Sampling

Sampling, except in boring holes, was carried out twice on the following days:

- 1st sampling: 2 and 3 June 1994
- 2nd sampling: 17 June 1994

The extraction of samples from boring holes was carried out from 7 May to 14 June 1994
Sediment sampling was carried out on 2 June 1994.

af. Results of Water Quality and Sediment Analysis

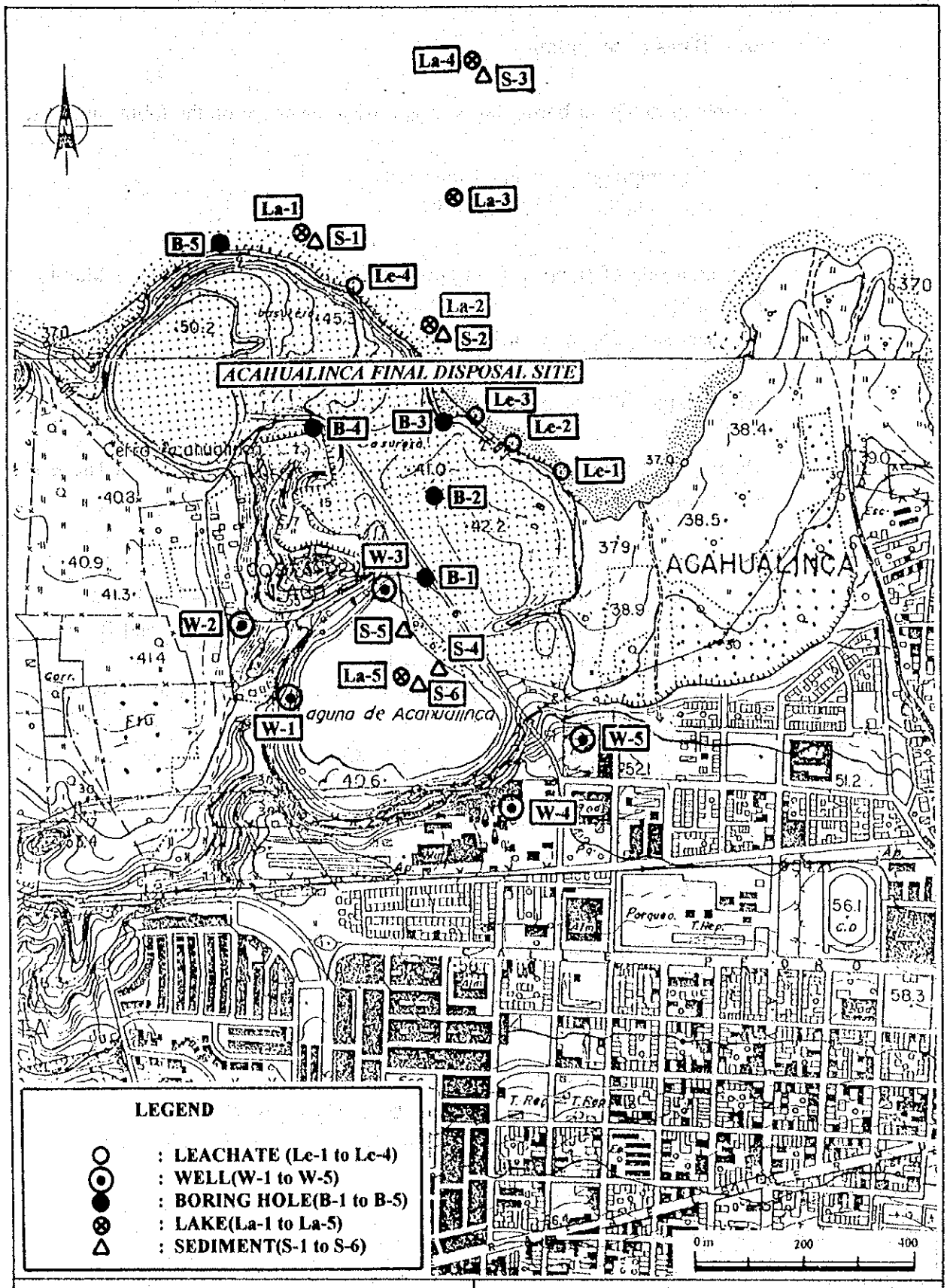
The results of the water quality analysis are presented in Table D.2.1a. The results are summarized as follows:

- Cd, Cr^{+6} and PCB were not detected.
- Pb was detected in most water samples except B-1, B-2 and B-4.
- As was detected in most water samples except W-1, W-2 and B-4.
- Hg was detected in all water samples.
- Cu was detected in most water samples except Le-1, Le-4, W-2, W-3, W-4 and B-4.
- The concentrations of COD, SO_4^{-2}, Cl^- and T-N were high in Leachate water.
- A high BOD concentration was detected in lake water.
- The minimum and maximum values detected are summarized in Table D.1.3b.

The results of the lake sediment analysis are presented in Table D.2.1c.

The results are summarized as follows:

- Cd was not detected
- Other items, except Zn for S-2 and S-4, were detected
- The value of Cu and P in Lake Acahualinca is higher than the value in Lake Managua



THE STUDY ON THE IMPROVEMENT OF THE SOLID WASTE MANAGEMENT SYSTEM FOR THE CITY OF MANAGUA
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure D.1.3a

Map of Water Quality Survey Point

Table D.1.3a Result of Water Quality Analysis

Number of Sampling Point	Date of Sampling	Type of Water	Water Temperature C	pH	COD mg/l	BOD mg/l	SO4-2 mg/l	Cl- mg/l	T-N mg/l	Pb mg/l	As mg/l	Cd mg/l	Cr+6 mg/l	Hg mg/l	PCB ng/l	Cu mg/l
Le-1	2 JUN 1994	Leachate	31	7.5	136	47	2900	245	8.34	0.1	0.01	n.d	n.d	0.04	n.d	n.d
	17 JUN 1994	Leachate	30	7.8	276.5	40	625	110	6	0.05	n.d	n.d	n.d	0.05	n.d	n.d
	Average		30.5	7.7	206.25	43.5	1762.5	177.5	7.17	0.075	0.005	n.d	n.d	0.045	n.d	n.d
Le-2	2 JUN 1994	Leachate	36	7.9	296	112	2300	786	40.3	0.14	0.02	n.d	n.d	0.07	n.d	0.032
	17 JUN 1994	Leachate	32	8.1	371	132	2250	619	31.8	0.03	n.d	n.d	n.d	0.044	n.d	0.037
	Average		34	8.0	334.5	122	2275	703.5	36.05	0.085	0.01	n.d	n.d	0.057	n.d	0.0345
Le-3	2 JUN 1994	Leachate	33	7.3	2273.3	84	2050	519	95.2	0.06	0.04	n.d	n.d	0.11	n.d	0.051
	17 JUN 1994	Leachate	30	7.4	998.4	20	1125	424	44.1	0.03	0.01	n.d	n.d	0.4	n.d	0.06
	Average		31.5	7.4	1635.9	42	1587.5	471.5	69.65	0.045	0.025	n.d	n.d	0.255	n.d	0.0555
Le-4	2 JUN 1994	Leachate	32	7.8	163	40	2050	1357	90.7	n.d	n.d	n.d	n.d	n.d	n.d	n.d
	17 JUN 1994	Leachate	34	7.5	200	40	2450	1013	112	0.11	0.01	n.d	n.d	0.14	n.d	n.d
	Average		33	7.7	181.5	40	2250	1185	101.35	0.055	0.005	n.d	n.d	0.07	n.d	n.d
W-1	2 JUN 1994	Well	29	7.6	54	28	550	74.4	8.1	0.06	n.d	n.d	n.d	n.d	n.d	0.008
	17 JUN 1994	Well	29	7.3	26	15	310	125	3.03	n.d	n.d	n.d	n.d	0.011	n.d	0.006
	Average		29	7.5	40	21.5	430	99.7	5.565	0.04	n.d	n.d	n.d	0.0055	n.d	0.007
W-2	2 JUN 1994	Well	31	7.9	1593	12	875	184	1.7	0.03	n.d	n.d	n.d	0.011	n.d	n.d
	17 JUN 1994	Well	30.5	7.8	77	10	140	229	1.22	n.d	n.d	n.d	n.d	0.11	n.d	n.d
	Average		30.75	7.9	835	11	507.5	206.5	1.46	0.015	n.d	n.d	n.d	0.0605	n.d	n.d
W-3	2 JUN 1994	Well	29.5	7.7	71	72	1012	100	43.3	0.04	0.01	n.d	n.d	0.1	n.d	n.d
	17 JUN 1994	Well	29	7.6	65	20	625	97.3	47.8	0.12	0.02	n.d	n.d	0.09	n.d	n.d
	Average		29.25	7.7	68	46	818.5	98.65	45.55	0.08	0.015	n.d	n.d	0.095	n.d	n.d
W-4	2 JUN 1994	Well	33	7.7	121.9	4.6	800	70	0.8	0.09	0.01	n.d	n.d	0.033	n.d	n.d
	17 JUN 1994	Well	31	7.8	25	4	950	99.8	1.1	0.06	n.d	n.d	n.d	0.04	n.d	n.d
	Average		32	7.8	73.45	4.3	875	84.9	0.85	0.075	0.005	n.d	n.d	0.0365	n.d	n.d
W-5	2 JUN 1994	Well	29.5	7.8	326	26	1150	63.4	0.34	0.03	0.02	n.d	n.d	0.27	n.d	0.057
	17 JUN 1994	Well	30	7.8	32.6	28	1525	110	0.73	0.07	0.01	n.d	n.d	0.02	n.d	0.053
	Average		29.75	7.8	179.3	27	1337.5	86.7	0.535	0.05	0.015	n.d	n.d	0.145	n.d	0.055
B-1	18 MAY 1994	Boring Hole	34	7.7	79	44	950	120	0.47	n.d	0.03	n.d	n.d	0.39	n.d	0.049
	19 MAY 1994	Boring Hole	32	7.0	110	40	625	175	50.1	n.d	0.01	n.d	n.d	0.05	n.d	0.08
	Average		33	7.4	94.5	42	787.5	147.5	25.285	n.d	0.02	n.d	n.d	0.22	n.d	0.0645
B-2	18 MAY 1994	Boring Hole	35	7.8	85.3	48	825	125	0.8	n.d	0.03	n.d	n.d	0.27	n.d	0.103
	31 MAY 1994	Boring Hole	34	7.8	72.8	32	1150	135	4.7	n.d	0.02	n.d	n.d	0.08	n.d	n.d
	Average		34.5	7.8	79.05	40	987.5	130	2.75	n.d	0.025	n.d	n.d	0.175	n.d	0.0515
B-3	24 MAY 1994	Boring Hole	30	7.7	93.6	44	3800	264	10.2	0.02	0.01	n.d	n.d	0.04	n.d	0.036
	27 MAY 1994	Boring Hole	31	7.9	214	36	1000	105	0.8	n.d	0.01	n.d	n.d	0.07	n.d	0.05
	Average		30.5	7.8	153.8	40	2400	184.5	5.5	0.01	0.01	n.d	n.d	0.055	n.d	0.043
B-4	6 JUN 1994	Boring Hole	35	7.8	245	16	1400	90	5.04	n.d	n.d	n.d	n.d	0.044	n.d	n.d
	14 JUN 1994	Boring Hole	35	7.7	588	40	1400	160	7.2	n.d	n.d	n.d	n.d	0.044	n.d	n.d
	Average		35	7.7	416.5	28	1400	125	6.12	n.d	n.d	n.d	n.d	0.044	n.d	n.d
B-5	1 JUN 1994	Boring Hole	28	7.8	132	40	1850	833	19.9	0.02	0.03	n.d	n.d	0.14	n.d	0.052
	6 JUN 1994	Boring Hole	32	7.7	979.2	33.3	3500	649	14.7	0.02	n.d	n.d	n.d	n.d	n.d	0.056
	Average		30	7.7	555.6	36.65	2575	741	17.3	0.02	0.015	n.d	n.d	0.07	n.d	0.054
La-1	2 JUN 1994	Lake	30	9.1	104	38	700	265	10.5	0.03	0.02	n.d	n.d	0.12	n.d	0.069
	17 JUN 1994	Lake	30	8.5	353	70	900	265	17.6	0.01	n.d	n.d	n.d	0.02	n.d	0.065
	Average		30	8.8	228.5	54	800	265	14.05	0.02	0.01	n.d	n.d	0.07	n.d	0.067
La-2	2 JUN 1994	Lake	32	7.8	1190	60	600	210	24.3	0.1	0.04	n.d	n.d	0.11	n.d	0.061
	17 JUN 1994	Lake	31	8.0	829	55	480	225	33.8	n.d	0.05	n.d	n.d	0.4	n.d	0.063
	Average		31.5	7.9	1009.5	57.5	540	217.5	28.95	0.05	0.045	n.d	n.d	0.255	n.d	0.062
La-3	2 JUN 1994	Lake	32	9.3	98	53	600	394	5.2	0.08	0.01	n.d	n.d	0.07	n.d	0.036
	17 JUN 1994	Lake	31	9.4	260	30	825	389	6.1	0.01	n.d	n.d	n.d	n.d	n.d	0.03
	Average		31.5	9.4	179	41.5	712.5	391.5	5.65	0.045	0.005	n.d	n.d	0.035	n.d	0.033
La-4	2 JUN 1994	Lake	32	9.5	96	30	700	374	3.7	0.07	0.02	n.d	n.d	0.07	n.d	n.d
	17 JUN 1994	Lake	31	9.4	136	20	875	369	5.42	n.d	n.d	n.d	n.d	0.011	n.d	0.005
	Average		31.5	9.5	117	25	787.5	371.5	4.56	0.035	0.01	n.d	n.d	0.0405	n.d	0.0025
La-5	2 JUN 1994	Lake	26.5	7.2	441	40	250	39.4	3.1	n.d	0.01	n.d	n.d	0.12	n.d	0.166
	17 JUN 1994	Lake	29	7.0	501	26	450	75	8	0.01	0.01	n.d	n.d	0.06	n.d	0.15
	Average		26.75	7.1	471	34	350	57.2	5.55	0.005	0.01	n.d	n.d	0.09	n.d	0.158

n.d : no detected

Table D.1.3b Maximum and Minimum Value of Water Quality Analysis

Type of Water		Water Temperat C	pH	COD mg/l	BOD mg/l	SO4-2 mg/l	Cl- mg/l	T-N mg/l	Pb mg/l	As mg/l	Cd mg/l	Cr+6 mg/l	Hg mg/l	PCB ng/l	Cu mg/l
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
Well	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	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
hole	Minimum	28	7	72.8	16	625	90	0.47	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Lake	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

n.d : no detected

Table D.1.3c Result of the Sediment Analysis

Number of Sampling Points	Cu mg/l	Zn g/l	Cd mg/l	As mg/l	Pb mg/l	Hg mg/l	P mg/l	SS mg/l
S-1	0.086	3.3	n.d	0.07	0.27	0.45	n.d.	372
S-2	0.128	n.d.	n.d	0.02	0.15	0.28	700	324
S-3	0.020	6.3	n.d	0.05	0.33	0.53	980	3494
average	0.078	3.2	0	0.05	0.25	0.42	560	1397
S-4	0.405	n.d.	n.d	0.06	0.20	0.38	1550	1536
S-5	0.030	5.8	n.d	0.09	0.13	0.12	1950	3365
S-6	0.240	1.6	n.d	0.08	0.16	0.25	850	9104
average	0.225	2.5	0	0.08	0.16	0.25	1450	4668

S-1 to S-3 ; Lake Managua
S-4 to S-6 ; Lake Acahualinca

b. Ambient Survey

ba. Objectives of the Survey

The objective of the survey is to determine the effects of operations near and at the disposal site on the atmosphere.

bb. Location of the Survey

The survey was carried out at the existing disposal site. The location of the survey is shown in Figure D.2.2a.

bc. Analysis Items

The following items were analyzed:

- dust
- suspended particular matter (SPM)
- ammonia
- methane

bd. Analysis Method

Each item was analyzed in accordance with the following method

- Dust
  The value of dust was measured using a plastic pan which was fixed by metal fittings 2.5 m above ground level. The dust fall amount for 7 days was considered as amount for 30 days.

- SPM
  The value of SPM was measured by the difference in weight of the filter before and after the experiment. The result of the SPM was given a total value of 7 days.

- Ammonia
  Ammonia was detected by using a test tube.

- Methane
  Methane analysis was carried using a portable Analyzer of combustible gas.

be. Survey Period

The survey was carried out during the following periods:

- Dust fall and suspended particulate matter:
  from 26 May to 2 June 1990.
- Ammonia and methane:
  24 June 1994

bf. Results of the Ambient Survey

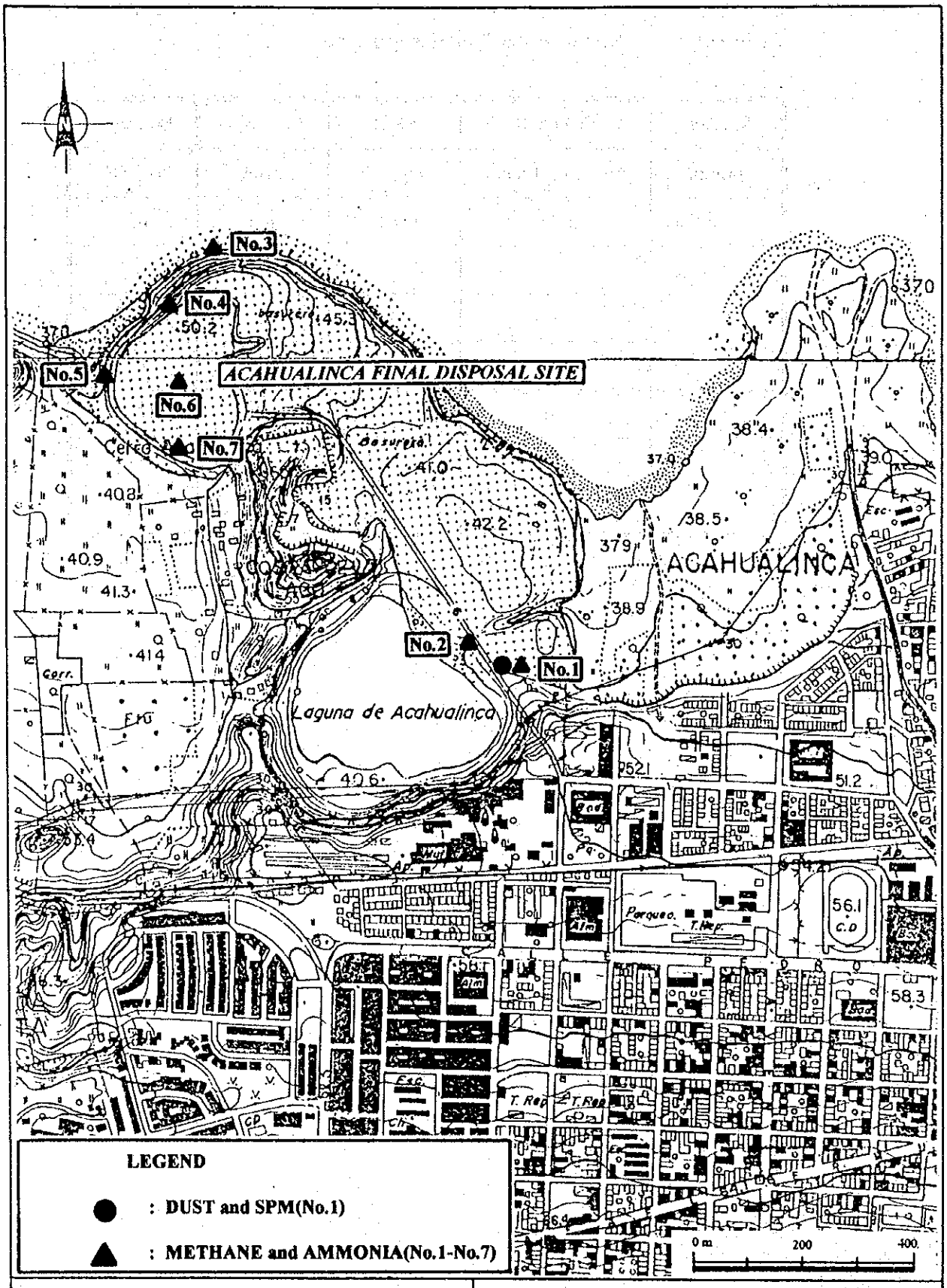
The results of the ambient survey are presented in Table D.1.3d and summarized as follows:

- The value of dust fall was 0.77 $g/cm^2/30days$
- The value of S.P.M. was 0.13 mg/m^3
- Ammonia was not detected
- Methane data ranges from 0.0 vol% to 0.5 vol%

Table D.1.3d Result of Air Pollution Analysis

Survey	Dust fall	SPM	Ammonia	Methane
points	$mg/cm^3/30days$	mg/m^3	ppm	vol %
1	0.77	0.13	n.d	n.d
2	–	–	n.d	n.d
3	–	–	n.d	n.d
4	–	–	n.d	0.5
5	–	–	n.d	0.4
6	–	–	n.d	n.d
7	–	–	n.d	n.d

n.d : not detected



THE STUDY ON THE IMPROVEMENT OF THE SOLID WASTE MANAGEMENT SYSTEM FOR THE CITY OF MANAGUA
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure D.1.3b

Map of Ambient Survey Point

c. Noise Survey

ca. Objectives of the Survey

This survey was carried out to determine the present noise level around the landfill site caused by the landfill operation, and in the vicinity due to the volume of traffic.

cb. Location of the survey point

The survey was carried out near the existing disposal site and the intersection of Triunfo Street and 27th avenue northwest, because most of the heavy equipment and waste collection vehicles operate in this site. Waste collection vehicles pass the intersection regularly also.

The survey points are shown in Figure D.2.3a.

cc. Survey Items

The level of noise around the landfill site including noise of heavy equipment and trucks was measured. The measured noise level near the intersection included noise of common vehicles and waste collection vehicles.

cd. Survey Method

- Instruments used : Noise meter(RION NL-04)
- Survey Time : Every 5 seconds for 10 minutes of every hour, for 24 hours

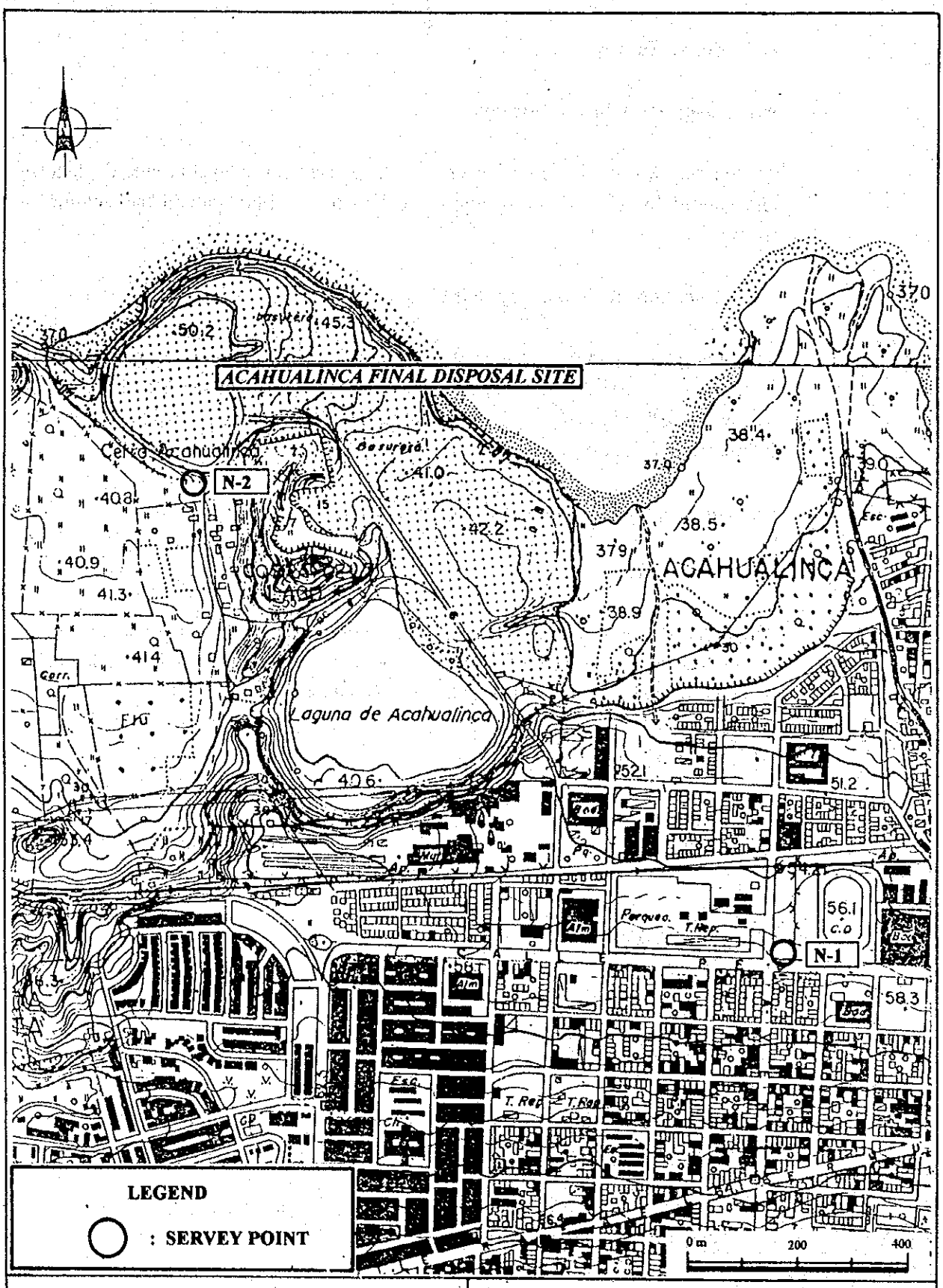
ce. Survey Period

The survey was carried out from 8:00am of May 19 until 7:10am of May 20 1994.

cf. Results of the Survey

The survey results are shown in Tables D.2.3a and b and Figures D.2.3b and c. The results are summarized as follows:

- The values of Leq range between 77.5 and 45.1 dB(A) at N-1 and between 57.7 and 43.5 dB(A) at N-2.
- The noise level at N-1 fluctuate in relation to traffic volume.
- The fluctuation of noise level at N-2 was not irregular.



THE STUDY ON THE IMPROVEMENT OF THE SOLID WASTE MANAGEMENT SYSTEM FOR THE CITY OF MANAGUA
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure D.1.3c

Map of Noise Survey Points

Table D.1.3e Result of Noise Survey of N-1

Date : 19-20 May 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

* The volume of traffic: section C

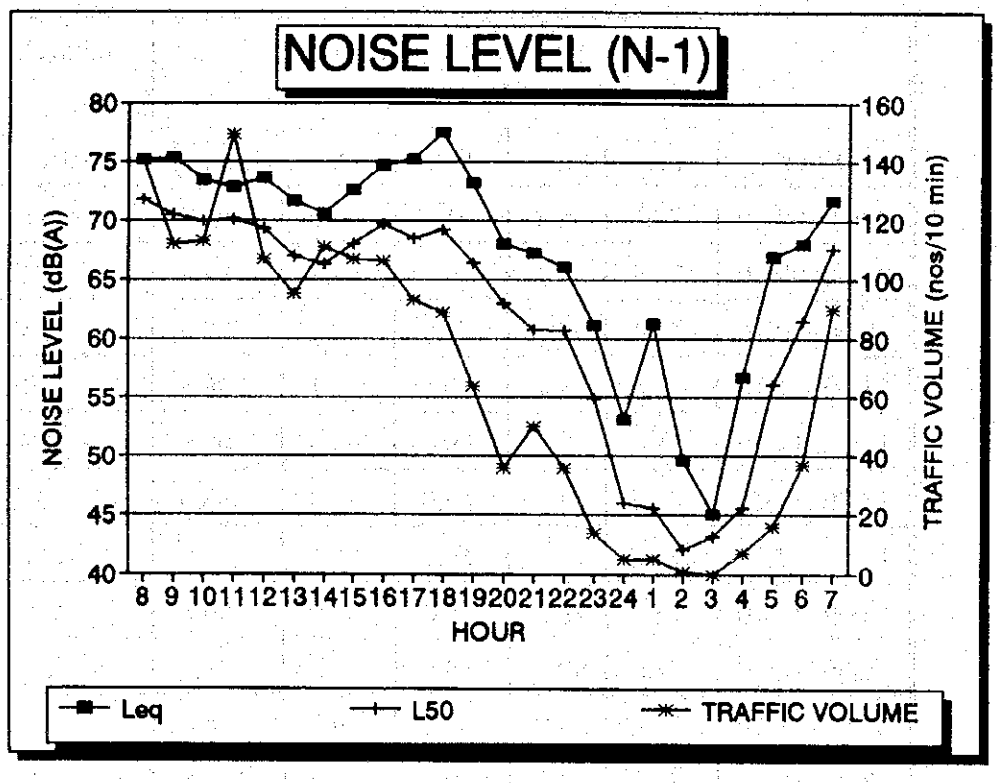


Figure D.1.3d Result of Noise Survey of N-1

Table D.1.3f Result of Noise Survey of N-2

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

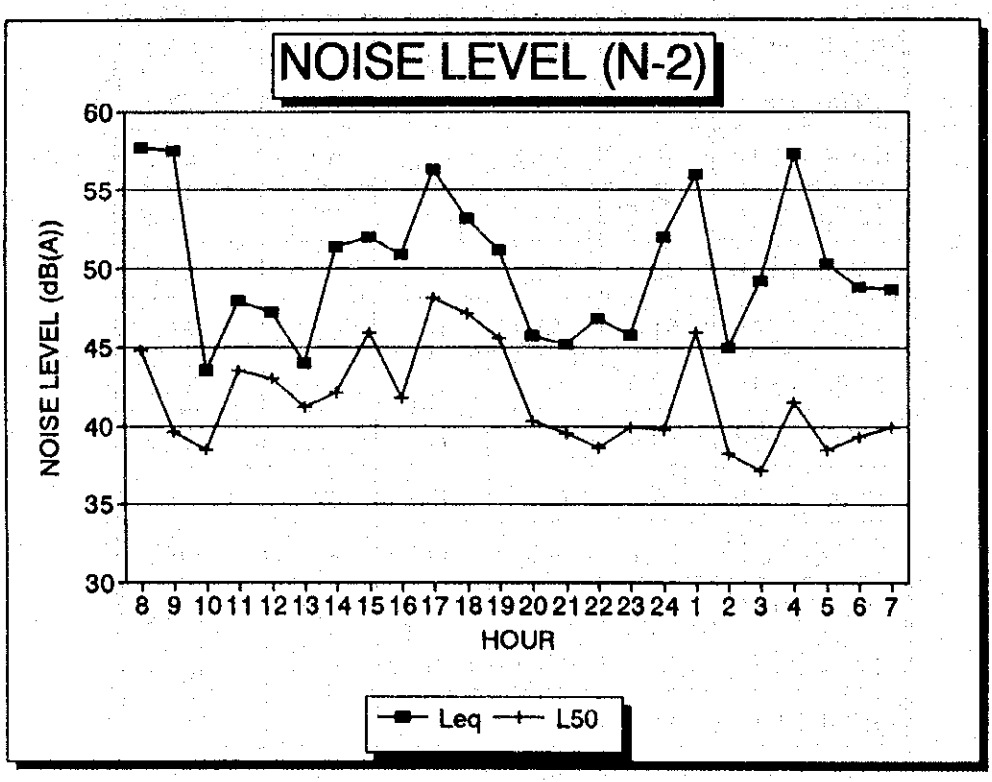


Figure D.1.3e Result of Noise Survey of N-2

d. Traffic Volume Survey

da. Objective of the Survey

The objectives of the traffic volume survey are:

- to determine the impact of waste collection vehicles on the traffic
- to determine the time fluctuations in traffic volume to formulate the collection and haulage plan

db. Location of the Survey

The traffic volume survey was carried out at the intersection of Triunfo Street and 27th Avenue northwest. The recycling center is near the intersection. Most waste collection vehicles pass the intersection on the way to the existing disposal site and the recycling center. The location is shown in Figure D.2.4a.

dc. Vehicle Category

The vehicles are measured according to the following three categories:

- large vehicles
- small vehicles
- waste collection vehicles

dd. Survey Method

The traffic volume was measured by counting the number of vehicles in passage.

de. Time of the Survey

The traffic volume survey was carried out from 8:00am of May 19 until 8:00 am of May 20 1994.

df. Results of the Survey

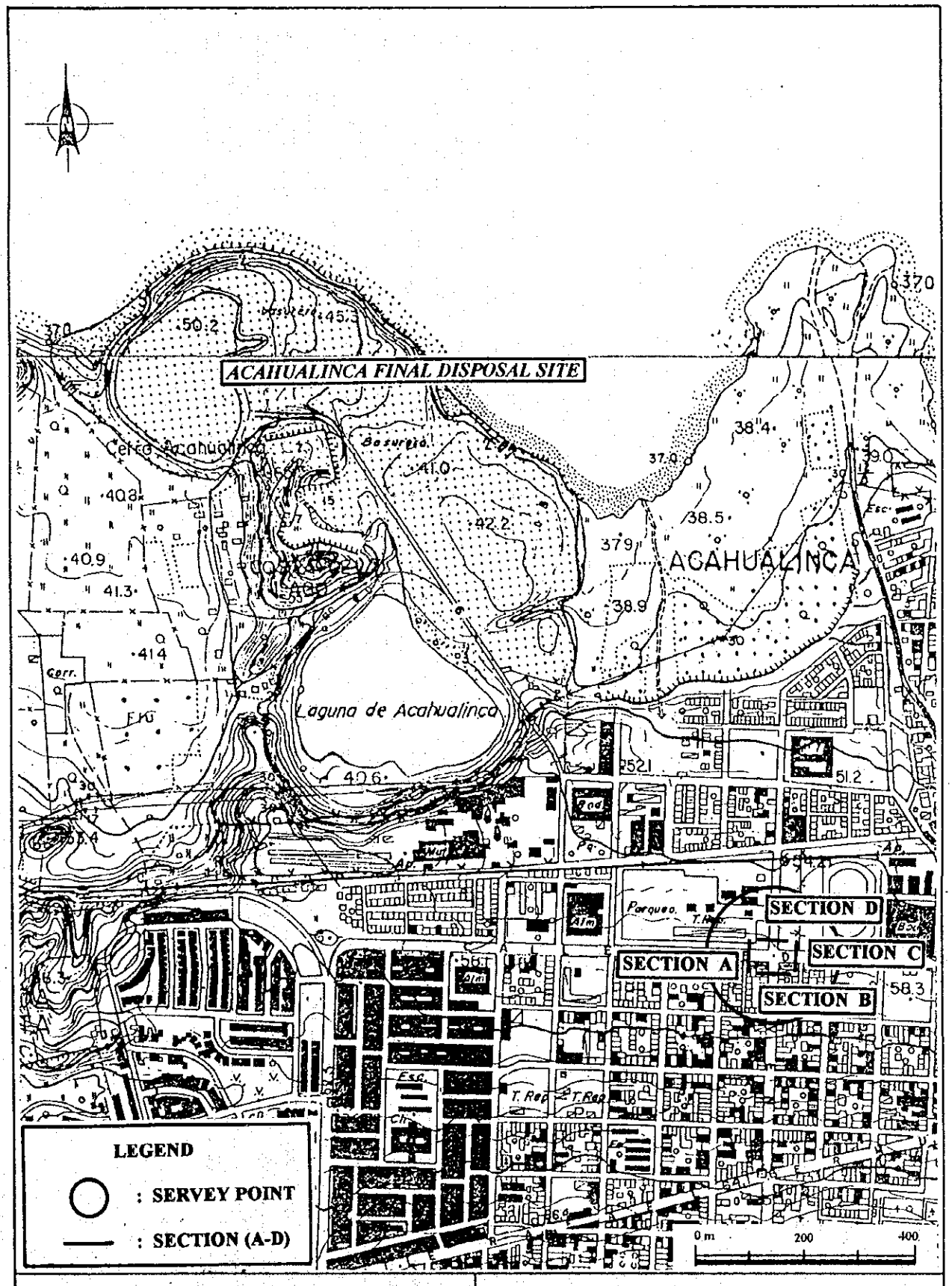
The results of the traffic volume survey are shown in Table D.2.4a and Figures D.2.4b to D.2.4c. The results are summarized as follows:

- The maximum volume of traffic was 9,121 vehicles/day at section A.

- The maximum volume of waste collection vehicles was 146/day at section A.

- The maximum percentage of the waste collection vehicles to the total traffic was 20.5% at section C.

- The traffic of waste collection vehicles is concentrated in the mornings.



THE STUDY ON THE IMPROVEMENT OF THE SOLID WASTE MANAGEMENT SYSTEM FOR THE CITY OF MANAGUA
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure D.1.3f

Map of Traffic Volume Survey Point

Table D.1.1g 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.
	nos/h	nos/h	nos/h	nos/h	%	%	nos/h	nos/h	nos/h	nos/h	%	%	nos/h	nos/h	nos/h	nos/h	%	%	nos/h	nos/h	nos/h	nos/h	%	%
06:00-09:00	322	84	15	421	14.9	2.4	188	30	7	205	14.6	3.4	391	112	16	709	13.8	2.3	31	6	2	39	15.4	5.1
09:00-10:00	310	87	26	423	14	6.2	159	41	15	209	19.6	7.2	340	109	39	488	15.9	8.2	47	5	21	73	6.8	28.8
10:00-11:00	324	87	14	425	11.1	2.3	191	41	18	230	16.1	7.2	336	99	32	464	14.8	4.8	39	12	39	79	15.4	48.7
11:00-12:00	322	79	12	409	12.2	3	169	43	14	222	19.4	6.3	338	109	21	464	16.9	3.2	40	7	25	72	9.7	34.7
12:00-13:00	494	72	7	573	12.6	1.5	169	34	12	215	15.8	6	383	99	14	496	18.6	2.2	38	9	24	69	13.2	36.8
13:00-14:00	447	69	3	519	13.3	0.6	130	40	8	187	36.2	4.3	467	111	8	576	19.3	1.4	24	11	13	48	22.9	27.1
14:00-15:00	309	93	3	397	12.9	0.8	169	39	5	207	17.4	2.4	366	113	3	484	16.8	0.4	23	9	3	35	16.8	8.4
15:00-16:00	302	87	3	392	14.7	0.8	209	42	4	249	16.9	1.6	350	109	2	461	16.5	0.3	34	4	1	39	10.3	2.6
16:00-17:00	391	99	0	649	15.1	0	174	28	0	202	13.9	0	586	120	2	714	16.8	0.3	30	4	2	36	15.4	7.7
17:00-18:00	486	84	2	564	11.9	0.4	191	29	3	223	13	1.3	546	69	0	630	14	0	41	5	1	47	10.6	2.1
18:00-19:00	360	37	0	397	9.3	0	117	30	0	186	22	0	366	67	0	466	14.7	0	30	5	0	35	30	0
19:00-20:00	302	26	0	328	7.9	0	98	16	0	114	16.7	0	330	46	0	376	12.2	0	11	1	0	12	8.3	0
20:00-21:00	111	14	0	125	11.2	0	80	12	0	91	14.8	0	126	24	1	150	15.7	0.7	10	0	1	11	0	9.1
21:00-22:00	148	20	0	168	11.9	0	48	9	0	57	14	0	163	26	0	189	13.8	0	12	0	0	12	0	0
22:00-23:00	96	11	0	107	10.3	0	37	5	0	42	11.9	0	117	16	0	133	12	0	9	2	0	11	18.2	0
23:00-24:00	86	2	0	88	2.3	0	21	4	0	25	16	0	70	5	0	75	6.7	0	9	1	0	10	10	0
24:00-01:00	36	0	0	36	0	0	10	1	0	11	9.1	0	39	1	0	39	2.6	0	3	0	0	3	0	0
01:00-02:00	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
02:00-03:00	18	0	0	18	0	0	6	0	0	6	0	0	18	0	0	19	0	0	0	0	0	0	0	0
03:00-04:00	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
04:00-05:00	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
05:00-06:00	69	20	0	89	22.7	0	26	15	0	41	36.6	0	83	30	0	113	26.6	0	5	1	0	6	16.7	0
06:00-07:00	191	36	4	247	21.1	1.6	60	23	0	85	39.4	0	223	73	8	304	24.7	2	8	4	3	15	26.7	13.3
07:00-08:00	418	76	4	461	16.3	0.8	129	29	1	159	18.2	0.6	482	101	5	588	17.9	0.9	19	5	2	26	19.2	7.7
Total	6859	1061	95	8035	13.1	1.2	2390	507	88	2985	17.8	3	7910	1466	146	9121	16.1	1.6	439	89	139	667	13.9	20.8

S.V.:SMALL VEHICLE

L.V.:LARGE VEHICLE

W.H.V.:WASTE COLLECTION VEHICLE

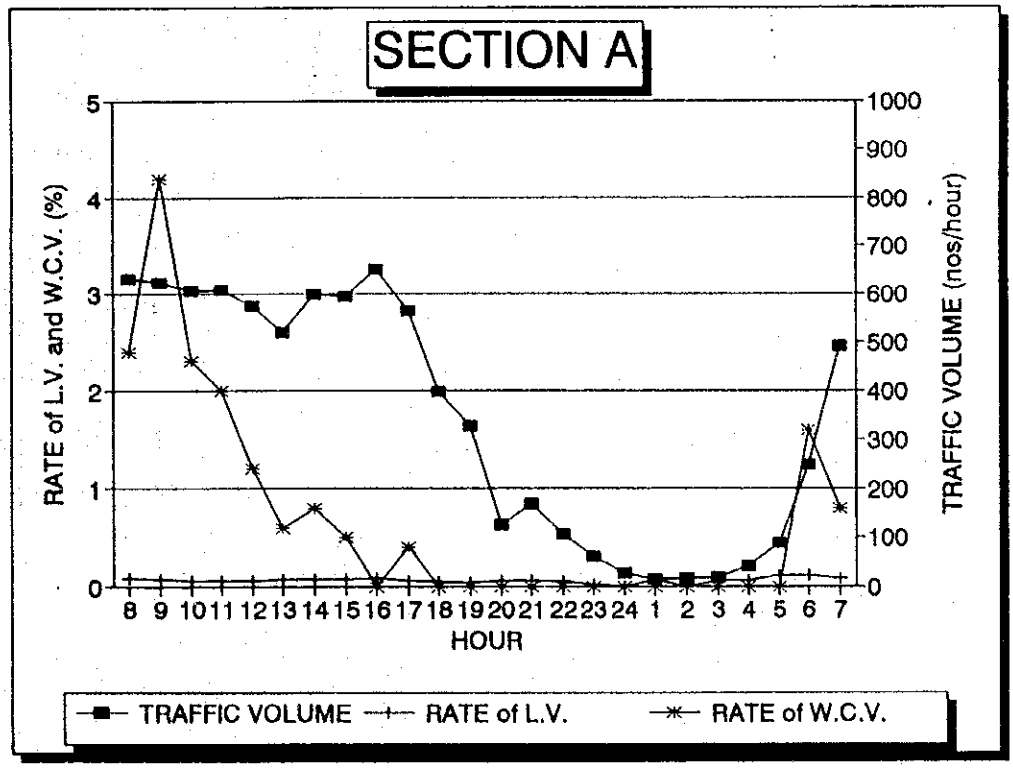


Figure D.1.3g Result of Traffic Volume Survey in Section A

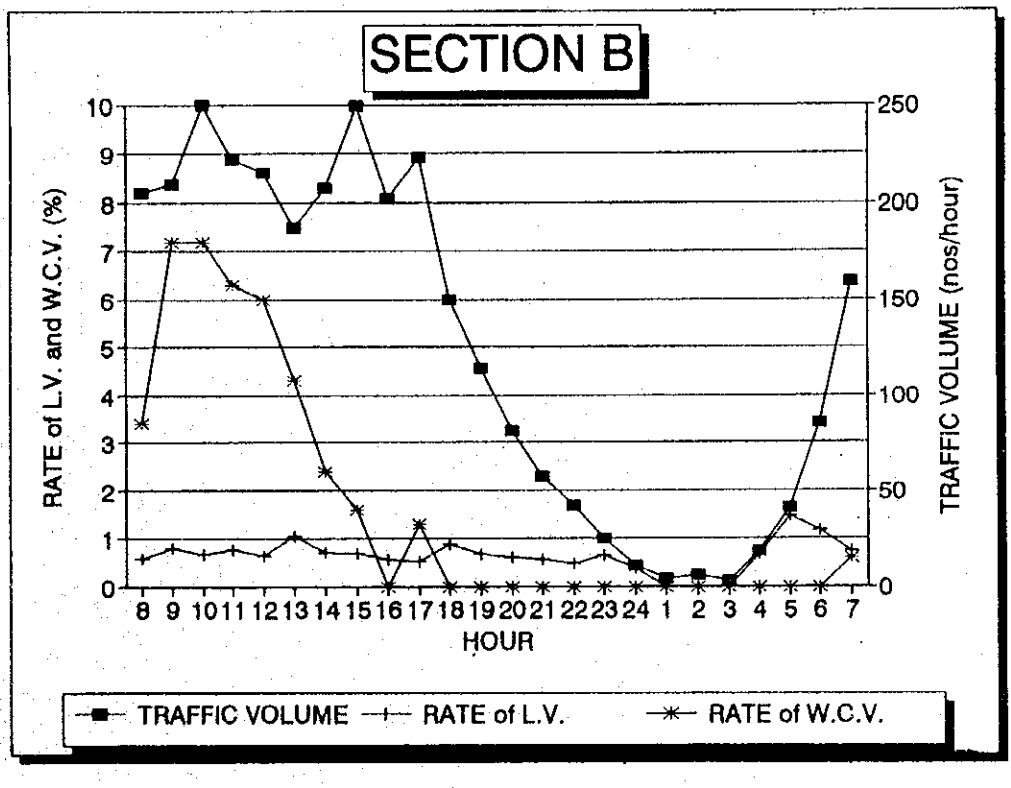


Figure D.1.3h Result of Traffic Volume Survey in Section B

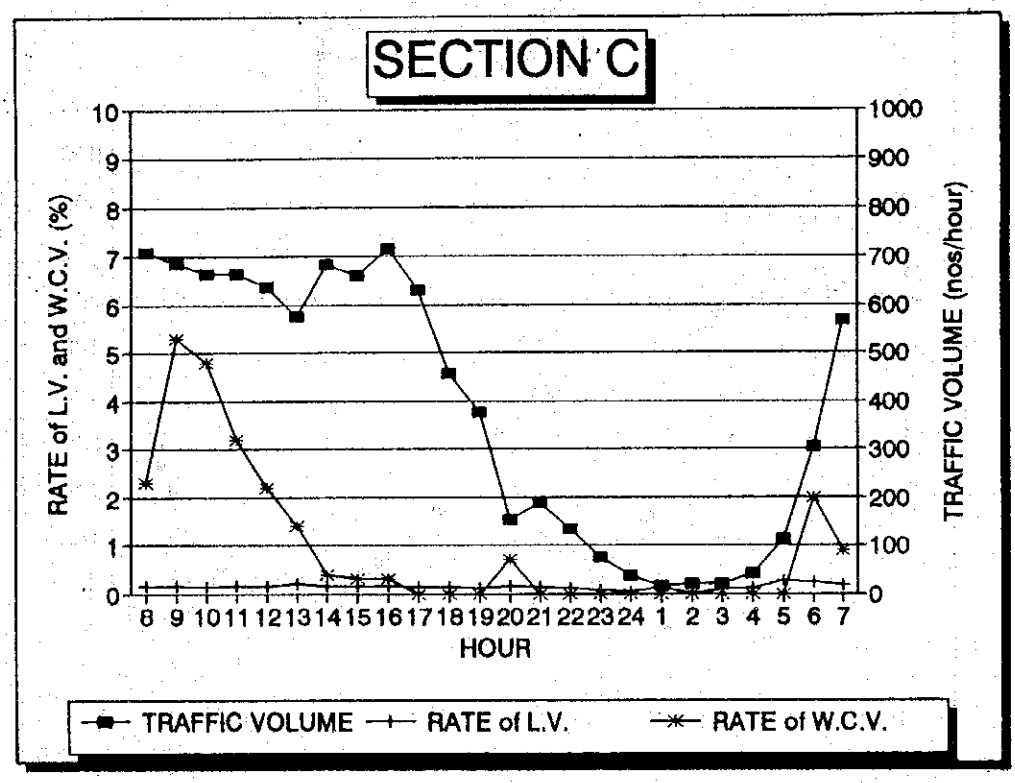


Figure D.1.3i Result of Traffic Volume Survey in Section C

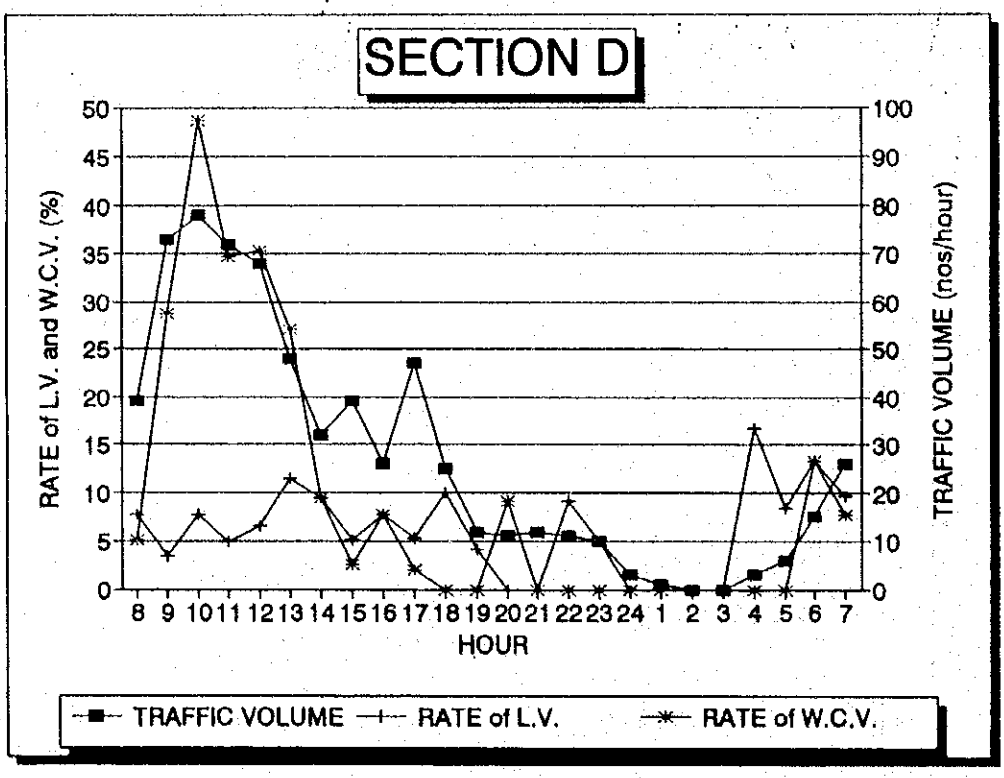


Figure D.1.3j Result of Traffic Volume Survey in Section D

e. Land Use Survey

ea. Objectives of the Survey

The objective of the land use survey is to understand the present land use conditions of the existing landfill sites and its surroundings.

eb. Survey Areas

The existing disposal site (400ha) and its surrounding area. The survey area is shown in Figure D.2.5a.

ec. Categories of Land Use

The land use categories used in this survey are as follows:

- Residential area
- Industrial area
- Agricultural area
- Commercial area
- Public area
- Forest area
- Sod area
- Wetlands
- Water bodies

ed. Survey Method

A land use map on a scale of 1/5,000 was prepared based on the field survey results.

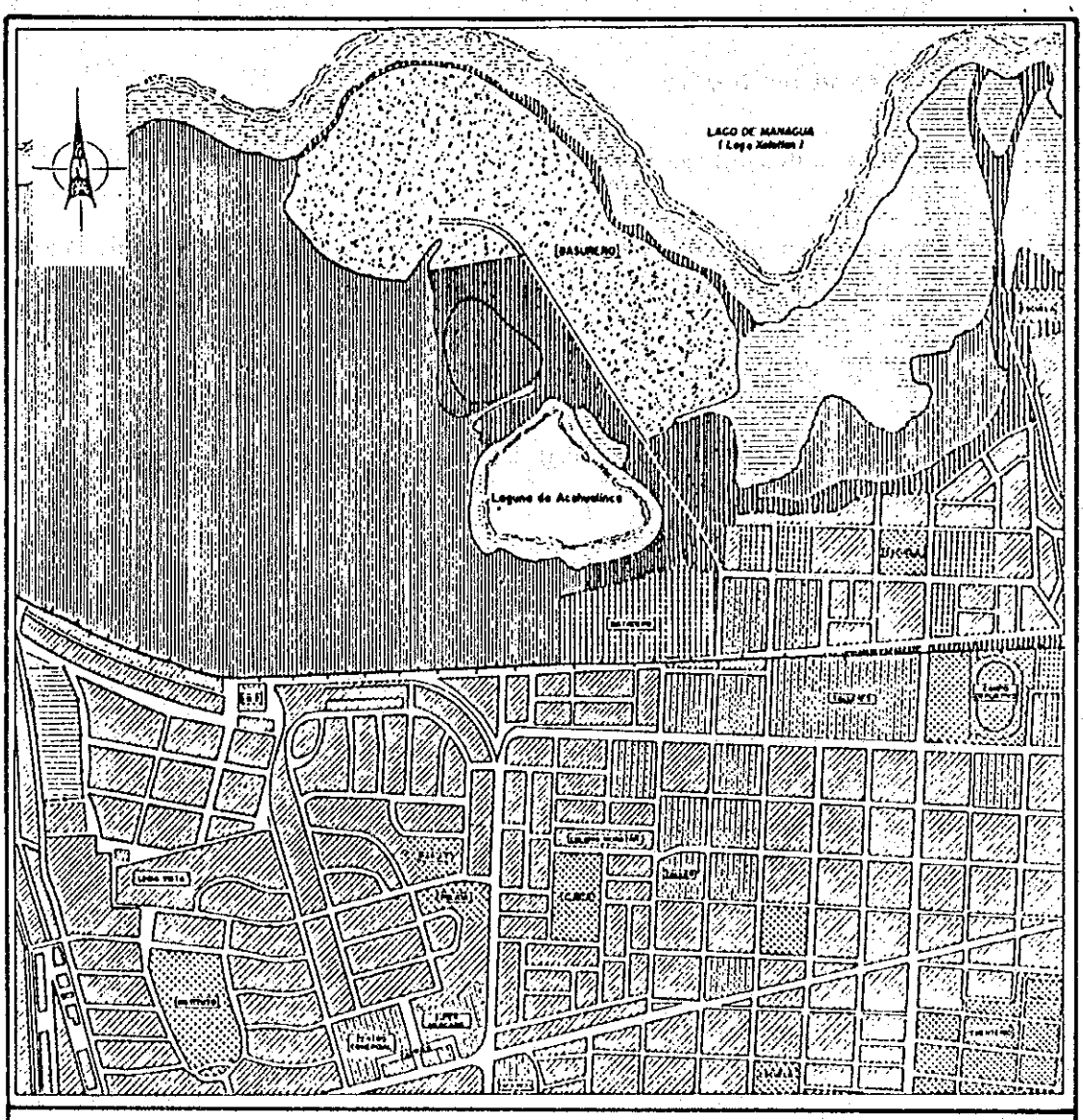
ee. Survey Period

The field survey for land use was carried out from 11 May until 30 June 1994.

ef. Results of the Survey

The land use map prepared is presented in Figure D.2.5a.

The Acahualinca disposal site is an area isolated from the hustle and bustle of residential area.



LEGEND

0 m 200 400

	Residential area		Agricultural area
	Industrial area		Sod area
	Forest area		Denuded area
	Commercial area		Disposal site
	Public area		Water body

THE STUDY ON THE IMPROVEMENT OF THE SOLID WASTE MANAGEMENT SYSTEM FOR THE CITY OF MANAGUA
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure D.1.3k
Land Use Map of Acahualinca
Disposal Site and surround Area

f. Findings

fa. Water Quality Survey

There are no environmental guidelines for water quality in Nicaragua. The values of NORMAS are the only guidelines used for drinking water. The guideline and maximum acceptable values of NORMAS are shown in Table D.2.6a. However, there are no values for are COD, BOD, TN, PCB and Cu.

Table D.1.3h The Guideline and Maximum Values of NORMAS

	Water Temp. °C	pH	$SO4^{-2}$ mg/lit	Cl^- mg/lit	Pb mg/lit	As mg/lit	Cd mg/lit	Cr^{+6} mg/lit	Hg mg/lit
Guideline Value	12	6.6–8.5	25	25	–	0.01	0.005	0.05	0.001
Maximum Value	25	–	250	250	0.01	–			

The results of the survey when compared to the table above are summarized as follows:

- Leachate water

. Water temperature – all results exceeded maximum values
. pH – all results did not exceed the guideline
. SO_4^{-2} – all results exceeded maximum values
. Cl^- – almost all results, except Le–1, exceeded maximum values
. Pb – all results exceeded maximum values
. As – almost all results, except Le–3, did not exceed the guideline
. Cd and Cr^{+6} : all results did not exceed the guideline
. Hg – all results exceeded the guideline

- Well water

. Water temperature – all results exceeded maximum values
. pH – all results did not exceed the guideline
. SO_4^{-2} – all results exceeded maximum values
. Cl^- – all results exceeded the guideline but did not exceed

maximum values

. Pb – all results exceeded maximum values
. As – almost all results, except W–3, did not exceed the guideline
. Cd and Cr^{+6} – all results did not exceed the guideline
. Hg – all results exceeded the guideline

– Borehole water

. Water temperature – all results exceeded maximum values
. pH – all results did not exceed the guideline
. SO_4^{-2} – all results exceeded maximum values
. Cl^- – all results exceeded the guideline but did not exceed maximum values
. Pb – almost all results, except B–5, did not exceed maximum values
. As – almost all results, except B–3 and B–4, exceeded the guideline
. Cd and Cr^{+6} – all results did not exceed the guideline
. Hg – all results exceeded the guideline

– Lake water

. Water temperature – all results exceeded maximum values
. pH – almost all results, except La–2 and La–5, exceeded the guideline
. SO_4^{-2} – all results exceeded maximum values
. Cl^- – all results exceeded the guideline and almost all point values, except La–2 and La–5, exceeded maximum values
. Pb – all results exceeded maximum values
. As – almost all results, except La–2, did not exceed the guideline
. Cd and Cr^{+6} – all results did not exceed the guideline
. Hg – all results exceeded the guideline

fb. Ambient Survey

There are no environmental standards or regulations concerning ambient quality in Nicaragua. However, there is a reference level given by the Panamerican Network for Air Contamination Sampling. The survey results were compared with this reference level and is presented in Table D.2.6b.

Table D.1.3i Evaluation of Ambient Survey Results

Items	Unit	Result of Survey	Reference Level
Dust Fall	mg/lit	0.77	0.5
SPM	mg/lit	0.13	0.1
Ammonia	PPM	N.D.	-
Methane	%	0.0 - 0.5	-

N.D. : Not Detected

Some of the data measured exceeded the reference level.

fc. Noise Survey

There are no environmental standards or regulations concerning noise in Nicaragua. The World Health Organization (WHO) in its document entitled "Environmental Health Criteria 12 - NOISE" recommends that the community/urban daytime (Leq) value should not exceed 55 dB(A), beyond which annoyance would increase. The survey results were compared with the values given by WHO and is presented in Table D.1.3j.

Table D.1.3j Evaluation of Noise Survey Results

unit:dB(A)

No. of Survey point	Day (7 to 19)	Night (19 to 7)	Value of WHO
N - 1	73.7	61.4	55
N - 2	50.8	49.4	-

The values for day and night are average values. The daytime value recorded exceeded the value given by WHO.

fd. Traffic Volume Survey

The maximum number of waste collection vehicles was 145 /day at section C. The maximum rate of waste collection vehicles at section D was 20.5 %/day and 48.7 %/hour (between 10:00am and 11:00am). The traffic of collection vehicles was only high for 4 hours, from 9:00 - 14:00 pm.

D.2 Investigation of the Acahualinca Newly Proposed Landfill Site (ANPLS)

The basic data required for the implementation of a feasibility study on the Acahualinca site as a proposed landfill site were obtained through the execution of topographic, geologic, land use and environmental surveys. The survey results are presented in this section.

D.2.1 Topographical Survey

A topographical map of the entire ANPLS area was drawn at a scale of 1:2000 after the completion of a topographical survey.

D.2.2 Geological Survey

Three boring activities were carried out at the ANPLS.

D.2.3 Land Use Survey the Surrounding Area

a. Objectives of the Survey

The objective of the land use survey is to determine the present land use conditions in the ANPLS disposal site and its surroundings.

b. Survey Area

Survey area is approximately within 10 km^2.

c. Categories of Land Use

The land use categories used for this survey are as follows:

- Residential area
- Industrial area

- Agricultural area
- Commercial area
- Public area
- Forest
- Wetlands
- Water Area

d. Land Use Map Preparation Method

Land use maps were prepared based on data obtained through field surveys.

e. Survey Period

The field survey for the land use map preparation was carried out from 28 November until 30 December 1994.

f. Results of the Survey

The land use map prepared is presented in Figure D.2.3a.

The characteristics of the proposed disposal site are as follows:

- Most of the land is either sod or used for agricultural purposes.
- There are no residents in the ANPLS, but an illegal settlement area exists to the southeast.

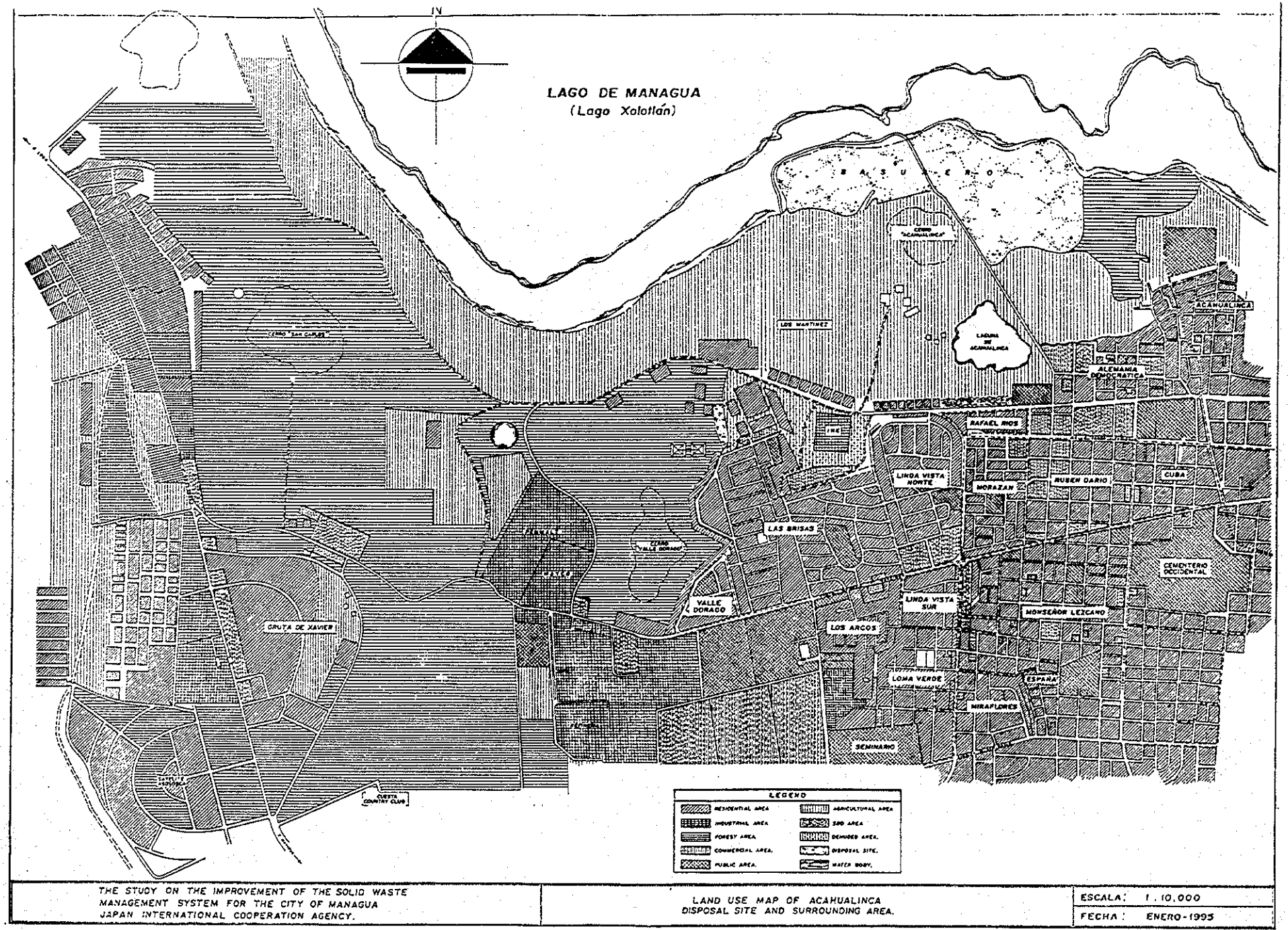


Figure D.2.3a Land Use Map of Acahualinca Disposal Site and Surrounding Area

D.2.4 Environmental Survey

An environmental survey was conducted to determine the present environmental condition in the Acahualinca newly proposed landfill site (ANPLS). The environmental survey consists of water quality survey, sediment survey and ambient survey.

a. Water Quality and Sediment Survey

aa. Objective of the Survey

The objective of the water quality and sediment surveys is to determine the present quality of:

- river water in the NPLS,
- groundwater near the NPLS,
- lake water near the NPLS,
- lake sediment near the NPLS

Further, to compare the survey with the water quality of the river located between the existing disposal site and NPLS, samples of leachate discharged from the existing disposal site were taken.

ab. Location of Sampling Points

Sampling was carried out in ANPLS in areas where water sample extraction is possible. Location of the sampling points are shown in Figure D.2.4.

ac. Analysis Items

The following items were analyzed:

- with regard to public health:
  Pb, As, Cd, Cr^{+6} , Hg, PCB, Cu and CN
- Others: pH, COD, BOD, OD, Total Nitrogen(T-N), SO_4^{-2} , Cl^-, HCO^-_3, Na^+, K^+, Ca^{2+}, Mg^{2+} and SS
- sediment
  Cu, Zn, O-P, Pb, T-Hg, Cd, As, SS, P, Pb, Hg and PCB

ad. Analysis Method

The water and sediment analyses were carried out in accordance with the "Standard methods for the examination of water and wastewater including bottom sediments and sludge", 18th edition, New York, APHA-AWWA-APCF.

APHA ; American Public Health Association
AWWA ; American Water Works Association
WPCF ; Water Pollution Control Federation

ae. Dates of Sampling

Water sampling was carried out twice in the following days.

- 1st sampling: November 23, 24, 1994
- 2nd sampling: November 30, 1994

Boring works were carried out from November 29 - December 6, 1994. Sediment sampling was carried out on November 24.

af. Results of Water Quality and Sediment Analyses

The results of the water quality analysis are presented in Table D.2.4a, and summarized as follows:

- Cd, Cr^{+6}, CN and PCB were not detected
- Pb was detected in all water samples
- As was detected in all water samples
- Hg was detected in all water samples
- Cu was detected in all water samples
- High levels of Pb, Ca^{2+}, Na^{2+}, K^{+}, Mg^{2+}, HCO^{-}_{3} and T-N were detected in leachate water
- The minimum and maximum values detected are summarized in Table D.2.4b

The results of the lake sediment analysis are presented in Table D.2.4c, and summarized as follows:

- PCB was not detected

- Cu, Zn, O–P, Pb and T–Hg were detected in all samples

ag. Findings

aga. Comparison of the Results of the Analyses with Parameter Standards

i Chemicals in drinking water significantly affecting public health

- Cn (cyanide) was not measured in all samples.

- Pb (lead) was detected in all water samples. All values were higher than the guidelines of CAPRE and WHO (0.01 mg/lit)

- All water samples contained As (arsenic) and the values were higher than the guidelines of CAPRE and WHO (0.01 mg/lit), except for values measured in WW1, W1 and leachates.

- Cd (cadmium) and Cr^{+6} (chromium) were not detected in the water samples. Standard value adopted by CAPRE and WHO is 0.01 mg/lit.

- T–Hg (mercury total) was detected in all water samples, and the values measured were higher than the guideline of CAPRE and WHO (0.001 mg/lit).

- Cu (copper) was detected in all water samples, and the values measured were higher than the guideline of CAPRE (1–2 mg/lit) and WHO (1 mg/lit), except for samples taken from boring holes and the Lake of Managua.

- PCB (polichlorynated Biphenyl) was not detected in the water samples.

ii Other Chemicals

- Cl^- (chloride) was detected in the water samples, and the values measured in Lake Managua and leachate water were higher than the guideline of CAPRE and WHO (250 mg/lit).

- SO_4 (sulfate) was detected in all water samples, and the values measured were higher than the guideline of CAPRE (25 - 250 mg/lit) and WHO (250 mg/lit), except for those measured in W1 and La3.

- Na^+ (sodium) was detected in all water samples. The values measured in

WW2, Le1, Le2, and Lake Managua were higher than the guideline of CAPRE (25–200 mg/lit) and WHO (200 mg/lit).

- K^+ (potassium) was detected in all water samples. The values measured in W2, W3, WW2, leachate water and Lake Managua were higher than the guideline of CAPRE (10 mg/lit).

- All water samples contained Ca^{++} (calcium) and the values measured in W2, WW2 and leachate water were higher than the guideline of CAPRE (100 mg/lit).

- All water samples contained Mg^{++} (Magnesium) and the values measured in Le1, Le3 were higher than the guideline of CAPRE (30–50 mg/lit).

agb. Other Comparison

- A medium (200 mg/lit) to high (300 mg/lit) concentration of BOD was measured in WW1.

- A medium (500 mg/lit) to high (1000 mg/lit) concentration of COD was measured in WW1, WW2. A low COD concentration (250 mg/lit) was measured in leachate and in Lake Managua.

- Le1, WW1, WW2 and Lake Managua were evaluated to contain a medium concentration of SS at 200 mg/lit. SS concentration in boring holes was higher than the concentration in wastewater at 350 mg/lit.

- PH measured in Lake Managua has high alkaline content (limit 9).

- The Cl^- concentration measured by other studies in Lake Managua were less than the value measured by this study (282 mg/lit, CIRA 1988; 234 mg/lit CIRA 1990), 275 to 316 mg/lit (average).

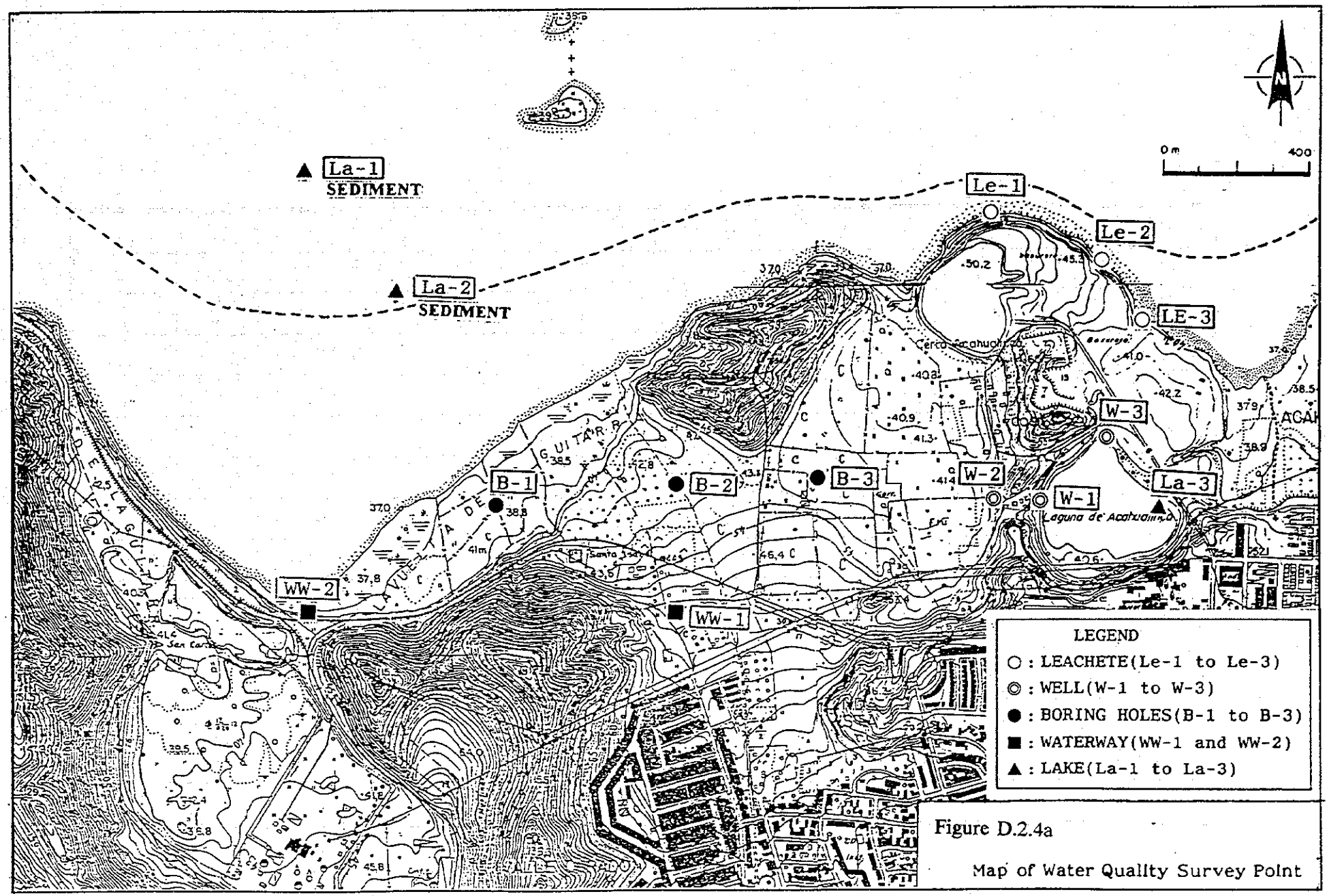


Figure D.2.4a

Map of Water Quality Survey Point

Table D.2.4a Result of Water Quality Analysis

Sampling Points	Date of Sampling	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
Le1	23-Nov-94	Leachate	30	7.58	363	40	4.07	35.67	3	0	515.39	560.28	0.06
	30-Nov-94		28	7.61	237	18	4.24	254.5	1.6	0	957.22	656.88	0.80
	Average		29	7.595	300	29	4.155	145.085	2.3	0	736.31	608.58	0.43
Le2	23-Nov-94	Leachate	28.5	8.24	89	20	2.58	25.77	5.6	0	515.39	328.44	0.07
	30-Nov-94		28	8.3	57	6	2.34	44.5	1.8	0	476.13	415.38	0.10
	Average		28.25	8.27	73	13	2.46	35.135	3.7	0	495.76	371.91	0.085
Le3	23-Nov-94	Leachate	31	7.4	271	120	37.22	235.5	0	0	260.02	618.24	0.03
	30-Nov-94		28	8.12	464	36	1.512	84.5	1.4	0	705.35	270.48	0.18
	Average		29.5	7.76	367.5	78	19.366	160	0.7	0	482.68	444.36	0.105
W1	23-Nov-94	Well	26.5	7.25	135	40	3.92	27.3	1.4	0	160	44.44	0.08
	30-Nov-94		26.5	7.3	34	3	3.6	23.67	2.8	0	162.02	36.71	0.03
	Average		26.5	7.275	84.5	21.5	3.76	25.485	2.1	0	161.01	40.575	0.055
W2	23-Nov-94	Well	27.5	7.85	68	60	0.075	1.76	1.6	0	957.22	260.82	0.05
	30-Nov-94		27.5	8	0	0	0.84	2	2.4	0	839.43	251.16	0.11
	Average		27.5	7.925	34	30	0.4575	1.88	2	0	898.33	255.99	0.08
W3	23-Nov-94	Well	27	7.6	226	60	27.86	16.25	1.4	0	677.41	92.74	0.07
	30-Nov-94		27.5	7.6	60	30	28.23	21.3	1.4	0	1035.8	88.87	0.08
	Average		27.5	7.6	143	45	28.045	18.775	1.4	0	856.58	90.805	0.075
WW1	23-Nov-94	Water Way	29	7.31	906	260	20.84	125	0.8	0	795.2	67.62	0.09
	30-Nov-94		28.5	7.62	775	240	27.1	209	0.4	0	795.2	83.076	0.01
	Average		28.75	7.465	840.5	250	23.97	168	0.6	0	795.2	75.348	0.051
WW2	23-Nov-94	Water Way	32	7.68	420	40	1.8	28.3	4	0	878.7	666.54	0.10
	30-Nov-94		31	7.4	306	78	0.63	26	1.6	0	795.2	695.52	0.12
	Average		31.5	7.54	363	59	1.215	27.15	2.8	0	836.95	681.03	0.11
B1	29-Nov-94	Boring Hole		7.9	136	12	2.96	1470	2	0	250	183.54	0.04
	30-Nov-94			8.4	123	6	0.24	320	2.2	0	677.41	189.47	0.08
	Average			8.15	129.5	9	1.6	895	2.1	0	463.71	186.51	0.06
B2	5-Dec-94	Boring Hole		8.7	205	42	0.71	71.33	2.8	0	859.07	193.2	0.05
	6-Dec-94			8.2	195	12	0.298	72	4	0	783.88	164.22	0.08
	Average			8.45	198	27	0.504	71.665	3.4	0	821.48	178.71	0.065
B3	29-Nov-94	Boring Hole		8	91	48	0.018	1594	3.8	0	598.89	154.56	0.06
	1-Dec-94			8.2	57	30	0.004	349	3.8	0	83.5	154.56	0.06
	Average			8.1	74	39	0.011	971.5	3.8	0	341.2	154.66	0.06
La1	24-Nov-94	Lake	27	9.18	317	60	4.3	90.5	8	0	598.9	270.48	0.04
	30-Nov-94		26.5	9.3	283	24	5.3	196	7	0	451	280.14	0.19
	Average		26.75	9.24	300	42	4.8	143.25	7.5	0	524.95	275.31	0.115
La2	24-Nov-94	Lake	27	9.12	227	80	3.53	77.33	6	0	716.7	285.94	0.23
	30-Nov-94		27	9.1	136	12	5.17	138	6.2	0	457.8	347.76	0.09
	Average		27	9.11	181.5	46	4.35	107.665	6.1	0	587.25	316.85	0.16
La3	23-Nov-94	Lake	26	7.19	362	40	3.192	23	1	0	95	38.64	0.04
	30-Nov-94		27.5	7.1	215	30	4.16	11.88	0.4	0	112	32.84	0.06
	Average		26.75	7.145	288.5	35	3.676	17.44	0.7	0	103.5	35.74	0.05

Table D.2.4b Result of Water Quality Analysis

Sampling Points	Date of Sampling	Type of Water	As mg/lit	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
Lc1	23-Nov-94	Leachate	0.08	0	0	5.59	n.d	2.22	568	179.4	17.36	180.36	73.872
	30-Nov-94	Leachate	0.32	0	0	10	n.d	2.53	496	420.1	23.06	172.34	37.42
	Average		0.2	0	0	7.795	n.d	2.375	532	299.75	20.21	176.35	55.646
Lc2	23-Nov-94	Leachate	0.25	0	0	8.34	n.d	2	574	275.9	47.3	38.08	23.571
	30-Nov-94	Leachate	0.13	0	0	8.34	n.d	2.14	680.8	310.8	22.07	32.87	26.15
	Average		0.19	0	0	8.34	n.d	2.07	627.4	293.35	34.685	35.48	24.861
Lc3	23-Nov-94	Leachate	0.16	0	0	8.34	n.d	1.38	1724	143.4	18.98	302.6	180.06
	30-Nov-94	Leachate	0.19	0	0	7.24	n.d	1.15	624	176.4	55.8	110.62	66.29
	Average		0.175	0	0	7.79	n.d	1.265	1174	159.9	37.39	206.61	123.18
W1	23-Nov-94	Well	0.20	0	0	6.14	n.d	2.27	217.00	59.45	11.68	25.25	6.172
	30-Nov-94	Well	0.49	0	0	5.59	n.d	2.37	238.40	42.95	6.96	26.052	6.46
	Average		0.345	0	0	5.865	n.d	2.32	227.7	51.2	9.32	25.651	6.316
W2	23-Nov-94	Well	0.17	0	0	5.4	n.d	6.15	296	82.47	14.14	131.06	22.113
	30-Nov-94	Well	0.17	0	0	3.94	n.d	6.36	272	66.67	9.38	132.67	20.46
	Average		0.17	0	0	4.67	n.d	6.255	284	74.57	11.76	131.87	21.287
W3	23-Nov-94	Well	0.21	0	0	3.94	n.d	3.5	345	85.32	11.09	66.33	13.122
	30-Nov-94	Well	0.22	0	0	5.04	n.d	2.5	376	81.66	23.9	63.73	10.84
	Average		0.215	0	0	4.49	n.d	3	360.5	83.49	17.495	63.53	11.981
WW1	23-Nov-94	Water Way	0.51	0	0	6.14	n.d	1.5	231	64.34	9.02	18.84	7.83
	30-Nov-94	Water Way	0.11	0	0	6.69	n.d	1.75	276	59.91	9.35	26.453	3.21
	Average		0.31	0	0	6.415	n.d	1.625	253.5	62.125	9.185	22.647	5.52
WW2	23-Nov-94	Water Way	0.16	0	0	3.94	n.d	3.57	130.00	230.40	10.25	124.25	25.37
	30-Nov-94	Water Way	0.01	0	0	7.79	n.d	3.36	175.20	211.20	22.50	130.3	28.43
	Average		0.085	0	0	5.865	n.d	3.465	152.6	220.8	16.375	127.28	26.9
B1	29-Nov-94	Boring Hole	0.15	0	0	4.49	n.d	0.90	258.40	51.96	7.29	56.112	9.23
	30-Nov-94	Boring Hole	0.16	0	0	6.69	n.d	0.96	296.52	65.90	11.92	58.6	10.09
	Average		0.155	0	0	5.59	n.d	0.93	277.46	58.93	9.605	57.356	9.66
B2	5-Dec-94	Boring Hole	0.19	0	0	3.38	n.d	1.126	118.4	75.81	9.12	18.036	3.16
	6-Dec-94	Boring Hole	0.22	0	0	8.34	n.d	1.105	126.4	68.85	9.92	22.85	7.34
	Average		0.205	0	0	5.86	n.d	1.1155	122.4	72.33	9.52	20.443	5.25
B3	29-Nov-94	Boring Hole	0.09	0	0	3.94	n.d	0.94	148	85.17	9.45	32.064	4.86
	1-Dec-94	Boring Hole	0.17	0	0	6.68	n.d	1.05	135.2	35.85	5.2	23.65	3.55
	Average		0.13	0	0	5.31	n.d	0.995	141.6	60.51	7.325	27.875	4.205
La1	24-Nov-94	Lake	0.33	0	0	10	n.d	0.56	484	279.4	33.5	15.233	15.552
	30-Nov-94	Lake	0.63	0	0	4.49	n.d	0.48	391.2	390.8	43.5	10.02	17.55
	Average		0.48	0	0	7.245	n.d	0.52	437.6	335.1	38.5	12.627	16.551
La2	24-Nov-94	Lake	0.12	0	0	7.24	n.d	0.60	494.00	355.70	37.90	21.24	24.84
	30-Nov-94	Lake	0.27	0	0	6.14	n.d	0.58	414.40	395.20	44.40	14.028	20.85
	Average		0.195	0	0	6.69	n.d	0.59	454.2	375.45	41.15	17.634	22.845
La3	23-Nov-94	Lake	0.13	0	0	5.59	n.d	3.053	156	29.9	6.55	29.66	1.46
	30-Nov-94	Lake	0.18	0	0	7.24	n.d	2.48	184	21.59	6.53	32.064	1.17
	Average		0.155	0	0	6.415	n.d	2.7665	170	25.745	6.54	30.862	1.315

Table D.2.4c Maximum and Minimum Value of Water Quality Analysis

Type of Water		Water Tempera-ture ℃	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
Well	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 Way	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 Hole	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
Lake	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

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	Maxi-mum	0	0	10	n.d	2.53	1724	420.1	55.8	302.6	180.06
	Mini-mum	0	0	5.59	n.d	1.15	496	143.4	17.36	32.87	23.571
Well	Maxi-mum	0	0	6.14	n.d	6.36	376	85.32	23.9	132.67	22.113
	Mini-mum	0	0	3.94	n.d	2.27	217	42.95	6.96	25.25	6.1722
Water Way	Maxi-mum	0	0	7.79	n.d	3.57	276	230.4	22.5	130.3	28.43
	Mini-mum	0	0	3.94	n.d	1.5	130	59.91	9.02	18.84	3.21
Boring Hole	Maxi-mum	0	0	8.34	n.d	1.126	296.52	85.17	11.92	58.6	10.09
	Mini-mum	0	0	3.38	n.d	0.9	118.4	35.85	5.2	18.036	3.16
Lake	Maxi-mum	0	0	10	n.d	3.053	494	395.2	44.4	32.064	24.84
	Mini-mum	0	0	4.49	n.d	0.48	156	21.59	6.53	10.02	1.17

b. Ambient Survey

ba. Objectives of the Survey

The objective of the survey is to determine the present air condition in ANPLS.

bb. Location of the Survey

The survey was carried out in ANPLS and the specific location of the survey is shown in Figure D.2.4b.

bc. Analysis Items

The following items were analyzed:

- dust
- suspended particulate matter (SPM)

bd. Analysis Method

Each item was analyzed in accordance with the following methods:

- Dust
  The value of dust was measured using a plastic pan fixed with metal fittings 2.5 m above ground level. The result of dust fall was converted into a 30 day value instead of 7 days.

- SPM
  The value of SPM was measured by the difference in the filter weight before and after the experiment. The result of the SPM was given a total value of 7 days.

be. Survey Period

The survey was carried out during the following periods:

- Dust fall and suspended particulate matter:
  December 5 to 12, 1994

bf. Results of the Ambient Survey

The results of the ambient survey are presented in Table D.2.4d and summarized as follows:

- The value of dust fall was 0.187 g/cm^2/30days.
- The value of S.P.M. was 153.98 μg/m^3

Table D.2.4d Result of Air Pollution Analysis

Survey	Dust fall	SPM
points	mg/cm^3/30days	μg/m^3
1	0.187	153.98

bg. Findings

bga. Comparison of the result of the analysis with Parameter Standard

- The REDPANAIRE (Panamerican Net of Sampling by Air Contamination) fixed the level references of dust fall and S.P.M at 0.50 mg/cm^2/30 days and 100 μg/m^3, respectively.

bgb. Comparison of the result of the analysis with Parameter Standard

- The measured value of dust fall (0.187 g/cm^2/30 days) was lower than the PANAIRE standard (0.50 mg/cm^2/30 days).

- The measured value of S.P.M (150 μg/m^3) was higher than the PANAIRE standard (100 μg/m^3).

- The sampling period was affected by draft current of air. The results reflected this condition.

bgc. Comparison of the result of the analysis with existing data

- The dust fall measured in May 94 was higher than the dust fall measured in December 94, while the SPM showed inverted results. The ambient in May is very different to December due to rain. Cold air current usually blows in December.

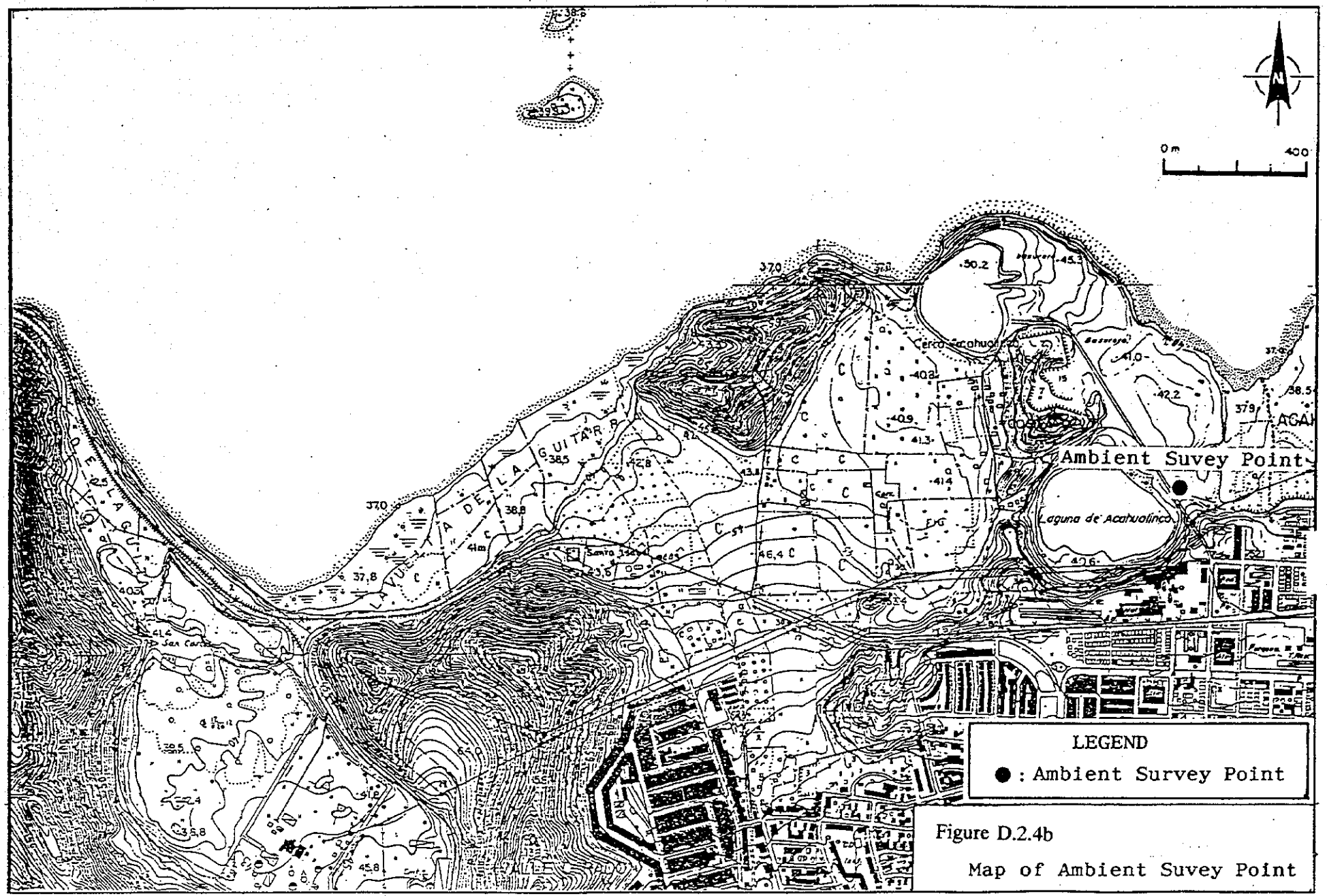


Figure D.2.4b

Map of Ambient Suvey Point

ANNEX E

OTHER FIELD SURVEYS

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ANNEX-E

E.1 Survey on Private Contractors

The solid waste management system in Managua is operated by the Public Cleansing Office which is under the Municipal Works and Services Office. As a public system, the municipality owns and operates all equipment, manages personnel, and determines user fees and revenues sources. Therefore, the private sector is not involved in the collection and disposal of solid waste.

Nevertheless, there are some industries, building contractors, slaughter houses and households that transport their wastes directly to the landfill site because the type of wastes they produce can not be hauled by the municipal collection trucks.

E.2 Survey on Scavengers

E.2.1 Survey Objectives

The objectives of this survey are:

- to understand the system and the organization concerning scavenging
- to understand the present working condition and environment
- to understand the present role of scavengers on SWM
- to forecast the social impact of the Master Plan

E.2.2 Survey Method

The survey was conducted as follows:

- Interviewed 30 scavengers in existing Acahualinca disposal site using questionnaires
- Attendance survey of scavengers for three days in the Acahualinca disposal site and surrounding areas;
- Interview survey with the authorities of the Municipality and Ministry of Health

E.2.3 Survey Results

a. Interview Survey of Scavengers

The interview survey carried out on 30 scavengers in the Acahualinca Landfill was carried out on the 10th, 13th and 14th of June, 1994.

The answers are summarized as follows:

Q–1 Is scavenging a full time job for you?

No.	Answers	Percentage
1	Yes	100.0
2	No	0.0

Q–2 How old are you?

No.	Answers	Percentage
1	0 – 14	23.3
2	15 – 30	26.7
3	31 – 40	20.0
4	more than 40	30.0

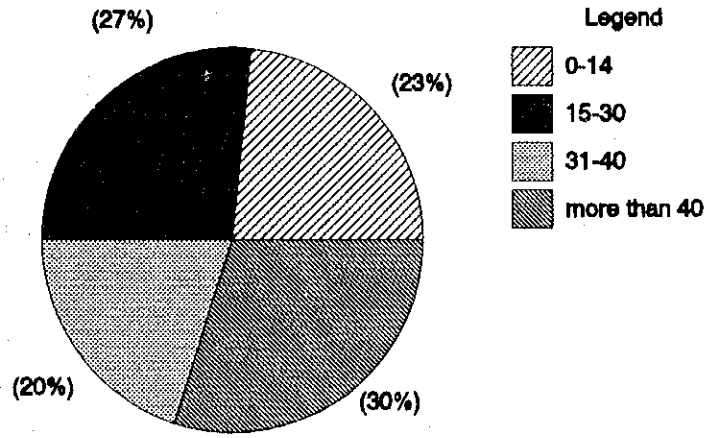


Figure E.2.3a Ages of Scavengers in the Acahualinca Landfill

Q-3 Gender?

No.	Answers	Percentage
1	Male	66.0
2	Female	34.0

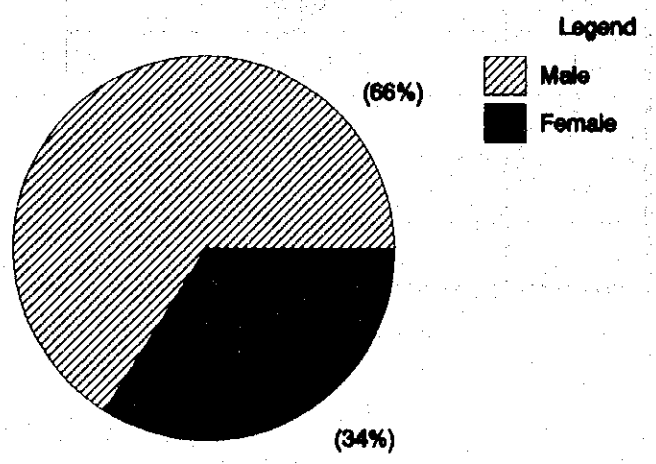


Figure E.2.3b Gender of Scavengers in the Acahualinca Landfill

Q-4 How many years of experience?

No.	Answers	Percentage
1	less than a year	10.0
2	2 to 4 years	33.3
3	5 to 10 years	36.7
4	11 to 15 years	6.7
5	more than 16 years	13.3

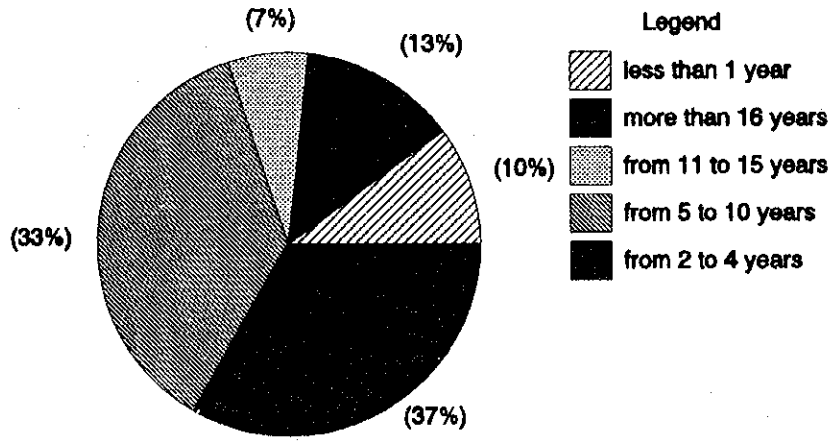


Figure E.2.3c Experience of Scavengers in the Acahualinca Landfill

Q–5 How many days per month do you work as a scavenger?

No.	Answers	Percentage
1	0 – 5 days	0.0
2	6 – 10 days	0.0
3	11 – 15 days	0.0
4	16 –20 days	0.0
5	21 – 25 days	96.7
6	26 – 30 or 31 days	3.3

Q-6 How many hours per day do you work as a scavenger?

No.	Answers	Percentage
1	0 - 8 hours	11.1
2	9 - 10 hours	44.4
3	11 - 12 hours	44.5

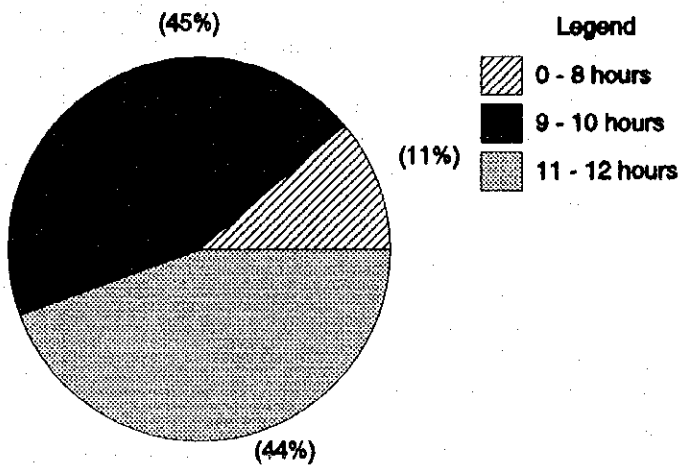


Figure E.2.3d Working hours of Scavengers in the Acahualinca Landfill

Q–7 Are you an employee?

No.	Answers	Percentage
1	Yes	100.0
2	No	0.0

Q–8 What kind of materials do you sort and what is their equivalent sale price?

No.	Material	Sale Price C$
1	Aluminum	0.88–2.2 per kg
2	Glass bottles	0.14–0.20 per unit
3	Various ferrous metals	0.17 per kg
4	Plastic bottles	0.10 per unit
5	Paper	1.65 per kg
6	Textiles	5.0 per sack
7	Cooper	4.4 per kg
8	Bronze	4.4 per kg
9	Cotton	4.4 per kg
10	Fat	200 per barrel

Q–9 How much do you earn as a scavenger.

They answered this question giving approximate figures on a daily basis.

No.	Answers	Percentage
1	0 – 10 C$	30.8
2	11 – 20 C$	15.4
3	21 – 30 C$	53.8

Q-10 Is the price of sorted material stable?

The price of materials is not considered stable by the majority of the people interviewed. The constant loss in the exchange rate of the national currency (cordoba) against the American dollar (US$) fluctuates the prices very often.

Q-11 Is the demand for sorted material limited?

The demand for sorted materials is variable.

Q-12 How many kilograms of material do you sell by items?

There were no specific answers to this question. The amount is measured by profit.

Q-13 Where and to whom do you sell the sorted materials?

Most of the interviewees sell the sorted materials to intermediaries located at the entrance of the landfill site, but did not give specific names.

Q-14 Describe any problem concerning your work in the landfill site

Both the scavengers and municipal authorities replied that there are no problems.

b. Interview survey with Related Authorities

ba. Public Cleansing Head Office of Managua Municipality

baa. Background

The operation of the of Acahualinca disposal site is performed by the department of Sanitary Landfill of the Public Cleansing Head Office.

The site is operated without prior planning and the daily work is performed according to the instruction of a supervisor and the experience of the operators of the three machineries assigned to the site without design and technical concept on how to operate a sanitary landfill. The solid waste is spread, compacted and covered with soil, when available. This place is considered as an open dump

managed with some ounce of control.

The main problems with the operation of the site are:

- lack of municipal support concerning final disposal;
- free access to the public;
- no daily coverage;
- there are no special areas designated for the disposal of hospital wastes and
- no environmental control measures to prevent pollution

In the perimeter of the landfill site are approximately 30 huts inhabited by scavengers that are made from sorted materials. An average of 250 scavengers work at the dump site everyday. The majority of the scavengers live in the northern sector of the Acahualinca district called "La Chureca"; the scavengers are called "Churequeros".

The scavengers work independently or with their family, and are not bound to any organization. They perform scavenging work between 8 to 12 hours a day. The materials are sorted when the wastes are unloaded and at times recyclables are selected during the unloading operations. Also a certain number of scavengers wait for vehicles at the entrance, where there is a higher chance of obtaining materials of greater demand.

An important form of scavenging is conducted by the municipal workers that pick up some valuable refuse before they arrive at the dump, placing the recyclables in baskets and sacks on top or in the hopper of each truck to be sold on route to the disposal facility.

Scavengers have very low income and are on the boundaries of extreme poverty, with high rate of illiteracy that forces them to limited types of jobs.

E.2.4 Findings

a. The Present Role of Scavengers in Solid Waste Management

The scavengers in Managua contributing to the achievement of the following:

- Reduction of the amount of solid waste to be disposed
- Collection of different types of recyclable materials
- Supplying empty bottles that could be used as containers to local food manufacturers reducing dependence on foreign imports

b. The System and the Organization concerning Scavengers

The scavengers at the Acahualinca site work independently, at times they operate in groups, specially the young members of the same family.

The present relationship with the Municipality is good, even though they are always afraid of being expelled from the site or prohibited from it. This lack of confidence was evident when the survey was carried out.

c. Present Working Condition and Environment

Almost all scavengers in the site are without adequate health protections. The municipal waste in Acahualinca is a mixture of different materials which are hazardous to the health of those who have direct contact with them. These hazardous materials are hospital, some industrial waste, and excreta matter, the latter is attributed to bad sanitation.

In the survey, scavengers of all age groups state that they do not suffer health problems. Visiting the Francisco Morazán Health Center and the Medical Post Miguel Aguilar in Acahualinca sector, the statistics show a high prevalence of diseases related to insanitary conditions coupled with malnutrition, poor and inadequate housing and other socioeconomic factors.

An agreement between the Director of Francisco Morazán Health Center and the representative of a non governmental organization, Two Generations, was signed to conduct a project focused on the Integral Attention of the young people in the

Acahualinca sector. The agreement was signed on June 8th, 1994, and the results are to be known in the near future.

d. Social Impact by the Master Plan

The number of scavengers working at the Acahualinca disposal site is growing every year. A survey conducted in August,1993 recorded an average of 200 hundred people dedicated to sorting activities. The present survey recorded approximately 250 scavengers, indicating a rapid yearly increase.

At present it is estimated that approximately 1400 people are engaged in scavenging work; almost 60% of them have worked at the landfill site for more than five years. Also it should be noticed that 43.3% of the scavengers started to work within the past four years as a consequence of the precarious economic situation of Nicaragua and the lack of employment opportunities.

It will be very difficult for these people to change their way of living and to find new jobs. Also the Municipality of Managua will face serious problems if the access to the landfill is closed. The society of Managua will also face many problems if scavengers lose their jobs.

Therefore, in the formulation of a plan concerning solid waste management it should be taken into account that scavenging is not a traditional activity which may influence the solid waste management system.

e. Recycling Amount through Scavengers

ea. Acahualinca disposal site

The amount of solid waste sorted and taken from the Acahualinca landfill site was estimated as follows:

- by interviewing scavengers and direct observations made from 14th May to 20th May, 1994.
- by interviewing scavengers on 10th, 13th and 14th June, 1994
- unit weight calculation of each material sorted

Table E.2.4a Result of Recycling Survey at Acahualinca Disposal Site

Type of Recycling Material	14th May (Sat.)	15th May (Sun.)	16th May (Mon.)	17th May (Tue)	18th May (Wed.)	19th May (Thu.)	20th May (Fri.)	Total	Weight Kg
Meat	3 barrels 2 sacks	–	–	–	4 sacks	5 sacks	4 sacks	3 barrels 15 sacks	2000
Plastic	9 sacks	1 sack	3 sacks	9 sacks	3 sacks	11 sacks	5 sacks	41 sacks x 4	164
Aluminum	18 sacks	10 sacks	15 sacks	–	–	–	–	43 sacks	161
Bottle	3 sacks	4 sacks	8 sacks	–	–	–	2 sacks	17 sacks	425
Wood	2 sacks	3 sacks	–	–	1 sack	7 sacks	–	13 sacks	390
Cardboard	2 sacks	1 sack	2 sacks	2 sacks	2 sacks	12 sacks	–	21 sacks	252
Iron	62 quintals	31 sacks	3 sacks	5 sacks	–	5 sacks	5 quintals	44 sacks 67 quintals	6600 6700
Paper	–	–	–	–	1 sack	–	–	1 sack	17
Leather					1 sack	3 sacks	–	4 sacks	68
Cotton	1 sack	–	2 sacks	1 sack	1 sack		2 sacks	7 sacks	63

Total amount through scavengers 16840 kg

eb. Collection Workers

The collection workers of approximately 25 municipal trucks sort an average of two sacks of bottles daily totaling 1250 kg.

E.3 Compost Market Survey

E.3.1 Method of the Survey

a. Objectives of the Survey

The embedding of organic materials in the soil improves soil condition and creates equilibrium in the ecological system. Composting is being considered for the intermediate treatment of municipal solid waste and reutilization of the organic component of municipal solid waste.

Composting is primarily aimed to convert a large proportion of solid wastes into a marketable product for agricultural use, i.e., soil conditioner and fertilizer. The viability of composting can be determined by conducting a survey on compost marketability and demand. A market study was conducted to determine the amount of compost that can be produced from available municipal waste.

b. Compost Market Survey Flow

The Study Flow Chart is shown in Figure E.3.1a

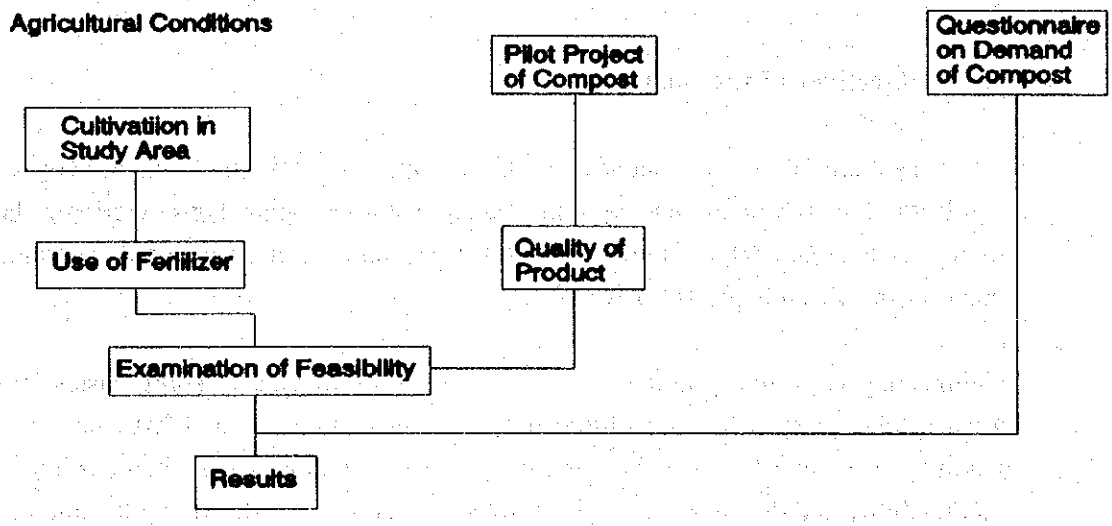


Figure E.3.1a Compost Market Survey Flow Chart

E.3.2 Study Results

a. Present Agricultural Conditions

aa. Cropping System in the Pacific Ocean Coast

Irrigation is carried out from December during the dry season and is followed right away by the first cropping period. The crops cultivated in the area ranges from rice, vegetables, kidney beans, sorghum, maize, cotton, sesame seeds, peanuts and sugar cane. Productivity in the area is generally low as only large scale farmers carry out irrigation. The harvest season is in May. The second cropping period starts in August.

ab. Agricultural Products Cultivated in Managua (Region III) in 1994

The main agricultural products in Managua, including coffee beans and sugarcane for export, are shown in Table E.3.2a.

Maize, kidney beans, rice and sorghum are the 4 major crops for domestic consumption.

Table E.3.2a Agricultural Products in Managua (Region III) **(1994)**

	Items	Area (ha)	Unit Yield (kg/ha)	Production (ton)
Export	Total	12,953.9	2,980	23,712
	Sesame seeds		-	-
	Cotton		-	-
	Banana		-	-
	Coffee	4,648.1	434	2,017
	Sugar Cane	8,305.8	2,547	21,155
	Peanuts			-
	Tobacco			-
Domestic	Total	12,933.1	-	20,009
	Maize	3,948.0	1,449	5,721
	Kidney beans		517	1,102
	Red	2,131.2	517	1,102
	Black	2,131.2	-	-
	Rice		1,277	675
	Rice cultivated in dry field	528.8	1,277	675
	Rice cultivated in irrigated field	528.8	-	-
	Sorghum		3,319	12,510
	Raw product for Industries	6,345.1	2,298	10,850
	Others	4,723.6	1,021	1,656
	Soy bean	1,621.5	-	-
		-		

Agricultural activities are concentrated along the Pacific Coast due to geologic influences. Agricultural productivity decreases further inland, especially where the Tipitapa and San Francisco Libre alcalde offices are located due to rough terrain and poor soil quality.

The agricultural products are mainly exported from the port of Corint.

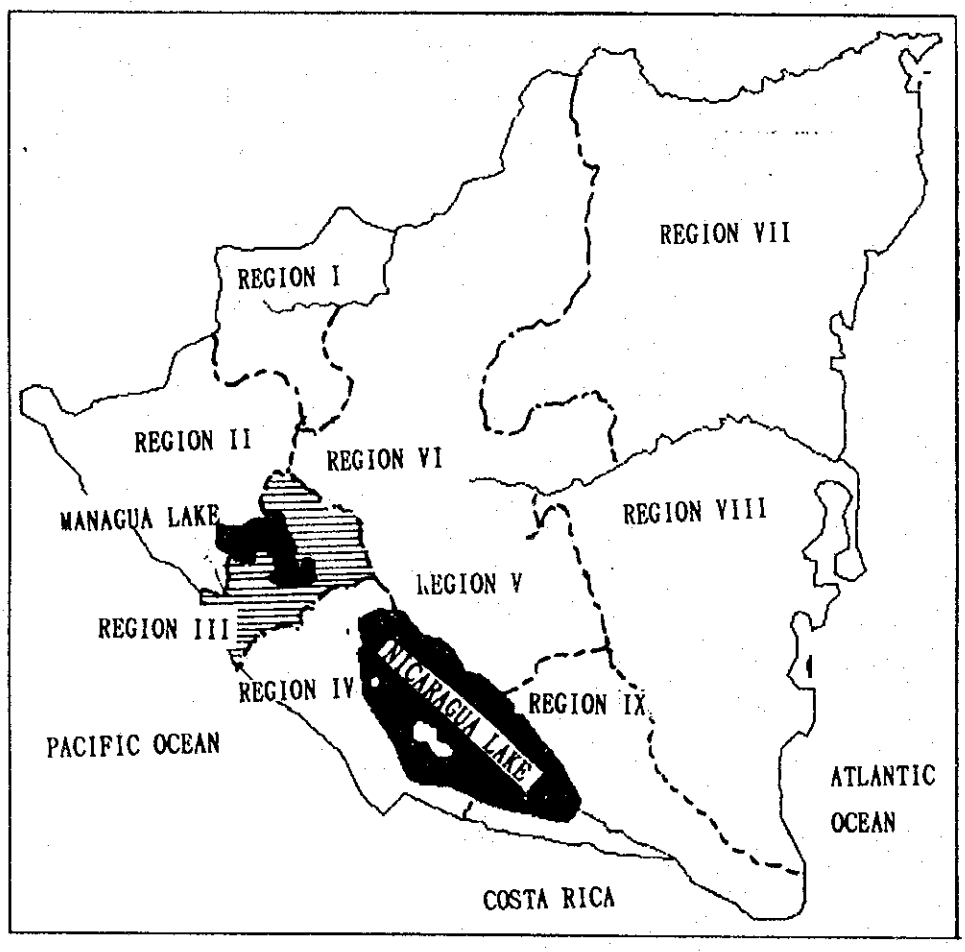


Figure E.3.2a Location of Managua (Region III) in Nicaragua

ac. Cultivation in the Municipality of Managua

There is limited information on primary agricultural products cultivated in the first cropping period. Basic data on agricultural output during the second cropping period in the Municipality of Managua is shown in Table E.3.2b. Very little agricultural activity can be observed in D2 and D4 as these are urbanized areas. Coffee and vegetables are produced in large quantities in D7, which is located in the high terrains of Managua.

Vegetables, kidney beans, maize and rice are produced in large quantities in Districts 1,3,5 and 6, which are located in the lowland area.

Table E.3.2b Production Output in the Second Cropping Period in Districts 1,3,5,6 and 7 in Managua (1992–1993)

Products	Cultivated Land (ha)		Idle Land (ha)		Irrigable Land (ha)		Unit Yield (kg/ha)		Production (ton)	
	D1,3,5,6	D7	D1,3,5,6	D7	D1,3,5,6	D7	D1,–3,5,6	D7	D1,–3,5,6	D7
Total	715	5,966	94	39	621	5,926	–	–	1,595	266
Export	41	5,797	18	–	23	5,797	–	–	7	–
Sesame seeds	41	–	18	–	23		319	–	7	–
Coffee	–	5,797	–	–	–	5,797	–	–	–	–
Domestic	674	169	75	39–	598	129	–	–	1,588	266
Rice	152	14	23	3	129	11	319	255	42	3
Kidney beans	222	88	25	8	197	80	383	319	77	26
Maize	145	32	28	11	116	20	447	319	53	7
Sorgo	50	–	–	–	51	–	319	–	17	–
Banana	51	–	–	–	51	–	–	–	–	–
Vegetables	54	35	–	18	54	18	25,352	12,766	1,398	230

Note: These figures represent the production output of the agricultural cooperative and small and medium scale farmers. Small and medium scale farmers make use of what little land they have efficiently.

Idle lands: lands made unavailable for agricultural use for fallowing or natural reasons

Source: Ministerio de Agricultura y Ganadería
Departemento de Operaciones de Campo

Table E.3.2c Production Output of the Agricultural Cooperative in the Second Cropping Period in Districts 1,3,5,6 and 7 in the Municipality of Managua (1992–1993)

Cultivation	Cultivated Land (ha)		Idle Land (ha)		Irrigable Land (ha)		Unit Yield (kg/ha)		Production (ton)	
	D1,3,5,6	D7	D1,3,5,6	D7	D1,3,5,6	D7	D1,3,5,6	D7	D1,3,5,6	D7
(1) Agricultural Co-operative	380	99	43	30	337	68	–	–	754.3	21.4
Export	14	–	5	–	9	–	–	–	2.9	–
Sesame	14	–	5	–	9	–	319	–	2.9	–
Coffee	–	–	–	–	–	–	–	–	–	–
Domestic Consumption	366	99	38	31	328	68	–	–	751.4	21.4
	46	7	8	–	38	7	319	255	12.2	1.8
Rice	130	53	13	–	117	48	383	319	45.1	15.3
Kidney beans	84	21	18	5	67	13	447	319	29.9	4.3
Maize	51	–	–	8	51	–	319	–	16.2	–
Sorgo	30	–	–	–	30	–	–	–	–	–
Banana	25	18	–	18	25	–	25,352	–	648.0	–
Vegetables										

Table E.3.2d Production Output of PMP (Small and Medium Scale Farmers) in the Second Cropping Period in Districts 1,3,5,6 and 7 in the Municipality of Managua (1992–1993)

Cultivation	Cultivated Land (ha)		Idle Land (ha)		Irrigable Land (ha)		Yield (kg/ha)		Production (ton)	
	D1,3,5,6	D7	D1,3,5,6	D7	D1,3,5,6	D7	D1,3,5,6	D7	D1,3,5,6	D7
(2) PMP	334	5,797	51	9	283	5,858	–	–	806.6	238.7
Export	27	5,797	13	–	14	5,797	319	–	4.3	–
Sesame	27	–	–	–	14	–	319	–	4.3	–
Coffee	–	5,797	–	–	–	5,797	–	–	–	–
Domestic Con-	307	71	37	9	270	61	–	–	801.6	238.7
sumption	105	7	15	3	90	4	4	255	290.1	1.1
Rice	92	35	12	3	80	32	4	319	30.5	10.3
Kidney been	60	11	10	4	49	7	5	319	22.1	2.3
Maize	–	–	–	–	–	–	–	–	–	–
Sorgo	22	–	–	–	22	–	–	–	–	–
Banana	28	18	–	–	28	18	25,532	12,766	720.0	225.0
Vegetable										

P.M.P : Small and medium scale farmers

Table E.3.2c and Table E.3.2d show the production output from individual sectors, and indicate no discrepancies in the yield of the agricultural cooperative and small and medium scale farmers.

ad. Fertilizer Consumption

Table E.3.2e shows the chemical fertilizer consumption in the whole of Nicaragua, which varies depending on the cultivated crops.

Banana cultivation consumes 240 kg/ha of fertilizer, while other crops consume 170 kg/ha or less.

ae. Chemical Fertilizer Consumption in Vegetable Cultivation

Table E.3.2f indicates chemical fertilizer consumption by vegetable type, which supposedly varies from 316 to 652 kg/ha.

Table E.3.2e Chemical Fertilizer Consumption for the Cultivation of Principal Crops in Nicaragua

Crops	Area (x1,000 ha)	N		P_2O_5		K_2O		Total (kg/ha)
		Quantity (kg/ha)	Total (ton)	Quantity (kg/ha)	Total (ton)	Quantity (kg/ha)	Total (ton)	
Cereals	265	40	11,525	72	4,650	–	–	112
(Total)	22/25	30/65	660/1,625	30/30	660/750	–	–	60/95
Rice	183	45	8,200	12	2,200	–	–	57
Maize	57	30	1,700	30	1,700	–	–	60
Sorghum								
Cassava	1	90	90	50	50	30	30	170
Kidney	65	18	1,170	30	1,950	–	–	48
beans	4.5	150	675	60	270	30	135	240
Banana	6.6	–	–	–	–	–	–	–
Peanuts	72	90	6,480	50	3,600	20	1,400	160
Coffee	0.6	100	60	–	–	–	–	100
Tobacco	2.1	90	189	40	84	20	42	150
Cotton								

Table E.3.2f Chemical Fertilizer Consumption by Vegetable Type

Vegetable Type	Type of Fertilizer	Consumption (kg/ha)	Unit Cost (C$/kg)	Cost (C$/ha)
Tomato	12-30-10 Urea 46% Foliate	261 261 130	1.15 1.39 0.35	300 363 46
Onions	12-30-10 Urea 46%	391 261	1.15 1.39	450 363
Cabbage	12-30-10 Urea 46%	391 130	1.15 1.39	450 181
Green pepper	12-30-10 Urea 46%	261 261	1.15 1.39	300 363
Carrots	12-30-10 Urea 46%	261 65	1.15 1.39	300 90
Sugar beets	12-30-10 Urea 46%	261 65	1.15 1.39	300 90
Lettuce	12-30-10 Urea 46%	261 65	1.15 1.39	300 90
Garlic	12-30-10 Urea 46%	391 130	1.15 1.39	450 181
Papain	12-30-10 Urea 46%	261 130	1.15 1.39	300 181
Melon	12-30-10 Urea 46%	326 130	1.15 1.39	375 181
Cucum-ber	12-30-10 Urea 46%	196 130	1.15 1.39	225 181
Water melon	12-30-10 Urea 46%	326 130	1.15 1.39	375 181
Young Maize	12-30-10 Urea 46%	391 196	1.15 1.39	450 272
Range		316 - 652	2.54 - 2.89	390 - 813

Note: - US$ 1.00 = C$ 5.00 (official exchange rate)
C$ 5.40 (black market)

- Papain is a type of local vegetable

Source: Cultivando Hortalizas
Elaborado por Departamento de Transferencia de Tecnología, Estación Experimental "Raul Gonzáles", Valle de Sébaco Matagalpa, 15 October 1992

ae. Estimated Fertilizer Consumption in the Municipality of Managua

Table E.3.2g shows the estimated amount of chemical fertilizer consumed in Managua, under 3 assumptions:

1. Fertilizer consumption based upon Tables E.3.2e and E.3.2f.
2. No production at the irrigation stage
3. Double cropping in irrigable areas

According to Table E.3.2h, about 2,800 tons of chemical fertilizers are consumed per annum.

Table E.3.2g Estimated Chemical Fertilizer Consumption in the Municipality of Managua

Crops	Fertilizer Consumption (kg/ha)	Irrigable Area (ha)			Total Fertilizer Consumption (ton)
		D1,3,5,6	D7	2 cropping periods (Total)	
Sesame	-	32	-	64	0
Coffee	160	-	8,222	16,444	2,631
Rice	95	183	16	398	38
Kidney Beans	48	280	114	788	38
Maize	57	165	29	388	22
Sorghum	45	72	0	144	6
Banana	15	73	0	146	2
Vegetables	650	76	25	202	131
Total				18,574	2,868

b. Pilot Project for Compost Production at Acahualinca by ALMA

ba. Pilot Project Outline

The pilot project for composting was executed by ALMA in Acahualinca under the guidance of a Dutch expert in April 1993. This project is summarized below.

Segregation was carried out to separate compostable and non-compostable waste.

The produced compost are not for sale and are used instead for soil conditioning of the greenbelt area. Compost production between November 1993 to January 1994 is outlined in Table E.3.2h.

The works carried out in the Pilot Project are briefly outlined below:

Type of waste for composting	-	Oriental market waste
Collection frequency	-	Almost every two days
Composting mechanism	-	Manual operation
Waste separation	-	Separation using sieves
Method of production		

1. Waste piling
2. Piled wastes are turned upside down after (1) month
3. Piled wastes are turned upside down again after 2 months
4. Sieving is carried out twice

Productivity	-	approximately 4.8 tons/month
Total number of workers	-	4 (3 operators and 1 supervisor)
Salary	-	C$1,679.39 /month
Production cost	-	C$ 1.4/kg

bb. Chemical Analysis of the Pilot Composting Project

The result of chemical analysis of the compost are shown in Table E.3.2j.

Table E.3.2h Compost Production in Acahualinca (Aug. 17,1993 – Oct. 08,1993)

Pile Nº	Initial Date (1993)	Waste Volume Disposed in Acahualinca (m^3)	Solid Waste Source	Screening Date		Compost Processed		Production (kg)	Required Period for Processing (day)
				First	Second	(Sack)	Unit Weight (kg/sack)		
1	August 17	49	Market Oriental	Nov.24&26, 1993	Dec.9&10, 1993	115	35	4,025	113
2	August 27	13	Market Mayor	Nov.29, 1993	Jan.05, 1994	16	35	560	128
3	September 9	20	Market Oriental		Dec.13, 1993	33	35	1,155	94
4	September 13	28	Market Oriental	Dec.01, 1993	Dec.14, 1993	50	35	1,750	91
5	September 24	42	Market Oriental	Dec.02, 1993	Dec.14,1993 Jan.05,1994	55	35	1,925	101
6	September 28	42	Market Oriental	Jan.05, 1994	Jan.06&07, 1994	66	35	2,310	99
7	September 27	14	Market Oriental	Jan.10, 1994	Jan 11&24, 1994	59	35	2,065	117
	September 29	14	Market Oriental						
8	October 1	28	Market Oriental	Jan.12,94	Jan.24&25,94	46	35	1,610	114
9	October 8	28	Market Oriental	Jan.13,94	Jan.25,94	51	35	1,785	107
Total		278	Market Oriental			491		17,185	Average 107

Note: 0.28 ton/m^3 : Unit weight of Market Waste
278 m^3 : 77.84 tons

Productivity 17,185 kg/107 x 30 = 4.8 tons/month

Table E.3.2i Result of Chemical Analysis of Compost

Composition		[1]Masaya Compost Plant	[2]Acahualinca Compost Plant	[3]Colonia Centro America	Austrian Standard (min)	EC Standard	Japanese Standard
Nitrogen	(%)	1.70	0.05	0.13	0.8	0.6	1.2
Phosphate	(%)	0.40	0.172	0.91	0.4	0.5	0.5
Potassium	(%)	1.70	0.705	2.56	0.3	0.3	0.3
pH		7.8	7.7	6.2		–	6.0 – 7.0
Organic Material	(%)	14.0	12.5			–	–
Water content	(%)	38.0	20.0			–	–
Calcium Carbonate	(%)	–	3.9			0.3	4.0
Cr	(mg/kg)		18.0			150	
Ni	(mg/kg)		26.0			50	
Cu	(mg/kg)		140.0	2.91		300	
Zn	(mg/kg)		210.0	5.12		1,000	
As	(mg/kg)		< 9			–	50
Cd	(mg/kg)		< 0.6			5	5
Hg	(mg/kg)		0.34			5	2
Pb	(mg/kg)		130.0			750	
Hydrocarbon	(mg/kg)		< 0.8				
Mineral oil	(mg/kg)		+ 160				
Chlorobenzene	(mg/kg)		< 1.0				
Alkylbenzene	(mg/kg)		< 1.0				
Organic Solvent	(mg/kg)		< 5.0				

Source: [1] Programa de Investigación y docencia en el medio Ambiente. Evaluación y Adaptación de la Tecnología de la compostificación para el tratamiento de los desechos sólidos orgánicos de la ciudad de Masaya. Managua, Nicaragua, Febrero 1994
Ing. Mercedes Arguello Herrera

[2] Plan para el Manejo de Desechos Sólidos para Managua, Hermanamiento Amsterdam, Managua
Author: Ing Koen de Jung

[3]Universidad Nicaragua de Agraria (Juhe 3, 1993)

The results of the chemical analysis state the insufficient content of phosphoric acid and nitrogen in the compost produced. These chemicals should be supplemented therefore when using compost produced in Acahualinca.

An experiment carried out by the Managua Municipality indicate the efficacy of the utilization of compost produced in Acahualinca in vegetable cultivation: vegetables cultivated with compost grew better than those without. The Municipality of Managua promotes compost production with the assistance of a Dutch expert and at the same time conducts surveys on the compost market.

c. Questionnaire Survey

The result of the compost market survey on 12 farmers is presented in Table E.3.2j.

ca. Poultrymen (organic fertilizer producers)

Poultry excrements are not utilized as organic fertilizers and are disposed of near the farm.

cb. Farmers (potential compost user)

Almost 50% of the farmers are ignorant of producing compost out of domestic solid waste. Regardless of whether they are ignorant of composting or otherwise, farmers showed interest in compost utilization. It is assumed therefore that farmers will opt to use compost if the quality is good and the price is reasonable.

Table E.3.2j(1) Results of Compost Market Questionnaire Survey

Agricultural District	D6 (Poultry)	D3 (Farming)	D3 (Farming)	D3 (Farming)	D3 (Farming)	D6 (Horticulture)
Items	Poultry Farm "La Estrella"	Farm in Plaza "JM" 4 1/2 km	Farm in the area of the Laboratory "Padre Fabreto", 3 c. al lago	Farm in the area of the Health Center "Pochocuape", 1 c. al sur	"Pochocuape Farm"	"Monte Fresco" Nursery 3 1/2 km
Products	Hens for production of eggs	– Banana – Pineapple – Citrus Fruits – Nursery of precious wood	– Banana – Citrus Fruits – Plum – Avocado – Papaya – Maize – Tomato – Beans – Kidney Beans – Pepper – Coffee	– Banana – Plum – Mango – Lemon – Oranges – Kidney Beans – Maize – Wheat	– Kidney Beans – Maize – Tomato – Fruits – (cucurbit pepa) – Lemon – Oranges – Pepper – Mango	– Gardens – Palm trees – Cut and potted plants
Area	4.2 ha	cultivated area: 3.5ha total area: 28.2 ha	2.3 ha	0.9 ha	cultivated area: 2.1ha total area: 9.9 ha	4.2 ha
Fertilizer Application	Fertilizer is not used but produced; 210m³ – yearly production	90 kg of NPK fertilizer 90 kg of nitrogenous waste fertilizer Total 180 kg	45 kg of nitrogenous waste 45 kg NPK Total 90 kg	None	90 kg	270 kg nitrogenous waste 180 NPK
Fertilizer Cost	–	–	–	–	Unknown	C$ 150.00
Method of Use	–	Manual	Manual	–	Manual	Manual
Specification of Fertilizer	Organic fertilizer (poultry excrement)	Chemical fertilizer	Chemical fertilizer	None	Chemical fertilizer	Chemical fertilizer
Existing Problems	Fertilizer is disposed in the area surrounding the industry	Expensive fertilizer haulage price	Problems conceming fertilizer haulage	Unstable economic condition	Expensive fertilizer haulage price	no problems
Green Areas	none	–	They have green areas	–	–	They have green areas
Workers	30	–	The owner cultivates the land	The owner cultivates the land	The owner cultivates the land	1
Opinion on Solid Waste Composts		Ignorant about compost, but willing to test it.	No compost utilization due to ignorance of compost quality.	Ignorant about compost, but willing to test it.	Have not used compost but have attended seminars on compost	Ignorant about compost, but willing to test it.

Table E.3.2j(2) Results of Compost Market Questionnaire Survey

Agricultural District	D6 (Farms)	D6 (Farms)	D5 (Farms)	D5 (Farms)	D5 (Farms)	D5 (Farms)
Items	"Sabana Grande" (nursery)	Farm in the town of "Los Laureles"	Farm in Buenos Aires, La Bodega, costado sur del cementerio	Farm in Billares Las Enramadas	Farm in Iglesia Evangélica 500 vrs abajo	Farm in the area of Colegio Carlos Fonseca, Enramadas 500 vrs abajo
Products	– Fruits (mango, lemon, citrus fruits) – Avocado – Cut and potted plants	– Maize – Sesame – Kidney beans – Sorghum – Cassava – Tomato – Gourd	– Maize – Gourd – Pumpkin – Sorghum – Sesame	– Citrus Fruits (orange, lemon, mandarin, plum – Avocado – Prune – Mango – Grasses	– Kidney Beans – Maize – Sweet Pepper – Tomato – (cucurbita papa) – Cucumber – Cassava	– Cassava – Maize – Kidney Beans – Sweet Pepper – Tomato – Gourd
Area	1.1 ha	98.8 ha	63.4 ha	0.4 ha	3.5 ha	99 ha
Fertilizer Application	A total of 225 kg of nitrogenous waste and NPK fertilizer; compost is used regularly	90 kg of NPK 90 kg of nitrogenous waste Total 180 kg/ha	90 kg of nitrogenous waste 90 kg of NPK Total 180 kg/ha 1,350 kg of fertilizer for 11 ha of land	90 kg/year	64 kg/ha	128 kg/ha, but in some cases, 191 kg/ha
Fertilizer Cost	Nitrogenous waste cost ranges between C$85–92/ha NPK fertilizer cost ranges between C$113–128/ha The compost is prepared within the farm	NPK price is C$136/ha, Nitrogenous waste price is C$156/ha	Nitrogenous waste and NPK price is C$106/ha	NPK is C$106/ha, Nitrogenous waste is C$78/ha	Nitrogenous waste and NPK price is C$106/ha	Nitrogenous waste and NPK price is C$99/ha
Application method	Manual	Manual	Manual	Manual	Manual	Manual
Specification of Fertilizer	Organic and chemical fertilizer	Chemical fertilizer	Chemical fertilizer	Chemical fertilizer	Chemical fertilizer	Chemical fertilizer
Existing Problem	Problems in fertilizer quality, Expensive price	Expensive price	Expensive price	No problem	Expensive price, Haulage problems	Problems concerning quality, expensive price, high labour cost
Green Areas	They have green areas	–	–	–	–	–
Workers	4	The owner cultivates the land	None	None	None	None
Opinion on Solid Waste Compost	Knows about composts and uses it regulary	Knows about compost but would like to test the quality	Ignorant about compost, but willing to test it.	Ignorant about compost, but willing to test it.	Ignorant about compost, but willing to test it.	Ignorant about compost, but willing to test it.

E.3.3 Survey Findings

a. Principal Crop of Study Area

The principal crop is sesame seed for export and vegetable, kidney beans, maize, rice and sorghum for domestic consumption.

b. Chemical Fertilizer Consumption

Almost all farmers use fertilizer for agricultural production. The estimated chemical fertilizer consumption in the study area is approximately 2,800 tons/year.

c. Pilot Project for Compost Production at Acahualinca

Under the guidance of a Dutch expert, the pilot project for compost production started in April 1993 at Acahualinca.

Production amounted to approximately 4.8 tons/month; compost processing takes about an average of 105 days.

Based on the results of the chemical analysis, however, the quality of compost produced in Acahualinca should be improved.

d. Pilot Project for Compost Production in Central America

The pilot project site only measures 0.18 ha. With financial help from the government of Amsterdam, the pilot project was carried out until March 1994. Although the project primarily hired 5 people, only two people were left employed by January 1995.

The amount of compost produced monthly is 1.35–2.25 tons and the period required for compost production is 80–90 days, including organic waste collection and compost packing. Compost is sold at a retail price of C$30/45kg.

The monthly income of the workers is insufficient as it only averages C$50/month.

e. Future Demand of Compost

About 50% of the farmers interviewed are ignorant of the production of compost out of solid waste.

The compost surveys carried out indicate that all farmers are interested in the utilization of compost, intending to use the product if the test results justify its efficacy. The surveys show however that the retail price established for the product is the major factor that would stop farmers from using compost, regardless of whether the product is proven effective or not.

f. General Recommendations

The pilot project for compost production carried out under the guidance of the Dutch expert was completed in March 1994. The operation of the composting plant was handed over to ALMA, who shall now determine whether the plant should remain open or not. ALMA also carried out a compost market survey.

Composting is an effective means of reducing the amount of waste disposed at the Acahualinca final disposal site. The compost retail price presently established is not very attractive however. Regardless of its present unprofitability, the composting experiment should be continued in order to accumulate data necessary for the establishment of a permanent composting plant.

E.4 Survey on Recycling System

E.4.1 The Method of the Survey

a. Objective of the Survey

The present study was carried out to identify the present status, issues and problems regarding the recycling system in Managua, considering recycling in its broadest sense, encompassing the full range of resources recovery and reutilization techniques, including repair, use as raw materials, material recovery, and energy conversion of refuse, broken machine parts and discharged consumer products.

The objectives of the study are:

- to understand the present recycling system;
- to understand the present waste amount recycled;
- to understand the actual trends in recycling activities; and
- to obtain basic data to forecast the impact by the Master Plan on recycling and formulate strategies for future recycling options and planning.

b. Method of Survey

The recycling flow diagram in the study area was prepared according to the existing conditions surveyed and information given by the counterparts.

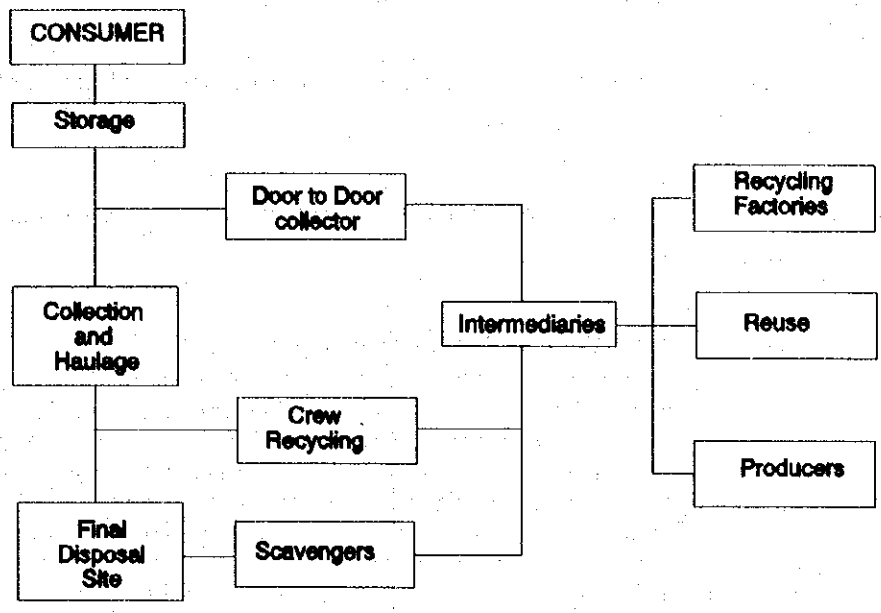


Figure E.4.1a Recycling Flow Diagram in the Study Area

To verify this flow diagram, interview surveys were carried out with the following institutions and persons:

- scavengers at the Acahualinca landfill site
- waste collectors sorting recyclable materials
- intermediaries
- door to door collectors
- factories using returnable containers
- factories purchasing recycled materials

E.4.2 Result of the Survey

a. Primary Sorters

a.a Scavengers in the landfill site

Approximately 250 scavengers work full time in the Acahualinca landfill site. They sort paper, cotton, shoes, spareparts of machinery, aluminum, bronze, bottles, plastic vessels, ferrous metals, plastic bottles and fat.

After sorting the materials scavengers sell them to intermediaries at the landfill site,

on the city boundaries and adjacent streets.

The total amount of reusable materials recovered at the Acahualinca landfill site is estimated to be 16.8 tons per day.

The selling price of sorted materials from scavengers to intermediaries are summarized in Table E.4.2a.

Table E.4.2a Selling Price List from Scavengers

Materials	Selling Prices in Cordobas
Aluminum	0.88 to 2.2 / kg
Bottles	0.12 to 0.20 / kg
Ferrous metals	0.17 / kg
Plastic bottles	0.10 / unit
Paper	1.65 / kg
Textiles	5.0 / sack
Cooper	4.4 / kg
Bronze	4.4 / kg
Fat	200 / barrel
Cotton	4.4 / kg

The fat is recovered from the slaughterhouse and is used to produce soap.

ab. Door to Door Collector

According to the public opinion survey, there are a few door to door collectors of recyclable materials. At the same time it was very difficult to identify those collectors during the survey because the frequency of their visits is not determined.

Considering the above mentioned reasons, the amount of recyclable material collected by door to door collectors is quite limited.

ac. Collection Crews

Municipal waste collectors segregate recyclable materials at the curbside before loading them onto the vehicles. On their way to the landfill, they sell these materials to intermediaries. An average of two sacks containing sorted materials

unloaded from the collection trucks during the survey. The amount of recycled materials is significant.

ad. Public Cooperation

The public opinion survey shows that householders are willing to cooperate with recycling programs if their time and efforts are compensated. They prefer to sell recyclables to collectors rather than shops.

Putting a price for the return of bottles is a system that encourages people to carry out recycling. Some bottles are collected and kept in the houses for different purposes.

Generally speaking, recycling activity by consumers is not developed; there is not enough information on the benefits of recycling that would encourage the citizens to change their traditional attitudes and behavior patterns.

b. Intermediaries

Four intermediaries were identified during the survey.

During the survey they were reluctant to give information because they felt it may interfere with their business. After explaining the purposes of the survey, some information were obtained, but their reliability is questionable and may require confirmation from scavengers and final purchasers in order for it to be interpreted correctly.

ba. Bottles

A bottle intermediary located at Acahualinca landfill was interviewed and the following information was obtained:

- daily investment of C$ 1,000 and C$ 1,200
- bottles are bought mainly from the collection crews of 25 trucks daily
- the price of a bottle is 0.20 to 0.30 cordobas, i.e, from C$ 4.80 and C$ 7.20 for a box (12 bottles). The selling price is C$ 6.0 and C$ 10.00 for a box.
- They also buy car batteries, approximately 50 a week. The buying price is C$ 2.00 and the selling price is between C$ 3 and C$ 4.
- there are two employees in charge of receiving and classifying bottles
- bottles obtained from various sources are assembled and graded to meet the needs of the buyers. To the extent that there is available space and some cash

flow, the bottles are stored. This allows for a supply which matches demand, and therefore better prices.

- materials are sold to food processors such as: CAPRI, GLADYS, DUQUI and some honey producers

bb. Metals

Location of the intermediary site is at Casa Pellas, one block to the east of the Managua Lake. This is a family business. The materials are bought from scavengers working at the Acahualinca landfill site and at the entrance of the site. They also obtain materials from inner cities.

They buy mixed metals at the price of C$ 7.00/qq (45 kilograms) and sell them to other intermediaries that haul the materials to El Salvador and Guatemala for US$ 4 or 5 per qq (45 kilograms). Every 15 days they sell approximately 1500 qq (67,500 kg) of metals for export. They also buy box springs from mattresses at a price of C$20 and sell them for C$ 40.

Two other intermediaries established on the road to the Augusto César Sandino Airport were surveyed. One of them the National Recycling of Nicaragua, buys all kinds of metals and export 6,800 kg a month to other Central American countries, and has been operating for three years.

The other one, Marber Metals S.A, has been operating for four years and exports about 60 tons a month of materials to the United States.

Table E.4.2b Buying Price of Sorted Materials by Intermediaries (Cordobas)

	Acahualinca Intermediary (1)	Acahualinca Intermediary (2)	National Recycling of Nicaragua	Marber Metals S.A
Bottles	0.20 - 0.30/unit			
Batteries	0.20/unit			
Metals		0.15/kg		
Box Spring		20-40/unit		
Copper			5.28/kg	4.40/kg
Bronze			5.28/kg	2.20/kg
Solid Aluminum			4.62/kg	1.32/kg
Radiators			4.62/kg	2.20/kg
Aluminum Can				0.77/kg
Condensers				1.54/kg

bc. Shoes

The surveyed intermediary does not have a specific purchasing area for the materials. He moves to different places especially where municipal trucks unload other recyclables.

In the area there are about 5 or 6 buyers of shoes which are obtained from the collection crews. The sorted shoes are used for two purposes: the ones in regular condition are repaired, while the sole of irreparable ones is separated and sold at the Oriental market.

Shoe collectors buy the materials from the collection crews; information about prices was not obtained.

c. Final Purchaser

ca. Bottles

Bottles are purchased and used as containers by four or five local food manufacturing industries. One of these industries, CAPRI, was surveyed and the following results were obtained:

- recycling involves the direct reuse of the bottles without changing its basic form, after purification
- the bottles are used as containers for tomato sauce, mustard, vanilla, chili and vinegar
- they buy the bottles from the Acahualinca intermediaries
- the 12 oz bottle is purchased for C$ 0.25 and the 5 oz for C$ 0.20
- they are buying 2,400 bottles a week but 9,600 bottles are needed for full production
- according to our interview there are 10 to 15 companies in the same production line in Managua
- The price of the bottles bought from manufacturing plants in Costa Rica and Guatemala is 1.0 cordoba per unit. Using bottles sorted from waste save the purchase costs.

cb. Paper

Recycling of paper is done mostly by Industrias Papeleras Mercurio S.A acting as an intermediary and final purchaser in Managua.

They buy approximately 70 tons of paper a month from different sources such as offices, shops, and houses, and export 40 to 45 tons a month to the United States and to the International Paper company in Guatemala; the rest is sold in Nicaragua to UCASA in Masaya, CARTONOSOL,and Kimberly Clark. The buying price is about $30 dollars per ton and the selling price depends on the quality of the paper (i.e. US$ 290 per ton for bond paper and US$ 95 a ton for newspaper materials). The industry seems to be very profitable and provides jobs to 25 people.

E.4.3 Findings

a. Present Recycling System

aa. Bottles

A large amount of bottles are directly reused without changing the basic form and function.

Establishing the use of bottles according to shape, size, etc., such as the ones used for soft drinks and in beer factories has facilitated this level of reuse. Also the high price for set for the return of each bottle has encouraged consumers to return bottles.

There are no glass factories in the countries and demand is high; importation is expensive and recycling helps create jobs and puts less pressure on foreign exchange. Moreover, various bottles without deposit are also being reused as containers of local products such as honey, tomato sauce, mustard, etc.

ab. Paper and Cardboard

The characteristics of recycling of paper and cardboard does not involve intermediaries. Scavengers at the landfill site sort paper in small quantities and sell it directly.

Paper factories and related enterprises buy the material directly from the generation sources in offices and shops before they become contaminated and degraded.

ac. Iron

Iron recycled is exported to some Central American countries and the United States. Two recycling intermediaries located on the road to the Augusto César Sandino Airport claim to export 60 tons and 68 tons of material a month, respectively. The other intermediary that appears more informal, located in Acahualinca landfill site, says that it exports 150 tons of mixed materials a month.

ad. Aluminum

The price of solid aluminum is quite high, therefore it is well recycled. Aluminum cans are also sorted and sold for 0.77 Cordobas a kilogram (there are approximately 55 cans in one kilogram).

There are no aluminum recycling factories in Nicaragua, therefore this material is sent abroad for recycling.

af. Plastics

Plastic objects and bottles are sorted at the landfill, but no information about their recycling and reuse was obtained.

b. Waste Amount Recycled

The waste amount recycled in the study area is estimated to be 12.8 tons a day, according to the data obtained through the survey. This quantity is considered approximate as the information was obtained from uncooperative people.

c. Recent Trends in Recycling Activities

Although it is not new, recycling is becoming increasingly important in municipal solid waste management as communities, businesses, and industries battle against the rising costs and are beginning to consider the environmental impacts of improperly handled hauled waste.

The number of scavengers is increasing rapidly due to a high rate of population growth in the country. These people live in poverty, have very low income, high rate of illiteracy and without job opportunities. They consider scavenging as their only way of earning a living.

Many people are becoming interested in the potential benefits of recycling and in how to achieve a more sustainable economy for the city and the country.

d. The Present Recycling System

The present recycling system provided many people with benefits and compensates them for their time and effort.

The present socio-economic situation in Nicaragua encourages people to look for ways of living and recycling actually provides them with work. The formulation of the Master Plan will consider different recycling options available and the strategic planning of the development of recycling programs. When properly implemented, a recycling program can become a popular municipal waste

management activity among the citizens. In many communities recycling represents a new waste management option that is unfamiliar to many people.

The Municipality of Managua should see through the desire os the citizens and businesses to "do the right thing", design programs that facilitate recycling, and aggressively promote plans and programs to all members of the community.

Public participation in recycling will be one of the most important factors which will decide the program's success.

E.5 Time and Motion Survey

E.5.1 Outline of the Survey

a. Objectives of the Study

Solid waste collection involves intensive work. At the same time, its cost occupies a large portion of the total cost of SWM. Therefore, the following measures are necessary to improve collection efficiency:

- Maximum use of the truck capacity
- Maximum use of legal working hours

It is necessary to understand precisely the present condition of solid waste collection and find its problems in order to prepare an improvement plan. This survey was carried out with this objective in mind.

b. Content of the Survey

The survey includes:

- time, distance and weight of waste for collection and haulage.
- type of dustbin and container used
- working efficiency of collection workers
- collection routes
- level of discharge cooperation in waste collection activities
- service level
- maintenance and condition of equipment

E.5.2 Methodology

The Department of Collection and Cleansing of Managua Municipality is the organization authorized for waste collection and haulage work. The following three sections in the department are responsible for waste collection work:

- Household Collection: in charge of collection using compaction trucks,

(including those collecting waste from 0.83 m^3 containers) and 4 m^3 tractor pulled carts.

- Collection through dump sites : in charge of collection of waste from the several registered small dumps existing in the city.

- Collection through containers : in charge of the removal and haulage of 15 m^3 roll-on, roll-of containers to the disposal site.

The Household Collection Section divides the city into 82 collection areas. The collection service of each area is done through a fixed route. In addition to the collection service of residential areas there is a route for commercial and market waste, a route for hospital waste and three routes for industrial waste.

Six collection vehicles selected according to the type and conditions of the area were traced for this study. Their activities were recorded precisely. The type of vehicle, responsible organization and area/route traced are shown in Table E.5.2a.

Table E.5.2a Type of Vehicle, Responsible Organization and Area/Route Traced

Type of Vehicle	Responsible Organization	Area/Route Traced
Compactor Truck	Household Collection Section	Residential Area (Middle Income) Route 4-2
Compactor Truck	Household Collection Section	Residential Area (High Income) Route 5-9
Cart Tractor	Household Collection Section	Residential Area (Low Income) Route 3-B
Screw Type Collection Truck	Household Collection Section	Markets, Supermarkets, Offices
Roll-on Roll-off Truck	Collection through Containers Section	Markets
Wheel Loader and Dump Truck	Collection through Dump Sites	Oriental Market and Illegal Dumping Site

The location of the areas studied during the time and motion survey is shown in Figure E.5.2a. The activities of the vehicles were recorded precisely using a record sheet. All waste collection stations and routes were marked on the map.

The amount of waste collected by the compactor truck and screw type collection truck was weighed using a portable type truck scale at the Acahualinca disposal site. On the other hand, the amount of waste collected by the cart tractor, roll-on roll-off truck and dump truck was estimated from the hauled volume.

The amount of waste obtained during this survey should be supplemented by the amount of waste collected by the same vehicles in the same routes on the same days measured using the truck scale installed by JICA at the entrance of the Acahualinca disposal site.

The Team consisted of four members including a driver. The duties and responsibilities of each member were assigned in the preparation stage. The following tasks were assigned to each study team member.

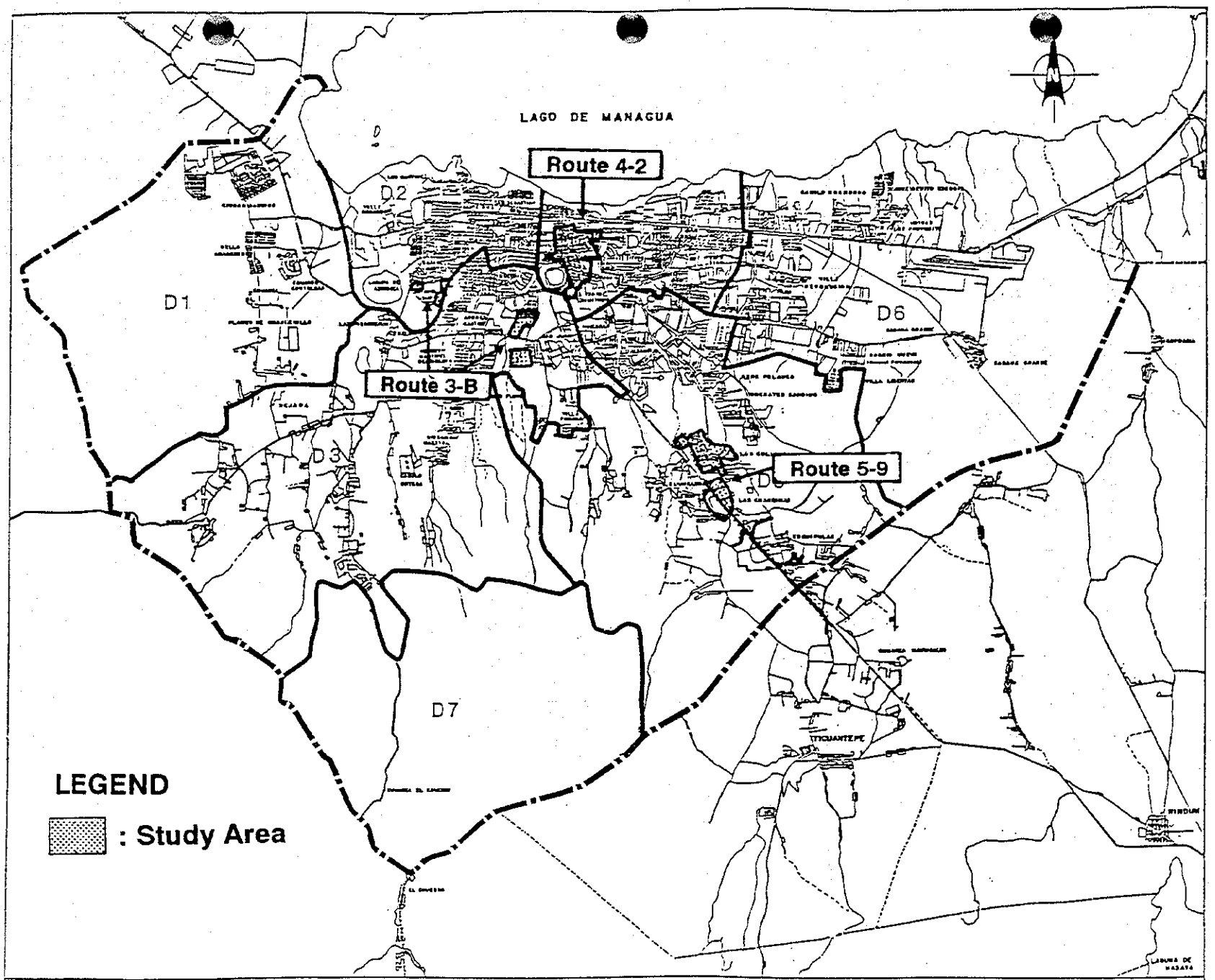
Group Leader	dustbin and container studies (size, condition, number), road condition, crew behavior, collection vehicle (condition, loading capacity, coverage area)
Member A	mapping of the route and marking points indicating the location of dustbins and containers
Member B	recording time, distance and weight measurements
Driver	tracing the solid waste collection vehicle

a. Time Recording

The following items were recorded:

- departure time from vehicle depot
- arrival and departure time from each collection route
- arrival and departure time from disposal site
- arrival time at vehicle depot

The time consumed in each cycle was calculated later.



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

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure E.5.2a Study Area of the Time and Motion Survey

b. Distance

The following distances in kilometers were recorded in the field using the odometer of a car.

- initial indicator in kilometers at the time of departure from the vehicle depot
- distance in kilometers at the time of arrival at each station
- distance in kilometers at the time of arrival at the disposal site
- distance in kilometers at the time of arrival at the vehicle depot

c. Dustbins and Containers

Dustbins and containers were counted and classified according to their size and types.

d. Mapping

The following information was marked on the map:

- collection route
- collection points
- direction of truck depot
- direction of disposal site
- serial number of the collection points