R/MB=	
MiT/TsI=	0.63
MT/TsI=	0.19
R/TsI=	

Other indices may be calculated for a specific analysis, taking Relevant Costs as:
= RC = PpE + (S.M.P):

WRC=	2755
MkRC=	556
ARC=	497
WT/WRC=	0.09
MkT/MkRC=	3.16
AT/ARC=	0.67

Some conclusions are as follows:

- Taxes correspond to 88% of the MB and 7% of foreign donations
- In proportion to the total tax income (TsI), direct municipal taxes for services and usage (MT) correspond to only 19%, and imposed taxes (MiT) correspond to 63% (these were national taxes transferred provisionally to the municipalities).
- 56% of TsI correspond to the tax on sales and services.
- The waste & cleansing tax covers only 9% of the relevant costs (RC) of the services.
- Market and abattoir taxes cover 316% and 67% of the services respectively.

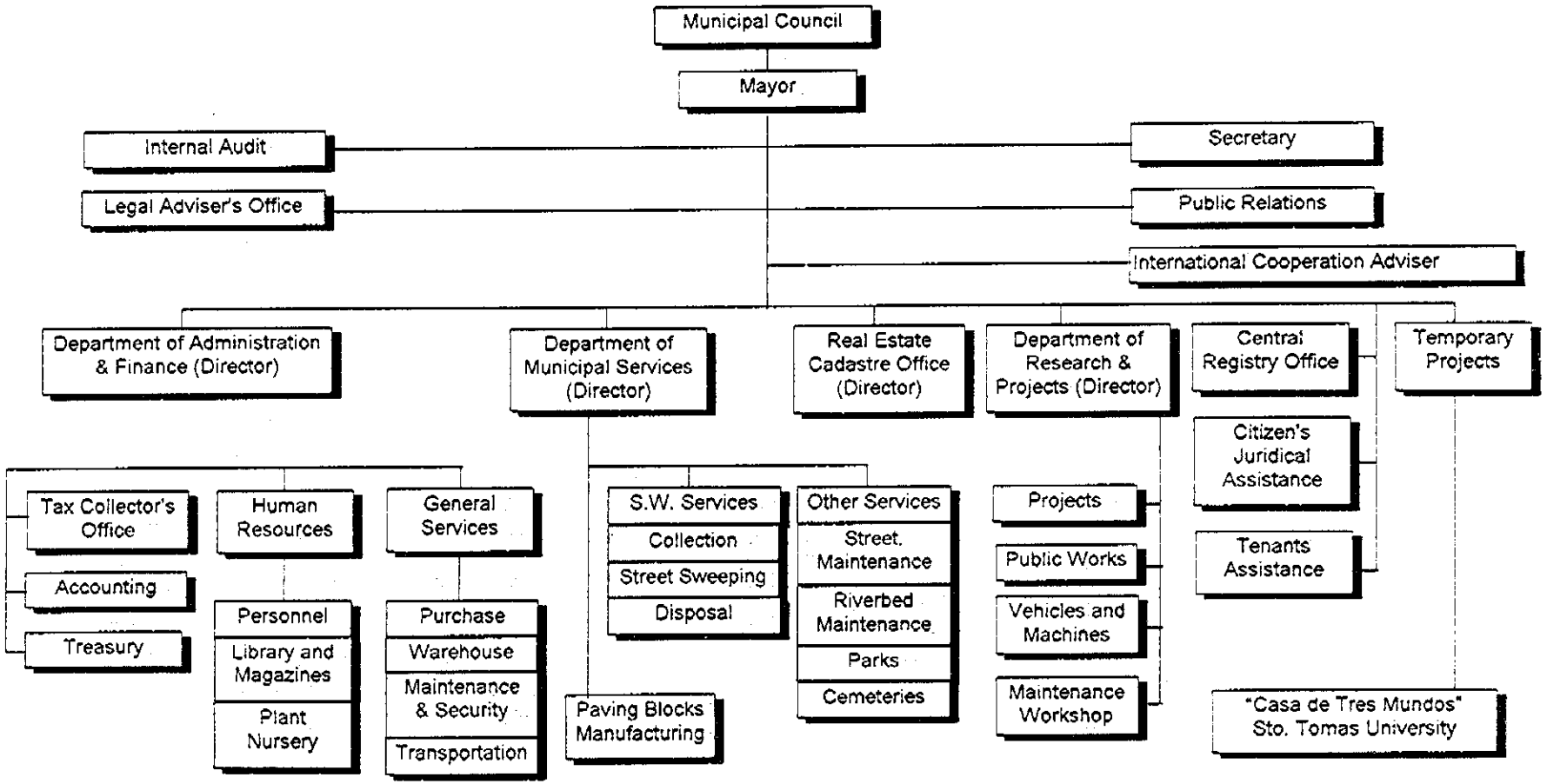


Figure 2-14: Organization Chart of the Municipal Government of Granada

b. Employment

"Statistics of socio-labor in Granada City" surveyed by MITRAB reported that the number of people in employment in Granada was 27,434 in 1994. From that data, the unemployment rate can be calculated as 9.2 percent. The major economic activity is "social, community services", with 8,352 people involved, followed by "commerce, restaurant and hotel", with 8,004. Employees of these two major activities occupied about 60 percent of the whole workforce. The rate of concentration to above two activities is the lowest in the study areas because the number of employees in the manufacturing sector was 7,540 (18.4 percent). Employees in the informal sector shared 65 percent, with 17,748 people, therefore the EAP seems considerably low.

c. Income Level

It is difficult to compare the income level in Granada with other cities because of the absence of an income distribution table. The survey executed in August 1993 by FIDEG reported that the rate of households below the poverty line was 77.3 percent, higher than the 75.1 percent in Leon.

INSSBI reported that the average weekly salary was C$250.74.

2.4.4 Population of Granada

a. Population by Municipality in Granada Department

With a population of 155,683 persons (INEC 1995 preliminary census), the department of Granada represents 3.6% of the country's total population. Occupying a land area of 929 km^2, it has a population density of 168 persons/km^2. The department is made up of 4 municipalities: Granada, Diria, Diriomo and Nandaime.

Sixty two percent of the department's total population is concentrated in the municipality of Granada, which is inhabited by 96,996 people.

b. Population of the Urban Area of Granada Municipality

With 71,783 inhabitants in a land area of 14.30 km^2, the population density in the urban area of Granada Municipality is estimated at 5,020 persons/km^2.

Table 2-10: Urban and Rural Area Population of Granada Municipality

Granada	Area (km^2)	Population (1971)	Population (1995)	Population Density (p/km^2)	Growth Rate (1971/1995)
Urban Area	14.30	35,422	71,783	5,020	2.99
Rural Area	516.70	9,031	25,213	49	4.37
Total	531.00	44,453	96,996	183	3.30

Source : Population data (INEC); Growth rates estimated by the Study Team

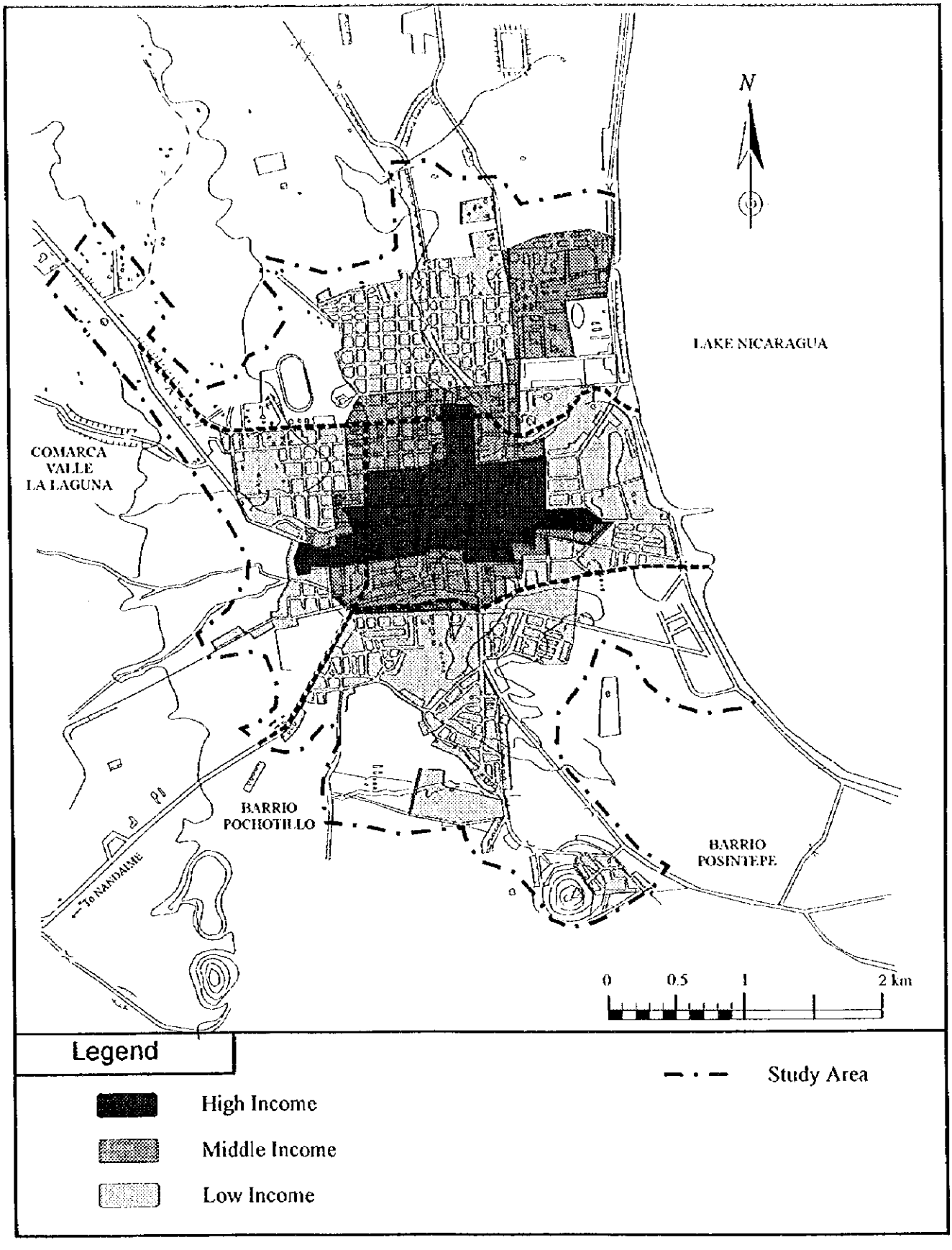


Figure 2-15: Zones Categorized by Income in Granada

2.4.5 Housing Conditions in Granada

a. Housing

According to the 1995 census conducted by INEC, the number of housing units in the municipality in 1995 totaled 16,731, indicating an increase of 94% from the 1971 figure of 8,605. The number of housing units in the urban area (12,651) was also found to exceed the number in the rural area (4,080).

The total housing distribution within the municipality in Granada Department is shown in table below.

Table 2-11: Number of Housing Units in Granada Department

Municipality	1971			1995			Growth Rates		
	Total	Urban	Rural	Total	Urban	Rural	71/95 (T)	71/95 (U)	71/95 (R)
1. Granada	8,605	5,354	3,251	16,731	12,651	4,080	2.81	3.65	0.95
2. Diria	373	257	116	1,051	574	477	4.41	3.40	6.07
3. Diriomo	987	755	232	3,295	1,198	2,097	5.15	1.94	9.61
4. Nandaime	1,458	1,128	330	5,729	2,658	3,071	5.87	3.64	9.74
Total	11,423	7,494	3,929	26,806	17,081	9,725	3.62	3.49	3.85

Source : Population Census Data, 1995 (INEC)

2.4.6 Urban Structure

a. Evolution of the City of Granada

Figure 2-16 shows the evolution of the city of Granada from the 17th century to 1996.

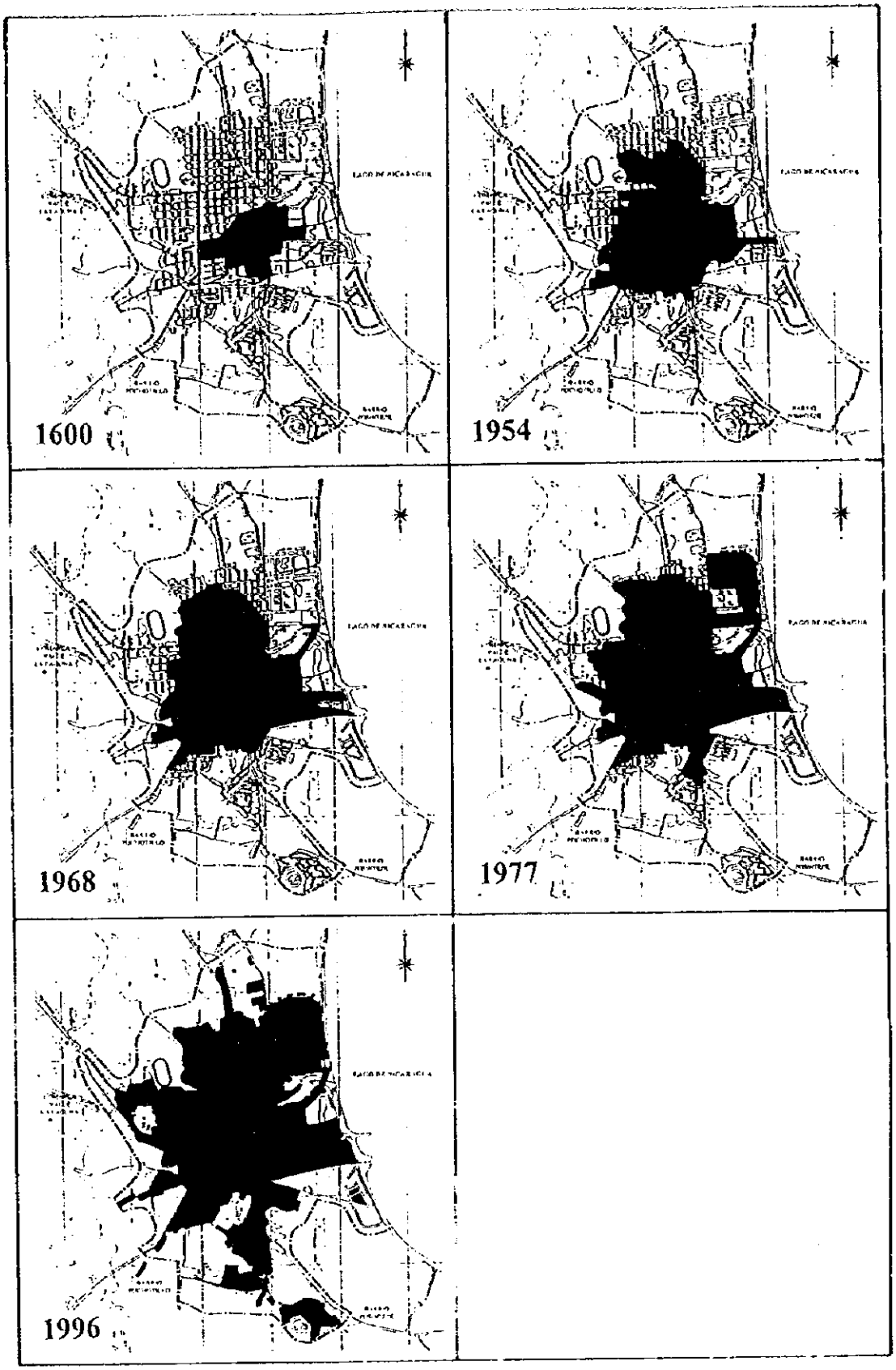


Figure 2-16: Urbanization of Granada

b. City Development Plan

Only two reports were made in the study area: the "Urban Development of Granada" (1978) and the "Regulating Plan" of Granada (1982). Although these reports are dated, they were reviewed. Due to the political situation at the time these reports were made, they were never executed. However, they were used as bases for the formulation of the guidelines on urban regulations in October 1982.

The Regulating Plan contained the following general guidelines relevant to urban development:

- zoning regulation and land use
- regulation for urban development
- regulation for construction permits
- regulation for preservation of historic areas in Granada

Currently there are no city development plans. The municipal government does not have an Urban Planning Section although it has an office responsible for the preservation of historic sites and properties.

c. Land Use

As previously mentioned, there are no land use maps. Therefore, a land use map was prepared based on information provided by the municipal government of Granada and the field survey carried out by the Study Team, using the available cartographic map. This land use map is shown in Figure 2-17.

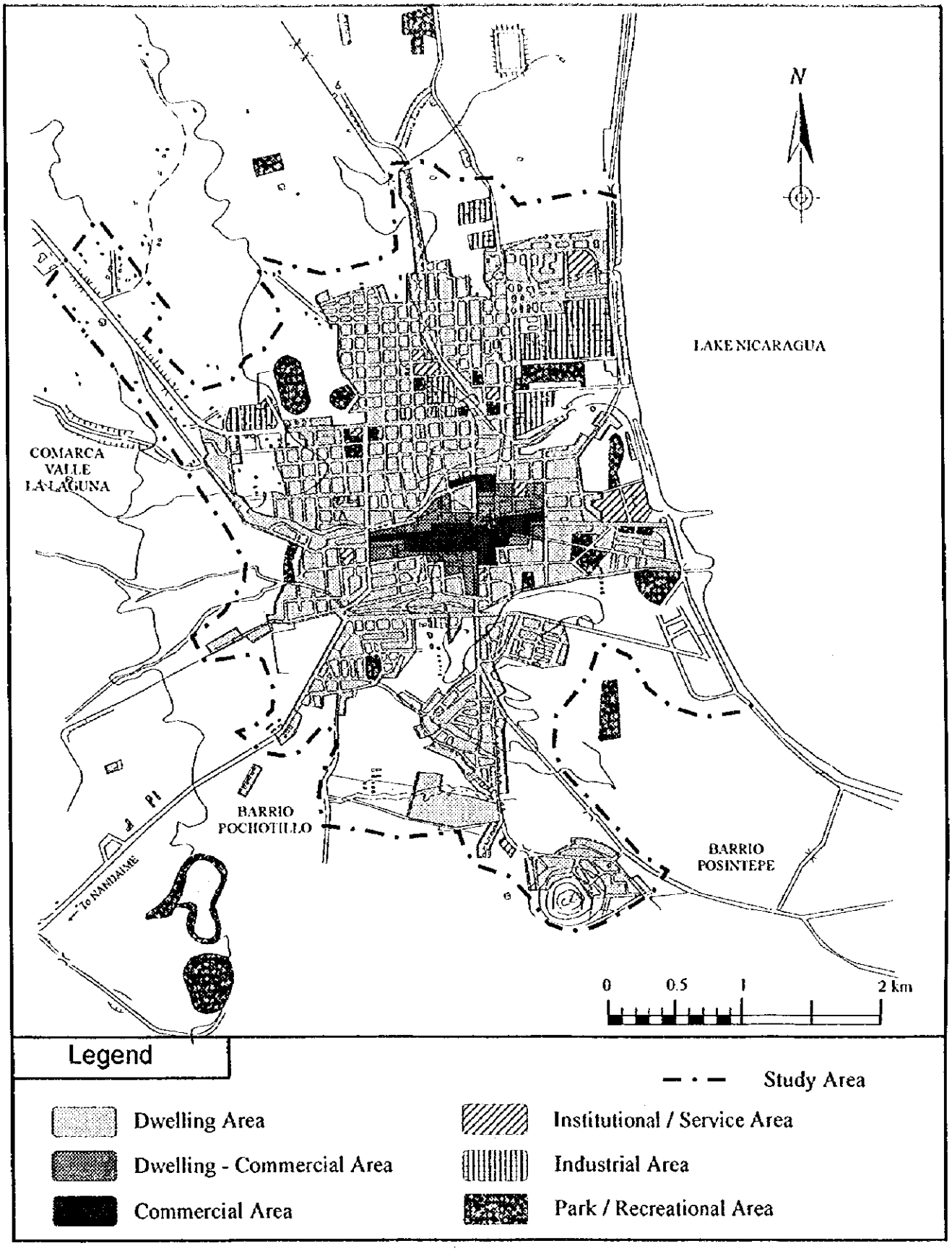


Figure 2-17: Current Land Use in the Urban Area of Granada

d. Industry

The main economic activity in the municipality is agriculture, followed by manufacturing. However, the latter is more vital to regional and national economic development. The manufacturing industries in the area include soap factories and medium scale factories manufacturing textile, shoes, clothes, tobacco, vinegar, sauces, and ice cream. The important factories in the city are: PREGO (soap factory), E. CHAMORRO (soap factory), MONISA (food), IUCASA (paper), AGROTEX (cloth), TEXLASA (textile), CARTONSOL (cardboard factory). There are also 4 medium scale factories within the city area.

Soap factories are located along streams, a main environmental concern in the area. The factories indirectly contaminate Lake Nicaragua (the country's most important water resource) as they discharge their effluents (e.g., detergents, chemical substances) into the watercourses along the streams.

e. Infrastructure

e.1 Road Transport

Road transportation is the main means of transportation in the city. Cars, motorcycles, buses, taxis, and trucks make up the city's transportation system.

e.2 Road Network in the City of Granada

The roads in the city are arranged in a grid formation extending from the central plaza area towards outlying districts. Expansion, however, is restricted in the eastern section by the presence of Lake Nicaragua.

The Pan American Highway is the main artery which crosses the department of Granada in a south-easterly direction. This highway connects the city of Granada to the cities of Masaya and Nandaime, as it extends toward Rivas until the border with Costa Rica.

The city of Granada has 122.8 km of roads, 42.4 km of which are paved either in asphalt or stone blocks. The rest are unpaved.

Because it contains many *arroyos* (streams) intersecting from east to west, Granada has 31 bridges (31). Eight of the main bridges are constructed over the Aduana stream, 6 over Zacateligue stream, and 17 over other major streams in the city.

The maintenance and construction of roads, bridges, sewerage, and other public utilities within the city area are supervised by the municipal government. The maintenance and construction of roads outside the city are supervised by MCT.

2.4.7 Economic Conditions

a. Regional Economy

There is no study on Gross Regional Domestic Product(GRDP) in Nicaragua. The basic data needed to estimate GRDP such as industrial production and commercial sales and services according to regions are too dated to estimate the current GRDP.

The results of the calculation of GRDP, as with Leon, is shown in Table 2-12.

Table 2-12: GRDP in Granada Region in 1991 and 1995

Unit : C$ million in 1980

	1991		1995	
		%		%
Total	505.3	100.0	523.0	100.0
Primary Sector	77.4	15.3	154.2	29.5
Secondary Sector				
Manufacturing	238.6	47.2	190.1	36.3
Construction	17.1	3.4	34.9	6.7
Mining	0.0	0.0	0.0	0.0
Tertiary Sector				
Commerce	90.2	17.9	71.8	13.7
Government	54.3	10.7	44.3	8.5
Transport & Communication	1.5	0.3	1.3	0.3
Bank, Security & Others	10.1	2.0	4.2	0.8
Electric, Gas & Water Supply	0.6	0.1	15.2	2.9
Property & Dwelling	13.0	2.6	5.5	1.1
Other Services	2.4	0.5	1.4	0.3
Population			155.683	
GRDP/capita			3,359.1	

Source : Calculated by JICA Study Team based on;
Anuario Estadistico 1995, INSSBI
Informe Anual 1995, BCN
Compendio Estadistico 1987-1991, INEC

The GRDP in 1995 was 3.5 percent higher than in 1991, which is a unique characteristic to Granada region. A significant increase was recorded in agriculture, construction, electricity, gas and water supply. Manufacturing, the major industry, decreased to 80 percent of 1991. GRDP in current price was C$374 million, that is 78 percent of Leon region.

GRDP per capita in 1995 was C$3,359 in constant price (1980), which is 75 percent of the GDP per capita (C$4,481).

2.4.8 Relevant Studies and Projects

Data and information regarding studies and projects realized in Granada, which are related with this Study, are obtained from the counterpart. Section B.4.8 in Annex B, Volume IV, lists those studies and projects.

CHAPTER 3

Field Investigation

3 Field Investigation

The following surveys were carried out in order to identify and understand specific features and key indicators of the USE in the 3 principal cities:

- Public Opinion Survey
- Water Quality Survey (rainy season and dry season)
- Water Pollutional Load Survey
- Waste Amount and Composition Survey (rainy season and dry reason)
- Industrial Waste Survey
- Medical Waste Survey
- Survey on Inundation Damage

3.1 Public Opinion Survey (POS)

a. Objectives of the POS

The primary objective of the Public Opinion Survey (POS) was to identify the following issues with regard to urban sanitation environment (USE) in the three cites (Leon, Chinandega, and Granada):

- public awareness on USE
- opinion on present USE
- needs for improvement
- willingness to pay (WTP) and ability to pay (ATP) for improvements

b. Samples and Items of Survey

The POS was carried out in accordance with the survey flow described in Figure 3-1. The survey was subcontracted to the local consultant, EGO, through a tender process.

The POS played a considerably important role in:

- determining appropriate charges for the sanitation services.
- selecting a first priority city from the 3 principal cities.
- selecting first priority project(s), etc.

Therefore, the contents of the POS questionnaire were fully examined by the Team and the counterpart and finalized.

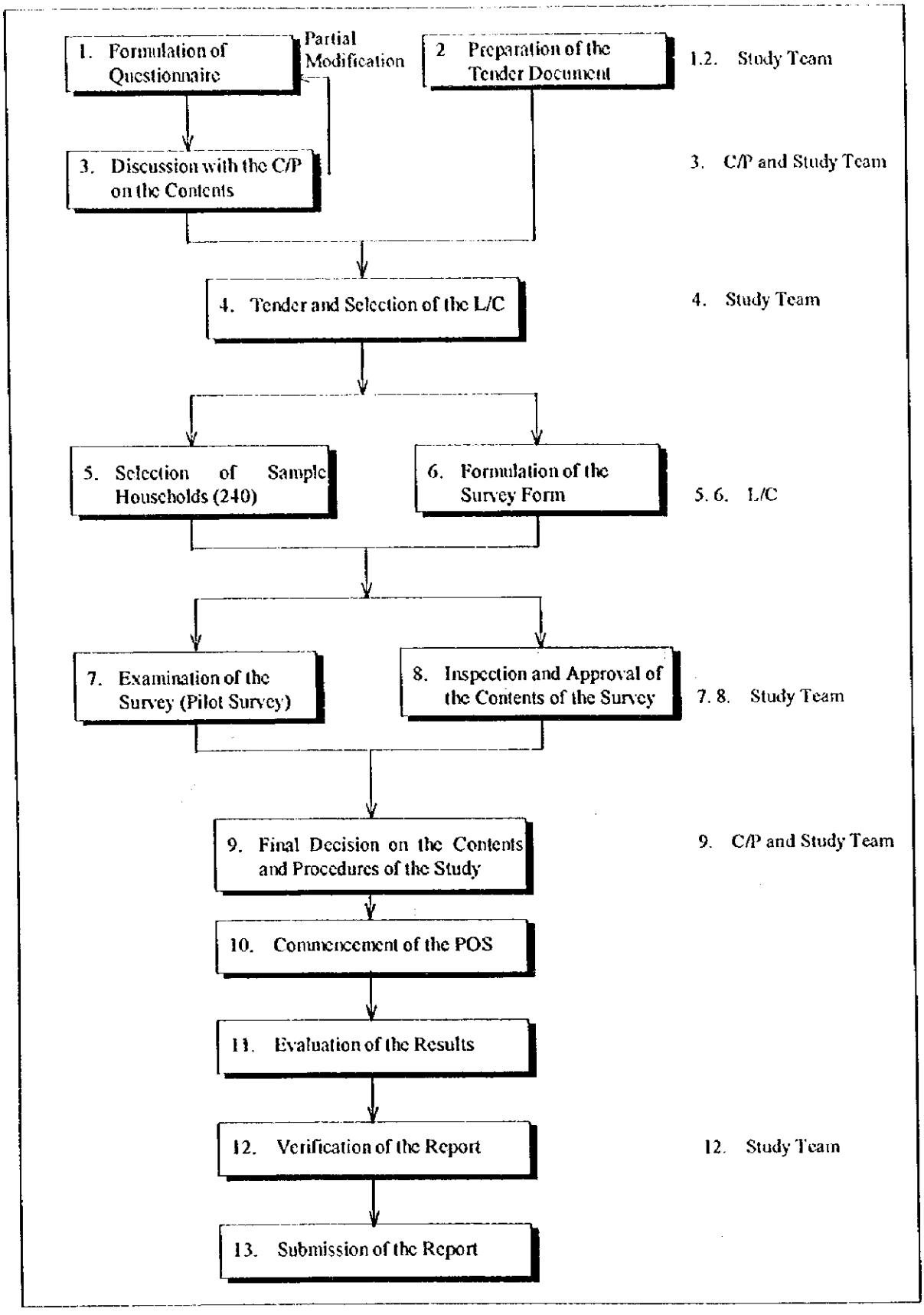


Figure 3-1: Flow of POS

b.1 Sample Number and Survey Area

The Team initially proposed a sample number for each of the 3 cities, as follows:

- urbanized area: 30 samples
- semi-urban area: 30 samples
- commercial area: 20 samples

Discussion between the counterpart and the Team members was extended to determine the distribution of the sample numbers in proportion to the USE problems. Consequently, the counterpart proposed:

- urbanized area: 30 samples
- semi-urban area: 40 samples
- commercial area: 10 samples

The Team accepted the new proposal.

The selection of the survey sampling area (i.e., urban, semi-urban, and commercial areas) was assigned to counterpart members from respective municipalities due to their knowledge of intrinsic situations in each area of the city.

In general, the sample areas represented:

- **urban area:** the city center and/or traditionally established areas (in some cases newer residential areas) with fewer problems on urban infrastructure.
- **semi-urban area:** urban fringe areas and some barrios/repartos newly extended and/or isolated from the city center, with more problems related to urban infrastructure and sanitation.
- **commercial area:** the area where commercial activities are concentrated in each city.

b.2 Survey Items

The survey items were, in general, categorized into:

- General awareness on USE
- Present situation of public services related to USE
- Community participation
- Diseases and USE
- Needs and willingness to pay (WTP) for the improvement of USE

c. POS Findings

The following information were obtained through the POS:

- **A great majority receive water supply services.** Where interviewees presently pay C$73.76/month on average for the service, WTP (the additional amount payable by those who pay for the service today) for water supply improvement is very small (C$0.47/month). It could be concluded that the **present water charges** are very close to the people's **maximum affordable amount** for the service. Additional cost bearing of water charges by beneficiaries would be very difficult.

- The majority expressed that they are in need of a sewer service. Where only 39 out of 240 pay an average of C$24.49/month for the sewer system, **WTP** (the additional amount payable by those who pay for the services today) for sewer improvement is very small (C$2.23/month). It could be concluded that the **present sewer charges** is also close to the people's **maximum affordable amount** for the service.

- Another **WTP** (the amount payable by those who do not receive any services today) for sewer improvement is C$8.32/month. The difference between the "present sewer charge" and this "low WTP (C$8.32/month)" suggests there could be a compromise and/or reconciliation between **"improvement needs"** and **"affordable practices"** for domestic wastewater disposal.

- The majority (187 out of 240) receive SW collection services. Where the average charge for SW collection service is C$16.60/month, **WTP** (the additional amount payable by those who pay for the services today) for SW collection service improvement is C$5.27/month. It could suggest, in comparison with "water" and "wastewater" sectors, that people are still able to **afford** to bear some additional cost for improving the "SW collection service".

- Most people expressed a strong willingness to take part in community activities for USE improvement. However, in reality community participation has not been substantive. Efforts by both authorities and communities (i.e., beneficiaries of USE improvement) should be made in this area, in order to easily introduce the community's activities into USE improvement.

- Leon citizens show the highest financial ability to pay for the services than the other two cities. Granada shows a higher incidence of "gastroenteric diseases and diarrhea" than the other 2 cities; Chinandega has a higher incidence of "malaria and dengue" than the other 2 cities. SW Problems are expressed in Leon more than in the two other cities.

- In general, the "semi-urban area" has more problems related to USE (e.g., smaller coverage of USE services) and a greater dissatisfaction for USE services are expressed.

d. Findings

Details of the Public Opinion Survey (POS) is described in Annex C in Volume IV.

3.2 Water Quality Survey (WQS)

a. Objectives of the Survey

Objectives of this survey were to interpret the present state of water source (underground water) contamination and the present river water quality at the outlet of the present sewage treatment plants in the 3 cities.

b. Method of the Survey

The survey was carried out in two phases (once in the rainy season, Aug/Sep 1996, and once in the dry season, Jan/Feb 1997) in order to make a comparison.

Three (3) wells in each city, which serve as a water supply source for the city, were sampled to measure the present degree of water source contamination.

River water was sampled at the upstream and downstream of the lagoon effluent outlet of the sewage treatment plants in each city, in order to quantify the present river water quality. However, since Granada sewage treatment plant does not discharge its effluents into a river, instead the wastewater flows through a pastureland and ends in a marshland, where the effluents infiltrate into the ground. Therefore, samples were taken at the lagoon outlet and the marshland. Analysis items are listed in the table below.

Table 3-1: Items for the Water Quality Analysis

On-site Analysis	Laboratory Analysis
1. Ambient Temperature (AT) 2. Sample Temperature (ST) 3. pH	1. DO (Dissolved Oxygen) 2. COD (Chemical Oxygen Demand) 3. BOD (Biochemical Oxygen Demand) 4. SS (Suspended Solid) 5. E.coli. (Escherichia Coliform)

All the analyses were made in compliance with the standard methods of "APHA(American Public Health Association)-AWWA(American Water Works Association)- WPCF(Water Pollution Control Federation)", Standard method for the examination of water and wastewater 17th edition 1989".

b.1 Sampling Point

The sampling points in each city are listed in the table below.

Table 3-2: Sampling Point

	Well	River water
Leon	1.Los Tanques 2.Ruben Dario 3.San Carlos	1. Rio Chiquito (upper and lower stream of "El Cocal") 2. Rio Chiquito (upper and lower stream of "Subtiava")
Chinandega	1. El Calvario 2. Las Pilas 3. Los Angeles	Rio Acome (upper and lower stream of "El Cocal")
Granada	1. Escudo No.1 2. El Escudo No.2 3. Quinta Ena No.4	Outlet of the sewage treatment plant and the terminal marshland

c. Results of the Survey

c.1 Well Water Quality

The results of the survey are tabulated in Table 3-3.

Table 3-3: Results of Well Water Quality Survey

	Season	Date	AT °C	ST °C	pH	DO mg/l	BOD mg/l	COD mg/l	SS mg/l	E coli. NMP/100ml
Leon										
San Carlos	Rainy	29/Aug/96	32	29	7.2	8.1	0	30	0	4
	Dry	20/Jan/97	29	30	7.5	-	1.2	6.0	4	930
	mean value		31	30	7.3	8.1	0.6	18	2	467
Ruben Dario	Rainy	29/Aug/96	30	29	6.6	8.3	0.1	4.8	0	<3
	Dry	20/Jan/97	29	28	6.6	-	4.1	21.0	2	93
	mean value		30	29	6.6	8.3	2.1	12.9	1	48
Los Tanques	Rainy	29/Aug/96	31	28	7.1	7.5	0.4	25	0	<3
	Dry	20/Jan/97	25	26	7.3	-	0.3	12.0	120	<2.2
	mean value		28	27	7.2	7.5	0.4	18.5	60	<3
Chinandega										
Los Angeles	Rainy	5/Sept/96	26	28	7.4	8.2	0.2	24.2	0	<3
	Dry	21/Jan/97	27	28	6.8	-	0.7	8.3	4	<2.2
	mean value		27	27	7.0	8.2	0.5	16.3	2	<3
Las Pilas	Rainy	5/Sept/96	27	28	7.6	8.3	0.1	3.6	0	<3
	Dry	21/Jan/97	25	25	6.5	-	0.5	23.0	16	<2.2
	mean value		26	27	6.8	8.3	0.3	13.3	8	<3
El Calvario	Rainy	5/Sept/96	28	28	7.8	8.2	1.1	30.4	0	4
	Dry	21/Jan/97	27	27	7.3	-	0.3	8.9	4	11
	mean value		30	30	7.5	8.2	0.7	19.7	2	8
Granada										
Quinta Ena	Rainy	10/Sep/96	26	31	7.5	7.9	1.1	31	0	<3
	Dry	23/Jan/97	28	30	7.1	-	1.1	14.0	4	9
	mean value		27	31	7.3	7.9	1.1	22.5	2	6
Escudo 1	Rainy	10/Sept	32	29	7.7	7.9	2.1	18	4	4
	Dry	23/Jan/97	27	26	7.3	-	0.1	7.4	4	430
	mean value		30	28	7.5	7.9	1.1	12.7	4	217
Escudo 2	Rainy	10/Sep/96	32	29	7.6	8.4	1.8	20	4	<3
	Dry	23/Jan/97	27	31	6.8	-	0.1	6.7	16	150
	mean value		30	30	7.0	8.4	1.0	13.4	10	77

c.2 River Water Quality

The results of the survey are tabulated in Table 3-4.

Table 3-4: Results of River Water Quality Survey

	Date	AT °C	ST °C	pH	DO mg/l	BOD mg/l	COD mg/l	SS mg/l	E coli. NMP/100ml
Leon "El Cocal"									
Upper	Aug/30/96	30	32	6.5	0.2	111	209	92	2,400
	Jan/20/97	27	28	7.4	2.9	132	892	66	110,000,000
mean value		29	30	6.8	1.6	122	551	79	50,001,200
Lower	Aug/30/96	29	33	8.4	0.7	76	147	162	11,600,000
	Jan/20/97	28	29	7.6	5.7	60	2,083	206	1,500,000
Mean Value		29	31	8.0	3.2	68	1,115	184	6,550,000
Leon "Subtiava"									
Upper	Aug/30/96	31	33	8.4	4.1	24	56	52	430,000
	Jan/20/97	28	30	7.4	4.3	332	1,116	68	70,000
mean value		30	32	7.7	4.2	178	586	60	250000
Lower	Aug/30/96	28	32	7.7	4.3	37	72	68	280,000
	Jan/20/97	28	29	7.1	4.9	204	1,339	128	21,000,000
Mean Value		28	31	7.3	4.6	121	706	98	10,640,000
Chinandega									
Upper	Sept/5/96	31	32	7.7	7.2	41	52	48	430,000
	Jan/21/97	27	30	6.8	8.8	216	923	38	460,000
Mean Value		29	31	7.0	8.0	129	488	43	445,000
Lower	Sept/5/96	32	32	7.6	7.2	72	163	108	430,000
	Jan/21/97	27	29	7.1	7.1	564	1,391	110	1,100,000
Mean Value		30	31	7.3	7.2	318	777	110	765,000
Granada									
Outlet	Sep/12/96	33	33	7.9	0	300	491	512	90,000,000
	Jan/23/97	29	27	8.1	12	50	268	122	300,000
Mean Value		31	30	8.0	6	175	380	317	45,150
Pond	Sep/12/96	33	36	10	0.4	150	411	244	<3
	Jan/23/97	28	28	7.8	8.5	202	655	240	70,000
Mean Value		31	32	8.1	4.5	176	533	242	35,002

d. Findings

d.1 Well Water

High COD recorded in wells where biological contamination is not suspected might be attributable to reductive inorganic substances dissolved in the underground water.

d.1.1 Leon

According to the survey results in the rainy and dry seasons, 2 wells (i.e., San Carlos and Ruben Dario) out of 3 surveyed may possibly be polluted with organic wastewater including nightsoil. Furthermore, the water quality of the well in Ruben Dario suggests "slow filtration" and "disinfection", because the results were classified as Class B according to the water categories proposed in INAA's Pre-feasibility Study.

According to the survey carried out by INAA in 1996, although substances detected that are stipulated in the WHO guideline were lower than the limit specified, organo-phosphorous compounds were detected in several wells in Leon. Therefore, it is necessary to continue monitoring for agro-chemical contamination, and it may be necessary to take countermeasures such as abandonment of contaminated wells.

d.1.2 Chinandega

According to the survey results in the rainy and dry seasons, it is highly unlikely that the 3 wells surveyed in Chinandega (i.e., Los Angeles, Las Pilas, El Calvario) are polluted with organic wastewater including nightsoil.

According to the survey carried out by INAA in 1996, although substances detected that are stipulated in the WHO guideline were lower than the limit specified, organo-phosphorous compounds were also detected in several wells in Chinandega. Therefore, it is necessary to continue monitoring for agro-chemical contamination, and it may be necessary to take countermeasures such as abandonment of contaminated wells.

d.1.3 Granada

According to the survey results in the rainy and dry seasons, it is highly unlikely that wells of Escudo I and Escudo II in Granada are polluted with organic wastewater including nightsoil. However, it is possible that these wells are contaminated with intestinal pathogens from humans or animals.

The results in the rainy season suggested that Escudo I and Escudo II require "slow filtration" plus "disinfection". Meanwhile the results in the dry season indicate improvement in water quality and they only require "disinfection". In relation to this, continuous monitoring of well water quality is necessary in the future.

On the other hand, the WPLS carried out by the Team in the rainy season found that highly concentrated organic wastewater including chromium is discharged from the tannery into a volcanic crater, which is located upstream of the ground water sources of the city. Underground water contamination therefore is highly conceivable.

Furthermore, in view of what was suggested in the CIRA's report on La Joya dumping site, it is very possible that La Joya dumping site might be polluting the city's potable water sources.

d.2 River Water

d.2.1 Leon

i. El Cocal

In the rainy season, bacteriological processes in El Cocal lagoon were insufficient and high levels of E.coli. were recorded in the effluent. Meanwhile, in the dry season the lagoon's bacteriological processes improved but at the same time high COD was recorded.

It could be concluded that:

- In the rainy season, stormwater intrusion into the sewer system decreased the effectiveness of the lagoon's bacteriological processes.
- In the dry season, the lagoon's sewage water inflow became stable and consequently algae growth improved bacteriological processes in the lagoon.
- On the other hand, in the dry season, the lagoon effluent containing algae raised the COD level.

These events are inevitable with lagoon style treatment methods. If the effluents are intended to be utilized as liquid fertilizers, high organic levels in the effluent would be a merit; in that respect bacteriological processes would be a key factor. However, if the lagoon treatment is intended mainly for pollution prevention of the receiving public waters, the present El Cocal treatment system has limitations for such purposes.

ii. Between El Cocal and Subtiava

To compare the downstream of El Cocal and upstream of Subtiava in the rainy season, it was considered that Rio Acosasco, which flows into the Rio Chiquito between El Cocal and Subtiava, discharges clean water and improves the river water quality (in all parameters: BOD, COD, SS and DO).

On the other hand, in the dry season, BOD upstream (60mg/l) is lower than in the downstream (332mg/l). It is difficult to make a deduction as to why this happens. However, a possible cause for this might be that in the dry season, the river flow is small and slow, and water may be stagnant in places. Algae in the El Cocal effluent may have putrefied in the stagnant water, consequently raising the BOD level. Meanwhile, E.coli. and COD attributable to algae might be reduced through the putrefaction.

iii. Subtiava

It was observed that bacteriological treatment function of Subtiava largely reduced in the dry season, contrary to its effectiveness in the rainy season. Presently in the dry season, the bacteriological feature of the Subtiava effluent is the same as untreated sewage. Meanwhile, the lagoon presently achieves biological treatment of sewage (BOD, COD) only to the level of river water quality. Therefore, it might be concluded that sewage treatment functions of the Subtiava in the dry season are considerably deteriorated.

d.2.2 Chinandega

Comparison of the upstream and the downstream water samples indicate that:

- Both in the rainy and dry seasons, the same biological features were observed (i.e., river water quality deteriorated with the introduction of lagoon effluents); BOD and COD levels in the dry season were much higher than those in the rainy season.
- On average throughout the year, biological features of river water deteriorated with the introduction of lagoon effluent (i.e., BOD and COD concentrations rose 2.5 and 1.6 times respectively after receiving the lagoon effluent), and bacteriological features of the river water also deteriorated when the lagoon's effluent was introduced (i.e., E.coli. concentration rose 1.7 times after receiving the lagoon effluent).

d.2.3 Granada

Comparing the two seasons, the lagoon treated effluent shows an improvement in the dry season in all parameters analyzed (i.e., BOD, COD, SS and E.coli.). In particular, the dry season improvement in BOD and E.coli are outstanding. (BOD: rainy season 300 mg/l, dry season 50 mg/l; E.coli.: rainy season 90,000,000 MNP/100ml, dry season 300,000MNP/100ml). This could be concluded that stormwater intrusion into the sewer system is substantially small. Therefore, the lagoon functions properly in the dry season.

Meanwhile, the quality of the marshland sample in the dry season was far worse than that in the rainy season. It could be concluded that the effluent is comparatively small and substances putrefy in stagnant water. Furthermore animal excreta from cattle farming might contribute to the deterioration of the water quality of the marshland.

e. Findings

Details of the Water Quality Survey (WQS) are described in Annex D in Volume IV.

3.3 Water Pollutional Load Survey (WPLS)

a. Objective of the Survey

The objective was to understand the pollutional load from contamination sources in the 3 cities.

b. Method of the Survey

b.1 Work Flow of the Survey

The WPLS was carried out in accordance with the work flow indicated in Figure 3-2.

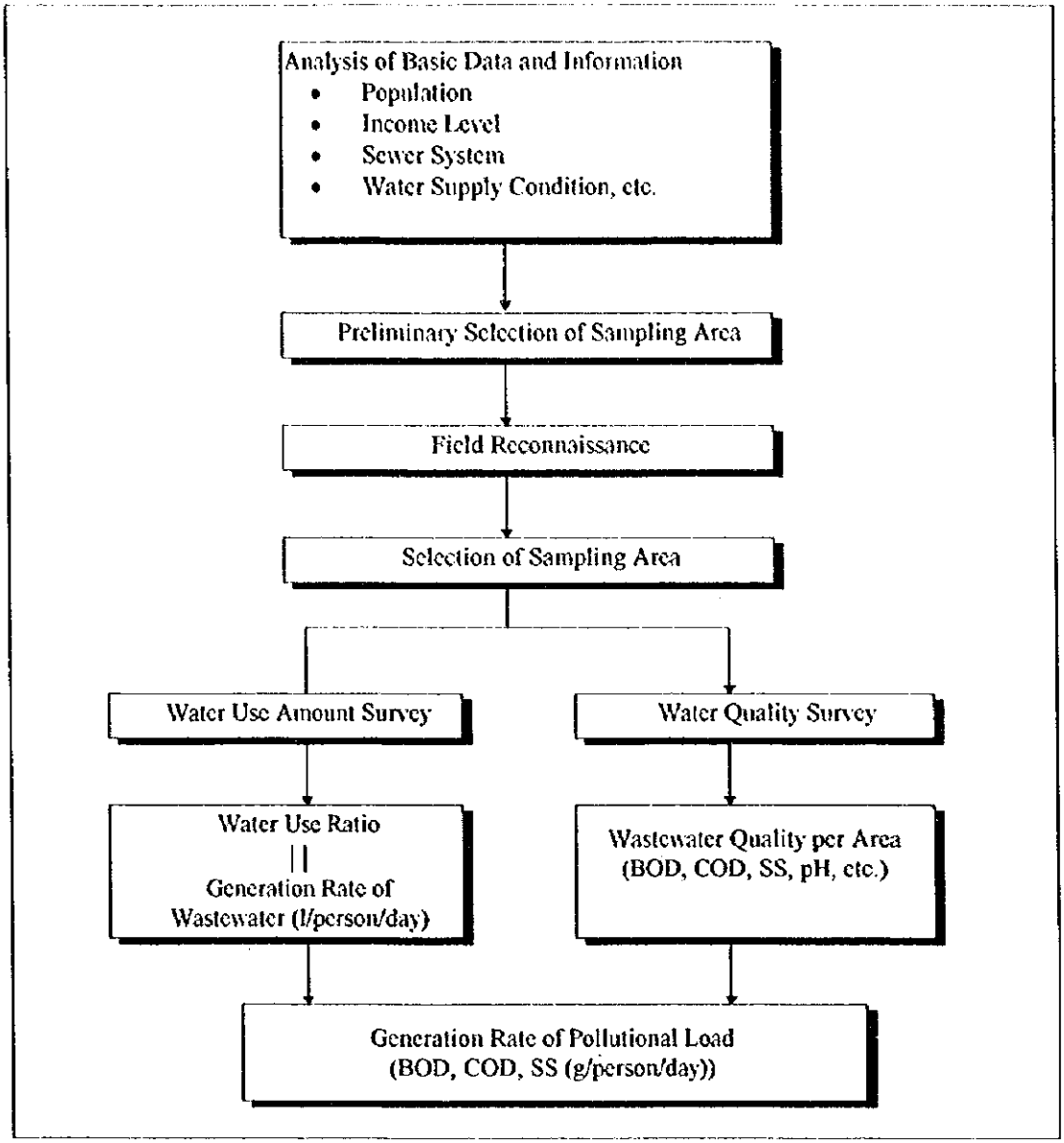


Figure 3-2: Work Flow of WPLS

b.2 Sampling Point

A total of 15 sampling areas, as listed below, were selected in each city for the WPLS.

- 3 in high income residential areas
- 3 in middle income residential areas
- 3 in low income residential areas
- 2 industrial areas
- 2 market areas
- 2 office areas

Sampling points to represent the various sampling areas in the 3 cities were determined following the discussion between the Team and the counterpart, as tabulated in Table 3-5. Sampling manholes for the residential areas were selected as either the second or third manhole from the most upstream point of the sewer nets.

Table 3-5: Selected Sampling Points

		Leon	Chinandega	Granada
High income residential areas	A-1	Residencial Fatima	Los Angeles	Parque Los Generales
	A-2	Residencial Col. Universitaria	Monserrat 1ra. Etapa	Parada de Buses Mgua.
	A-3	Residencial Posada del Sol	San Luis	Carreter Managua - Granada
Middle income residential areas	M-1	Col. San Mateo	El Naranjo (Pump st.)	Villa Tepetate
	M-2	INO 2c. al S. 1c. al O.	Monserrat 2da. Etapa	Villa Sandino
	M-3	Col. 4 de Mayo	Calle Centro Urbano	El Palenque
Low income residential areas	B-1	Colonia 1ro.de Mayo	Monserrat 2 de Etapa	La Loquera
	B-2	Reparto J. Benito Escober	Ayapal	La Gran China
	B-3	Fundeci 2da. Etapa	Ayapal	El Bolson
Industrial areas	F-1	Agrosa (Vegetable oil)	Ecuanica (Seafood)	E. Chamorro (Soap)
	F-2	Rolac (Battery)	Gracsa (Vegetable oil)	Reptinica (Tannery)
Market areas	Ma-1	Mercado Santos Barcenas	Mercado de Mayoreo	Mecardo Central
	Ma-2	Mercado Central	Mercado Central	Spuermecado Lacayo No.1
Office areas	O-1	Alcaldia	Alcaldia	Alcaldia
	O-2	BANADES	INAA	INAA

b.3 Survey Items

Survey items for the WPLS are listed in the table below.

Table 3-6: Items for the Water Pollutional Load Survey

On-site Survey	Laboratory Analysis
1. Ambient Temperature (AT)	1. DO (Dissolved Oxygen)
2. Sample Temperature (ST)	2. COD (Chemical Oxygen Demand)
3. pH	3. BOD (Biochemical Oxygen Demand)
4. Water Use Amount	4. SS (Suspended Solid)
5. Population of Sampling Point (Residential Area)	5. Total Chromium (for factories)
6. Number of Employees and Floor Area (Factories)	
7. Number of Shops and Employees (Market)	
8. Number of Employees and Floor Area (Office)	

All the analyses were conducted based on the "APHA-AWWA-WPCF, Standard method for the examination of water and wastewater 17th edition 1989".

c. Findings

c.1 Residential Areas

The WPLS indicated that BOD load rate of residential areas in 3 cities were approximately 50 to 59 g/person/day, which coincide with the rate used for the design of the sewage treatment plant in the city of Chinandega[1]: 52g/person/day.

[1] Informe Final Estudios y Diseños de Ingenieria para la Rehabilitacion de la Estacion de Bombeo y Lagunas de Estabilizacion de Aguas Servidas de la Ciudad de Chinandega, INAA-BID, Octubre 1993

Table 3-7: Summary of Load Ratio

	Leon	Granada	Chinandega	Total or Weighted Ave.
Population (person)				
High Income	32	69	51	152
Middle Income	61	58	322	441
Low Income	30	38	43	111
Total	123	165	416	704
BOD Load Rate (g/p/d)				
High Income	48.2	46.5	58.2	50.2
Middle Income	69.2	63.4	55.7	58.6
Low Income	48.4	46.7	60.9	52.7
Weighted Average	58.7	52.5	56.5	55.9
COD Load Rate (g/p/d)				
High Income	92.0	88.3	136.5	105.3
Middle Income	133.4	101.2	119.9	119.3
Low Income	72.5	96.6	123.2	100.4
Weighted Average	107.8	94.7	122.3	113.3
SS Load Rate (g/p/d)				
High Income	42.5	125.1	127.2	108.4
Middle Income	67.1	71.9	97.0	89.6
Low Income	44.7	55.7	92.8	67.1
Weighted Average	55.2	90.4	100.3	90.1

c.2 Factories

Pollutional load of factories range widely depending upon industrial categories. Even within the same industrial category, differences in production processes alter pollutional load rate largely. In particular, factories in industrialized economies adopt highly rationalized technologies to use up raw materials and minimize the generation of pollutants, and most factories in developing economies are short of rationalized production processes. Therefore, pollutional load rate differs widely between factories in developed countries and developing countries even though they may be in the same industrial category. Table 3-8 presents the outcome of the pollutional load survey categorized by the CIIU code.

Table 3-8: Water Pollutional Load Rate

City	No.	CIIU	Load Rate (1) (g/m^2/day)				Load Rate (2) (g/employee/day)			
			BOD	COD	SS	Cr	BOD	COD	SS	Cr
Chinandega	F-1	3114	0.4	0.9	0.2	0.0	6.6	14.0	3.0	0.0
Leon	F-1	3115	2.9	4.6	10.1	0.0	15.0	24.4	52.8	0.0
Chinandega	F-2	3115	0.2	0.4	0.0	0.0	4.1	8.4	0.7	0.1
Granada	F-2	3231	126.8	142.4	121.7	1.9	10,384.6	11,665.4	9,969.2	155.8
Granada	F-1	3523	2.3	53.5	2.3	0.3	73.6	1,711.2	73.6	11.0
Leon	F-2	3839	0.0	0.2	0.0	0.0	0.2	1.5	0.0	0.0

c.3 Markets

Table 3-9 shows "water use amount (per area)" and "pollutional load (per area)" obtained through the survey, as well as an example from Japan. Water use ratios (per area) in the 3 cities are about one-third of that in Japan. Meanwhile pollutional load rates in the 3 cities are generally higher than that in Japan. It could be attributed to

markets discharging concentrated wastewater more often than in Japan (e.g., BOD load in Japan is about 200 mg/l, the survey results ranged from 73 to 1540mg/l - most of them exceeded 500mg/l).

Table 3-9: Water Use Amount and Pollutional Load

		Water Use ($l/m^2/day$)	Load Rate ($g/m^2/day$)		
			BOD	COD	SS
Leon	M-1	7.8	9.9	20.6	9.8
	M-2	7.8	5.4	9.5	5.6
Chinandega	M-1	4.8	2.8	4.1	2.1
	M-2	4.5	0.3	0.5	0.5
Granada	M-1	8.4	4.6	5.5	7.5
	M-2	4.8	7.3	11.2	6.4
Average		6.4	5.1	8.6	5.3
Japan*		20.0	4.0	-	2.0

Note : * The Building Center of Japan

c.4 Offices

Table 3-10 shows the "water use amount (per floor area)" and "pollutional load (per floor area)" of offices obtained through the survey, and an example from Japan. Water use rates (per floor area) as well as BOD load rates (per floor area) in the 3 cities range from about 50% to 60% of that in Japan.

Table 3-10: Water Use Amount and Pollutional Load

		Water Use ($l/m^2/day$)	Load Rate ($g/m^2/day$)		
			BOD	COD	SS
Leon	O-1	24.5	1.3	3.4	0.7
	O-2	7.5	0.6	2.1	0.4
Chinandega	O-1	8.8	0.4	0.6	0.5
	O-2	2.9	0.0	0.0	0.1
Granada	O-1	5.1	2.0	3.2	1.7
	O-2	2.3	0.3	0.4	0.2
Average		8.5	0.8	1.9	0.7
Japan*		15.0	1.5	-	1.2

Note : * The Central business district of Japan

d. Findings

Details of the Water Pollutional Load Survey (WPLS) are described in Annex E in Volume IV.

3.4 Waste Amount and Composition Survey (WACS)

a. Objectives and Definitions

a.1 Objective of the Survey

Generally, the quantity and composition of solid waste depend on the characteristics of the city/area studied, such as economic conditions, lifestyle of the people, population density, public perception of environmental issues, etc. The waste amount and composition survey (WACS) played a considerably important role in obtaining necessary basic information on waste generation rate, discharge and recycling amount, self-disposal and collection amount, and ultimately helped to clarify the waste stream in the study area for planning a sound solid waste management system.

On the basis of information gathered during the WACS, a true picture of the solid waste situation in the study area can be seen. The WACS was carried out in August-September 1996 in order to obtain waste data for the rainy season, which is one of the main climatic features in Nicaragua, and again in January 1997 to obtain waste data for the dry season. The average data was determined by using both results.

a.2 Definitions of Wastes

In order to clarify the contents of the WACS and the waste stream, the terms used in the Study are defined as follows:

- **Household Waste**

  Waste generated in or discharged from each household including waste from shops. However, waste generated through commercial activities are excluded.

- **Commercial Waste**

  Only refers to wastes generated and discharged from shops or any other establishment through commercial activities. Shops include restaurants, stationery shops, grocery shops, etc.

- **Market Waste**

  Waste generated in or discharged from markets both wholesale and retail.

- **Institutional Waste**

  Waste generated in government offices and offices of state and private enterprises.

- **Street Sweeping Waste**

  Street sweeping waste includes all waste generated by street sweeping services.

- **Bulky Waste**

  Abandoned bulky items (such as furnitures and vehicles) discharged from the above-mentioned sources.

- **Other Waste**

  Wastes disposed of at the present disposal site in the study area and are not mentioned above (i.e. not MSW).

b. Method of the Survey

b.1 Waste Amount Survey

The waste amount survey used in this study is divided into the following two methods:

- Generation rate survey at generation sources
- Final disposal amount survey at the present landfill in each city

The method applied to the WACS is tabulated in Table 3-11.

Table 3-11: Method of the Waste Amount Survey

Category	Generation Rate Survey	Disposal Amount Survey
MSW (Total)	X	X
Household Waste	X	
Commercial Waste	X	
Market Waste	X	
Institutional Waste	X	
Street Sweeping Waste	X	
Bulky Waste		X
Others (Total)		X

Note : The items marked "X" were surveyed in the Study.

b.2 Generation Rate and Composition Survey

The method of the survey is tabulated in Table 3-12. Considering daily fluctuations in the generation of waste, the survey was conducted for 8 consecutive days in each city. The data from the first day was used only as a reference.

Table 3-12: Method of the Survey

Generation Source	Collection of Samples	Measurement of Waste Amount	Waste Composition Survey
Household (High Income)	by plastic bag	by spring balance	Analysis Items :
Household (Middle Income)	by plastic bag	by spring balance	-ASG (Apparent Specific Gravity)
Household (Low Income)	by plastic bag	by spring balance	- Physical composition in wet base (kitchen waste, paper, textile, plastic, glass, grass and wood, leather and rubber, metal, ceramic and stones, other)
Commercial Shops	by plastic bag	by spring balance	
Institutions	by plastic bag	by spring balance	
Markets	by collection truck	by weighbridge	
Street Sweeping	by plastic bag	by spring balance	-

c. Findings

The waste generation rates and compositions obtained through the WACS, (one in the rainy season and another in the dry season) are presented as an average in Table 3-13

and Table 3-14 respectively. Furthermore, the "waste streams" for the 3 cities are shown in Figure 3-3, Figure 3-4 and Figure 3-5.

Table 3-13: Waste Generation Rates

Category	Unit	Generation Rate			
		Leon	Chinandega	Granada	Average
Household Waste	g/person/day	736	629	661	675
Commercial Waste (Restaurants)	g/shop/day	18,739	15,035	11,553	15,109
Commercial Waste (Others)	g/shop/day	2,199	1,080	1,749	1,676
Institutional Waste	g/person/day	172	89	34	98
Market Waste	g/shop/day	2,315	3,450	2,715	2,827
Street Sweeping Waste	g/km/day	23,385	20,175	66,470	36,677

Table 3-14: Waste Composition

Classification			Unit	Household				Commercial		Institution	Market
				High Inc.	Middle Inc.	Low Inc.	Average	Restaurant	Others		
Leon	Apparent Specific Gravity		(kg/l)	0.31	0.23	0.32	0.27	0.49	0.15	0.08	0.32
	Combustibles	Kitchen waste	%	59.95	36.39	12.03	26.13	78.87	28.49	18.79	42.52
		Paper	%	10.32	6.77	2.08	4.75	5.92	24.76	62.29	13.38
		Textile	%	1.66	2.32	1.75	2.03	0.50	2.32	2.06	3.86
		Plastic	%	5.40	6.45	4.09	5.32	2.68	7.04	9.79	7.36
		Grass and wood	%	13.13	24.64	48.71	35.26	3.70	18.98	3.04	23.77
		Leather and rubber	%	5.48	10.33	1.30	5.98	0.15	6.47	0.07	0.48
		Sub-total	%	95.94	86.90	69.96	79.47	91.82	88.06	96.04	91.37
	Incombustibles	Metal	%	1.65	1.85	1.67	1.76	3.15	2.91	1.88	1.52
		Glass	%	1.13	1.12	1.59	1.34	3.58	0.92	0.19	0.76
		Ceramic and Stone	%	0.51	2.97	4.10	3.39	0.94	2.31	0.98	2.66
		Others (soil, etc.)	%	0.77	7.16	22.68	14.04	0.51	5.80	0.91	3.69
		Sub-total	%	4.06	13.10	30.04	20.53	8.18	11.94	3.96	8.63
Chinandega	Apparent Specific Gravity		(kg/l)	0.23	0.19	0.18	0.19	0.28	0.05	0.04	0.33
	Combustibles	Kitchen waste	%	71.38	48.15	28.09	39.86	65.08	32.14	9.47	31.01
		Paper	%	7.16	2.36	0.97	1.91	4.97	31.37	73.09	7.64
		Textile	%	0.84	1.30	1.63	1.43	0.27	4.16	2.38	1.31
		Plastic	%	5.87	3.42	1.90	2.82	2.34	12.20	8.79	6.33
		Grass and wood	%	5.63	32.25	47.51	38.21	17.81	12.63	0.82	41.19
		Leather and rubber	%	0.41	0.12	1.23	0.64	0.00	1.23	0.83	0.23
		Sub-total	%	91.29	87.60	81.33	84.86	90.47	93.73	95.38	87.71
	Incombustibles	Metal	%	3.09	1.75	0.94	1.43	2.08	2.15	4.47	0.90
		Glass	%	4.33	1.16	0.45	0.96	2.14	1.44	0.00	0.59
		Ceramic and Stone	%	0.86	6.13	7.99	6.77	2.57	2.06	0.00	5.40
		Others (soil, etc.)	%	0.43	3.36	9.29	5.97	2.74	0.62	0.15	5.40
		Sub-total	%	8.71	12.40	18.67	15.14	9.53	6.27	4.62	12.29
Granada	Apparent Specific Gravity		(kg/l)	0.28	0.28	0.21	0.25	0.38	0.08	0.04	0.48
	Combustibles	Kitchen waste	%	68.42	53.07	44.71	49.84	78.28	27.11	22.41	77.14
		Paper	%	13.37	8.50	1.09	5.29	6.23	32.99	59.06	3.69
		Textile	%	3.34	3.21	0.52	1.98	0.34	4.09	4.20	0.20
		Plastic	%	5.07	9.68	2.33	6.11	2.55	11.14	5.75	5.08
		Grass and wood	%	4.70	17.26	34.97	24.90	8.24	5.79	2.34	6.02
		Leather and rubber	%	0.00	0.52	0.06	0.29	0.03	0.76	0.81	2.46
		Sub-total	%	94.90	92.24	83.68	88.41	95.67	81.88	94.57	94.59
	Incombustibles	Metal	%	1.15	1.29	0.90	1.11	1.37	6.21	3.29	0.84
		Glass	%	1.33	1.73	0.29	1.05	0.41	8.57	0.00	0.84
		Ceramic and Stone	%	1.90	3.04	7.86	5.21	2.09	1.15	0.00	2.61
		Others (soil, etc.)	%	0.72	1.70	7.27	4.22	0.46	2.19	2.14	1.12
		Sub-total	%	5.10	7.76	16.32	11.59	4.33	18.12	5.43	5.41

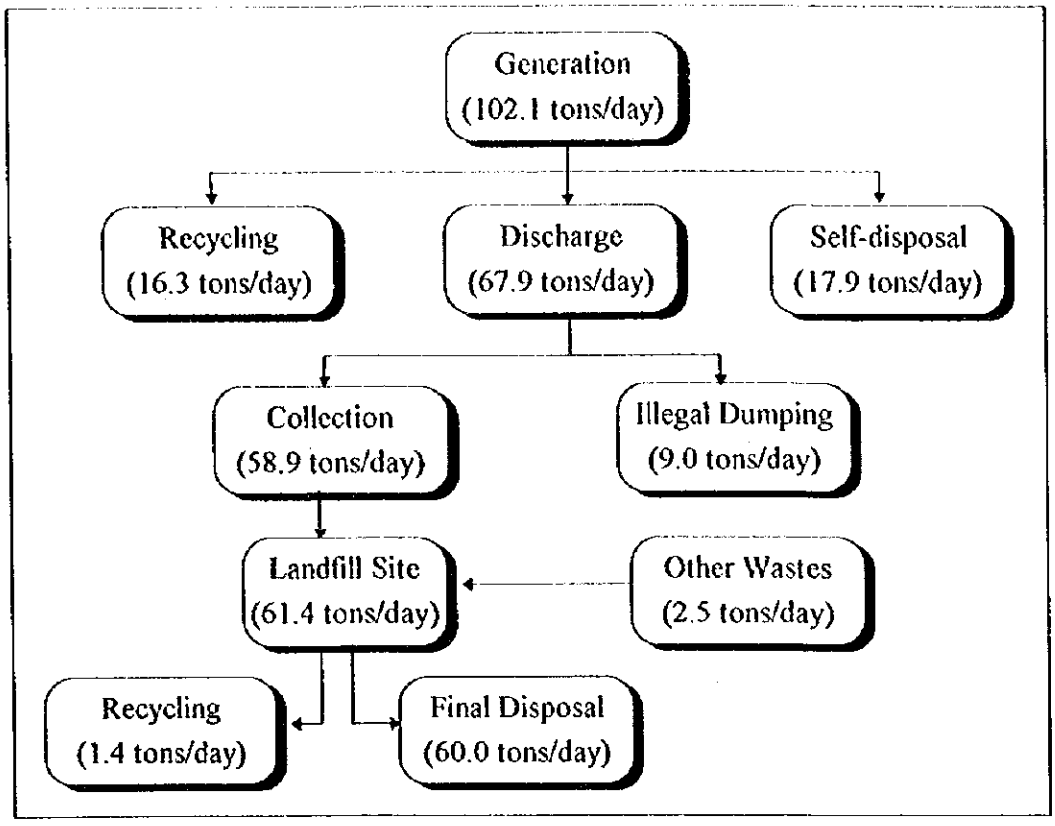


Figure 3-3: Waste Stream of Leon in 1996

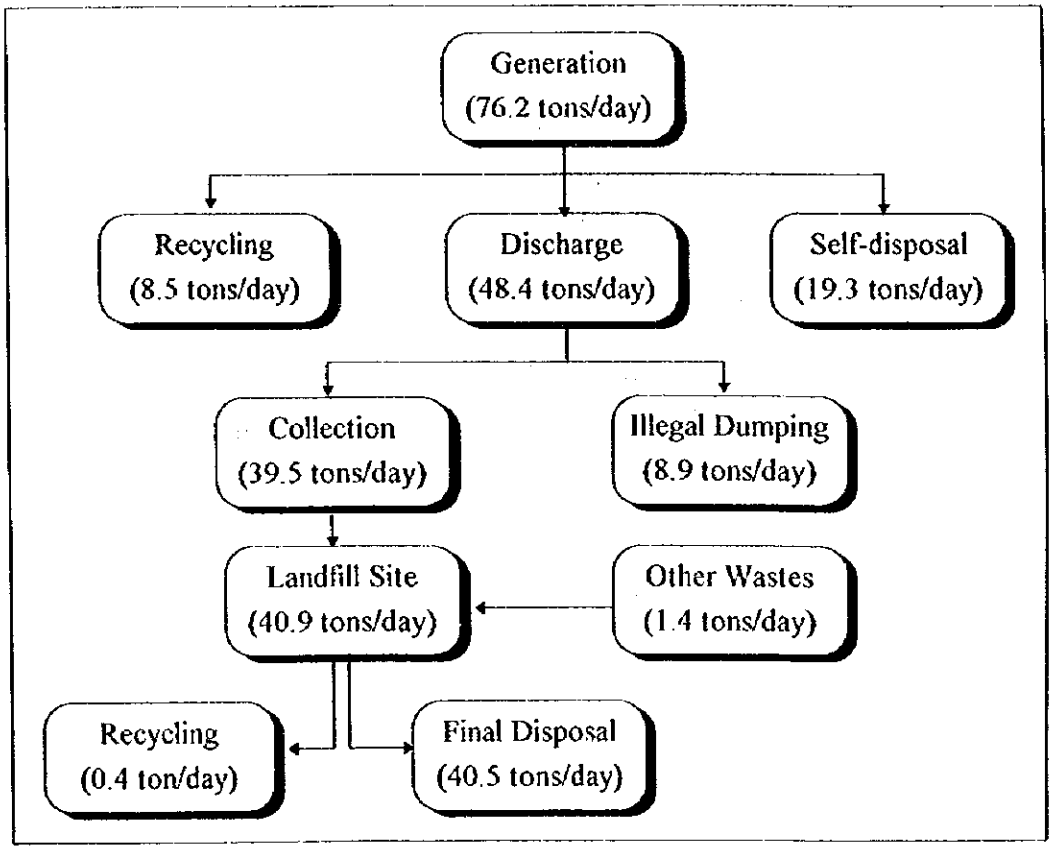


Figure 3-4: Waste Stream of Chinandega in 1996

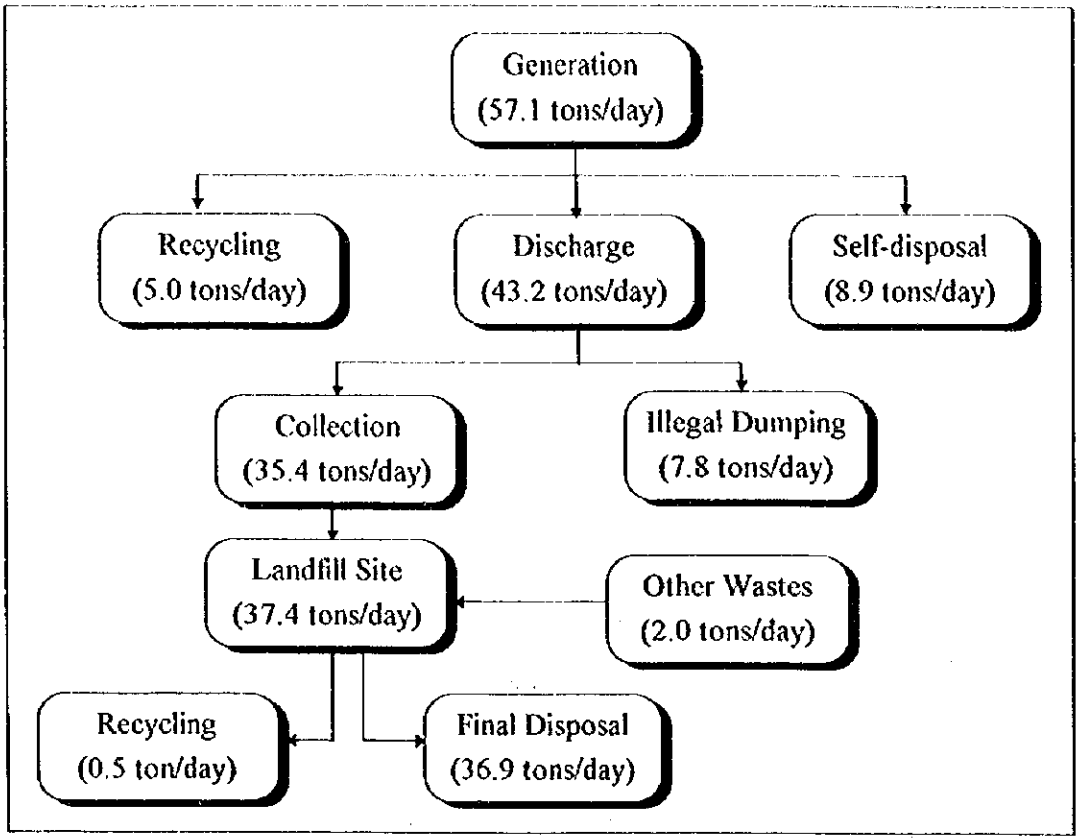


Figure 3-5: Waste Stream of Granada in 1996

d. Findings

Details of the Waste Amount and Composition Survey (WACS) are described in Annex F in Volume IV.

3.5 Industrial Waste Management Survey

a. Objective of the Survey

a.1 Objective of the Survey

The objective of this survey was to interpret the present state of industrial waste management (from generation to final disposal) in the 3 cities. The amount and type of industrial waste generated from major industries in each city and its treatment and/or disposal methods were investigated through an interview survey.

a.2 Limitations of the Survey

The types and features of industrial waste generated are diverse and generation amount also differs greatly depending upon industrial category and/or technology employed in production. Therefore, if all types and amount of industrial waste actually generated were to be surveyed in a manner that is employed for the municipal SW amount survey, (see 2.4.2 WACS) a considerable amount of time and cost would have been required. Furthermore, it was quite possible that some factories may have rejected the survey on the basis that disclosure of the composition of their industrial waste may reveal

information on unique industrial processes to others. Consequently, it was nearly impossible to carry out field investigations on the actual amount and composition of industrial waste. Therefore, in order to identify and understand the present state of industrial waste, a questionnaire survey was conducted.

The Study invited 10 representative factories from each city to participate in the questionnaire survey. The outcome of this Industrial Waste Survey was based on two major conditions:

1. Data and information were limited to what the factories divulged.
2. Samples were collected from about 10 major factories from each city.

The outcome in hand regarding industrial waste is conditional. Although industrial waste surveys have intrinsic difficulties in practice, the survey method employed in the Study is common in many countries including Japan.

b. Method of the Survey

b.1 Work Flow of the Survey

The Industrial Waste Survey was carried out in accordance with the work flow indicated in Figure 3-6.

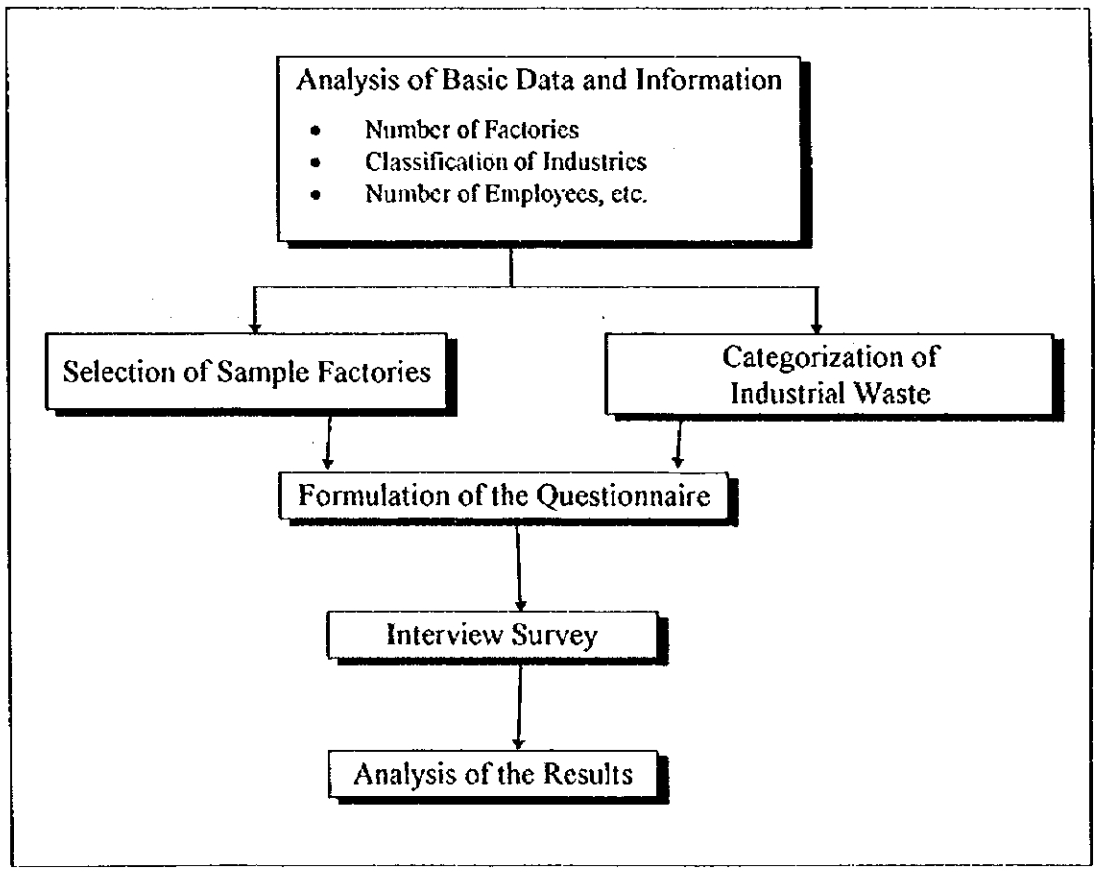


Figure 3-6: Work Flow of the Industrial Waste Survey

b.2 Selection of Sample Factories

For the selection of sample factories, major factories in each city were listed by the counterpart, then the discussion was extended to selecting 10 representative factories from each city. Factories selected for the survey are listed in Table 3-15.

The major products of the sample factories are categorized in accordance with the CIIU (International Standardized Industrial Classification) code. Industrial classification for the sample factories in the study follows the CIIU code of major products.

Table 3-15: List of Selected Factories

Location	No.	CIIU	Name of Companies	Nos. of Employees	Main Products
Leon	1	3839	BATERIAS ROLAC S.A.	37	Batteries
	2	3116	ENABAS	26	Grain
	3	3115	SUC. ENRIQUE MANTICA BERIO S.A.	26	Sesame
	4	3232	MARROQUINERIA CENTROAMERICANO	24	Leather company
	5	3115	GRUPO INDUSTRIAL AGROSA	229	Vegetable oil, soap, flour
	6	3412	CARTONICA	113	Cardboard boxes
	7	3231	TENERIA BATAAN S.A.	100	Leather production
	8	3551	REENCAUCHADORA MODERNA	23	Realignment of tires
	9	3512	FORMULADORA INTERNACIONAL AGRICOLA S.A.	14	Pesticides and fertilizers
	10	3512	SERVICIO AGRICOLA GURDIAN S.A.	22	Pesticides and fertilizers
Chinandega	1	3115	INVERCIONES ALPHA	28	Sesame
	2	3111	PORCINA SAN BENITO	52	Pork meat
	3	3122	ALIMENTOS MEJORADOS S.A.	60	Animal feed
	4	3115	GRASAS Y ACEITES S.A.	111	Vegetable oil
	5	3114	EMPACADORA ECUANICA	202	Shrimp processing
	6	3111	AVICOLA GUADALUPE	20	Chicken meat
	7	3512	INSECTICIDA SAN CRISTOBAL	20	Pesticides and fertilizers
	8	3116	SEMILLA Y PROCESOS S.A.	320	Peanuts
	9	3116	MANICERA, S. A.	348	Peanut production
	10	3116	INSDUSTRIA GENIMA S.A.	80	Flour and bran
Granada	1	3219	AGROTEX S.A.	10	T-shirt
	2	3211	TEXTILES DEL LAGO S.A.	79	Yarn and textiles
	3	3523	E. CHAMORRO Y CIA, LTD.	100	Soap, vegetable oil
	4	3523	PREGO	110	Soap production
	5	3111	AVICOLA SAN FELIPE S.A.	101	Chicken
	6	3412	CORTONOSOL	15	Solid cardboards
	7	3122	MOLINOS DE NICARAGUA S.A.	175	Wheat and animal feed
	8	3231	REPTILES DE NICARAGUA	26	Tannery
	9	3411	IUCASA	63	Toilet paper
	10	3522	INDUSTRIAS FARMACEUTICAS CEGUEL S.A.	98	Medicine

b.3 Categorization of ISW (Industrial Solid Waste)

Since a standard industrial waste classification is not clearly established in Nicaragua, the Team employed a categorization of 24 ISW, based on the ISW classification employed in Japan and a classification used in JICA's ISWM study in Chile by the Team, as shown in Table 3-16.

Table 3-16: Category of ISW

No.	Type of Waste	No.	Type of Waste
1	Ash, combustion residue	13	Carcasses
2	Dust	14	Glass and ceramics
3	Slag from melting	15	Metal and scrap
4	Sludge	16	Paper and cardboard
5	Asbestos	17	Plastics
6	Acid	18	Rubber
7	Alkalis	19	Textile
8	Oily waste	20	Leather
9	Chemical residue	21	Wood
10	Waste from food production	22	Construction and demolition waste
11	Waste similar to domestic waste	23	Water
12	Animal manure	24	Others

b.4 Formulation of Questionnaire

The questionnaire form for each ISW is shown in Table 3-16 and was organized to identify, for example:

- generation amount
- nature
- characteristic
- temporary storage method
- storage period
- treatment method
- disposal method
- disposal amount
- transportation method

Respective survey items listed above are categorized as shown in Table 3-17. Factories' consciousness regarding the cost burden of industrial solid waste treatment/disposal were also surveyed. (Survey questionnaire used are affixed in Annex C).

Table 3-17: Survey Items

Item	Contents
Nature	Solid, Liquid, Semi-dry, Gas
Characteristic	Organic, Inorganic, Corrosive, Explosive, Reactive, Toxic, Putrescible, Non-biodegradable
Temporary storage method	Garbage bag, Dustbin, Tank, Drum, Pit, Lagoon, Open air, Others
Temporary storage period	Daily, Weekly, Monthly, Annually
Treatment method	Burn, Crushing, Compaction, Dehydration, Neutralization, Bio-decomposition, Others
Disposal method	Landfill, Recycle, Unknown, Sold to the others, Discharge to sewer, Municipal landfill, Discharge to environment, Others
Transportation method	Municipality, Contractor, Own means

c. Findings

c.1 Generation Amount

Generation rates (per employee) are calculated from survey data. The total industrial waste generation amount was estimated from the generation rate of the total employees in the three cities. The survey results indicate:

- As shown in the table below, total industrial waste generation in the three cities is around 1,156,000 tons/year. 98.7% of the generated industrial waste (1,142,000 tons/year) is industrial wastewater and the remaining 1.3% (14,800 tons/year) is industrial solid waste.
- In comparing the three cities, Granada generates the most industrial wastewater, 1,044,500 tons/year. Its major polluting sources are industries in category CIIU 3523 (i.e., detergent production) and industrial wastewater, generating 920,000tons/year.
- In comparing the three cities for industrial solid waste, Leon produces the most, 7,400 tons/year; most waste being generated from food production (i.e., 12,300 tons/year)".

Table 3-18: Estimated Amount of Industrial Waste

Unit : ton/year

	Leon	Chinandega	Granada	Total
Industrial Wastewater	91,200	5,500	1,044,500	1,141,200
Industrial Solid Waste	7,400	6,400	1,000	14,800
Industrial Waste, Total	98,600	11,900	1,045,500	1,156,000

c.2 Nature and Characteristics of Industrial Waste

c.2.1 Industrial Wastewater

Corrosive, toxic, and reactive substances from factories are defined as hazardous waste. About 88% of industrial waste generated in the three cities is considered to be hazardous wastewater (see the table below).

Table 3-19: Estimated Generation Amount of Hazardous Wastewater

Unit : ton/year

	Leon	Chinandega	Granada	Total
Hazardous Wastewater Generation Amount	91,200	40	916,360	1,007,600

c.2.2 Solid Waste

Corrosive, toxic, and reactive substances from factories are defined as hazardous waste. About 10% of industrial waste generated in the three cities is considered to be hazardous solid waste (see the table below).

Table 3-20: Estimated Generation Amount of Hazardous Solid Waste

Unit: ton/year

	Leon	Chinandega	Granada	Total
Hazardous Solid Waste Generation Amount	1,034	370	3	1,407

c.3 Transportation Methods

The survey revealed that 94% of total industrial solid waste (disposal amount 10,000 tons/year) are transported by firms' own means, and the rest (about 6%) are subject to municipal solid waste collection.

c.4 Disposal Methods

c.4.1 Industrial Wastewater

A large proportion of industrial wastewater from surveyed factories is discharged into public water bodies and/or sewer systems without treatment.

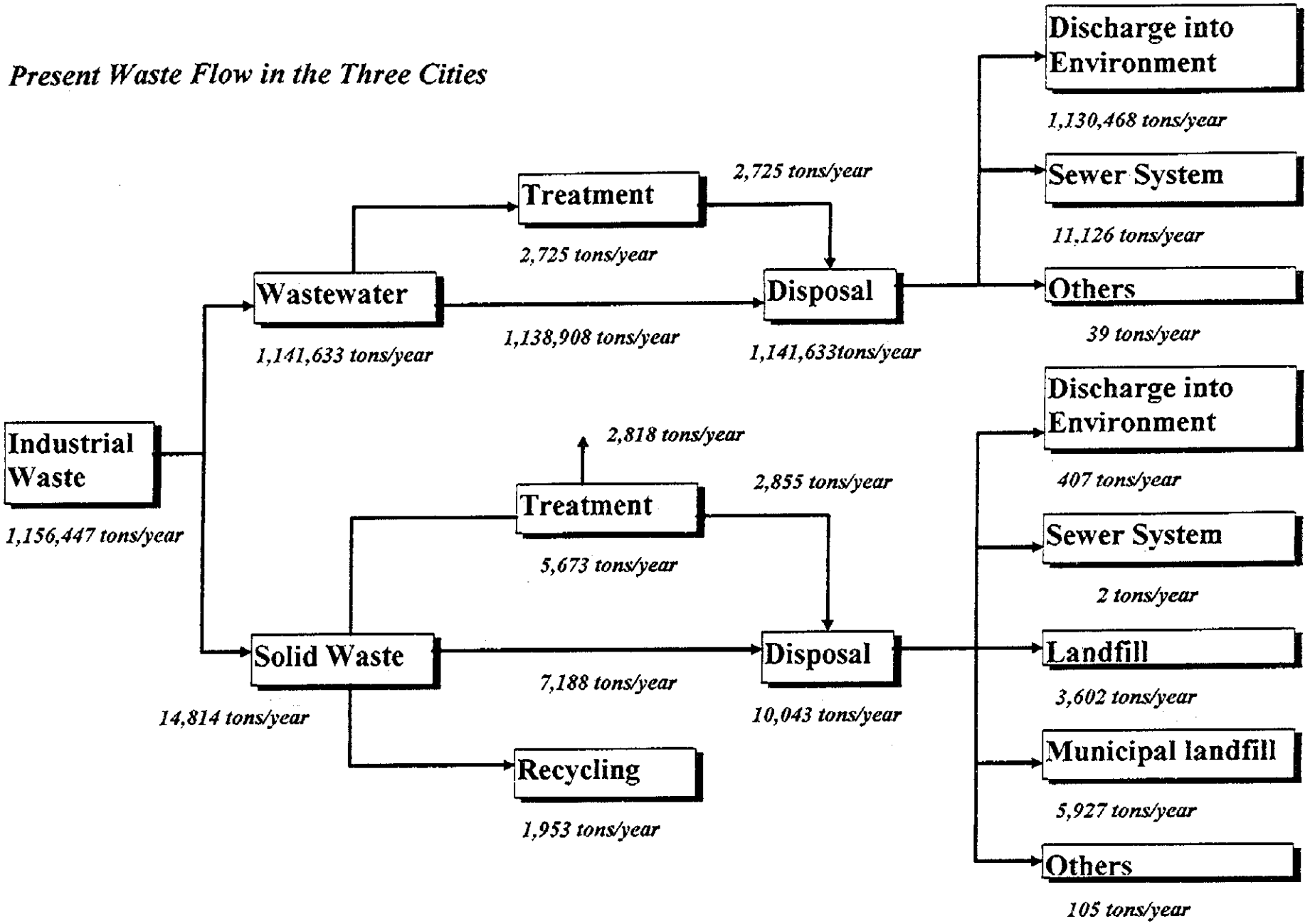
c.4.2 Industrial Solid Waste

The survey led to the following findings with regard to the disposal of industrial solid waste in the 3 cities:

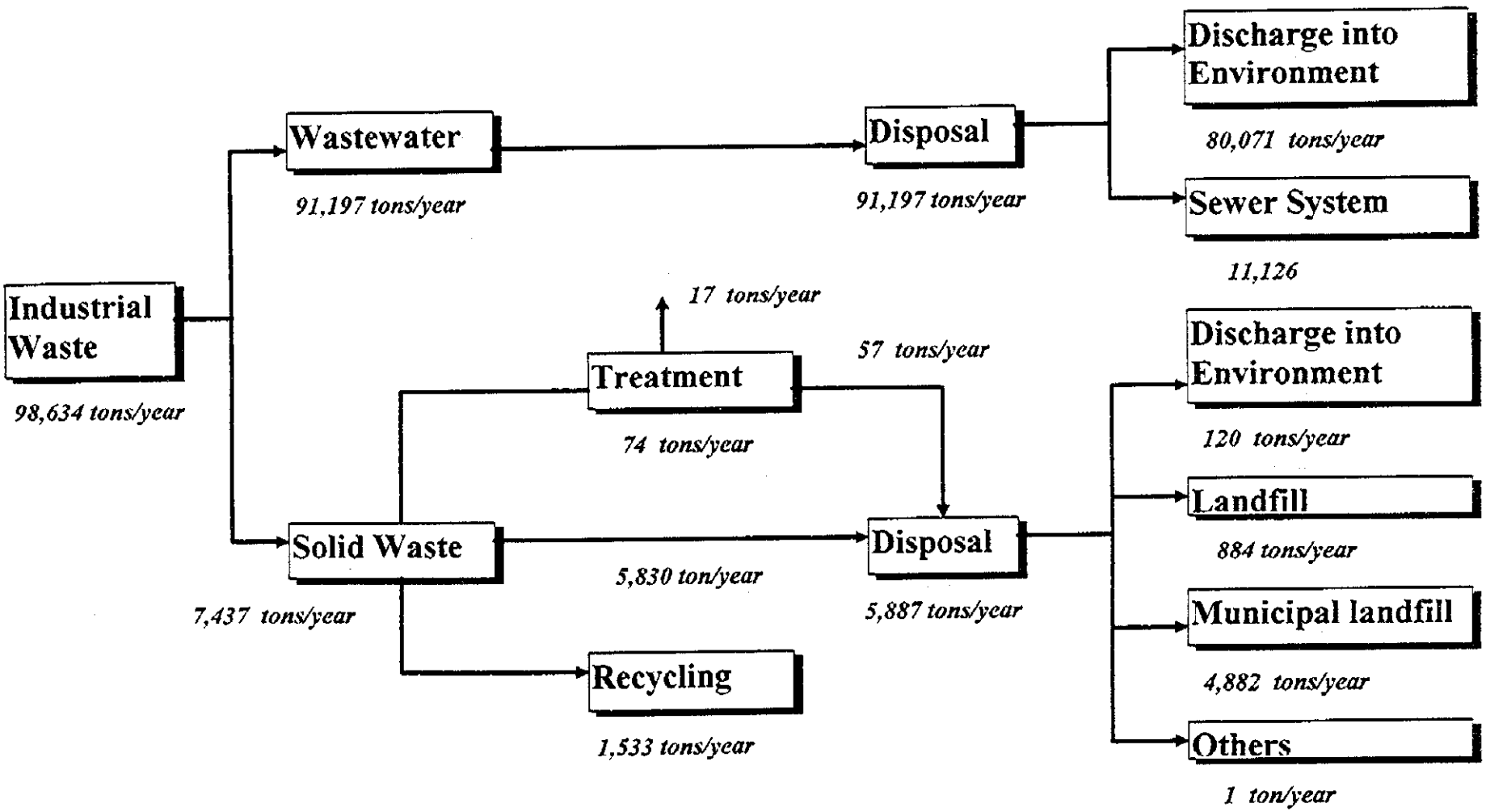
- Mean value of intermediate treatment rate (intermediate treatment amount/generation amount) in the 3 cities is 38%. Intermediate treatment rate in the 3 cities are: Leon 1%, Chinandega 83%, and Granada 32%. Incineration (i.e., open burning) is predominant among other forms of treatment.
- Generated solid waste is subject to landfill disposal, of which 50% is disposed of in municipal landfills.
- Mean value of recycling rate in the 3 cities is 13%.

c.5 Present Waste Flow

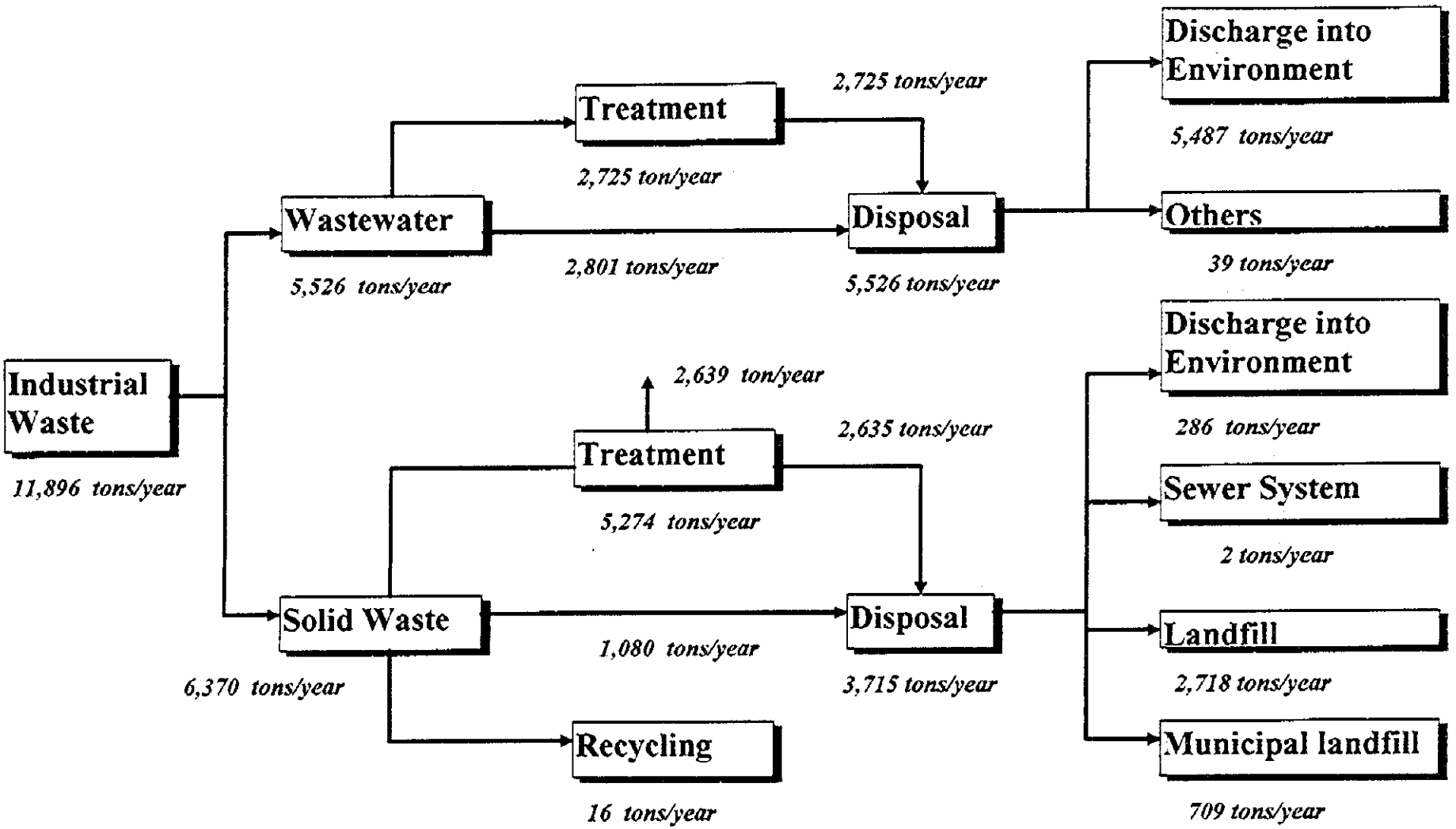
Present Waste Flow in the Three Cities



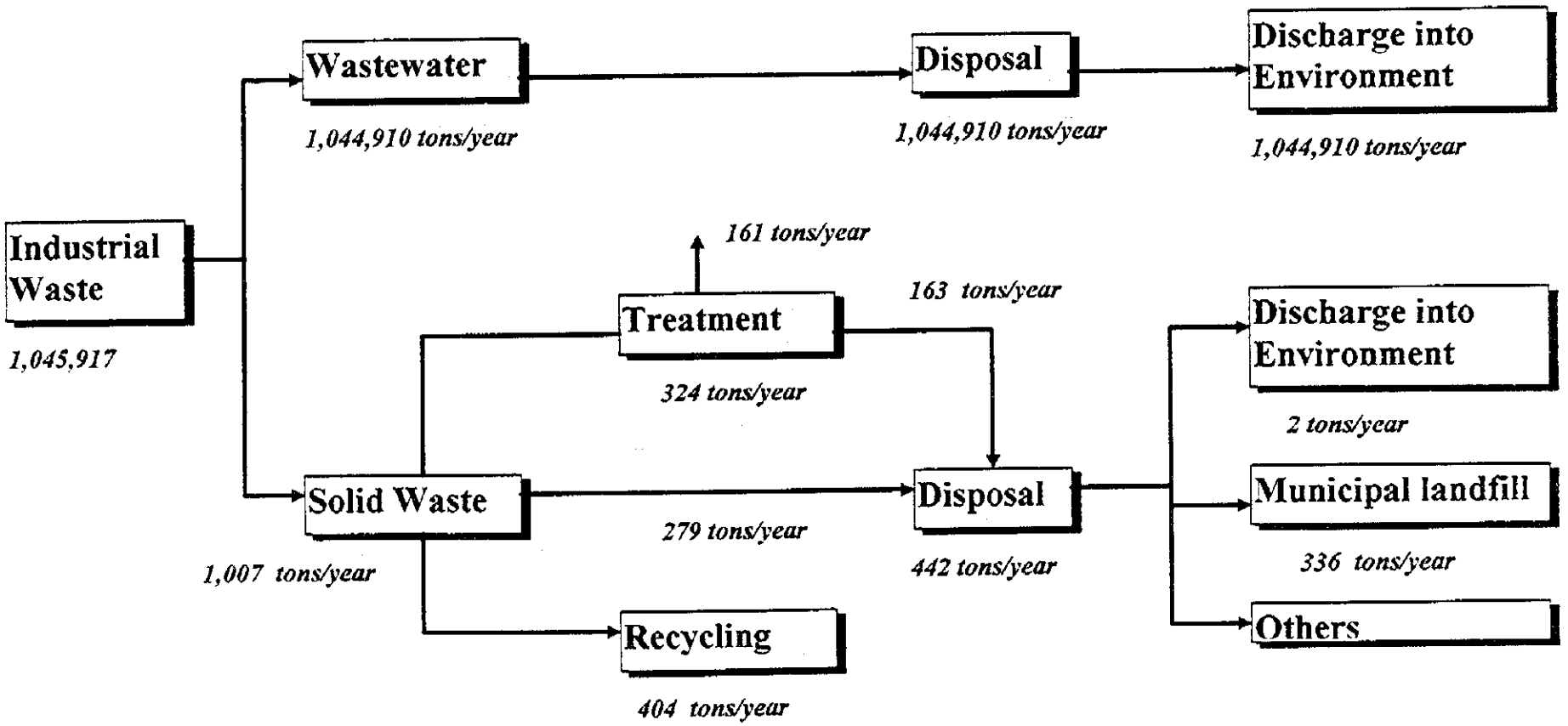
Present Waste Flow in Leon



Present Waste Flow in Chinandega



Present Waste Flow in Granada



d. Findings

Details of the Industrial Waste Management Survey are described in Annex G in Volume IV.

3.6 Medical Waste Management Survey

a. Objectives and Limitations of the Survey

The objective of the survey was to understand the present state of medical waste management (from generation to final disposal), especially concerning infectious waste and wastewater in the 3 cities. The amount and type of medical waste generated from medical institutions in each city, and its treatment and/or disposal methods were investigated through a questionnaire survey.

It is almost impossible to investigate the actual amount and composition of medical waste in the same way as municipal solid waste, because medical waste includes infectious waste such as hypodermic needles, surgical scalpels and other waste from surgical procedures; handling medical waste would expose investigators to the risk of infection. Therefore, a questionnaire survey is normally used as a survey method on medical waste management; the study adopted this method.

However, only typical medical institutions were asked to participate in the questionnaire, therefore, the survey results contain a certain limitation in accuracy and its applicability.

b. Method of the Survey

b.1 Samples of Medical Institutions

Since the population of the 3 cities is almost 150,000 each, and approximately 19 medical institutions are located in each city, it was judged that the overall situation of medical SWM would generally be understood by inviting 5 or more major medical institutions in each city to participate in the questionnaire survey.

Table 3-21: Medical Institutions Selected for Questionnaire Survey

Owner	Category	Leon	Chinandega	Granada	Total
Public	Hospital	2	2	1	5
	C/S	2	2	3	7
	Others	0	1	1	2
Private		1	1	1	3
Total		5	6	6	17

b.2 Classification of Medical Waste

Waste generated at medical institutions may be basically categorized into two: infectious/hazardous waste and common (domestic) waste, as shown in Table 3-22.

Common waste is not hazardous. Meanwhile, infectious/hazardous waste should be handled and controlled with care.

Table 3-22: Classification of Medical Wastes

Classification	Risk of Infection/ Hazard	Samples of Waste
1.Risky Waste	yes	a. infectious wastes (sharps, hypodermic needles, surgical scalpels, broken glasses, etc.) b. blood (human blood, serum, plasma, blood products, etc.) c. infectious waste from laboratories, waste from patients with infections and wastewater
2. Animal Waste from Laboratories	yes	a. carcasses from clinical trials, etc.
3.Hazardous Waste	yes	a. chemical waste (medicines, disinfectants, solvents, etc.), b. radioactive waste, etc.
4.Common (domestic) Waste	no	a. office waste (paper, plastic, floor sweeping waste) b. kitchen waste (food, food wrapping, cans,), packing waste, bulky waste garden waste (flowers) c. domestic wastewater (from laundries, etc.)
5. Special Waste	yes	a. ash from incinerators, sludge, etc.

b.3 Questionnaire Survey Items

(1) Details of the medical institution
(2) Generation of medical waste (solid and liquid)
(3) Collection of wastes
(4) Treatment of medical wastes
(5) Disposal of medical solid waste
(6) Training and instructions
(7) Opinion on future improvement of medical waste management

c. Findings

c.1 Generation of Medical Waste

c.1.1 Generation of Medical SW in Each City

Table 3-23 shows the generation of medical waste in each city, based on the questionnaire survey.

Table 3-23: Generation of Medical SW by City

City			Leon	Chinandega	Granada	Total
Number of beds			538	327	175	1,040
Surveyed medical institutions*1			5	6	6*1	17
Generation (kg/day)	Waste Type	Risky*2	149.3	36.9	27.0	213.2
		Hazardous*3	4.8	3.0	1.6	9.4
		Common*4	139.1	56.2	25.0	220.3
		Special*5	1.6	0.03	0.0	1.63
Total			294.8	96.13	53.6	444.53

Note : *1 includes one laboratory.
*2 infectious waste (sharps, blood, used dressing, etc.), infected waste from laboratories, waste from patients with infections, wastewater, etc.
*3 chemical waste (medicines, disinfectants, solvents, etc.) radioactive waste, etc.
*4 office waste, kitchen waste, packing waste, bulky waste, garden waste, domestic wastewater, etc.
*5 ash from incinerators, sludge, etc.

c.1.2 Incineration

Table 3-24 indicates that 8 medical institutions incinerate infectious wastes on-site, but the incineration system varies from primitive burning in the open to a temperature controlled incinerator in Chinandega City. Medical institutions without incinerators normally dispose of risky medical wastes at the municipal final disposal site through the municipal collection service. Hypodermic needles in Chinandega have been disposed of systematically under the guidance of a JOCV volunteer.

Table 3-24: Infectious Waste Incineration Methods by City

City	With Incineration				Without Incineration	Total
	Mechanical *1	Primitive				
	Incinerator Controlled	Furnace*2	Open air *3			
			On-site	Off-site		
Chinandega	1	2	0	0(6)	3	6
Leon	0	0	1	1	3	5
Granada	0	1	2	0	3	6
Total	1	3	3	1	9	17
Share (%)	5.9	17.6	17.6	5.9	52.9	100.0

Note: Values in ( ) show hypodermic needles only
*1 temperature controlled mechanical incinerator
*2 primitive furnace without any control
*3 primitive incineration in the open on-site which sometimes creates air pollution affecting the surrounding residents

c.2 Present Hospital Wastewater Management

c.2.1 Hospital Wastewater Management

As shown in Table 3-25, almost all medical institutions (94 %) discharge wastewater into the sewer or soak pit without any treatment. Only 1 hospital (6%), located in Chinandega, of the 17 medical institutions surveyed, discharge wastewater into the river after treatment by a septic tank.

Table 3-25: Current Medical Wastewater Management

Unit : number

Treatment	Without			With	Total
	Discharged into Sewer	Partially Discharged into Sewer and Partially into Soak Pit	Discharged into Soak Pit	Septic Tank to River	
Chinandega	4	0	1	1	6
Leon	4	1	0	0	5
Granada	4	0	2	0	6
Total	12	1	3	1	17
share(%)	70.6	5.9	17.6	5.9	100

c.2.2 Inspection by Medical Institutions

Decree No.33-95 states that medical institutions have an obligation to inspect the quality of wastewater. However, none of the institutions have been carrying out inspections.

3.7 Inundation Damage Survey

a. Objective of the Survey

The objective of this survey is to roughly understand the extent of damage due to inundation in the three cities: Leon, Chinandega, and Granada.

b. Methods of the Survey

The local staff, under the supervision of the Study Team, conducted a questionnaire survey from September to October 1996, at the end of the rainy season.

Two families were chosen from each area within the municipalities predisposed to inundation. With a total of 28 such areas, the total number of interviewed families was 56.

The survey items are as follows:

- experience of inundation
- frequency
- depth of inundation
- duration of inundation
- degree of damage caused by inundation

c. Findings

The number of inundation prone areas and number of households interviewed in the survey are shown in the table below.

Table 3-26: Survey Results

Unit : numbers

City	Inundation Prone Areas		Households Interviewed	
	Surveyed	Damage declared	Surveyed	Damage declared
Leon	15	15	30	28
Chinandega	10	8	20	15
Granada	3	3	6	6
Total	28	26	56	49

Of the total 56 households interviewed, 49 households (26 areas) answered that they have had inundation damage. The following was found from the survey.

- All 26 areas, where inundation damages were reported, suffered more than twice a year.

- The considerable majority (53%, 26/49) replied that inundation continues for 1 to 3 hours. Meanwhile, a number (16%, 8/49) of interviewees replied that inundation lasts more than 24 hours.
- A great majority (96%, 47/49) answered that their houses were damaged through inundation.
- Almost half of the interviewees (47%, 23/49) answered that they have suffered from diseases related to inundation.

d. Findings

Details of the Inundation Damage Survey are described in Annex I in Volume IV.

CHAPTER 4

Preliminary Study for Site Selection

4 Preliminary Study for Site Selection

4.1 Major Facilities for the Study and Candidate Sites

4.1.1 Land Acquisition Procedure and Relevant Legislation

a. Land Acquisition Procedure and Relevant Legislation

Firstly, the Municipal Government should declare the pre-selected land as "public property" to allow entrance and investigation without incurring any municipal expenses, and to prevent increase in land value.

The selected area should then be presented by the Municipal Government, through INIFOM, to MARENA and MINSA for ratification, and to confirm that it is not restricted for development of for the proposed usage. MARENA and MINSA will conduct the evaluation together and grant their approval along with recommendations, if necessary.

After receiving these agencies' approval, the Municipal Government should carry out the necessary procedures for the expropriation of the required area. The price should be appropriately decided with the owner's consent or through judicial course. Payment should be in the present currency or as agreed upon.

MARENA could ask for an Environmental Impact Assessment (EIA) if the location and the dimension of the land are considered precarious.

b. Relevant Legislation

Declaration of land as public property and expropriation are regulated by:

- Ley de Expropiación No. 229, enacted in 1976
- Constitución de la República de Nicaragua, enacted in 1987 and amended in February 1995. (Art.44)
- Ley de Municipios No. 40, enacted in August 17, 1988.
- Ley General del Medio Ambiente y los Recursos Naturales No. 217, enacted in June 6, 1996.
- Decree No. 35, enacted in 1994 - on EIA

MARENA will no longer establish norms on land usage based on potential contaminative activities, according to Law No. 217 - 96. The urban areas are also regulated by Decree No. 895, enacted in December 14, 1981 - "Ley de Expropiación de Tierras Urbanas Baldías".

4.1.2 Major Facilities for the Study

The construction of various facilities is required for the improvement of USE. The selection of sites for the construction of required facilities is not a responsibility of the Study Team. However, the Team pointed out that site selection works should only be carried out for the following USE facilities subject to EIA, in accordance with Nicaraguan legislation, Decree No 45-94:

Water Supply Sector :	Water Purification Plant
Sewage Sector :	Sewage Treatment Plant
SWM Sector :	Intermediate Treatment Plant, Transfer Station and Final Disposal Site

The three cities currently use underground water as potable water source. Therefore, the construction of a water purification plant was not considered in the Study. Current municipal SWM conditions in the three cities also indicate the absence of an immediate need for an intermediate treatment plant and transfer station. Consequently, the Team conducted a preliminary investigation on the candidate sites (presented by each municipality) for the SW final disposal site and sewage treatment plant, which may be difficult to acquire due to strong opposition from residents of neighboring areas, etc. The investigation included:

- Identification of land acquisition procedures, relevant legislation and procedures to gain neighborhood consensus;
- Topographical and geological surveys to ascertain suitability, based on existing data available;
- Field reconnaissance to understand conditions affecting the location and the environment of the candidate sites.

The candidate sites for USE facilities presented by 3 municipalities are shown in the table below.

Table 4-1: Candidate Sites

Facility / Name of City	Sewage Treatment Plant	Final Disposal Site
Leon	3 sites (expansion of present plants (2))	2 sites
Chinandega	2 sites (expansion of present plant (1)	5 sites
Granada	1 site (expansion of present plant)	1 site

The outcome of the preliminary investigation of candidate sites is presented in the IT/R (1).

4.1.3 Neighborhood Consensus

Generally the localization of facilities such as power stations, chemical factories, solid waste disposal sites, sewage treatment facilities, etc., evoke feelings of discontent, disgust and consternation from residents of areas in proximity to the candidate sites because of the negative impacts of these undertakings (e.g., nuisance, pollution, health risks, decline in living standards, etc.). People complain and protest against these activities, and such protests are famous in democratic countries worldwide as the NIMBY (Not in My Backyard) syndrome. Locally rejected land-use facilities could be referred to as NIMBY facilities.

In many countries where opinions and protests are emphatically expressed, cases such as "neighborhood objection ends in suspension of projects" or "objection ends in a consensus" usually become the outcome either within or outside of a legal framework.

In Nicaragua today, activities emphatically expressing neighborhood objections against NIMBY facilities are rare. Rarer still are cases where objections and protests result in project withdrawal or a neighborhood consensus.

As often heard in recent years (and should be true), Nicaragua is undergoing changes geared toward democracy. Parallel to this metamorphosis is the tendency of the citizens to freely express personal opinions and ideas.

Therefore, procedures in acquiring neighborhood consensus will have to be commenced soon in the future. This could be initially carried out informally, and eventually within a legal framework once such activities become prevalent.

Information on similar cases in Nicaragua where public opinions or protests were in anyway expressed or processed were gathered to give the Team insight on what consensus making procedure to propose.

4.2 Site Selection and Evaluation Items

4.2.1 Site Selection

The process involved in the selection of the sites in this study is shown in the following table.

Table 4-2: Site Selection Flow and Assignment

Stage	Study Flow	Assignment	
		Nicaragua	Study Team
1st Work in Nicaragua P/R(1)	Three Cities **Preliminary study for site selection (1)** Collection of site information	1. To show candidate sites. 2. To show relevant materials.	1. To conduct field reconnaissance. 2. To examine relevant materials.
1st Work in Japan IT/R(1)	Three Cities **Preliminary study for site selection (2)** Examination of evaluation items and assessment of the suitability of candidate sites		3. To examine evaluation items for site selection. 4. To assess the sites based on information acquired in the 1st work in Nicaragua. 5. To clarify the rest of the information to be collected in the 2nd Work in Nicaragua.
2nd Work in Nicaragua PR/R(2)	FPC **Site Selection (1)** Investigation for the selection of sites for M/P, F/S.	1. To show the rest of the information. 2. To confirm the possibility of entering and conducting investigations in the candidate sites.	6. To collect the rest of the information. 7. To enter and investigate the candidate sites 8. To select the sites for M/P and F/S 9. To clarify the investigation to be conducted in the 3rd Work in Nicaragua.
2nd Work in Japan IT/R(2)	FPC: **Site Selection (2)** Site selection and IEE. Other Cities: **Site Selection (1)** Showing the evaluation items.		[FPC] 1. To conduct IEE on the sites for the F/S. (Other cities) To show the investigation items for site selection.
3rd Work in Nicaragua P/R(3)	FPC **Further Investigation** Further investigation on sites selected for the F/S.	1. To conduct the investigation regarding EIA assigned to Nicaraguan side. 2. To conduct the investigation for construction of facilities assigned to Nicaraguan side.	1. To conduct the investigation regarding EIA assigned to the study team. To conduct the investigation for construction of facilities assigned to the study team.
3rd Work in Japan DF/R	FPC **EIA** EIA on sites selected for F/S.		1. To conduct EIA on the sites selected for the F/S. (The study team shall detail the results of the EIA in the report)

4.2.2 Evaluation Items for Site Selection

Evaluation items for assessing the suitability of the candidate sites and for selecting the facility sites mentioned in 3.1 are shown in Table 4-3 below.

Table 4-3: Site Selection Evaluation Items

Items	Evaluation
1) Possibility of land acquisition	
a. present land use	
b. land ownership	
c. necessity of compensation	
2) Possibility of getting neighborhood consensus	
a. neighboring inhabitants	
b. neighboring landowners	
c. water users in lower reaches	
d. community	
e. mayor	
3) Compatibility with development plans	
a. compatibility with development plans	
b. conformity with urbanization trend	
4) Environmental Acceptability	
a. drinking water quality	
b. groundwater quality	
c. surface runoff	
d. risk of flooding	
e. topography	
f. wind direction	
g. precipitation, evaporation	
h. neighboring land use	
i. distance to airport and other public facilities	
j. distance to nearest village	
k. distance to nearest house	
l. distance to periphery of urbanized area	
m. access road passing residential area	
n. fauna and flora	
o. scenery	
p. historic buildings	
5) Economic feasibility	
a. land area (ha)	
b. land price	
c. expected life period (year)	
d. availability of covering soil (for landfill site)	
e. availability of public services (water supply, sewage, electricity, telephone)	
f. distance to center of city	
g. elevation of land	

4.3 Outcomes of the Preliminary Study

4.3.1 Candidate Sites for Sewage Treatment Plant

The sites shown by INAA are assumed as appropriate candidate sites for sewage treatment plants based on the results of the preliminary study for site selection conducted in the 1st Work in Nicaragua.

To select sites for facilities planned in the M/P and F/S, further investigations were conducted in accordance with the evaluation items in Section 4.2.2.

The results of the preliminary study are shown in Table 4-4 below.

Table 4-4: Results of the Preliminary Site Selection Study for Sewage Treatment Plant

Major Item	Leon	Chinandega	Granada
1) Possibility of land acquisition	The new candidate site is a private land. At present, INAA is negotiating with the landowner for its acquisition. The possibility of acquiring the area adjacent to the existing plant is not clear.	The new candidate site is a private land where the conduct of field studies was not allowed. The possibility of acquiring the area adjacent to the existing plant is not clear.	The possibility of acquiring the land is not clear.
2) Possibility of getting neighborhood consensus	Careful study should be made around the two candidate sites adjacent to each existing plant, to gain neighborhood consensus, since there are inhabitants in these areas.	Careful study should be conducted on the site neighboring the existing plant since its residential area is expanding. Conditions in the other site are unknown as entry has been denied.	Careful study should be conducted since houses are scattered around the site.
3) Compatibility with development plans	Should be compatible with the municipal urban plan.	Absence of development plans.	
4) Environmental Acceptability	There is fear that new plants would generate offensive odor and aeration equipment would create noise.		There is fear that aeration equipment would create noise.
5) Economic Feasibility	The candidate sites are located in nearly the most lowly elevated sections of projected service areas. This satisfied the minimum requirement for sewage treatment plant.		

4.3.2 Candidate Final Disposal Sites

According to the results of the preliminary study for site selection conducted in the 1st Work in Nicaragua, the sites shown by the Leon Municipality which are compatible with the city's urban plan were considered as suitable candidate landfill sites. The sites in Chinandega were also considered suitable for such development. But the candidate site in Granada City is not economically appropriate.

To select sites for facilities planned in the M/P and F/S, further investigations were conducted in accordance with the evaluation items in Section 4.2.2.

The results of the preliminary study are shown in Table 4-5 below.

Table 4-5: Results of the Preliminary Site Selection Study for Landfills

Major Item	Leon	Chinandega	Granada
1) Possibility of land acquisition	All sites are privately owned. The possibility of acquiring all sites is not clear.		
2) Possibility of getting neighborhood consensus	Careful study should be conducted since the sites are located in the upper reach of a stream, although there are no villages around them.	Careful study will be needed on the two sites as they are surrounded by villages.	There are no villages and houses around the site.
3) Compatibility with development plans	The location of the candidate sites are compatible with the urban plan of the city.	No development plans.	No development plans.
4) Environmental Acceptability	No problem has been confirmed at present.	Careful study should be conducted on the two sites as they are located in the upper reach of a groundwater resource used as the city drinking water source. Also, a study should be conducted on the site adjacent to a village.	No problem has been confirmed at present.
5) Economic Feasibility	The condition of candidate sites have not been defined so that life periods cannot be estimated. Therefore, the economic feasibility of the sites is not clear.		The site is assumed to be economically infeasible. Because it is far from the center of the city, it would incur high transportation costs. And the construction of a lengthy access road would require a huge initial investment.

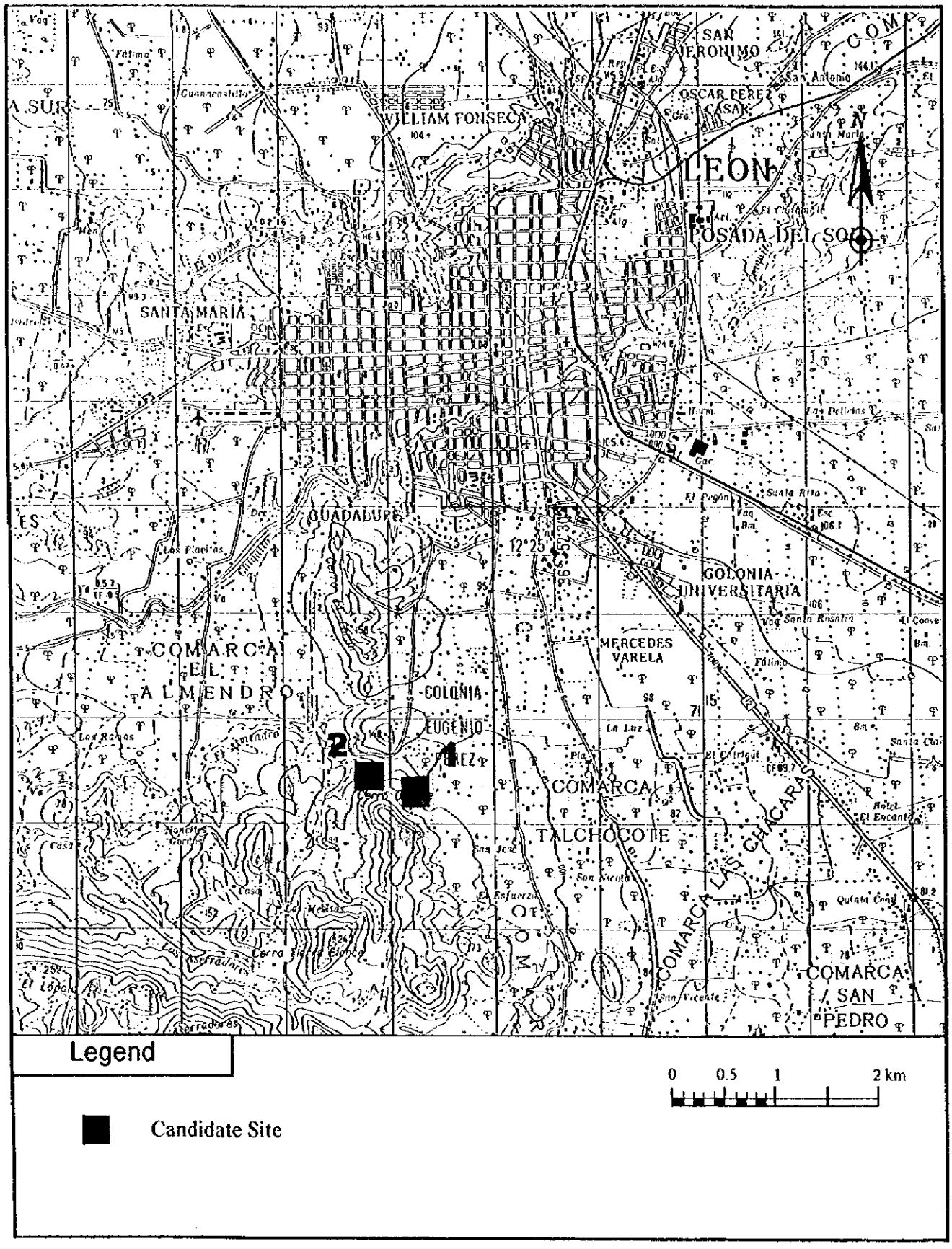


Figure 4-1: Location Map of Candidate Landfill Site in Leon

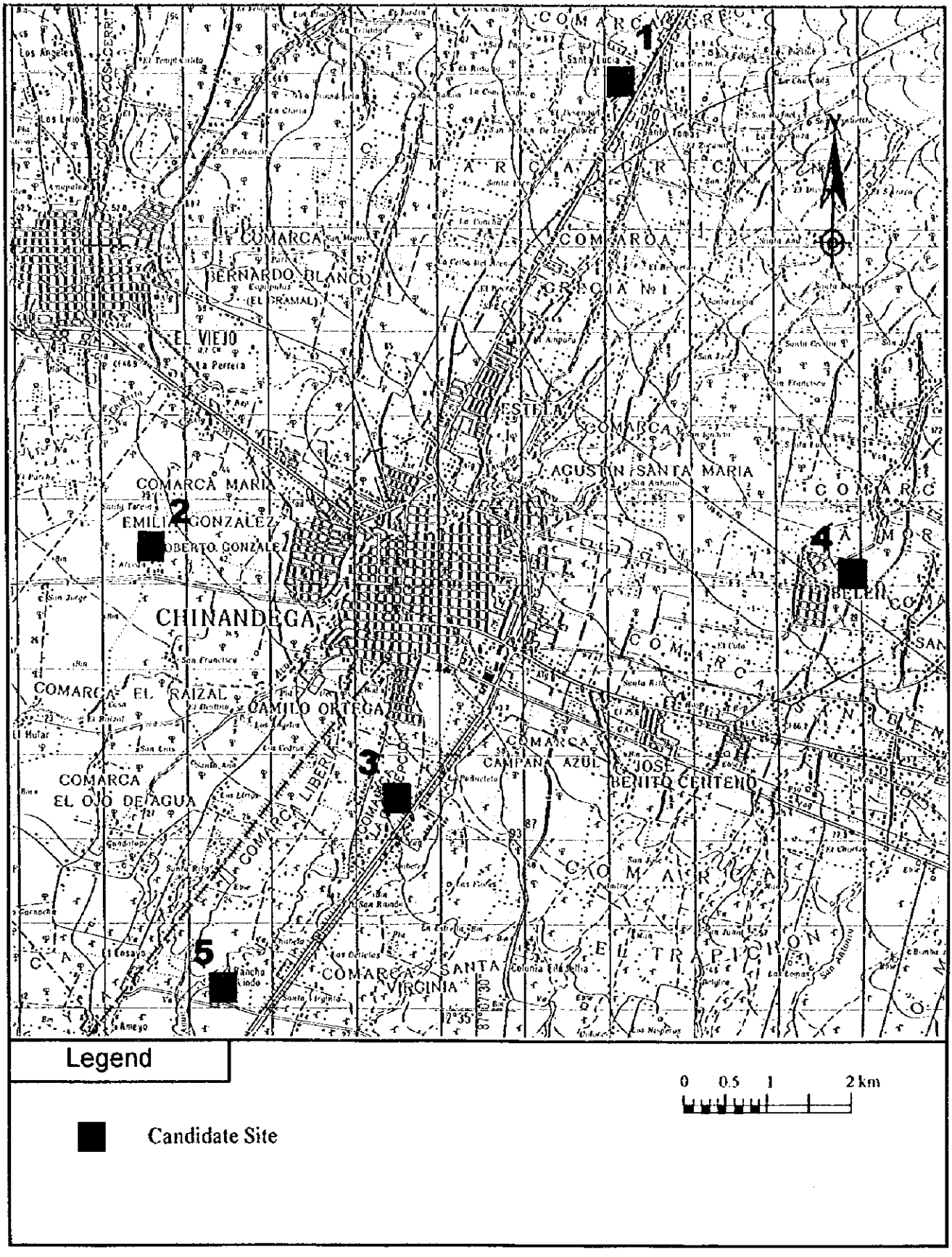


Figure 4-2: Location Map of Candidate Landfill Site in Chinandega

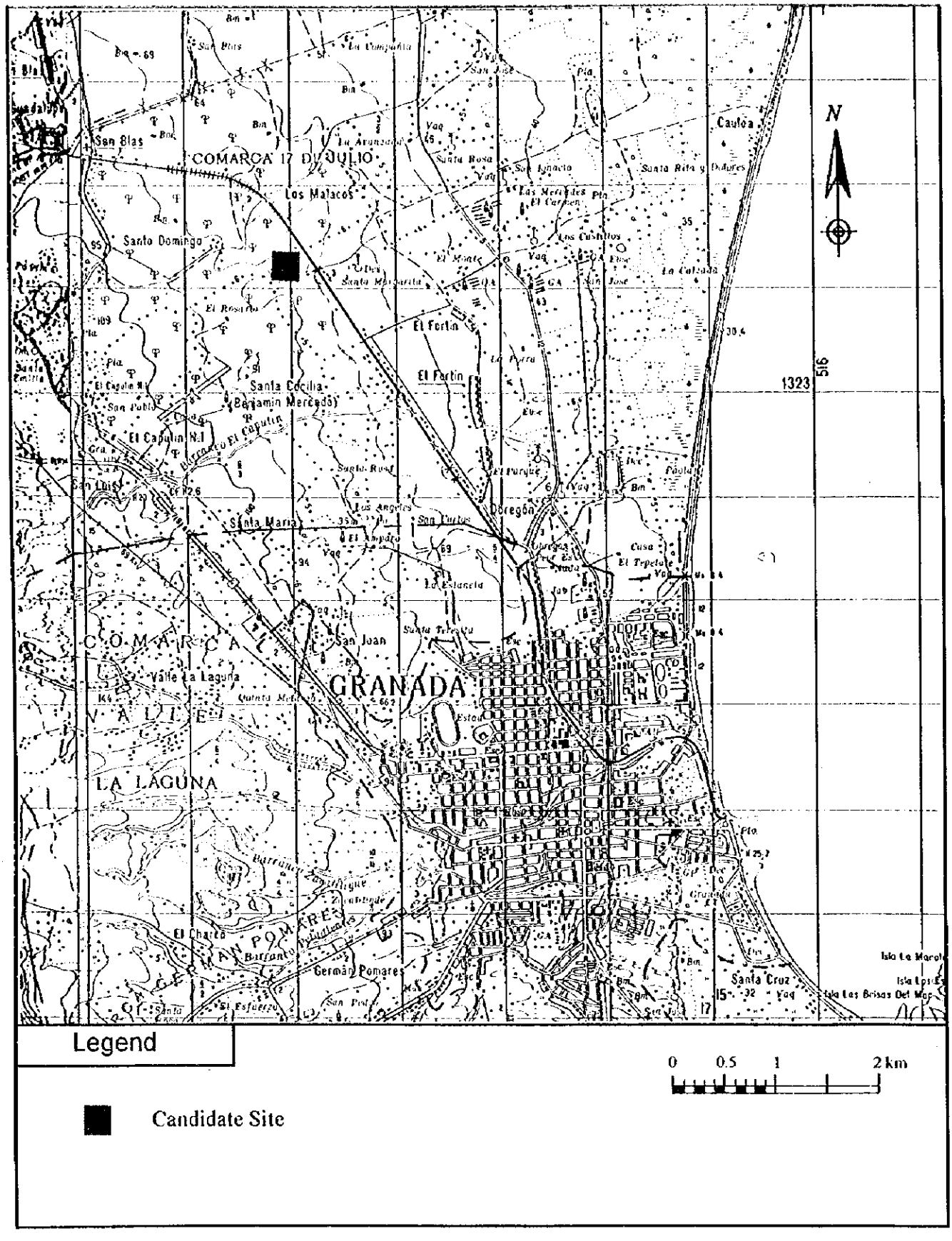


Figure 4-3: Location Map of Candidate Landfill Site in Granada

CHAPTER 5

Present USE

5 Present USE

Relevant organizations and their respective jurisdiction over USE are summarized in Table 5-1 in order to understand the current state of USE in Nicaragua. Current water supply management, stormwater management, DWWM, industrial wastewater management and solid waste management of three cities are summarized in Table 5-2, Table 5-3, Table 5-4, Table 5-5 and Table 5-6 respectively.

Table 5-1: Relevant Organizations and their Respective Jurisdiction over USE

Fields / Items	WATER SUPPLY	WASTE WATER			Rain Water	SOLID WASTE				
		Domestic Wastewater		Industrial		Domestic	Industrial		Medical[*1]	
		On-site	Off-site	Waste Water		SW	NHW	HW	NIW	IW
Consolidation of Regulations/ Norms (Standards)	INAA	INAA MINSA Municipality	INAA MARENA (2)	MARENA INAA	Municipality MINSA	MARENA MINSA Municipality	MARENA MINSA Municipality	MARENA MINSA	MARENA MINSA Municipality	MARENA MINSA
Monitoring and Guidance	INAA	MINSA Municipality	MARENA INAA	MARENA INAA (6)	Municipality MINSA	MINSA Municipality	MARENA MINSA Municipality	MARENA MINSA	MARENA MINSA Municipality	MARENA MINSA
Financial Management	Decree 32-95	N. E.	Decree 32-95	Decree 32-95	N. E.	Municipality	Generator (8) Municipality	Generator (8)	Municipality	N. E.
Permission for Facility Construction	INAA (1) MARENA (2) MCT (3)	MINSA Municipality	MARENA (2)(5) INAA (6) MCT (3)	MARENA (2)(5) INAA (6)	N. E.	MARENA (2)	MARENA (2) Municipality (7)	MARENA Municipality (7)	MARENA (2) Municipality (7)	MARENA MINSA Municipality (7)
Planning of Projects	INAA (ENACAL)	Generator Municipality (4)	INAA (ENACAL) MCT (3)	Generator INAA (ENACAL) MARENA (5)	Municipality	Municipality	Municipality Generator	Generator	Municipality Generator	Generator
Implementation of Projects	INAA (ENACAL)	Generator Municipality (4)	INAA (ENACAL)	Generator INAA (ENACAL)	Municipality	Municipality	Municipality Generator	Generator	Municipality	Generator

Note : (1) Technical evaluation
(2) Environmental evaluation
(3) Political evaluation
(4) If conducted as a collective project
(5) Discharge in natural water
(6) Discharge in sewage system
(7) Land usage
(8) Not established but traditionally expressed for mining
N.E. = Not Established

NHW = Non-hazardous Waste
NIW = Non-infectious waste
HW = Hazardous Waste
IW = Infectious Waste

*1 Relevant organizations and their respective jurisdiction over medical liquid waste management is the same as medical SWM.

Table 5-2: Current Water Supply Management

Item	Leon	Chinandega	Granada
1. General Condition			
Area			
City total (km^2)	820	647	531
Urban area (km^2)	19.1	16.1	14.3
Population			
City total (persons)	161,530	117,037	96,996
Urban area (persons)	123,865	97,387	71,783
2. Basic Items			
Projected service area	19.1 km^2	16.1 km^2	14.3 km^2
Water supply coverage area	14.4 km^2	7.5 km^2	8.4 km^2
Supplied population (1995)	114,199	72,077	64,411
Coverage rate (population)	92.2 %	74.0 %	89.7 %
Number of connections	20,198	12,533	11,352
Water production amount (1995)	10,599,899 m^3/year	5,083,403 m^3/year	6,107,590 m^3/year
Water production rate	254.3 l/person/day	193.2 l/person/day	259.8 l/person/day
Efficiency rate	58 %	72 %	57 %
Water consumption amount (1995)	6,185,190 m^3/year	3,657,990 m^3/year	3,454,251 m^3/year
- Domestic use	86.3 %	89.3 %	85.7 %
- Commercial use	3.2 %	5.1 %	3.6 %
- Industry use	0.2 %	0.02 %	1.2 %
- Others	10.3 %	5.6 %	9.6 %
Water consumption ratio	148.4 l/person/day	139.0 l/person/day	146.3 l/person/day
3. Water source			
Type of water source	Groundwater	Groundwater	Groundwater
Number of wells	8	6	6
Data on wells			
- Pump capacity	32 - 84 liter/sec	12 -109 liter/sec	36 - 78 liter/sec
- Total pump capacity	502 liter/sec	391 liter/sec	292.4 liter/sec
- Construction year [*1]	1950 - 1996	1950 - 1996	1950 - 1996
- Daily operation time	12 - 19 hrs./day	12 hrs./day	10 - 15 hrs./day
- Type of pump	Electric Motor Pump	Electric Motor Pump	Electric Motor Pump
- Total production amount	10,599,899 m^3/year	5,083,403 m^3/year	6,107,590 m^3/year
4. Disinfection			
System	Line injection	Line injection	Line injection
Method	Chlorination	Chlorination	Chlorination
5. Water transmission and distribution facilities			
Method	Mainly direct connection	Mainly direct connection	Mainly direct connection
Distribution reservoir			
Number of reservoir	3	5	4
Total volume of reservoir	9,000 m^3	9,100 m^3	8,356 m^3
Construction year	1893 - 1972	1950 - 1996	1967 -1996
Transmission and distribution			
Total length of network	193,340 m	112,690 m	98,447 m
Pipe material	PVC:54%, CI:3% AC:42%, GI:1%	PVC:59%, CI: 4%, AC: 37%,	PVC:30%, CI: 56%, AC: 14%,
Construction year [*1]	1950 - 1996	1950 - 1996	1950 - 1996

[*1] The most important rehabilitation and expansion works have been during the period 1972 - 74 and 1994 - 96.

Item	Leon	Chinandega	Granada
6. Problems with the present facilities			
Supply sources			
Production capacity	Insufficient to cover the whole urban population.	Insufficient to cover the whole urban population.	Insufficient to cover the whole urban population.
Water quality	Contamination by agrochemicals and high nitrate levels.	Contamination by agrochemicals and high nitrate levels.	High nitrate levels.
Transmission and distribution			
Transmission	Lack of regulation reservoir (direct connection to distribution net)	Lack regulation reservoir (direct connection to distribution net)	Lack of regulation reservoir (direct connection to distribution net)
Distribution	Insufficient supply pressures in high areas	Insufficient supply pressures in high areas	Insufficient supply pressures in high areas
Storage	Insufficient storage volume		
7. Operation and maintenance of facilities			
Responsible authority	INNA Region II Leon branch office	INNA Region II Chinandega branch office	INNA Region IV Granada branch office
Type of operation	Direct	Direct	Direct
Number of persons	82(inc. sewage)	45(inc. sewage)	48(inc. sewage)
8. Finances			
INAA annual budget	C$ 302,605,000/ year	C$ 302,605,000/ year	C$ 302,605,000/ year
Regional bureau budget	C$ 17,926,000/ year	C$ 13,765,000/ year	C$ 9,026,000/ year
Water charges			
- For household	C$ 1.96/ m^3	C$ 1.73/ m^3	C$ 2.03 / m^3
- For others	C$ 3.57/ m^3	C$ 4.30/ m^3	C$ 5.47/ m^3
Collection method	Direct collection	Direct collection	Direct collection
Collection rate	96 %	98 %	96 %
Revenue of water charge	C$ 15,244,000/ year	C$ 12,235,000/ year	C$ 9,106,000/ year

9. Legislation

Decree No. 123-79, as INAA's Organization Law, authorizes INAA to set standards and specifications for design, construction and operation of urban and rural water supply systems.
Currently, the National Assembly is discussing a new structure for the Water Supply and Sewage Sector, e.g.:

- creation of ENACAL (state enterprise to be in charge of operational and managerial duties)
- reduction of INAA to a regulatory, fiscal and pricing agency,
- sector's policy making, planning and coordination to be transferred to the MCT.

(cf.: Presidential Decree Nos. 27-95, 31-95, and 32-95, which were returned for Legislative approval)

Table 5-3: Current Domestic Waste Water Management

Item	Leon	Chinandega	Granada
1. Basic Item			
Projected service area	19.1 km^2	16.1 km^2	14.3 km^2
Projected service population	123,825	97,387	71,783
Sewer system (off-site)	55.3 %	33.6 %	21.9%
On-site system	44.7 %	66.4 %	1.6%
Soak system (sumidero)	2.1 %	4.0 %	37.5%
Latrine system	35.2 %	51.8 %	28.1%
No-system	7.4 %	10.6 %	10.9%
2. Sewer system			
Service area	9.45 km^2	2.57 km^2	2.0 km^2
Service population	68,510	32,752	15,706
Number of connections	12,117	5,695	2,768
Coverage rate (population)	55.3 %	33.6 %	21.9 %
Length of pipe line	83,460 m	45,500 m	27,874 m
Number of pump stations	1	1	1
STP intake (1995)	5,663,277 m^3/year	2,405,703 m^3/year	946,080 m^3/year
Daily STP intake (1995)	15,516 m^3/day	6,591 m^3/day	2,592 m^3/day
Sewage production per capita	226.5 liters/pers./day	201.2 liters/pers./day	165.0 liters/pers./day
Sewage treatment plant (STP)			
Number of STP	2	1	1
Treatment method	Facultative lagoon	Facultative lagoon	Facultative lagoon
Treatment capacity	Subtiava: 6,400 m^3/day El Cocal: 1,600 m^3/day **Total 8,000 m^3/day**	2,300 m^3/day	3,450 m^3/day
Intake amount (mean value of 1995)	Subtiava 11,286 m^3/day El Cocal 4,230 m^3/day **Total 15,516 m^3/day**	6,591 m^3/day	2,592 m^3/day
Intake water quality	BOD: 300-340 mg/l COD: 500-600 mg/l S S : 238-340 mg/l	BOD: 360-480 mg/l COD: 594-840 mg/l S S: 270-329 mg/l	BOD : 440 mg/l COD : 500 mg/l S S : 260 mg/l
Water quality following treatment	BOD : 80 - 160 mg/l COD : 220-240 mg/l S S : 90 - 180 mg/l	BOD: 80 - 120 mg/l COD: 297-440 mg/l S S : 136 - 220 mg/l	BOD : 280 mg/l COD : 300 mg/l S S : 240 mg/l

Item	Leon	Chinandega	Granada
Discharge point	Rio Chiquito	Rio Acome	Infiltration
Problems with the present system			
Sewer network	Lack of capacity Rainwater wrongfully connected to wastewater	Lack of capacity Rainwater wrongfully connected to wastewater	Lack of capacity Rainwater wrongfully connected to wastewater
Sewage Treatment Plant	Overload Unknown water wrongfully connected	Overload Unknown water wrongfully connected	Unknown water wrongfully connected
Improvement plan status	Rehabilitation of both the present STP	Rehabilitation of the present STP	Rehabilitation of the present STP
Operation and maintenance			
Responsible authority	INNA Region II Leon branch office	INNA Region II Chinandega branch	INNA Region IV Granada branch office
Number of persons	82 (inc. water supply)	45 (inc. water supply)	48 (inc. water supply)
Finances			
INNA annual budget (inc. water supply)	C$ 302,605,000	C$ 302,605,000	C$ 302,605,000
Regional bureau budget (per annum, inc. water supply)	C$ 17,926,000	C$ 13,765,000	C$ 9,026,000
Sewage charge	30% of total charge	30% of total charge	30% of total charge
Charge collection method	Direct collection	Direct collection	Direct collection
Collection rate	98 %	98 %	96 %
Revenue from sewage charge (C$ 1,000)	C$ 2,682,000	C$ 1,530,000	C$ 753,000
Legislation	Waste water standards have been established but there are no regulations on penalties, inspections or guidance. Decree No. 123-79, as INAA's Organization Law, authorizes INAA to set standards and specifications for design, construction and operation of urban and rural water supply systems. Currently, the National assembly is discussing a new structure for the Water Supply (and Sewage) Sector, e.g.: • creation of ENACAL (state enterprise to be in charge of operational and managerial activities • reduction of INAA to a regulatory, fiscal and pricing agency • the sector's policy making, planning and coordination to be transferred to the MCT. (cf.: Presidential Decree Nos. 27-95, 31-95, and 32-95, which were returned for Legislative approval)		

Item	Leon	Chinandega	Granada
3. On-site treatment / disposal			
Facilities			
- Human excreta	Septic tank and Latrine	Septic tank and Latrine	Septic tank and Latrine
- Sullage	Septic tank, Soak pit	-	Soak pit
Discharge point of septic tank			
- Human excreta	Infiltration into the ground, discarded on roadsides, etc.	Infiltration into the ground, discarded on roadsides, etc.	Infiltration into the ground, discarded on roadsides, etc.
- Sullage	Infiltration into the ground, discarded on roadsides, etc.	Infiltration into the ground, discarded on roadsides, etc.	Infiltration into the ground, discarded on roadsides, etc.
Lifespan of facilities	Latrine 3 - 5 year	Latrine 3 - 5 year	Latrine 3 - 5 year
Construction cost of facilities - Septic tank	C$ 4,000/unit	C$ 3,000/unit	C$ 5,800/unit
Responsible authority	INNA, MINSA, Municipality	INNA, MINSA, Municipality	INNA, MINSA, Municipality

Table 5-4: Current Industrial Wastewater Management

Item	Leon	Chinandega	Granada
Number of factories	27	14	12
Treat. / disposal method	Mainly untreated (discharge into the environment and/or sewer)		
Categorization of industry	Not established	Not established	Not established
Categorization of industrial waste	Not established	Not established	Not established
Categorization of hazardous industrial waste	Not established	Not established	Not established
On-site treatment (Infiltration/evaporation)	0%	49.3%	0%
Untreated	100%	50.7%	100%
Sewer discharge	12.2%	0%	0.03%
Major contamination source	Tannery, Food production, Detergent production, etc.	Beverage, Food production, Agricultural industries, etc.	Tannery, Food production, Basic chemicals, etc.
Responsible authority	INAA, MARENA	INAA, MARENA	INAA, MARENA
Legislation	Waste water standards have been established but there are no regulations on penalties, inspections or guidance.		

Table 5-5: Current Storm Water Management

Item	Leon	Chinandega	Granada
1. Basic Items for Planning			
Storm water control plan	No plan	No plan	No plan
Return rate	Not defined	Not defined	Not defined
Rainfall intensity formula	Not defined	Not defined	Not defined
Rainfall intensity (mm/hour)			
1/10years	75.0	93.9	86.8
1/5years	66.1	79.2	76.7
Present flood damage	Yes	Yes	Yes
2. Present Facilities	Rainwater drainage pipes, ditches and canals are partly installed, but not enough to prevent damage.	Rainwater drainage pipes, ditches and canals are partly installed, but not enough to prevent damage.	Rainwater drainage pipes, ditches and canals are partly installed, but not enough to prevent damage.
3. Responsibility Organizations			
i) Planning	None	None	None
ii)Construction and Maintenance	Street Maintenance Department of the Municipality	Works and Internal Services Department of the Municipality	Municipal Services Department of the Municipality
iii)Disaster Relief	Emergency Operation Center	Emergency Operation Center	Emergency Operation Center
4. Finances			
Financial Source	No specific source. Budget apportioned from the municipal budget.	No specific source. Budget apportioned from the municipal budget.	No specific source. Budget apportioned from the municipal budget..

Table 5-6: Current Solid Waste Management (as of 1996)

Item	Leon	Chinandega	Granada
1. Basic Item			
Projected service area	19.1 km^2	16.1 km^2	14.3 km^2
Population in the study area	133,997	100,748	76,250
Waste generation amount	102.1 ton/day	76.2 ton/day	57.1 ton/day
Waste discharge amount	67.9 ton/day	48.4 ton/day	43.2 ton/day
Waste collection amount	58.9 ton/day	39.5 ton/day	35.4 ton/day
Final disposal amount	60.0 ton/day	40.5 ton/day	36.9 ton/day
Coverage rate (waste amount)	86.7 %	81.6 %	82.0 %
Coverage rate (population)	80.0 %	51.0 %	63.0 %
Service population	107,918	51,382	48,037
Non-service population	26,799	49,366	28,213
Length of road swept	55 km	45 km	35 km
2. Collection and Transport			
Collection system	Curb collection	Curb collection, public container collection	Curb collection
No. of collection vehicles	Compactor: 5 (12 m^3) Dump truck : 2 (8 m^3, 6 m^3 capac.)	Tractors: 6; Container truck : 1, Container: 6	Tractor: 2; Dump truck : 1; Truck: 3
Transportation system	Direct haulage	Direct haulage	Direct haulage
Responsible authority	Municipal Services Department	Municipal Services and Administration Department	Municipal Services Department
No. of personnel	45	37	32
Unit cost of collection	C$ 14/m^3	C$ 52.4/ton	C$ 110.2/ton
3. Street sweeping			
Cleaning method	Manual	Manual	Manual
Length of road	226 km	91 km	49 km
Length of road swept	55 km	45 km	35 km
Waste generation amount	1.9 ton/day	1.6 ton/day	1.2 ton/day
Responsible authority	Municipal Services Department	Municipal Service and Administration Department	Municipal Service Department
Number of personnel	28	49	31
Unit cost of street sweeping	C$ 3/m	C$ 1.20/m	C$ 1.09/m
Equipment used	Broom, shovel, handcart	Broom, shovel, handcart	Broom, shovel, handcart
4. Intermediate treatment	None in particular	None in particular	None in particular

Item	Leon	Chinandega	Granada
5. Recycling			
Recycling Amount			
At generation point	16.3 ton/day	8.5 ton/day	5.0 ton/day
At landfill	1.4 ton/day	0.4 ton/day	0.5 ton/day
Recycling System	No organized recycling	No organized recycling	No organized recycling
6. Final disposal			
Disposal method/level	Open dumping	Open Dumping	Open Dumping
Final disposal site from generation center	4 km	4 km	5 km
Responsible authority	Municipal Services Department	Municipal Services Department	Municipal Services Department
No. of personnel	2	1	1
Unit disposal cost	C$ 1.00 /m^3	C$ 5.89 /m^3	C$ 4.26 /ton
Main equipment	Bulldozer: 1	Bulldozer: 1	Bulldozer: 1 (rental: occasional use)
7. Maintenance of Vehicles and Equipment			
Maintenance shop	2	1	1
Responsible authority	Department	Municipal Service Department	Municipal Shop
No. of employees	8	7	3
8. Operation			
Responsible authority	Municipal Services Department(disposal, treatment, collection)	Municipal Services Department(disposal, treatment, collection)	Municipal Services Department(disposal, treatment, collection)
Number of persons	72 + temporary workforce	87	63
Type of operation	Municipal operation	Municipal operation	Municipal operation
9. Finances			
City budget	C$ 32,213,000	C$ 15,084,000	C$ 14,327,000
Cleansing department budget	C$ 2,741,000	C$ 2,086,230	C$ 1,431,000
Management of service recipients	Municipality	Existence of a register	Existence of a register
Fee collection method	Door to door and at the office	Door to door	Door to door
Level of fee collection	Only 36% is collected	Although a fee collection system is established, the rate of fee collection is very low. Around 45% of service beneficiaries do not pay their taxes	Although a fee collection system is established, the rate of fee collection is very low. The fee is insignificant; a mere technicality.

Item	Leon	Chinandega	Granada
Collection fee Revenue (1995)	C$ 5-10-15-28/m The Municipal Tributary Plan (MTP) sets four levels of taxes, including one for "refuse and street sweeping". This direct tax is charged only if services are performed. No less than 50% of the service cost must be paid. C$ 1,341,000	C$ 10-40-75-120/m The Municipal Tributary Plan (MTP) sets four levels of taxes, including one for "refuse and street sweeping". This direct tax is charged only if services are performed. No less than 50% of the service cost must be paid. C$645,000	C$ 2 - 4 - 5/m The Municipal Tributary Plan (MTP) sets four levels of taxes, including one for "refuse and street sweeping". This direct tax is charged only if services are performed. No less than 50% of the service cost must be paid. C$ 106,000
10. Contract to private sectors	None	None	None
11. Legislation	Law No. 217 - 96 establishes the responsibility for collection/treatment/disposal of non-hazardous SW to municipalities, and MARENA and MINSA are responsible for normative matters. A chapter on HW states those who manage them must know the physical, chemical, and biological characteristics (Art. 131); articles 132 & 133 prohibits the import of toxic waste and sets conditions for their export . Law No. 40-88 authorizes the municipalities to collect/dispose HW, but does not give the authority to penalize defaulters.		
12. Public cooperation	The municipality produces public notices on each item, however there is a lack of sufficient cooperation.	The municipality produces public notices on each item, however there is a lack of sufficient cooperation.	The municipality produces public notices on each item, however there is a lack of sufficient cooperation.
13. Medical solid waste disposal	Discharge with MSW and disposal responsibilities of the discharger are ambiguous. Also, disposal standards and regulations are not established. In the case of HW, according to Art. 131, the institution should know its physical, chemical, and biological properties **only**. Private medical institutions claim to totally or partially separate HW and DW by either using an autoclave, boiling or incineration. Private	Discharge with MSW and disposal responsibilities of the discharger are ambiguous. Also, disposal standards and regulations are not established. In the case of HW, according to Art. 131, the institution should know its physical, chemical, and biological properties **only**. Partial separation of HW from DW (mostly hypodermic needles). HWs are burned either at the dumping site or at medical institutions. Training	Discharge with MSW and disposal responsibilities of the discharger are ambiguous. Also, disposal standards and regulations are not established. In the case of HW, according to Art. 131, the institution should know its physical, chemical, and biological properties **only**. Generally no separation of DW and HW at medical institutions. Very little training of personnel in handling HW. The

Item	Leon	Chinandega	Granada
	institutions seem to provide some training on handling HW. State medical institutions neither separate nor provide training to handle HW. The municipality is in charge of collection and disposal of medical waste in the municipal landfill.	on handling HW is limited to induction courses. The municipality is in charge of collection and disposal of medical waste in the municipal landfill.	municipality is in charge of collection and disposal of medical waste in the municipal landfill.
14. Industrial solid waste disposal	Discharge of industrial waste with MSW and disposal responsibilities of the discharger are ambiguous. At times industries dispose of their waste by themselves, in other cases the municipality takes care of it. Some of the industries have their own disposal site. Also, disposal standards and regulations are not established. In the case of HW, according to Art. 131, institutions should know its physical, chemical, and biological properties only.		
15. Present situation and problems	Poor services due to non payment of fees. Inappropriate location of the disposal site. Lack of equipment for constructing the foundation of the new disposal site.	Poor services due to non payment of fees. Riverwater pollution due to leachate. Lack of equipment for constructing the new disposal site. Lack of environmental and sanitary education.	Poor services due to non payment of fees. Groundwater pollution due to leachate. Lack of equipment for constructing the new disposal site and transportation.