ANNEX J

Present USE and its Management

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J Present USE and its Management

J.1 Present USE of the Country

J.1.1 Water Supply

a. Technical System

The Institute of Aqueducts and Sewers of Nicaragua (INAA) is responsible for the sanitary and potable water supply services nationwide. The institute's responsibility includes the planning, administration, and operation of the potable water and sewer systems.

a.1 Service Coverage

By the end of 1994, INAA operated and maintained 148 aqueducts for the supply of potable water to 171 locations nationwide. INAA services 55% of the national population and 80% of the urban population: about 1.7 million of the citizens in the urban areas and around 0.6 million of the citizens in the rural area.

Table J-1: Service Coverage (1995)

Item	Urban Area	Rural Area	Total
Total Population	2,138,180	2,001,306	4,139,486
Service Population	1,725,582	560,366	2,285,948
Service Coverage	80.7%	28.0%	55.2%

Source: Normalization Management of INAA (July/96)

a.2 Supply Indicators

a.2.1 Unaccounted For Water (UFW)

The UFW in 1995 (national average, with the exclusion of Region IV) accounts for about 45% of the total amount of water produced nationwide.

Table J-2: Unaccounted For Water Rate in 1995

Item	*Nationwide	Leon	Chinandega	Granada
Production (m^3/year)	178,462,251	10,599,899	5,083,403	6,107,590
Consumption (m^3/year)	98,213,386	6,185,190	3,657,990	3,454,251
Unaccounted Water (m^3/year)	80,248,865	4,414,709	1,425,413	2,653,339
UFW Ratio (%)	45.0	41.6	28.0	43.4

Note: *excluding Region VI
Source: INAA Statistics

a.2.2 Type of Connection

Table J-3 shows the amount of water used in cubic meters and in percentage by the "type of connection" nationwide. Household water use accounts for about 90% of the total amount of water supplied.

Table J-3: Current Type of Connection (1995)

Type of Connection	Amount (m^3/year)	Share (%)
Household	85,347,444	87.1
Commercial	4,680,421	4.8
Industrial	714,713	0.7
Government	7,270,943	7.4
Total	98,013,521	100.0

Source: INAA Statistics

a.2.3 Water Production and Consumption

Table J-4 shows the amount of water produced and consumed by region. The national average production and consumption rates are 284 l/person/day and 139 l/person/day, respectively.

Table J-4: Water Consumption Rate in 1994

Region	Production (m^3/year)	Consumption (m^3/year)	Service Population (persons)	Rate (l/person/day)	
				Production	Consumption
Region I	10,000,807	5,561,090	170,396	160.8	89.4
Region II	24,665,468	13,940,674	330,090	204.7	115.7
Region III	106,084,256	59,825,428	858,395	338.6	190.9
Region IV	30,159,888	14,433,099	341,535	241.9	115.8
Region V	5,963,931	3,580,693	98,575	165.8	99.5
Region VI	22,385,856	-	115,317	531.8	-
ZE I	775,470	502,677	11,391	186.5	120.9
ZE II	216,820	104,373	1,997	297.5	143.2
ZE III	595,611	265,356	8,135	200.6	89.4
Total	200,848,107	98,213,390	1,935,831	284.3	139.0

Source: INAA Statistics

a.3 Supply Source

The article "Situación de la Calidad de Agua de Nicaragua" by Ing. Mario Gutiérrez, in the publication Revista Ambiente, Year 2, No.3, July 1996, states the following information.

a.3.1 Pacific Zone

The pacific zone is composed of Region II (departments of Chinandega and Leon), Region III (department of Managua), and Region IV (departments of Masaya, Granada, Carazo and Rivas). Groundwater is the main water supply source in these regions which are equipped with about 285 deep wells. These regions also use 11 existing shallow sources, of which 10 are rivers or springs of minimal flow, and one a lake (Asosca) that supplies water to a quarter of the population of Managua.

Table J-5: Number of Water Sources in the Pacific Zone

	Deep Wells	Surface Water	Rivers or Springs	Lake
Number of Sources	285	11	10	1

The turbidity of the groundwater sources in the departments of Granada and Leon were found to average 0.75 and 4.98, respectively. Meanwhile, the electric conductivity and chloride contents of the groundwater sources in the departments of Rivas and Carazo were found to vary extremely, presumably because the data used were taken from offshore wells subject to saline intrusion.

Nitrate is another essential INAA parameter for water quality analysis. The groundwater sources in Managua were observed to contain values ranging from 1.8 to 33 mg/l, while those in Region II (Leon) were found to contain values as high as 45 mg/l.

Due to the vast use of pesticides in Region II, groundwater sources are probably contaminated. In Leon, a well in a small area was found to contain water with hardness ranging from 400 to 600 mg/l and a temperature exceeding 32°C. This condition may be attributed to volcanic activity in the region.

The analysis of the quality of the shallow sources indicate that Asosoca Lake shows a turbidity of 0.4 UNT, while the river Jesús in San Rafael del Sur showed a turbidity of 150 UNT. On the other hand, electric conductivity varies between 385 and 500 S/cm. The iron levels in the Tamarindo River in the department of Leon were found to surpass the acceptable limit set by INAA.

a.3.2 North Zone

This zone is formed by Region I (departments of Esteli, Madriz, Nueva Guinea) and Region VI (departments of Matagalpa and Jinotega), and uses about 34 shallow water sources, e.g., main rivers and springs.

The groundwater sources in the department of Matagalpa were found to average a maximum turbidity of 29.86 UNT and an electric conductivity of 832.42 s/cm. In the department of Madriz, groundwater had a maximum hardness averaging 280 mg/l. Finally, the fluoride concentration in the groundwater sources in the departments of Esteli, New Segovia and Madriz averaged 0.14, 0.12 and 0.24, respectively.

The shallow water sources were observed to be less hard, with lower pH and sulfate (5 mg/l) concentrations. The fluoride concentrations range from 0.10 to 0.19 mg/l. The sources in Jinotega and Matagalpa were found to have a turbidity of 6.2 UNT and 13.6 UNT, respectively. The color of the shallow water sources in this zone was darker than what the turbidity value may indicate.

a.3.3 Central Zone

This zone represents Region V (departments of Boaco and Chontales). The two parameters used to analyze the quality of the groundwater sources in this zone are based on the established water quality guidelines. The turbidity of these sources was measured to average 5.9 UNT, while electric conductivity averaged 758.5 s/cm. Four parameters were used to analyze the quality of the shallow water sources used in this region. The analysis was considered to give objectionable results: turbidity (22.7 UNT), color (110 UC), total iron (0.43 mg.l) and fluoride (0.21 mg/l).

a.3.4 Atlantic Zone

The groundwater sources in this zone were found to be high in electric conductivity (1,077 S/cm) and chloride (250 mg/l). The results of the analysis on the shallow water sources vary by region. In R.A.A.N, the sources showed high turbidity (18 UNT), fluoride (0.175 mg/l) and alkalinity (13.5 mg/l) values. In R.A.A.S, the turbidity (11.7 UNT), fluoride (0.15 mg/l) and total iron (0.5 mg/l) values measured were objectionable. The water source in Special Zone III was observed to have low fluoride concentration (0.07 mg/l).

a.4 Existing Infrastructure for Water Quality Control

Until 1989, the central laboratory in Managua was the only one that could conduct water quality analysis. Now, with the expansion of the services of INAA, 9 laboratories, one for each region, have been constructed.

Each laboratory is installed with the equipment necessary for pathogenic analysis. However, only the laboratories in Regions I, III, and IV can analyze the physical and chemical properties of water at present. On the other hand, only the laboratory in Region III can conduct wastewater analysis and special water quality analysis.

a.5 Monitoring of Pathos and Residual Chlorine Sampling

In 1991, INAA earnestly began to purchase and install chlorinators in urban aqueducts nationwide as a countermeasure against the widespread outbreak of cholera. Furthermore, in that same year, 8,281 samples of fecal coliform were taken. Sampling increased in 1992, as the epidemic increasingly affected the population.

The installation of chlorinators in large quantities increased the decline in bacterial contents in the water from a negative ratio, e.g., 80.7% in 1991, to 95.9% in 1995. Simultaneously, distribution systems nationwide were able to suppress the concentrations of chlorine residues. Due to massive chlorination, the percentage of the service population rose from 64% in 1991 to 96% in 1995.

Table J-6: Number of Residual Chlorine Test and Bacteria Tests

Year	No. of Residual Chlorine Tests	Number of Bacteria Test			
		Total	Water Sources	Distribution Net	Negative Rate (%)
1991	-	8,281	2,095	6,186	80.7
1992	25,568	12,718	3,423	9,295	90.8
1993	35,570	13,360	3,515	9,845	90.8
1994	35,728	1,727	3,085	8,644	95.0
1995	50,350	12,433	3,251	9,182	95.0
total	147,234	48,519	15,367	43,152	-

Source: Ing. Mario Gutierrez , Revista Ambiente, Ano 2 No. 3 July 1996

b. Institutional System

INAA - Instituto Nicaraguense de Acueductos y Alcantarillado is the national entity in charge of planning, executing and controlling the municipal and local water and sewage system since 1979. INAA transferred these responsibilities only to Region VI, which consists of the northern departments of Matagalpa and Jinoteca, with the agreement of the municipalities.

The National Assembly is discussing a new structure for the potable water and sewage sector, proposed by the Central Government. The aim of this proposal is to create an incentive to decentralize services and encourage private participation in the sector. The new structure was the subject of Presidential Decrees No. 27-95/31-95 and 32-95 published in the official journal "La Gaceta", dated June 26, 1995, that became the Legislative Power because the acts must be laws and not decrees to modify the previous ones. These decrees reflect the new sectorial policy, although may suffer any changes, and must be considered by JICA's team.

Presently INAA, manages potable water and sewage through its seven delegates, and is improving its performance these last years in all aspects: operational, human and economic resources. Relevant indices are shown on Table J-8. The urban population covered by the potable water supply services was 80,7% in 1995. In that year, INAA operated 148 water supply systems for 171 cities, including Matagalpa and Jinotega departments.

The INAA employed 2,416 people as of June 1995; 1,998 where working for local branches.

In August 1996, INAA fixed nine different tariffs: 3 uni-residential and 2 multi-residential buildings, and one for each other usage: commercial, industrial, governmental, and public supplier. Each tariff presents different unit prices, increasing for larger consumers.

INAA plans to extend the potable water supply to 85% of the urban and 45% of the rural population by 2000, and this project includes educational programs to motivate the people not to wastewater (e.g., leakage).

J.1.2 Stormwater Control

a. Technical System

With the exception of a few, most of the departments in Nicaragua are equipped with stormwater drains, but these drains only cover a small area. Although this is not one of the concerns of this study, it is important to note that the topographic features, e.g., slopes, in cities like Managua, Masaya, Matagalpa, Granada, and Chinandega facilitate the natural drainage of wastewater to lakes, lagoons or natural basins.

Approximately 30 years ago, unsystematic developments in the peripheries of cities resulted in the improper use of the soil, implementation of inappropriate agricultural methods, and the destruction of natural vegetation: factors which consequently decreased water retention capabilities. This induced erosion, and maximized river flow. These conditions aggravated slope gradients which vary from 2% to 15%, and in some areas, up to 50%.

Accordingly, stormwater flow accelerated and induced undercuts, silt and sediment deposits in the existing drainage systems.

While some drainage systems are presently managed and repaired, some are not. There are also no cleaning programs, and drainage rehabilitation or reconstruction works are limited.

Since the rainfall levels in Nicaragua have remained the same for some time, rainfall was not considered one of the factors causing drainage problems. Nevertheless fluctuations in runoff coefficient and the following cause drainage problems: increase in agricultural areas; cultivation without soil protection measures, e.g., terrace construction; felling of trees from the banks of small streams and lakes; diversion of river routes; access roads without stormwater drainage control; increase in urban development, etc.

It is necessary to adopt countermeasures taking national characteristics into account, to avoid neglecting the specific considerations that define the master plan of each municipality or locality.

Public participation in coordination with institutions responsible for stormwater drainage management would determine the success of this endeavor.

b. Institutional System

Stormwater drainage services are a municipal responsibility, according to Municipal Law No. 40-88. But the preservation of the quality of water bodies (rivers, lakes, seas) receiving stormwater drainage is the responsibility of MARENA.

There are no taxes directly allocated for maintenance and improvement of streets and stormwater drainage facilities. Their costs might be considered as compensated by the tax on vehicle circulation (Impuest de Rodamiento y Navegación Acuática - Dec. No. 251-80, art. 4), whose collection and the incomes were transferred to the municipalities through a Ministry Accordance (Acuerdo Ministerial) No. 48 of Financial Ministry, from 31 July 1991. Only the municipality of Managua has a definitive competence stated by Law to collect tax and use its incomes.

Due to shortage in equipment and financial resources, drains are only installed in new or rehabilitated paved streets, and the municipalities only extend maintenance services when critical situations occur.

As the sewer net is insufficient, household wastewater or effluent from "in loco" wastewater treatment plant are discharged into the natural or artificial drainage system.

Accordingly, unsanitary problems arise as well as potential conflicts between the municipalities and INAA. The latter is exacerbated by shortage in stormwater drainage, which results in the accumulation of stormwater in the sewers. Sewage is discharged into lagoons for biological treatment and surplus stormwater in the sewage is considered to disturb this natural process.

The municipalities have no power to pose a sanction against illegal discharge into the drainage system but may solicit the help of MINSA/SILAIS for the enforcement of legislation against violators.

Another condition that may result in a conflict between government organizations is the competence of MARENA in establishing norms for the inspection and prohibition of illegal discharge in view of the quality of waste to be discharged into bodies of water (Law No. 217-96 and Decree No. 33-95). Section 2.19 of Article 2 of Decree 33-95 defines water bodies where wastes are discharged into as natural drainage beds. Article 7 of the same decree stipulates that the stormwater drainage system should be used for the drainage of water free of waste, water from cooling towers, and stormwater from industries. The pollutional load in these waters was not taken into consideration.

These conditions show the need for detailed and precise definitions of the use of micro and macro-drainage systems for stormwater and wastewater collection.

J.1.3 Domestic Wastewater Management

a. Technical System

INAA operates and maintains 20 sewer systems in 20 cities, covering a population of 1.05 million. Its services covers 37% of the national urban population (if excluding the city of Managua, this index is reduced to 13%).

The length of pipelines installed totals approximately 1,353 km, 64% of which is in Managua. Sewers in the rural area comprise of septic tanks or latrines.

Most of the sewer facilities were constructed or installed more than 20 years ago and only 43% of the urban cities (excluding Managua) have a sewage collection service. In the past urban developments did not include sewer system development.

Table J-7: Technical Information on Principal Sewer Systems in 1995

Reg.	Department	Localities	Total Connection	Length (km)	Lagoons	Existing No.
I	Esteli	Esteli	5697	66.34	3	
I	Madriz	Somoto	546	12.27	1	
I	Chinandega	Chinandega	5220	42.2	1	
I	Chinandega	Corinto	883	8.7		X
I	Chinandega	El Viejo	133	1.37	1	
I	Chinandega	Leon	11226	189	3	
I	Managua	Granada	2566	27.9	2	
I	Granada	Masaya	5273	41.7	3	
I	Rivas	San Juan del Sur	97	6.6	1	
I	Zona Especial II	San Carlos	149	2.29		X

Source: Pre-facility Study INAA- March 1996

The migration of the rural population to the cities resulted in the random development of new areas without adequate infrastructure, and this should be taken into consideration in the improvement of sanitary conditions. Lack of sanitary infrastructure exposes the population to infectious diseases, e.g., cholera, typhoid, malaria.

With the exclusion of Matagalpa and Jinotega, which are the responsibility of the municipal governments, the existing sewer systems are managed, operated and maintained by INAA.

Only eight of the existing sewer systems treat its effluents in facultative stabilization lagoons, either using one or two stages.

It was observed that existing treatment plants only reduce the concentration of pollutants in the effluents to a minimum, due to hydraulic overcharge during rainy conditions or deficiencies in structural design (short circuits, dead hydraulic spaces, etc.).

To minimize these problems, INAA is concluding a rehabilitation program for the major treatment plants (Masaya, Granada, Chinandega, Esteli, León, Somoto) to improve effluent quality according to the established international norms. On the other hand, we must emphasize the recent actions undertaken to accomplish a number of sewer improvement projects in other areas of average size.

The large number of latrines (wet system) in the urban and rural sectors are considered to contaminate shallow local groundwater resources used for drinking, agriculture and by industries.

The limited coverage of proper sewer services or the improper treatment of effluent have direct deleterious environmental effects. Effluent is sometimes discharged directly into lagoons, as in Masaya, or in lakes Managua and Nicaragua - water bodies which are deemed potential water supply sources in the future. These practices are unstoppable at present and their continuous usage is, therefore, foreseen to adversely affect water quality and consequently public health.

b. Institutional System

Household wastewater management is a concern of INAA when it is discharged into the sewer system, and of MARENA because the contents of the sewers are discharged into rivers, lakes, etc. (under Decree No. 33-95). However, there are no hygienic alternatives for household wastewater not connected to the sewers. These households use the stormwater drains when they exist, or the streets and the ground to discharge used water.

One of the main concerns in household wastewater management is the charging of sewer collection services by volume of water supply. Households located in front of sewers are charged 30% of the water supply fee for sewage collection, even if they are not connected to the system. The total revenue from sewage collection services for 1996 is estimated at 36.6% of the total revenue from potable water supply.

Wastewater from septic tanks or from housing drains is discharged into natural or artificial stormwater drains. The municipalities are not authorized to control or prohibit irregular discharges, but with the help of MINSA/SILAIS, actions on municipal levels can be reinforced.

It is important to take into account that the responsibilities of INAA and the future ENACAL only cover sewage collection services, e.g., sewer drainage management, and do not include "on-site" treatment of wastewater, which should fall under the jurisdiction of MINSA/SILAIS and the municipal governments.

Meanwhile, the cost for sewage collection services is estimated to increase to 42.8% in 2000 and stabilize at 42.5% in the following years.

In 1995, 34.2% of the urban population were covered by the sewage collection services. This year, the operation of 20 sewage collection and treatment plants started in 20 cities throughout the nation. At present, INAA manages 148 water supply systems in 171 cities nationwide.

Table J-8: Management Indexed of INAA: Evolution

INDEXES		1990	1995	2002
a.	TOTAL POPULATION	3,512,235	4,139,486	5,213,385
b.	URBAN POPULATION	1,783,970	2,138,180	2,755,267
c.	RURAL POPULATION	1,728,265	2,001,306	2,458,118
d.	URBAN POPULATION SUPPLIED WITH WATER	1,320,582	1,725,582	2,341,977
e.	URBAN POPULATION SUPPLIED WITH SEWERS	553,300	730,415	1,102,415
f.	RURAL POPULATION SUPPLIED WITH WATER	311,080	560,366	1,108,362
g.	d./b. (%)	74.0	80.7	85.0
h.	e./b. (%)	31.0	34.2	40.0
i.	f./c. (%)	18.0	28.0	45.1
j.	PERCENTAGE OF POPULATION WITH WATER RATIONING	74.2	13.0	6.0
k.	PERCENTAGE OF SERVICE CONTINUITY	68.9	82.7	91.7
l.	PERCENTAGE OF CHLORINATED WATER	13.4	96.4	96.6

INDEXES		1990	1995	2002
m.	PERCENTAGE OF MACRO-MEASURING	13.9	77.5	88.5
n.	PERCENTAGE OF MICRO-MEASURING	30.8	62.1	77.7
o.	PERCENTAGE OF COLLECTED AND TREATED WASTEWATER	14.0	21.2	47.9
p.	EMPLOYEES / 1,000 CONNECTIONS	15.10	6.42	5.99
q.	PERCENTAGE COLLECTED / BILLED	75.0	96.0	100.0
r.	PERCENTAGE OF LONG TERM DEBTS / CAPITAL	0.0	54.0	57.0
s.	PAYMENT DELAY (MONTHS OF BILLING)	4.01	2.84	2.00

Source: INAA / PLANNING MANAGEMENT

J.1.4 Industrial Waste Management

a. Technical System

The discharge of industrial wastewater into rivers, lakes and streams is prohibited according to the Sanitary Code and the new acts, e.g., General Laws for the Conservation of the Environmental and Natural Resources (No.217-96), Decree No. 33-95. Industries must treat their effluents according to the standards stipulated in Decree No. 33-95.

Decree No. 33-95 authorizes INAA and MARENA to respectively manage, control and fine those who discharge IWW into the sewage systems, rivers, lakes, and streams. The decree also authorizes both government institutions to solicit the cooperation of municipal governments whenever necessary.

This decree establishes the wastewater quality standards to be discharged into rivers, lakes, streams, and the sewage system. Outflow with chemical constituents above the acceptable limits may be subject to the special conditions set by MARENA in cooperation with MINSA.

LAW No. 217-96 forbids the discharge of substances and residues that could contaminate water bodies or soil (refer to Article 113), and establishes that any discharge of wastewater should pass the inspection of the authority concerned (refer to Article 77). Decree No. 33-95 prohibits dilution of industrial effluents (refer to Article 8) but stipulates that wastewater from cooling towers, as well as stormwater and other "clean wastewaters" should be discharged into the stormwater drainage system (Article 7).

Presently, almost all industries in Nicaragua do not employ adequate wastewater treatment methods. Decree 33-95 enforces the formulation of a "gradual decontamination plan" to be implemented in two stages:

- first stage: to characterize and measure the flow rate of effluents.
- second stage: to study, design, implement, operate effluent treatment system.

b. Institutional System

Medium and large generators are solely responsible for the collection and disposal of their ISW; they dispose their ISW in the municipal disposal site. The ordinary municipal collection services do not include ISW; this may be collected by special services.

Law No. 217-96 stipulate that those who manage hazardous waste must know its properties (Art. 131). The next articles (132 and 133) prohibit the import and export of toxic substances and fix conditions to export toxic waste for disposal.

The responsible Authority must demand the treatment and safe disposal of residues from the mining industry (Art. 104).

Decree No. 33-95 establishes that sludge from treatment should be handled and disposed of according to MARENA's instructions.

J.1.5 Municipal SWM

a. Technical System

A technical system similar to a technical guideline regarding MSWM for the whole country was not found during the First Study Work in Nicaragua.

Meanwhile, a study on solid waste management in 41 municipalities (Study on the System of Garbage Collection and Treatment in 41 Municipalities of Nicaragua) was carried out under the supervision of INIFOM and was completed in August 1996. This study included the three cities (Leon, Chinandega and Granada).

According to this study, only 55% of waste generated in urban cites is under the collection services of municipalities at the national level. Besides the low waste collection coverage rate, present landfills are operated inappropriately as one of each three city stipulated in this chapter. Landfill site selection if done without an appropriate environmental impact assessment, and is often inadequate for a final disposal site.

b. Institutional System

Law No. 217-96, the responsibility of municipalities is fixed for collection/treatment/disposal system of non-hazardous solid waste, and for MARENA and MINSA their normative functions (Art. 129).

Law No. 40-88 also established the roles of municipalities for collection/disposal of MSW - but not the authority to penalize a violators. For this, municipal authorities have to work together with the assistance of MINSA, that have the competence.

The Municipal Tributary Plan includes a specific tax concerned with "waste and street sweeping" that should be charged where the service is done, and the beneficiary should pay at least 50% of the costs.

As a general rule, the service is very bad, the charges are lower than 50% of the costs (most municipalities do not know the costs), and few citizens pay the tax. It is common to fix different bases and percentages for residential, commercial, industrial and institutional generators.

J.1.6 Medical SWM

a. Technical System

The following are the technical systems for medical solid waste management in the whole country.

(1) No complete segregation of infectious/hazardous medical waste and domestic waste.

(2) "Code of Practice" on the treatment and disposal of infectious/hazardous wastes is not prepared yet.

(3) Although there was a program to install an incinerator for infectious/hazardous medical wastes in each principal municipality under the aid of EC in 1994, it has been canceled because of lack of agreement reached during discussions among the 5 Central American countries.

(4) Infectious /hazardous medical wastes are collected and disposed of at the municipal disposal site through the normal collection service without sufficient on-site segregation in many medical institutions

(5) The method of treatment and disposal for the infectious/hazardous waste is different among the medical institution.

(6) Final disposal is conducted either within the premises of medical institutions or municipal landfill site.

b. Institutional System

According to the Sanitary Code, MINSA is responsible for the enforcement of regulations concerning the disposal of solid waste from medical sources. Nonetheless, it has not established specific regulations. Public and private hospitals do not practice segregation or treatment of solid waste prior to disposal.

Law No. 217-96 does not refer to the disposal of medical waste, although it specifically assigns the municipality as the entity responsible for non hazardous waste collection and disposal (Article 129), and stipulates that it is the waste producers' responsibility to be aware of the kind of hazardous waste, including pathogenic waste, they discharge (Article 131).

There are no special services for the collection and disposal of medical solid waste. The municipalities of Leon, Chinandega and Granada collect and dispose these wastes along with domestic refuse. Hospitals and other medical institutions in these areas do not pay for special medical waste collection and disposal services.

Usually there are no special services for MSW, but they are subject to the above mentioned regulations for non-hazardous and hazardous SW, expressed in the Sanitary Code and Law No. 217-96.

The municipal services used to collect and dispose of MSW in dumping sites together with domestic refuse. Hospitals and public medical services do not have to pay for this service.

J.2 Present USE in Leon

J.2.1 Water Supply

a. Technical System

a.1 Service Coverage

The report on "Performance Indicators" in April 1996 indicates that the population with a water supply service in the urban area of Leon is estimated at 114,199 out of the estimated total of 123,865.

Table J-9: Service Coverage (April 1996)

	Household	Population (persons)	Area (km^2)
Total Number	21,906	123,865	19.1
Water Supplied	20,198	114,199	14.4
Service Coverage (%)	92.2	92.2	75.4

Source: INAA

a.2 Supply Indicators

a.2.1 Water Unaccounted for (1991 to 1995)

Unaccounted for Water (UFW) represents the difference between the measured amount of water produced (production) and the metered amount of water used (consumption). It refers to: (i) loss from leakage in service reservoirs, distribution pipelines, house connections, valves, hydrants, etc.; (ii) unauthorized use from hydrants or by illegal connections; (iii) nonmetered public use for fire fighting, street washing, construction, public buildings, etc.; (iv) meter failures, underread user meters, failure to read meters; and (v) nonmetered residential or commercial use.

The UFW ratio in 1995 was close to 42%. However, data for the last five years show a decrease in the UFW ratio in Leon. An increase in metered water supply connections has also been observed.

Table J-10: Potable Water Production and Consumption

Year	Production (m^3/year)	Consumption (m^3/year)	UFW (m^3/year)	UFW ratio (%)	Household Connections		
					with meter	without meter	Total
1991	11,588,745	6,025,553	5,563,192	48	10,396	5,484 (35%)	15,880
1992	11,176,690	6,199,830	4,976,860	45	9,936	6,415 (39%)	16,351
1993	10,960,436	5,924,753	5,035,683	46	10,926	6,610 (38%)	17,536
1994	10,932,957	5,894,270	5,038,687	46	12,058	6,731 (36%)	18,789
1995	10,599,899	6,185,190	4,414,709	42	13,079	6,412 (33%)	19,491
1996	-	-	-	-	13,657	6,082 (31%)	19,739

Source: INAA - Planning Management (July 1996)

a.2.2 Type of Connection

The number of connections in the urban area of Leon currently totals 20,198 (1996), over 90% of which are for household use.

Table J-11: Type of Connection (July 1996)

Type of Connection	Quantity	Ratio (%)
Household	19,069	94.4
Industrial	625	3.2
Commercial	292	1.5
Multi-family	163	0.8
Communal Tap	24	0.1
Government	25	0.1
Total	20,198	100.0

Source: INAA - Region II (July 1996)

a.2.3 Water Production and Consumption

i. Water Consumption Rate

Water production and consumption rates from 1991 to 1995 are tabulated in Table J-12.

Table J-12: Water Production and Consumption Rate

	Production (m^3/year)	Consumption (m^3/year)	Service Population		Rate (l/person/day)	
			No. of Households	No. of Persons	Production	Consumption
1991	11,588,745	6,025,553	15,880	95,280	333.2	173.3
1992	11,176,690	6,199,830	16,350	98,100	312.1	173.1
1993	10,960,436	5,924,753	17,356	105,216	285.4	154.3
1994	10,932,957	5,894,270	18,789	112,734	265.7	143.2
1995	10,599,899	6,185,190	20,198	114,199	254.3	148.1

The current average water consumption is 148 l/person/day (UFW not included). This is close to the standard value of 160 l/person/day proposed by INAA in the Pre-feasibility Study for cities with a population exceeding 50,000.

ii. Coefficient for Yearly Fluctuation

Based on the previous year's monthly production data, it is deemed reasonable to apply a coefficient of 1.25 (i.e., 25% increase in the peak) to cope with annual fluctuations.

iii. Coefficient for Daily Fluctuation

Based on the data obtained from the study on the Leon stabilization lagoons conducted by BID/INAA in June 1994 (Annex 2 of the report), a coefficient equivalent to 1.70 (i.e., 70% increase in the peak) should be applied to cope with daily fluctuations is deemed necessary.

a.3 Organizational Structure of the INAA Branch in Leon

The INAA office in Leon has a total of eighty two (82) employees assigned to the following positions:

Chief	1
Janitor	1
Secretary	1
Cashiers	2
Zone analysts	3
Collection analysts	4
Claim response technician	1
Collectors	17
Meter readers	6
in charge of commercial	1
in charge of claims	1
in charge of collection	1
Accountants	2
Plumbers	4
Plumbing assistants	5
Laborers	6
in charge of streets	1
Inspectors	2
Drivers	2
Pump operators	16
Pumping equipment operators A.N.	4
Technical officer	1
Other	1
Total	**82**

Also extra personnel is hired when work demand is high.

The current number of water supply connections is 20,198, and more than 4 employees are assigned per one thousand connections.

a.4 Supply Sources

The present water supply source for Leon is the aquifer found in the alluvial and volcanic deposits.

The underground water deposits found in Leon are the most valuable nationwide, as they possess high specific yield and transmissivity and shallow static water level: characteristics that stimulate remarkably high well water production and low water extraction costs.

The water supply network of Leon City is fed by eight borehole wells. Three of these are in the San Felipe well field (San Felipe 1, 2 and 3 wells) close to Barrio San Felipe, which is in the northern part of the city; these wells are constructed at an interval of 100 - 250 meters. Wells in Ermita and San Carlos, which are also in the northern part of the city, are constructed at intervals of 300 meters. Two wells are also constructed in Las Pilas and in Los Tanques, which are situated in the Posada del Sol area in the northeast periphery of the city. The last well is the Ruben Dario well, located in the southeast part of the city toward Las Delicias.

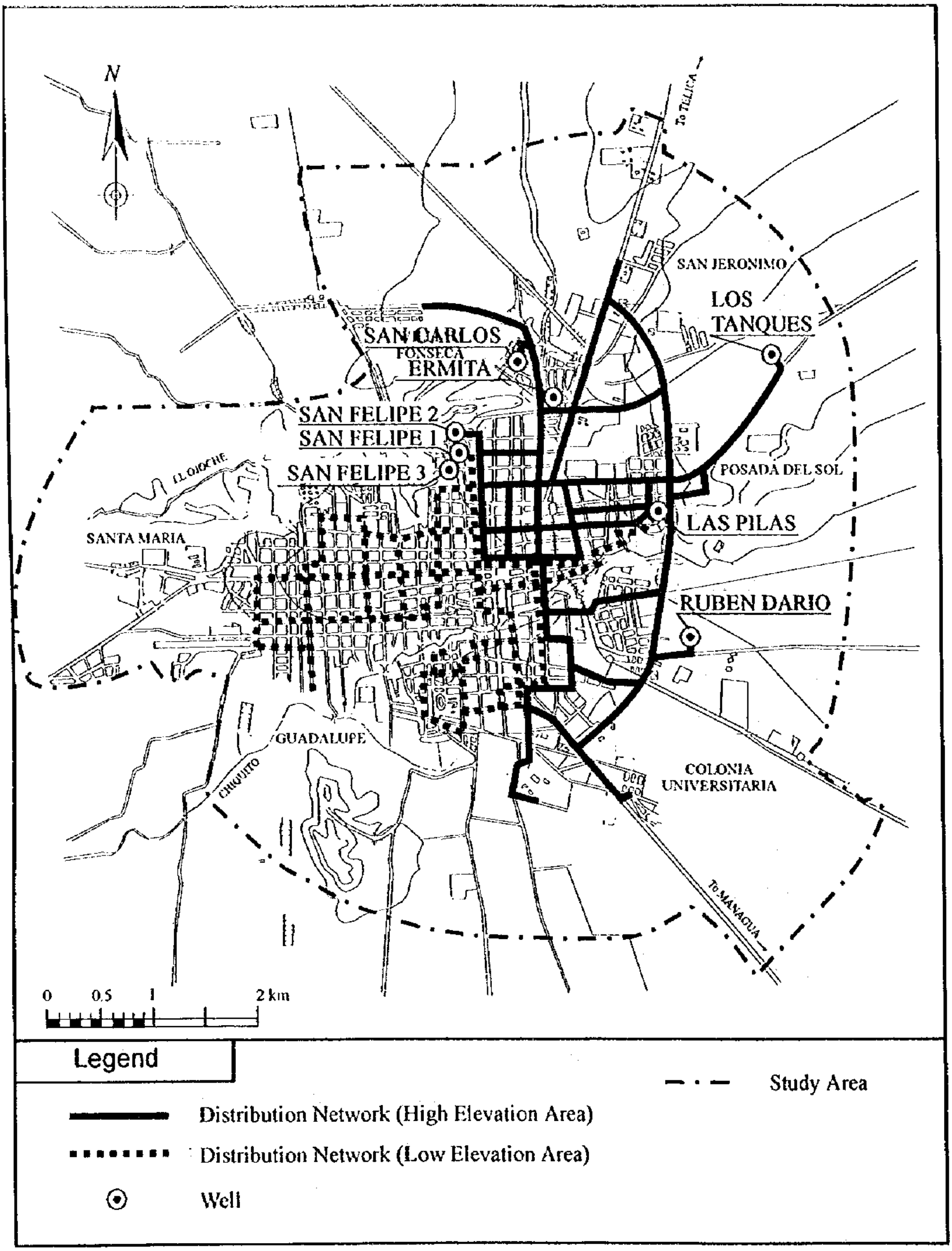

Figure J-1: Location of Existing Wells

The general characteristics of the wells, e.g. nominal pumping capacity, installation year, motor power, actual pump operation hours, are presented in the following table.

Table J-13: Characteristics of Existing Wells

Description	Capacity (l/sec.)	Installation Year	Power (Hp)	Operation Time (hours/day)
San Felipe I	73	1974	100	12
San Felipe II	56	1974	25	16
San Felipe III	70	1975	150	16
Ermita	41	1976	125	18
San Carlos	64	1974	150	16
Pila de Agua	84	1972	100	14
Los Tanques	32	1988	125	19
Ruben Dario	82	1993	150	15
Total	502	-	-	-

Source: INAA - Region II (July 1996)

The production of each existing deep well varies by operation hour. The following table details the monthly production and the pumping hours of each well.

Table J-14: Data on Existing Wells in 1996

Name	Data		January	February	March	April	May	June
San Felipe I	Production	m^3	132,691	117,451	123,495	107,204	40,365	89,018
	Pumping	hr.	505	447	470	408	276	353
San Felipe II	Production	m^3	76,201	74,597	87,832	91,842	78,006	79,410
	Pumping	hr.	380	372	438	458	389	396
San Felipe III	Production	m^3	94,857	107,656	128,966	131,997	58,013	128,735
	Pumping	hr.	378	429	514	626	262	513
Ermita	Production	m^3	0	0	0	21,060	116,291	9,653
	Pumping	hr.	0	0	0	144	507	66
San Carlos	Production	m^3	88,996	103,676	120,420	120,649	116,291	116,520
	Pumping	hr.	366	452	525	526	507	508
Pila de Agua	Production	m^3	136,429	123,953	136,017	165,874	171,604	148,382
	Pumping	hr.	459	411	451	660	569	492
Los Tanques	Production	m^3	63,588	66,654	72,786	61,885	70,060	62,339
	Pumping	hr.	560	587	641	545	617	549
Ruben Dario	Production	m^3	160,770	183,785	196,673	193,614	171,387	130.611
	Pumping	hr.	562	567	616	612	553	431
Total	Production	m^3	853,203	849,781	946,977	953,586	838,116	791,017
	Pumping	hr.	3,604	3,610	4,040	4,083	3,716	3,427

Source: INAA - Region II (July 1996)

Meanwhile, a 24 hour pumping operation would produce a maximum of 43,372 m^3/day (502 liters/sec). The eight wells, operated according to the times shown in the table above, were observed to have an average daily flow of 28,751 m^3/day (66.3% of maximum capacity) from January to June 1996.

A large number of wells are not equipped with flux measuring gauges, therefore the water production values indicated in the table above are rough estimates.

a.5 Water Quality

a.5.1 Well Water Quality

With respect to the water quality of the wells in Leon, references are from the report "Diagnosis of the Present Wells of Potable Water Supply in Leon City (November 1993)" and the results of the chemical and physical analysis made by the Department of Water Quality of INAA.

The well in Subtiava has recently been closed because the water was found to contain nitrate concentrations higher than the permissible level.

In terms of potability, the groundwater in Leon City may be considered of good quality.

The table below shows the values derived from the last analysis made by INAA on November 2, 1995.

Table J-15: Current Well Water Quality

Item	Unit	San Felipe I	San Felipe II	San Felipe III	Ermita	San Carlos	Pila de Agua	Los Tanques	Ruben Dario	INAA[1] Maximum Limits
Sampling date	-	10/08/94	10/08/94	10/08/94	10/08/94	10/08/94	10/08/94	10/08/94	10/08/94	
Climate	-	clear	clear	clear	clear	clear	clear	clear	clear	
Temperature	°C	29.5	29.0	29.5	29.0	29.0	29.5	29.5	-	18 - 30
Color	-	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	3.0	15
Turbidity	-	0.3	0.5	0.4	0.4	0.4	3.0	0.4	0.3	5
Dissolved Solids	mg/l	259	229	270	214	199	189	211	144	1,000
Conductivity	s/cm	300	300	300	290	260	220	260	280	400
pH	-	7.1	7.1	7.4	8.1	7.5	7.8	7.5	7.6	6.5 - 8.5
Total Hardness	mg/l	104	104	116	96	104	88	120	100	500
Alkalinity	mg/l	114	114	114	101	106	97	106	112	-
Calcium	mg/l	29	22	26	22	21	19	24	19	250
Magnesium	mg/l	7.8	12	2.7	9.8	13	9.8	15	13	50
Total Iron	mg/l	0.05	0.19	0.13	4.08	0.09	0.03	0.42	0.10	0.3
Sodium	mg/l	-	-	-	-	-	-	-	20.0	200
Bicarbonates	mg/l	140	140	140	124	129	118	129	137	-
Carbonates	mg/l	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-
Chloride	mg/l	18	13	20	15	15	13	9.2	15.0	250
Sulfates	mg/l	4.0	3.0	5.0	4.0	3.0	2.0	4.0	2.0	250
Nitrates	mg/l	30	18	38	18	5.0	10	21	8.1	50
Nitrites	mg/l	0.04	0.00	0.01	0.00	0.00	0.02	0.03	0.00	Tr
Fluoride	mg/l	0.27	0.26	0.35	0.28	0.18	0.23	0.27	0.72	0.7 - 1.5
Saturation Index	adm	-0.87	-0.98	-0.62	-0.04	-0.65	-0.42	-0.59	-0.64	-

Source: INAA - (July 1996)

The groundwater sources of the deep wells in Leon are considered slightly alkaline, and the pH is observed to be within the INAA's maximum limit (6.5 to 8.5) at 7.1 to 8.1. These conditions are thought to induce scales forming on the wells.

[1] Estudio de Priorizacion de Inversiones en el Sector de Agua Potable y Alcantarillado Sanitario Volumen I, Marzo, 1996 (INAA/ITS/LOTTI/LAMSA)

The chloride, sulfate, carbonate, calcium and magnesium concentrations in the groundwater sources of these wells are found to be far below the INAA's maximum limit. The concentration of dissolved solids is found to range between 144 mg/l and 270 mg/l, averaging 214 mg/l.

The nitrate values fluctuate between 5 mg/l and 38 mg/l, which are below the maximum limit of 50 mg/l.

The San Felipe number III well was found to contain high nitrates concentrations (38 mg/l), although the value is still lower than the maximum limit of 50 mg/l. However, INAA should be concerned about the recent increase in nitrate concentration.

The oxides of nitrogen found in some of the groundwater sources in Leon presumably originate from chemical effluents, e.g., fertilizers. It is very important to closely monitor the water quality of the wells (I, II, III) in San Felipe in anticipation of increment in nitrate concentration.

a.5.2 Chlorine Consumption

The amount of chlorine in the water supplied to the city of Leon depends on the residual chlorine in the distribution network: residual chlorine shall be kept to a minimum of 0.5 mg/l. The monitoring of residual chlorine in Leon is monitored weekly at 15 (fifteen) points within the distribution network.

Table J-16: Chlorine Consumption in Leon

Months year 1996	Hypochlorite (kg)	Gas chlorine (kg)
January	160	816
February	160	952
March	180	102
April	180	816
Total	680	2,686
Monthly Average	170	861*

Source: INAA - Region II (July 1996) (* the month of March is excluded from the calculation because chlorine distribution is abnormal.)

a.6 Water Transmission

The system does not have independent transmission pipelines connecting the wells to storage tanks. Only the Los Tanques and Pila de Agua wells are capable of directly transmitting water to the reservoirs. The rest of the wells are directly connected to the distribution network and cannot independently transmit water through to the reservoirs.

There are transmission pipelines that may be characterized as sub-transmission pipelines as they are connected to the storage tanks of "Los Tanques", which are used to distribute water to the Upper Zone Nr. 2. The pipelines are approximately 1.3 km long and made up of 450 mm asbestos cement pipelines and 500 mm PVC pipelines.

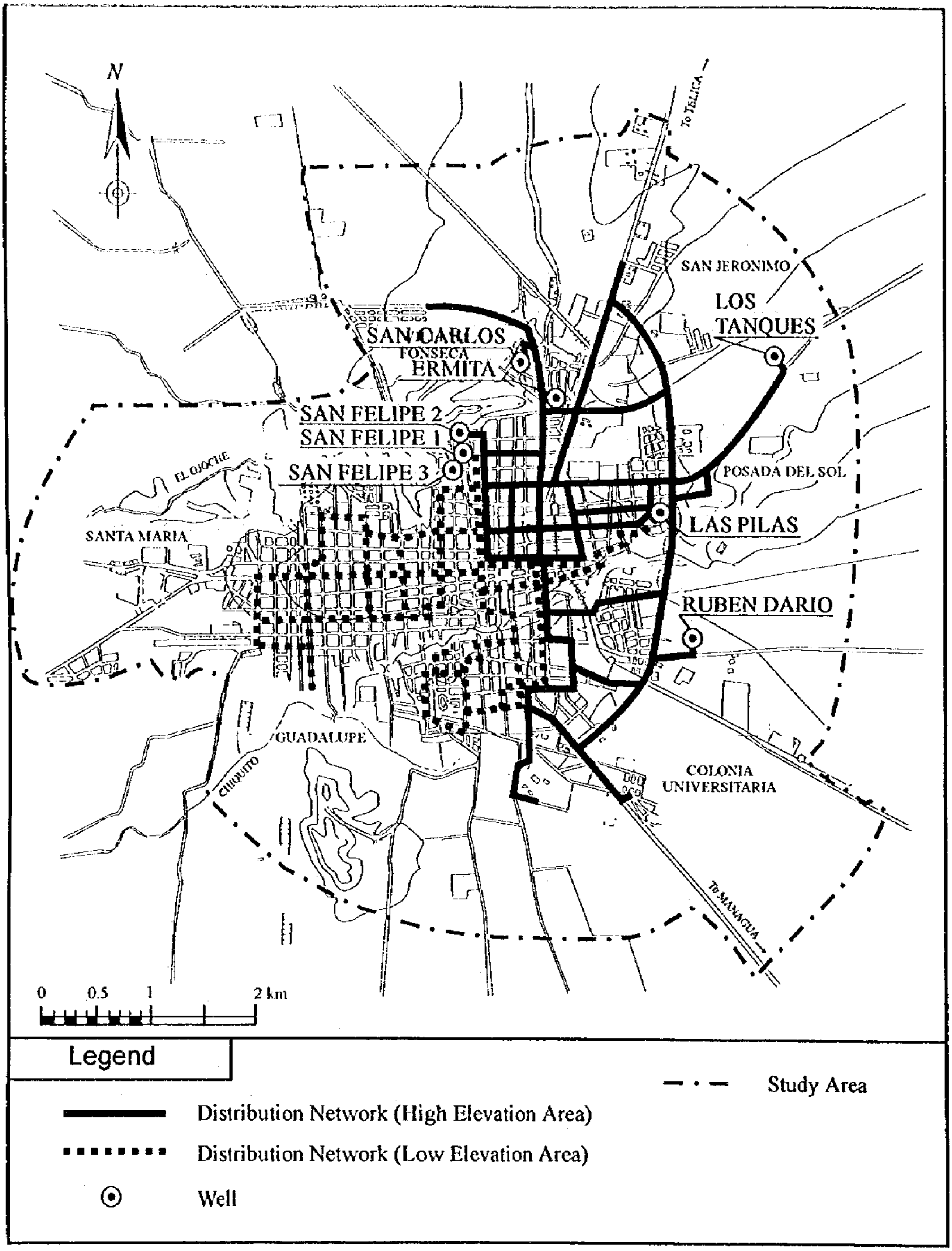

Figure J-2: Present Water Supply and Distribution System

a.7 Storage

According to the "Criteria for the Preliminary Design of Drinking Water Systems" employed by INAA, storage tanks are necessary for the following reasons.

- To compensate for the difference between instant public demand and actual production.
- To ensure minimal contact time, no less than 20 minutes, for chlorination.
- To provide water in case of interruption of services.
- To provide water for emergency use (in case of fire).

Water is currently stored in two identical steel tanks and one concrete tank. The two steel tanks are located on the same site northwest of the city.

The largest tank (Las Pilas) is made of concrete and built above ground. It can only store up to 2 meters of water but it has a width of 20m x 82.5m.

The elevation of this tank supposedly blocks water pressure from building up during peak demands. INAA is believed to replace some of the pipes to ease water flow.

The existing tanks can store water from the pumping wells but not all of the tanks are connected to the distribution network. However, this is compensated by the fact that several wells are directly connected to the network and not to the reservoirs. On the other hand, there are no reservoirs solely constructed for the distribution of water to the water supply system.

This situation is not a problem because the current flow capacity of the wells is enough to cover the deficiency in storage capacity. This is not however an ideal situation from a hydraulic viewpoint, because the hydraulic pressure in the distribution network significantly varies, straining the pumps of the wells.

The INAA Pre-feasibility Study Report states that the reservoirs do not receive water directly from the wells, and that they initially convey water to the network.

Table J-17: General Data on Existing Storage Tanks

Tank Name	Capacity (m^3)	Max. Elev. (m)	Bottom Elev. (m)	Diameter (m)	Height (m)
Los Tanques Uno	2,840	146.15	128.90	14.50	17.25
Los Tanques Dos	2,840	146.15	128.90	14.50	17.25
Las Pilas	3,320	116.25	114.25	20 x 82.5	2.00
Total	9,000	-	-	-	-

Source: INAA - Region II (July 1996)

There is a plan to build an additional reservoir with a storage capacity of 2,650 m^3 adjacent to the "Los Tanques" area.

a.8 Distribution Net

The distribution network in Leon City has a total of 193.34 km pipelines. More than 70% of the total length is made up of pipelines with a diameter of 100 mm or less.

The system consists of four types of piping materials: PVC, cast iron, asbestos cement and galvanized iron.

The water pressure in the distribution net is generally acceptable. However, water pressure is not very strong in the elevated parts of the network, and is usually below the required minimal head of 15m because storage tanks are constructed in areas with a lower elevation.

As a countermeasure and as a part of the drinking water supply system rehabilitation project, INAA is currently changing the pipe diameters at several points of the network.

The current structure of the distribution network is shown in the following table.

Table J-18: Distribution Network Structure

Diameter (mm)	PVC (m)	Cast iron (m)	Asbestos Cement (m)	Galvanized Iron (m)	Total (m)	Ratio (%)
50	82,050	-	-	-	82,050	42.43
75	7,580	1,830	12,880	850	23,140	11.97
100	11,740	1,900	21,510	230	35,380	18.30
150	3,080	900	14,770	-	18,750	9.70
200	-	1,550	9,970	-	11,520	5.96
250	-	-	5,360	-	5,360	2.77
300	320	-	8,180	-	8,500	4.40
350	-	-	6,720	-	6,720	3.48
400	-	-	600	-	600	0.31
450	-	-	1,320	-	1,320	0.68
Total	104,770	6,180	81,310	1,080	193,340	100.00
Ratio (%)	54.19	3.20	42.05	0.56	100.00	-

Source: INAA - Region II (July 1996)

b. Institutional System

The service is performed by INAA - Region II - Leon Branch that allocates 82 people for water supply and wastewater services.

During 1995, the city was supplied with 10,566,783 m^3 of water, and 5,698,555 m^3 (53,9%) of wastewater has been treated.

Table J-19: Economic Data on Water Supply and Sewage for Leon in 1995

Unit: C$ 1,000

Income/Expenditure	Water	Sewage	Total
Operational Incomes	15,244	2,682	17,926
Operational Expenditures	7,470	407	7,877
Total Incomes	-	-	17,927
Total Expenditures (depreciation included)	-	-	10,173
Results	-	-	7,753

Source: INAA/General Accounting System

J.2.2 Storm Water Control

a. Technical System

a.1 General Conditions

The annual precipitation for the past 20 years averages about 1,220mm, although data in this period fluctuated considerably, as mentioned in Chapter 1. The highest rain intensity for the past 20 years was 82.6mm/hr in 1981. The ten year (1/10 year) probable rainfall intensity was 75.0mm/hr, and the five year (1/5 year) probable rainfall intensity was 66.1mm/hr[2]. The rainfall data is attached to Chapter 5 of Data Book in Volume V.

There are no authorities responsible for planning storm water management. The Street Maintenance Department, however, is in charge of the construction and maintenance of storm water drains, while the Emergency Operation Center is in charge of disaster relief.

The Street Maintenance Department is responsible for the construction and maintenance of storm water drains because it is mainly in charge of the road network. Although the municipality is supposed to be responsible for storm water drainage control according to LAW on Municipalities No.40-88, it is trying to talk INAA into taking over the responsibility, since INAA is currently responsible for wastewater drainage control. Because storm water usually mixes with wastewater and vice versa, the municipality believes INAA should be responsible for storm water drainage as well.

a.2 Inundation Damage

a.2.1 Questionnaire Survey on Inundation Damage

A questionnaire survey was conducted on 56 families, two from each of the area the municipalities thought were most prone to inundation, as mentioned in Annex I in Volume IV, 'Inundation Damage Survey'.

This section shall only elaborate on the results of the survey conducted in Leon City.

The total number of inundation prone areas in Leon was 15, therefore, the total number of interviewed families was 30. These areas are shown in Annex I in Volume IV.

Results of the Survey

The results of the survey are shown in Annex I in Volume IV.

Of the 30 interviewees, 28 (93%, 28/30) have had inundation damages, and all suffered from it more than twice a year.

Depth of inundation varies from 5cm to 50cm. Sixteen (16) interviewees (57%, 16/28) answered that inundation continues from 1 to 3 hours, 8 interviewees (29%, 8/28) stated 3 to 6 hours.

All 28 of the interviewees answered that their houses have been damaged by inundation, but the number who reported damage to household goods only totaled 4 (14%, 4/28).

Nine (9) interviewees (32%, 9/28) answered that they have suffered from diseases, mainly cold, malaria and dengue fever, caused by inundation.

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[2] INITER

None of the interviewed families' business suffered from inundation. Twenty four (24) interviewees (86%, 24/28) reported a loss worth C$ 0-500.

a.2.2 Public Opinion Survey on Inundation Damage

The Public Opinion Survey (POS) was carried out at random and did not only cover inundation prone areas. According to the results of the survey, 25% of the interviewees answered that inundation significantly affected their daily life, while 19% have experienced flood damage.

b. Institutional System

Although considering drainage as an INAA duty, the street Maintenance Department (under Projects and Foreign Cooperation Division) do the drainage system maintenance.

That Division has planned a drainage system, and is building it slowly, together with the paving of streets.

The control of irregular discharges into the pluvial drains should be done by INAA.

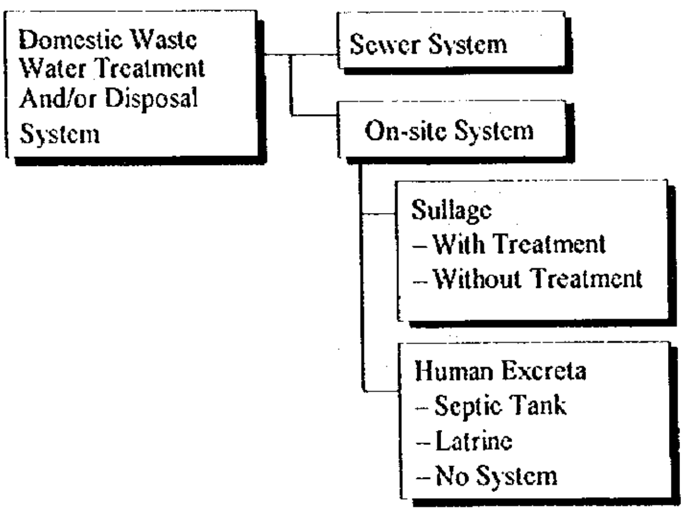
The possibility to draw up a cadastre and locate graphically the whole pluvial drainage system should be considered through the SISCAT managed by the Urban Planning and Control Division.

J.2.3 Domestic Waste Water Management

a. Technical System

a.1 Outline of Technical System

The present DWW treatment and/or disposal system consists of a sewer system and an on-site system. However, some areas are not covered by any system at all. The on-site system is generally made up of a septic tank and latrine.



Source: INAA- Region II

Figure J-3: Outline of Technical System

a.2 Sewer System

a.2.1 Service Coverage

The sewer system currently covers 58.6% of Leon City, and 61.4% of the total number of households covered by the potable water supply services are connected to the sewer system.

Table J-20: Service Coverage (1995)

	Household			Population (persons)		
	Number	Ratio (%)		Number	Ratio (%)	
Total Number	21,906	100		123,865	100	
Water Supplied	20,198	92.2	100	114,199	92.2	100
Sewer Connection	12,117	55.3	60.0	68,510	55.3	60.0

Source: INAA

a.2.2 Sewage Drainage Basin

The current system has two principal sewage drainage basins, and the first one covers the Leon downtown area, specifically the area between the Chiquito and Pochote rivers. The second is the entire area south of the Chiquito River toward the stabilization lagoons of El Cocal.

A pumping station was installed at Colonia 23 de Julio, located northeast of the city, to convey residual water to the sewage collector which transmits wastewater by gravity to the treatment site in El Cocal.

The third basin is at the end of the Pochote River, but this basin is currently not connected to the sewer system.

Table J-21: General Data on Sewage Drainage Basin

Item	SUBTIAVA	EL COCAL	Total
Population (persons)			
Total Basin Population	-	-	124,117*
Connected to sewers	49,592	18,918	68,510**
Number of Households			
Total No. of Households in the Basin	-	-	21,345
Connected to sewers	8,771	3,346	12,117
Approximate Basin Area (ha)	582	363	945
Waste Water Amount (m^3/day)	11,300*	4,200**	17,715

Note: * National Census (INEC), **Comment from INAA for PR (1)

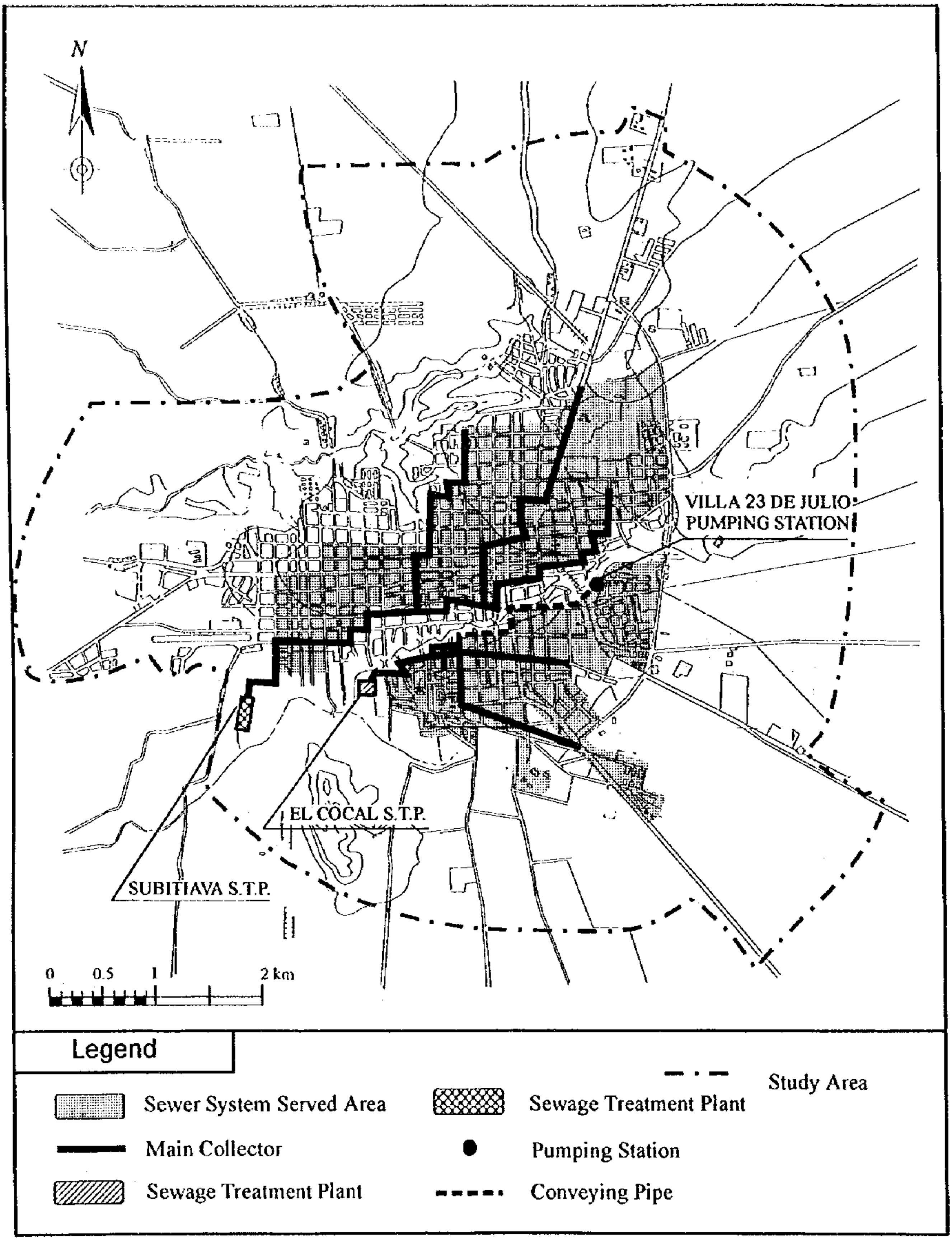


Figure J-4: Sewage Drainage Basin

a.2.3 Sewage Collection Systems

The sewage collection system in Leon comprises of a 49,140m sewer network and a pump station.

i. Sewer Network

The sewer system in Leon covers approximately 60% of the total urban area. The northwest sector of the city lacks a sewer system.

The system covers two specific zones: the central zone and the southern zone of the Chiquito River.

The total length of the existing sewer system for an estimated total street length of 203,500 m is 49,140 m, of which 34,320 m is installed in the central zone and 14,820 m in the southern zone of the Chiquito River. Sewers cover 24.1% of the total street length.

There sewer diameters ranging from 250 and 375 mm installed southward in the center of the city. The principal sewer is 600 mm in diameter and transports wastewater to the treatment site in Subtiava.

The discharge from Colonia 23 de Julio flows to conveyed by the sewers to a pumping station. Subsequently, wastewater is routed to the principal sewer through a 300 mm pipeline. The principal sewer in the southern zone of the Chiquito River transports wastewater from this area by gravity to the Cocal treatment site.

Table J-22: Length of Sewer Network in Leon

Diameter (mm)	Zone I (Central Zone) Subtiava (m)	Zone II (South Zone of Rio Chiquito) El Cocal (m)	Total (m)
150	900	-	900
200	22,530	10,170	32,900
250	2,520	1,900	4,420
300	3,020	2,050	5,070
375	2,410	150	2,560
525	1,140	550	1,690
600	1,800	-	1,800
Total	34,320	14,820	49,140

Source: INAA - Region II (July 1996)

It is reported that there is a high number of illegal storm water drain connections to the sewer system. These storm water drainage originate from households or streets and reduce the hydraulic capacity of the sewer network.

ii. Pumping Station

The report on specific studies on stabilization lagoons conducted by BID/INAA in October 1993 presents data and information on the pumping station in Villa 23 de Julio. According to the report the system has only one wastewater pumping station, which is located in Villa 23 de Julio. It is exactly at the end of the Río Chiquito bridge that unites Villa 23 de Julio with the southwestern part of Barrio El Calvario.

The pumping station comprises an inlet box, suction pit and submersible pumping equipment. The specifications of this pumping station are shown in Table J-23.

Table J-23: Specifications of the Villa 23 de Julio Pumping Station

General Information	
Location	Villa 23 de Julio
Construction Year	1973
Catchment area (ha)	60.52
Technical Specifications	
Inlet Box Main Structure Size Screen	 Reinforced concrete 1.80m ^{L} x 1.27 m ^{W} x 1.07 m ^{H} 1.45m x 1.00m x Pitch 25 m/m, Steel bar
Suction Pit Main Structure Size Effective Volume	 Reinforced concrete 3.53m ^{L} x 2.18m ^{W} x 2.95m ^{H} 16.0 m^3
Pumping Equipment Number of Pumps Type Capacity Power	 2 Submersible (LG 104 150) NA Electric motor 10^{HP} x 1,750 ^{rpm}
Daily Operation Hours	14

Source: INAA - Leon

a.2.4 Sewage Treatment

Two independent stabilization lagoons of the facultative type are used to treat wastewaters discharged in the Leon sewer system. These lagoons are the Subtiava and El Cocal lagoons, both located in the southern part of the city. The outflow of these lagoons is directed toward the Chiquito River. The characteristics of each treatment lagoon are presented below.

i. Stabilization Lagoon in Subtiava

The stabilization lagoon in Subtiava is facultative and receives around 70% of the flow from the sewer system in Leon. The principal characteristics of the lagoon are tabulated in Table J-24.

Table J-24: Characteristics of Subtiava Lagoon

Type of Lagoon	Facultative
Length x Width x Depth (m)	244.65 x 103.65 x 2.31
Average Shallow Area (m^2)	27,643
Average Water Volume (m^3)	63,854
Design Treatment Capacity (m^3/day)	13,700
Design Intake Water Quality (mg/l)	BOD: 300, E coli: 3 x 10^7 NMP/100ml
Design Treated Water Quality (mg/l)	BOD: 30, E coli: 5 x 10^5 NMP/100ml

INAA analyzed residual water in the plant on July 9, 1996, and the results are shown in the following table.

Table J-25: Data on Subtiava Lagoon

Parameters	Unit	General Intake	General Outlet	River Water		Discharge Limit	For Irrigation
				Upper*	Lower*		
No. of the Report	-	1/96	1/96	1/96	1/96		
Sampling Date	-	7/9/96	7/9/96	7/9/96	7/9/96		
Average Flow	l/s	143.6	138	-	-		
Ambient Temperature	°C	27.7	27.7	31	31		
Water Temperature	°C	29.0	30.4	31.5	31.5		
pH	-	7.1	7.3	7.5	7.2	6 -9	6.5 - 8.5
Dissolved Oxygen	mg/l	0.0	1.9	0.0	1.6	1.0	
Settleable Solids	mg/l	11.8	0.2	0.1	0.1		
Total Solids	mg/l	992	650	832	654		120
BOD	mg/l	320	140	160	140	90	120
COD	mg/l	568.6	235.3	431.4	333.3	180	200
Alkalinity	mg/l	257.3	226.4	247	237		
Nitrites	mg/l	0.1	0.2	2	1.5		
Nitrates	mg/l	10.4	3.0	6.0	6.0		
Phosphates	mg/l	49	27	51	44		
Fixed Solids	mg/l	470	368	424	296		
Volatile Solids	mg/l	522	282	408	358		
Dissolved Solids	mg/l	656	564	720	550		
Suspended Solids	mg/l	336	86	112	104	80	
Fecal Coliforms	NMP/100ml	$3x10^7$	$5x10^6$	$1.3x10^7$	$1.3x10^7$	$1x10^4$	1,000

Upper *: Upstream of treatment plant outlet
Lower*: Downstream of treatment plant outlet
Source: INAA - Management of Technical Standardization (July 1996)

The BOD, COD, and suspended solids' concentrations in the discharge of Subtiava Lagoon do not comply with the stipulated limits for each of the items. However, the effluent does not adversely affect the water quality of the recipient river. Instead it dilutes river water quality which is usually worse than the effluent, and consequently improves the quality of river water downstream.

ii. Stabilization Lagoons in El Cocal

The Treatment Plant in El Cocal consists of two lagoons of the facultative type. These lagoons receive about 30% of the sewage from Leon City.

The lagoons are identical in dimension and their principal characteristics are shown in Table J-26.

Table J-26: Characteristics of the El Cocal Lagoons

Type of Lagoon	Facultative
Dimensions (m)	139.8 x 59.8 x 1.8
Number of Lagoons	2
Average Shallow Area (m^2)	9,552
Average Water Volume (m^3/lagoon)	17,193 X 2 = 34,387
Design Treatment Capacity (m^3/day)	6,000
Design Intake Water Quality (mg/l)	BOD: 300, E coli: 2 x 107 NMP/100ml

INAA analyzed the residual waters in the plant on July 9, 1996, and the results are shown in the following table.

Table J-27: Data on the El Cocal Lagoons

Parameters	Unit	Lagoon I		Lagoon II		Discharge Limit	For Irrigation
		Intake	Outlet	Intake	Outlet		
No. of the report	-	051/96	052/96	053/96	054/96		
Sampling Date	-	5/8/96	5/8/96	5/8/96	5/8/96		
Average Flow	l/s	31.65	16.87	29.78	17.5		
Air Temperature	°C	33.5	33.5	33.5	33.5		
Water Temperature	°C	30.13	31.88	30.38	31.88		
pH	-	7.0	7.15	7.0	7.16	6 -9	6.5 - 8.5
Dissolved Oxygen	mg/l	0.3	4.71	0.3	5.3		
Settleable Solids	mg/l	5.0	0.5	5.0	0.5	1.0	
Total Solids	mg/l	686	606	680	606		120
BOD	mg/l	340	80	340	84	90	120
COD	mg/l	496	232	496	224	180	200
Alkalinity	mg/l	267	267	287	287		
Nitrites	mg/l	0.1	0.1	0.1	0.1		
Nitrates	mg/l	6.0	8.9	6.0	7.4		
Phosphates	mg/l	42.6	34.9	42.5	28.5		
Fixed Solids	mg/l	306	272	304	274		
Volatile Solids	mg/l	380	334	376	332		
Dissolved Solids	mg/l	448	424	466	442		
Suspended Solids	mg/l	238	182	214	164	80	
Fecal Coliforms	NMP/100ml	$3x10^8$	$1.7x10^7$	$1.7x10^8$	$2.4x10^7$	$1x10^4$	1,000

Source: INAA - Management of Technical Standardization (July 1996)

Data on the water quality of the Chiquito River is also presented in the report referred above. The quality of the water at the upstream and downstream effluent outlets of the lagoons are presented in the following table.

Table J-28: Water Quality of Chiquito River

Parameters	Unit	Upper*	Lower*	Discharge Limit	For Irrigation
No. of the Report	-	055/96	056/96		
Sampling Date	-	May/08/96	May/08/96		
Average Flow	l/s	-	-		
Air Temperature	°C	34.0	34.0		
Water Temperature	°C	35.0	34.5		
pH	ud	7.0	7.0	6 -9	6.5 - 8.5
Dissolved Oxygen	mg/l	0.4	1.0		
Settleable Solids	mg/l	3.0	4.0	1.0	
Total Solids	mg/l	828	814	80	120
BOD	mg/l	100	120	90	120
COD	mg/l	216	232	180	200
Alkalinity	mg/l	328	328		
Nitrites	mg/l	0.1	0.1		
Nitrates	mg/l	1.5	6.0		
Phosphates	mg/l	16.7	26.2		
Fixed Solids	mg/l	566	516		
Volatile Solids	mg/l	262	298		
Dissolved Solids	mg/l	644	604		
Suspended Solids	mg/l	184	210	80	
Fecal Coliforms	NMP/100ml	1.6×10^8	2.8×10^7	1×10^4	1,000

Upper *: Upstream of treatment plant outlet
Lower*: Downstream of treatment plant outlet
Source: INAA - Management of Technical Standardization (July 1996)

The COD and suspended solid concentrations in the discharge of the El Cocal lagoons do not comply with the stipulated limits. Significant amounts of algae in the effluent may be attributed to these concentrations. When comparing the water quality in the upstream and downstream outlets, an increase in the levels of BOD, COD, phosphorous, nitrogen and volatile solids was observed downstream.

Consequently, a decrease in the concentrations of microorganisms in the river was observed prior to the discharge of effluent from the lagoons.

iii. Water and BOD Balance

The water and BOD balance in 1995 were projected based on available data and assumptions for relative indicators listed in Table J-29. Figure J-5 shows the water balance and BOD balance.

Table J-29: Available Data and Assumptions for Water Balance and BOD Balance Estimation

Item	unit	Amount	Remarks
Population			
a. Water Supply Service Population	persons	114,199	
b. Connected to Sewers	persons	68,510	
Water Production			
c. Annual Production	m^3/year	10,599,899	1995
d. Daily Production	m^3/day	29,041	c./365
e. Water Production Ratio	l /p/d	254.3	d./a.
Water Consumption			
f. Annual Consumption	m^3/year	6,185,190	1995
g. Daily Consumption	m^3/day	16,946	f./30
h. Water Consumption Ratio	l /p/d	148.0	g./a.
Sewage Treatment			
i. Annual Intake	m^3/year	5,666,724	1995
j. Daily Intake	m^3/day	15,525	i./365
k. Sewage Generation Ratio	l /p/d	226.5	j./b
l. BOD Generation Ratio	g/p/d	58.8	Results of WPLS
m. Discharge Ratio	%	100	to supplied water
n. Intake BOD Concentration	mg/l	325	Mean value of two plants
"Subtiava"	mg/l	320,Q=11,286	measured on April/14/96
"El Cocal"	mg/l	340,Q=4,230	measured on April/14/96

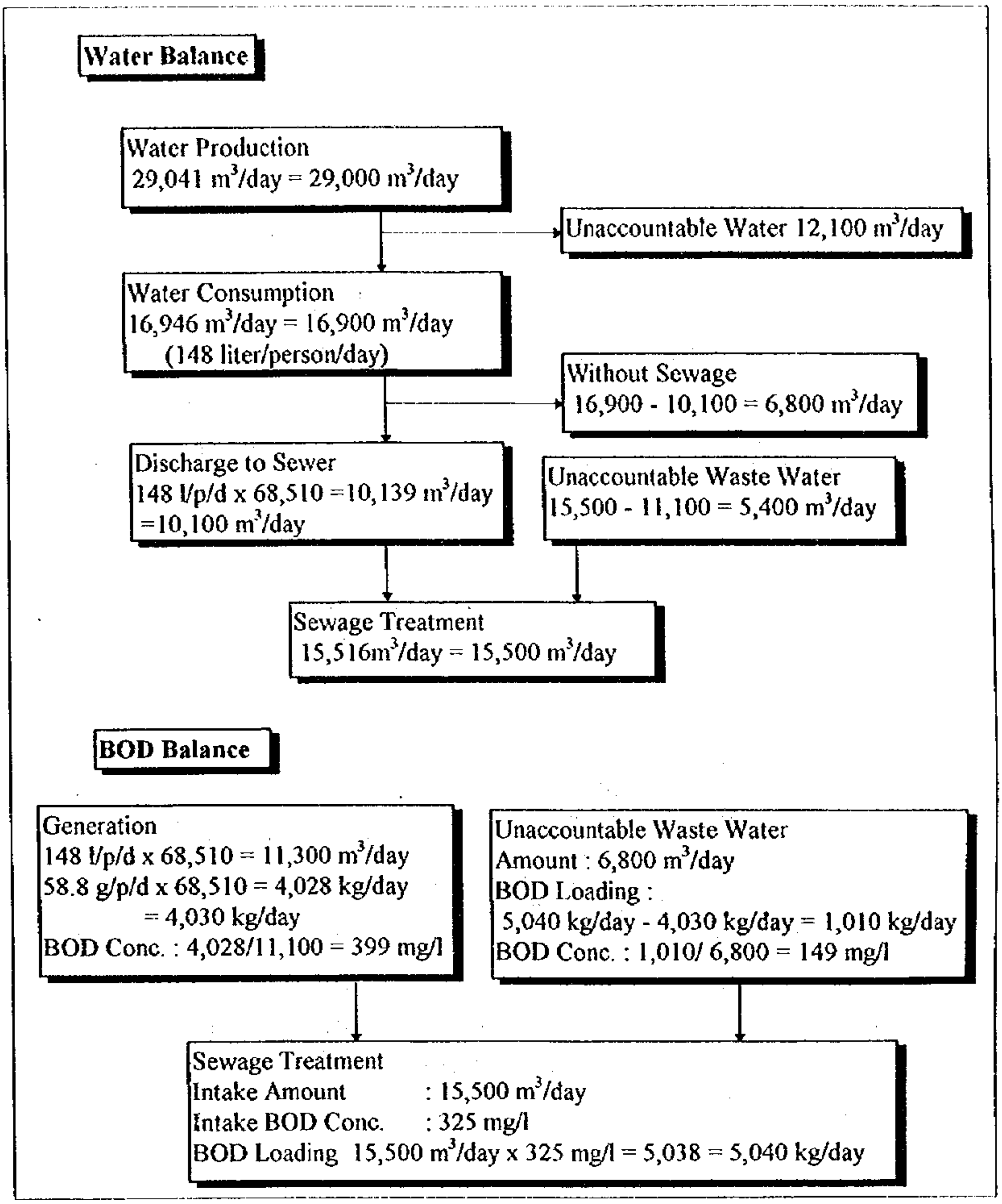


Figure J-5: Water Balance and BOD Balance in the Leon Sewage System

The water and BOD balance estimates imply:

- Approximately 6,800 m^3/day of unaccountable wastewater filters into the sewerage system, even under the assumption that 100% of potable water consumed reaches the lagoon.

- Where BOD generation per person is assumed at 58 g/person/day (results of WPLS by JICA), BOD concentration in the unaccountable waste total approximately 170 mg/l. On the other hand, if the total BOD load discharged into the lagoon is divided by the population connected to sewers, the BOD generation per person becomes 73.6 g/person/day.

iv. Treatment Capacity

The existing lagoons, located to the south of the city, discharge their effluent into the Chiquito River.

The principal characteristics of the lagoons are as follows:

Table J-30: Characteristics of Subtiava Lagoon

Type of Lagoon	Facultative
Dimensions (m)	244.65 x 103.65 x 2.31
Average Shallow Area (m^2)	27,643
Average Water Volume (m^3)	63,854

Table J-31: Characteristics of the El Cocal Lagoons

Type of Lagoon	Facultative
Dimensions (m)	139.8 x 59.8 x 1.8
Number of Lagoons	2
Average Shallow Area (m^2)	9,552
Average Water Volume (m^3)	17,193 x 2 = 34,386

The evaluation of the current conditions of the lagoons was fundamentally directed to:

i. qualitative observation of data obtained from latest water analysis.

ii. calculation of a maximum possible flow to be treated in the present lagoons.

The figures and indicators resulting from the latest analysis executed by INAA on May 8, 1996 and July 9, 1996 are assessed to be reliable. The ratio of BOD, COD, and fecal coliforms removed during treatment in the lagoons were analyzed and shown in the following table.

Table J-32: Efficiency of Stabilization Lagoons

	Removal Rate (%)	
	Subtiava Lagoon	El Cocal Lagoons
BOD	56	76
COD	59	53
Fecal Coliforms	83	94

The retention time in the Subtiava lagoon is approximately 5 days, and 6 days in the El Cocal lagoons.

Table J-33: Retention Time in the Stabilization Lagoons

	Subtiava Lagoon	El Cocal Lagoons
Lagoon Volume (m^3)	63,854	34,386
Intake Amount (m^3/day)	12,407 (July/9/96)	5,308 (May/8/96)
Retention Time (days)	5.1	6.4

It can be deduced that other wastewater (storm water or industrial wastewaters) have also been discharged into the lagoons in addition to DWW, because even with a short retention time, an 80 to 90% reduction in BOD concentration was observed. The INAA Pre-feasibility Study also confirms a sharp increase (threefold) in flow into the lagoons when it rains in the city.

The maximum potential flow to be treated in these lagoons is calculated based on the values of parameters used to determine the quality of wastewater that actually flows into the lagoons and the established standard discharge limits (the calculation is shown below).

Meanwhile the calculations for the facultative lagoon in Leon should be verified, only taking organic load into account since the reduction of pathogens is not the primary aim of this treatment process.

INAA standard BOD discharge: 90 mg/l

Calculation of the maximum flow of the lagoons in terms of BOD (90mg/l) discharge is as follows:

i. Subtiava Lagoon

BOD inflow: Li = 320 mg/l
Treated BOD: Le = 90 mg/l
$Q = (A \times 18 \times p(1.05)^{T-20}) / (Li-Le)$ ----------- (Marais)

Where:

A = 27,643 m^2
p = 2.31 m
T = 25°C
Li = 320 mg/l
Le = 90 mg/l
Q = 6,377.9 m^3/day or 73.8 liters/sec

The flow into the Subtiava lagoon amounts to 143.6 liters/sec, which is almost double the maximum flow of discharge that would produce BOD concentrations below the set norm. On the other hand, to meet the required pathogenic conditions, the functions of the lagoon should be changed to either anaerobic, facultative, or aerobic.

The above suggests the need for modification of the Subtiava lagoon by formulating a program that would enable the identification of areas in the sewer net where storm water mainly filters in, for the effective regulation of flow into the lagoon.

ii. For the lagoons of El Cocal, calculations are shown below.

BOD inflow: Li = 340 mg/l
Treated BOD: Le = 90 mg/l

$$Q = (A \times 18 \times p(1.05)^{T-20}) / (Li-Le) \text{ ---------- (Marais)}$$

Where:

A	=	9,552 m^2
p	=	1.80 m
T	=	25°C
Li	=	340 mg/l
Le	=	90 mg/l
Q	=	1,580 m^3/day or 18.3 l/sec

Table J-27 shows that the BOD concentration in the effluent discharged in El Cocal is 80 mg/l, and the flow rate is 16.87 liters/sec. These values are similar to the ones calculated above.

As a conclusion, the maximum flow to meet the set norms for lagoon effluent (with respect to organic load) is 18.3 liters/sec for each lagoon, or a total of 36.6 liters/sec.

It should be noted that the above analysis only covered organic load due to reasons previously mentioned.

a.2.5 Discharge Point

Effluents in the stabilization lagoons are currently discharged into the Chiquito River, which is also observed to be extremely contaminated with effluents from tanneries and slaughterhouses, as well as DWW.

The river originates about 2 km from the east of the city center at a minimum flow rate.

Pochote river originates from a spring very close to the city. It has minimum flow and is therefore not qualified as a potential recipient of wastewater.

The rivers and creeks in the city are the first connection points of household and industrial liquid and solid wastes. The seriousness of this problem intensifies because the drains of the neighboring areas along the river courses directly discharge DWW into the rivers.

a.3 Other Domestic Waste Water Treatment System

Of the urban households not covered by the sewer system, 2.1% use septic tanks and 33.7% use pit latrines. Latrines usually have an average life of three to five years, after which a new one is built nearby.

In the zones without a sewer system, shallow street drains are used for domestic effluent discharge.

Table J-34: Sanitation System in the Urban Area

Sanitation System	Household Ratio
Sewer System	55.3%
Septic Tank	2.1%
Latrine	35.2%
None	7.4%
Total	100%

Source: INAA Region II (Aug/1996)

b. Institutional System

The INAA is in charge of wastewater, and manages the sewerage system and a biological facultative lagoon treatment plant.

J.2.4 Industrial Waste Management

a. Technical System

a.1 Generation Sources

Table J-35 shows a list of major factories and main products. The major factories consist of 5 industrial categories (see Table J-36): CIIU3231, 3512, 3522 are most likely to produce hazardous waste.

Table J-35: List of Major Factories in Leon

CIIU	Name of Companies	No. of Employees	Main Products
3115	GRUPO INDUSTRIAL AGROSA	229	Oil, soap, flour
3115	JABON EL HOGAR	15	Soap factory
3115	SUC. ENRIQUE MANTICA BERIO S.A.	26	Sesame seeds
3116	CUKRA INDUSTRIAL S.A.	120	Peanuts production
3116	ENABAS	26	Grain
3121	ENISAL	28	Salt production
3121	FLAVIO VALLADARES S.A (ALASKA)	10	Ice production
3121	CELSA, S.A.	10	Soap production
3132	EMBOTELLADORA FLORES	11	Bottling company
3132	EMBOTELLADORA LACAYO	14	Bottling company
3219	COFECCIONES INDUSTRIALES ESTELA SALGADO	15	
3231	TENERIA BATAAN S.A.	100	Leather production
3231	TENERIA BAYARDO SALINAS ROJAS	30	Tannery, leather production
3231	TENERIA LOS LEONES	50	Tannery, leather production
3232	MARROQUINERIA CENTROAMERICANO (MACASA)	24	Leather company
3412	CARTONICA	113	Cardboard boxes
3512	FORMULADORA INTERNACIONAL AGRICOLA S.A.	14	Pesticides and fertilizers
3512	SERVICIO AGRICOLA GURDIAN S.A.	22	Pesticides and fertilizers
3522	LABORATORIO DIVINA S.A.	60	Pharmaceutical products
3551	REENCAUCHADORA MODERNA	23	Realignment of tires
3691	LADRILLERIA MODERNA	20	Bricks and tiles production
3691	LADRILLERIA ROSARIO	10	Bricks and tiles production
3691	LADRILLERIA SAN FELIPE	10	Bricks and tiles production
3691	ORONTE GALLO CARDOZA	20	Bricks and tiles production
3699	YESOS DE NICARAGUA	25	Chalk production
3822	IMPLEMENTO AGRICOLA S.A.	50	Production of agriculture equipment
3839	BATERIAS ROLAC S.A.	37	Batteries
Total Number of Employees		1,112	

Table J-36: Number of Factories and Employees

Category	CIIU	Number of Factories		Number of Employees	
		Number	Ratio	Number	Ratio
Food	3115	3	11.1%	270	24.3%
	3116	2	7.4%	146	13.1%
	3121	3	11.1%	48	4.3%
	3132	2	7.4%	25	2.2%
Clothing	3219	1	3.7%	15	1.3%
	3231	3	11.1%	180	16.2%
	3232	1	3.7%	24	2,2%
Chemicals	3512	3	11.1%	149	13.4%
	3522	1	3.7%	60	5.4%
	3551	1	3.7%	23	2.1%
Ceramics	3691	4	14.8%	60	5.4%
	3699	1	3.7%	25	2.2%
Metals	3822	1	3.7%	50	4.5%
	3839	1	3.7%	37	3.3%
Total		27	100%	1,112	100%

a.2 Generation Amount

Table J-37 shows the estimated waste generation amount based on the factories survey.

Table J-37: Waste Generation Amount in Leon (1996)

Waste Water (ton/year)	Solid Waste (ton/year)	Total (ton/year)
91,197	7,437	98,634

a.2.1 Waste Water

Figure J-6 shows the estimated wastewater generation amount of respective industrial categories based on the factories survey. CIIU3231 (leather tannery and finishing) is the largest wastewater generation source in Leon. Waste water from these industries contain chromium and organic materials (wastewater quality measured in a tannery factory in Granada by WPLS in this study was Cr 27mg/l, BOD 1,800mg/l and COD 2,022mg/l (see Annex E in Volume IV)).

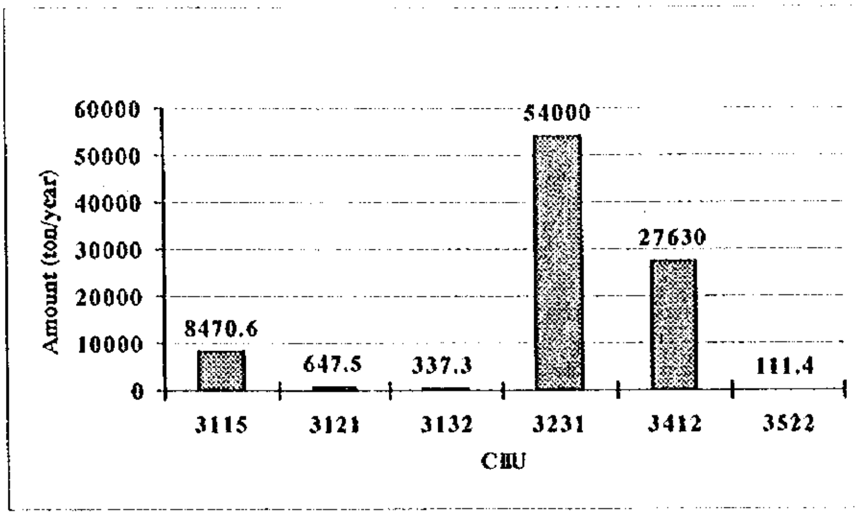


Figure J-6: Waste Water Generation Amount

a.2.2 Solid Waste

Figure J-7 shows estimated solid waste generation amount of respective industrial categories based on the factories survey. CIIU3116 (processing of dry seeds) is the largest solid waste generation source in Leon, and solid waste from these industries are composed chiefly of organic matter.

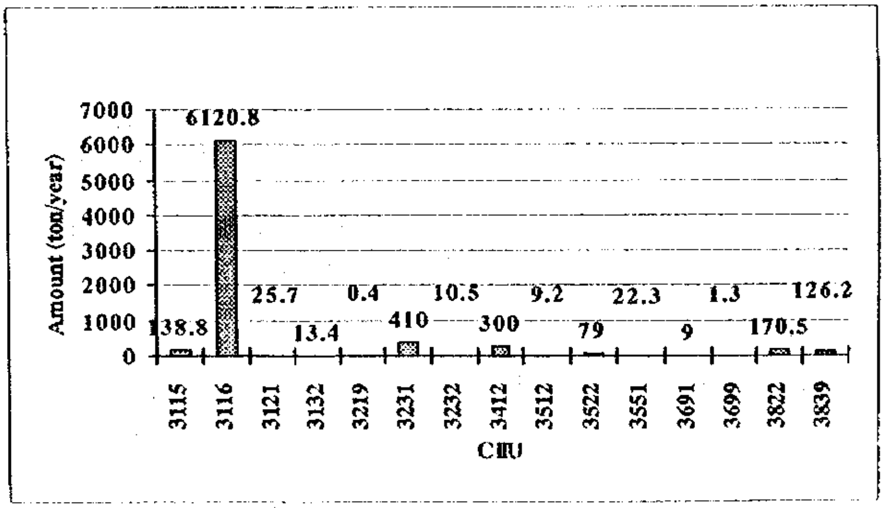


Figure J-7: Solid Waste Generation Amount

a.3 Treatment and Disposal

a.3.1 Waste Water

All generated wastewater is disposed into the environment without treatment: 88% of generated wastewater is disposed into public water bodies (e.g., rivers), and 12% into the sewer system.

a.3.2 Solid Waste

One percent of solid waste generated is treated, and the method employed consists of bio-decomposition, burning (open burning), and compaction.

Solid waste disposal methods are landfill (80% of generation amount) and recycling (20% of generation amount), and major disposal sites are municipal landfill sites (82% of disposal amount).

b. Institutional System

b.1 Industrial Waste Water

The local industries do not have treatment plants, and the effluents are discharged into the soil, water bodies, or sewage systems.

The entities responsible for regulation and control of wastewater are MARENA, INAA, MINSA, and the municipality at a subsidiary level.

b.2 Industrial Solid Waste

Industries pay taxes for "ordinary" public services, that do not include ISW collection-disposal. The ISW must be collected and disposed of by its generator - that usually implies delivering the waste to the municipal disposal site.

Control of ISW is performed by the municipality and MINSA/SILAIS inspections.

Law No. 217-96 confirms the municipal competence on non-hazardous waste, and fix directives for HWM that should be enforced by MINSA and MARENA. MARENA should also regulate sludge handling and disposal, according to Decree No. 33-95.

Statistics from 1992 state that there were 317 industries/1529 workers in Leon City, 6 gasoline stations and 9 mechanical workshops. Places that generate HW, e.g., chemicals (ICI pesticides; MACASA-toluene, other organic solvents), are airports used for spraying pesticides, tanneries etc. There are no special services for these places and there is a lack of effective control on these wastes (MINSA and MARENA competence).

J.2.5 Municipal SWM

In the Public Opinion Survey, a considerable number (58%, 46/80) of interviewees was affected by solid waste problems. The present situation regarding Municipal Solid Waste Management is described below.

a. Technical System

The Municipal Solid Waste Management in Leon City is executed by the Municipal Services Department (MSD) of Leon Municipality.

a.1 Discharge and Storage

The Study Team observed that there is no source separation at waste generation points. The wastes in reusable plastic bags, drums or other receptacles from houses are discharged at curbsides. Many people use reusable plastic bags: 34% of dischargers use them according to the report of "Study About the System of Garbage Collection and Treatment in 41 Municipalities of Nicaragua".

a.2 Collection and Transportation

i. Equipment

The MSD has 8 collection vehicles, as described in Table J-38, for waste collection and transportation. The equipment are parked at 'Plantel Municipal Service', a municipal workshop.

All of the equipment except one truck are more than 8 years old, and their performances have deteriotated. This impedes an efficient waste collection service.

Table J-38: Collection Equipment

Item	No.	Years	Make	Remarks
Compactor Truck	4	8	Benz	$12m^3$
	1	3	Benz	$12m^3$
	1	16	Benz	$8m^3$, out of order
Dump Truck	1	11	Japan	6ton
	1	16	Benz	6ton

ii. Frequency

Collection frequency for each kind of waste is shown in Table J-39. Collection services are executed by 45 personnel, with a working day of 10 hours.

Table J-39: Collection Frequency

Waste Category	Frequency
a. Residential areas	a. 2-3 times a week
b. Commercial areas	b. 3 times a week
c. Market areas	c. 7 times a week
d. Medical facilities	d. 3-6 times a week
e. Institutions	e. 3 times a week
f. Industries	f. 3 times a week
g. Street sweeping	g. 6 times a week

iii. Coverage rate

The collection service coverage rate is: 86.7% in relation to the waste amount and 80.0% to the population.

a.3 Street Sweeping

The total length of streets cleaned by the MSD is 55km out of a total 226.4km. Some parks and green areas are also included.

The streets in the city are fairly clean. The MSD uses wooden carts for street sweeping. The carts are very useful and appropriate for the limited budget, as they can be made and repaired by the employees.

Table J-40: Total Length of Roads in the Study Area

Type	Length
Asphalt	53.0 km
Block paved	49.0 km
Stone paved	1.5 km
Soil	122.3 km
Total	225.8 km

a.4 Intermediate Treatment and Recycling

There are no intermediate treatment facilities, and organized recycling was not observed in the study area. Only glass bottles, plastic and aluminum are collected by individuals for reuse.

The recycling amount is 16.3 ton/day at generation sources and 1.4 ton/day at the disposal site. Total recycling amount is 17.7 ton/day in the study area in Leon.

a.5 Final Disposal

The municipality has one landfill located 4 km south of the city center. The landfill has been used for about 5 years[3].

This landfill site is operated by one bulldozer used for 17 years. The working hours at the landfill is 9 hours a day from 5:30 a.m. to 15:30 p.m. There are no facilities such as a weighbridge, an administration hut, etc.

The landfill is located at the top of a hill which offers an extraordinary view point over the city, and where a historical fortress is located. Unfortunately, the existence of the landfill decreases the value of the hill as a tourist spot. Bulldozing the waste from the hill top is causing contamination of agricultural fields underneath and exposing houses to danger of landslides.

The waste disposal amount is 60.0 ton/day.

a.6 Maintenance of Vehicle and Equipment

The municipality has two workshops: 'Plantel Municipal Service', and 'Municipal Works'. The maintenance shop for executing repairs of the waste disposal equipment is 'Plantel Municipal Service' located in the northern part of the city. There are 8 employees in the workshop.

This workshop has very little maintenance equipment. The maintenance work is executed considerably well for its limited budget.

a.7 Illegal Dumping

Wastes dumped illegally are observed at many places in the city, especially along rivers and ditches. They cause rivers and ditches to overflow during heavy rains, and they are considered focal points of epidemic diseases.

The illegal dumping amount is estimated at 9.0 ton/day in the rainy season.

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[3] Municipal officer, Leon

b. Institutional System

The Solid Waste Collection sector is in charge of services, under MSD, and comprises domiciliary collection, street cleansing and refuse disposal.

MINSA/SILAIS cooperates with the municipality and provides legal support to sanctions if necessary.

The tax concerning SWM is monthly collected; during the year 1996 only 40% of the invoices have been paid, and the high percentage of unemployed people is the principal reason.

J.2.6 Medical SWM

Study Team conducted a questionnaire survey on medical waste management at 5 major medical institutions in Leon. The results are shown as follows.

a. Technical System

a.1 Segregation of Infectious/hazardous Medical Wastes

Many medical institutions do not segregate infectious / hazardous wastes from domestic wastes. In the questionnaire survey, only 1 medical institution (20%) completely segregated infectious / hazardous wastes from domestic wastes, however, they are mixed during public collection, according to visual observations. Three institutions (60%) conduct mix collection. The remaining institution (20%) segregates the wastes partially .

a.2 Treatment of Medical Wastes

There are 3 types of treatment methods of medical wastes, namely incineration (open air incineration by 1 institution (20%), sterilization (autoclave by 3 institutions or phenol treatment by one) (60%), and no treatment by 1 institution (20%).

a.3 Collection and Haulage

The municipality extends collection service of domestic waste to 3 institutions (60%). When the municipality collects domestic waste, medical waste is informally collected at the same time. Collection frequency varies from once a week (20%), 3 times a week (20%), daily (40%) and none (20%).

All of the 5 medical institutions are not satisfied with the public collection service level, based on the collection service frequency, training of the medical workers, collection method, etc.

a.4 Disposal

Three medical institutions incinerate infectious / hazardous waste in the open at their premises, 2 institutions dispose of medical wastes at the municipal landfill site (3 institutions did not reply) through domestic waste collection service without prior treatment.

a.5 Training and Education

Only one institution has written instructions, and on the other hand, 3 institutions have no written instructions. Three institutions have never received training on handling of medical waste. Leon is the worst in providing training to medical workers.

b. Institutional System

The municipal service collects and disposes of medical SW together with domestic and commercial refuse. There are no internal segregation or special services.

J.3 Present USE in Chinandega

J.3.1 Water Supply

a. Technical System

a.1 Service Coverage

The report on "Performance Indicators" in May 96 indicates that the population receiving water supply services in the urban area of Chinandega is estimated at 72,077 out of the estimated total urban population of 97,387.

Table J-41: Service Coverage (1995)

	Household	Population (persons)	Area (km²)
Total Number	16,935	97,387	12.1
Water Supplied	12,533	72,077	7.5
Service Coverage	74.0	74.0	62.0

Source: INAA Performance Indicators (May 1996)

a.2 Supply Indicators

a.2.1 Water Unaccounted for (1991 to 1995)

The ratio of UFW (Water Unaccounted for) in 1995 was about 28% of the amount of water produced. The data for the last five years, however, show a decrease in the UFW ratio in Chinandega. An increase in metered water supply connections has also been observed.

Table J-42: Potable Water Production and Consumption

Year	Production	Consumption	UFW	UFW ratio	Household Connections		
	(m^3/year)	(m^3/year)	(m^3/year)	(%)	with meter	without meter	Total
1991	6,148,916	3,437,655	2,711,261	44	6,709	2,963 (31%)	9,672
1992	6,697,993	3,469,534	3,228,459	48	7,030	2,837 (29%)	9,867
1993	5,251,066	3,270,034	1,981,032	38	9,748	752 (7%)	10,500
1994	5,064,903	3,447,217	1,617,686	32	10,148	770 (7%)	10,918
1995	5,083,403	3,657,990	1,425,413	28	10,533	2,000 (16%)	12,533
1996 (May)	-	-	-	-	10,612	1,970 (16%)	12,582

Source: INAA - Planning Management (July 1996)

a.2.2 Type of Connection

The number of water supply connections in the urban area of Chinandega currently totals 12,533 (July 1996), 95% of which are for household use.

Table J-43: Current Type of Connection (July 1996)

Type of Connection	Quantity	Ratio (%)
Household	12,183	97.1
Industrial	2	0
Commercial	269	2.1
Multi-family	69	0.6
Communal Tap	5	0.0
Government	25	0.2
Total	12,533	100.0

Source: INAA - Region II (July 1996)

a.2.3 Water Production and Consumption

i. Water Consumption Ratio

Water production and consumption from 1991 to 1995 are tabulated in Table J-44.

Table J-44: Water Production and Consumption Ratio

	Production (m^3/year)	Consumption (m^3/year)	Service Population		Ratio (l/person/day)	
			No. of Households	persons*	Production	Consumption
1991	6,148,916	3,437,655	9,672	62,868	268.0	151.1
1992	6,697,993	3,469,534	9,867	64,136	286.1	148.2
1993	5,251,066	3,270,034	10,500	68,250	210.8	131.3
1994	5,064,903	3,447,217	10,918	70,967	195.5	133.1
1995	5,083,403	3,657,990	12,533	72,077	193.2	139.0

Note: * 6.5 persons/household is assumed.

The current average water consumption is 139 liters/person/day (UFW not included). This is a little under the guideline value of 160 liters/person/day proposed by INAA in the Pre-feasibility Study for cities with a population exceeding 50,000.

ii. Coefficient for Yearly Fluctuation

Based on the previous year's monthly production data, it is deemed reasonable to apply a coefficient of 1.25 (i.e., 25% increase in the peak) to cope with annual fluctuations.

iii. Coefficient for Daily Fluctuation

Based on the data obtained from the study on the Chinandega stabilization lagoons conducted by BID/INAA in June 1993 (Annex 2 of the report), a coefficient equivalent to 1.70 (i.e., 70% increase in the peak) should be applied to cope with daily fluctuation.

a.3 Organizational Structure of the INAA Branch in Chinandega

The INAA office in Chinandega has a total of forty six (46) employees:

Manager	1
Person in charge of commercial waste	1
Person in charge of collection & haulage	1
Zone controllers	2
Cashier	1
Claims person / customer relations	1
Secretary	1
Administrative chief	1
Janitor	1
Collectors	2
Person in charge of meter reading	1
Inspector	1
Meter readers	4
Plumbers	5
Laborers	5
Assistant plumbers	2
Pump operators	10
Storekeeper	1
Driver	1
Technical chief	1
Group leader	1
Guards	2
Total	**46**

Also extra personnel are hired when the work demand is high.

The current number of water supply connections is 12,533, and nearly 4 employees are assigned per one thousand connections.

a.4 Supply Sources

The present water supply source for Chinandega is the aquifer found in the alluvial and volcanic deposits.

The subsoil in Chinandega possesses high specific yield and transitivity and shallow water level, characteristics that stimulate high well water production and low water extraction costs.

The water supply network of Chinandega City is fed by six borehole wells. Two of these, La Pila and La Mora, are located in the northeastern part of the city. Another two, El Jirón and 12 de Septiembre, are located in *Repartos Intervenidos* north of the city. Another well, El Calvario, is found in the downtown area, while the Los Angeles well is located in the barrio with the same name, in the eastern part of the city.

Each well is equipped with a vertical turbine pump with a vertical electrical motor. The vertical turbine pumps have different horsepower (from 10 to 150). The discharge of the wells vary from 12 to 109 liters/sec. The total water extraction capacity is 391 liters/sec.

The general characteristics of the wells, e.g., nominal pumping capacity, installation year, motor power, actual pump operation hours, are presented in the table below.

Table J-45: Characteristics of Existing Wells

Description	Capacity (l/sec)	Installation Year	Power (Hp)	Operation Time (hours/day)
Calvario	80	1973	100	12
La Pila	92	1972	100	12
La Mora	109	1978	100	12
Los Angeles	82	1993	150	12
12 Septiembre	12	1978	25	12
El Jirón	16	1978	10	12
Total	391	-	-	-

Source: INAA - Region II (July 1996)

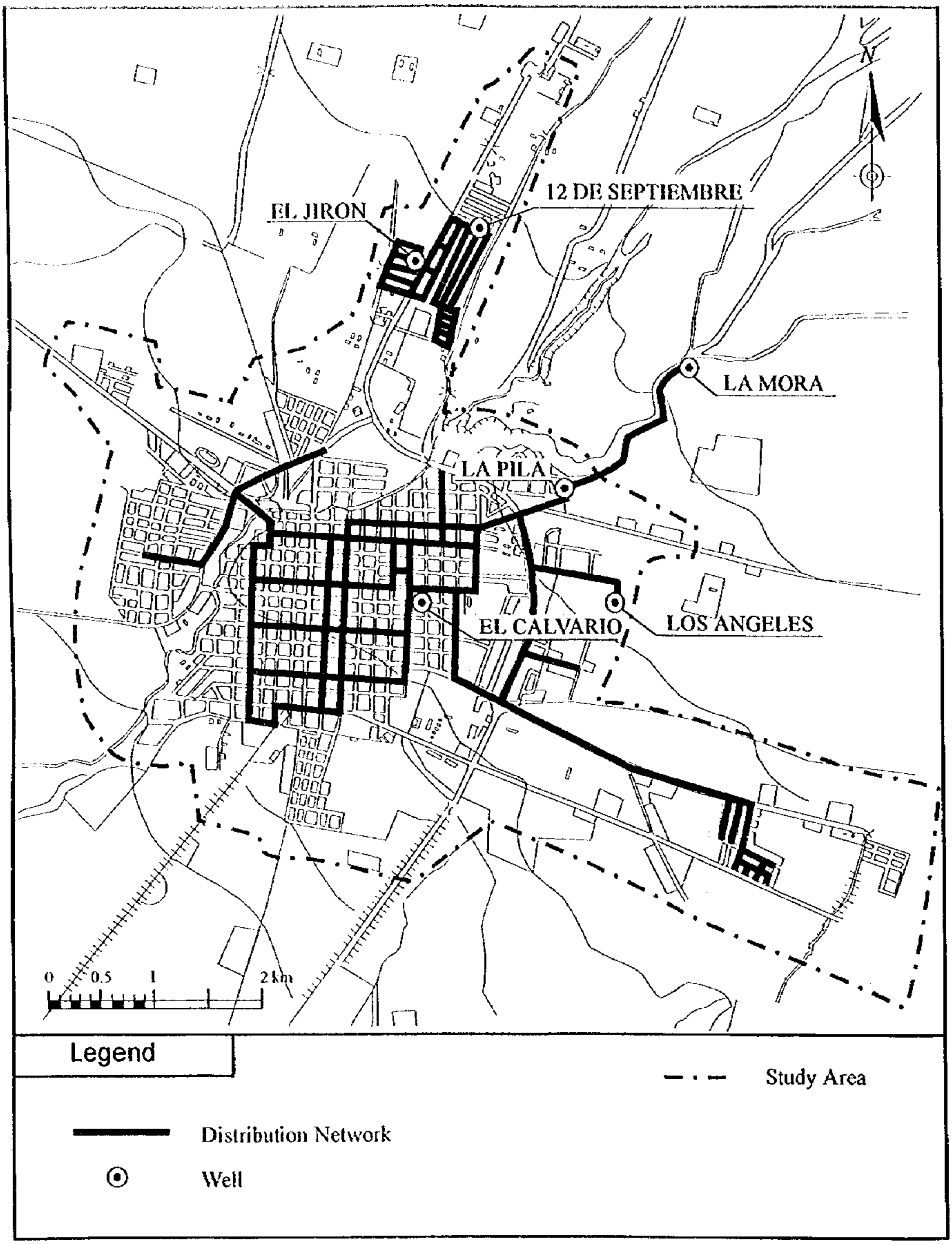

Figure J-8: Location of Existing Wells

The production of each existing deep well varies by operation hour. The following table details the monthly production and pumping hours of each well.

Table J-46: Data on Existing Wells in 1996

Well			1996					
Name	Data		January	February	March	April	May	June
Calvario	Production	m^3	39,290	54,833	115,956	131,870	121,194	104,837
	Pumping	hr.	113	150	333	367	390	275
La Pila	Production	m^3	104,625	139,173	92,652	100,587	88,481	69,058
	Pumping	hr.	296	284	279	273	230	186
La Mora	Production	m^3	99,586	114,101	135,583	133,179	103,636	113,329
	Pumping	hr.	362	393	392	394	306	338
Los Angeles	Production	m^3	136,640	129,008	135,913	114,621	100,518	96,327
	Pumping	hr.	369	365	381	323	264	272
12 de Septiembre	Production	m^3	21,216	20,361	32,534	20,939	18,736	19,023
	Pumping	hr.	469	122	538	400	473	461
El Jirón	Production	m^3	3,066	3,520	4,054	4,031	2,996	247
	Pumping	hr.	67	77	89	86	66	55
Total	**Production**	m^3	**406,823**	**460,996**	**516,692**	**505,401**	**435,765**	**402,821**
	Pumping	**hr.**	**1,737**	**1,393**	**2,014**	**1,846**	**1,739**	**1,587**

Source: INAA - II Region (July 1996)

The six wells have an average daily flow of 13,427.4 m^3/day (34.9% of maximum capacity) during the operation hours in June 1996 as shown in the table above. Meanwhile, a 24 hour pumping operation would produce a maximum of 33,782.4 m^3/day (391 liters/sec).

A large number of the wells are not equipped with flux measuring gauges, therefore, the water production values indicated in the table above are estimates.

a.5 Water Quality

a.5.1 Well Water Quality

With respect to the water quality of the wells in Chinandega, the INAA Department of Water Quality conducted hither water quality analyze to update its data on the chemical and physical properties of the water supply sources.

The Acome well has recently been closed because the concentration of pesticide in the water was higher than the permissible level.

In terms of potability, the groundwater in Chinandega City may be considered of good quality.

The table below shows the values derived from the last analysis made by INAA on January 10, 1996.

Table J-47: Current Well Water Quality

Item	unit	Calvario	La Pila	La Mora	Los Angeles	12 Septiembre	El Jiron	INAA Maximum Limits
Sampling date	-	10/Jan/96	10/Jan/96	10/Jan/96	10/Jan/96	10/Jan/96	10/Jan/96	
Aspect	-	clear	clear	clear	clear	clear	clear	
Temperature	°C	-	-	-	-	-	-	18 - 30
Color	-	1.0	1.0	0.5	0.5	1.0	0.5	15
Turbidity	-	0.4	0.4	0.2	0.2	0.4	0.2	5
Dissolved Solids	mg/l	-	-	-	-	-	-	1,000
Conductivity	s/cm	347	310	300	300	276	290	400
pH	-	7.4	8.0	7.5	7.6	7.6	7.2	6.5 - 8.5
Total Hardness	mg/l	148.0	120.0	120.0	128.0	124.0	120.0	500
Alkalinity	mg/l	128.0	124.0	120.0	120.0	104.0	116.0	-
Calcium	mg/l	33.6	32.0	32.0	28.8	29.0	27.2	250
Magnesium	mg/l	15.6	9.7	9.7	13.6	12.6	12.6	50
Total Iron	mg/l	0.11	0.05	0.03	0.04	0.18	0.03	0.3
Sodium	mg/l	5.1	12.4	12.6	11.6	10.5	13.0	200
Bicarbonates	mg/l	156.0	151.0	146.0	146.0	127.0	142.0	-
Carbonates	mg/l	-	-	-	-	-	-	-
Chloride	mg/l	13.3	16.7	13.3	15.0	13.3	16.7	250
Sulfates	mg/l	4.0	5.0	9.0	10.0	5.0	6.0	250
Nitrates	mg/l	26.6	20.4	20.9	21.2	24.0	20.9	50
Nitrites	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	Tr
Fluorine	mg/l	-	-	-	-	-	-	0.7 - 1.5
Saturation Index	adm	-0.50	0.11	-0.41	-0.35	-0.41	-0.79	-

Source: INAA - (July 1996)

The groundwater sources of the deep wells in Chinandega are considered slightly alkaline, and the pH is observed to be within the INAA's maximum limit (6.5 to 8.5) at 7.2 to 8.0. These conditions are thought to induce scales forming on the wells.

The chloride, sulfates, carbonate, calcium and magnesium concentrations in the groundwater sources of these wells are found to be far below the maximum limit. The nitrate values vary between 20.4 mg/l and 26.6 mg/l, which is below the maximum limit of 50 mg/l.

Some of the nitrates are presumed to have originated from the fertilizers used in agriculture.

a.5.2 Chlorine Consumption

The amount of chlorine in the water supplied to the city of Chinandega depends on the residual chlorine level in the distribution network: residual chlorine should be kept to a minimum of 0.5 mg/l. The residual chlorine in Chinandega is monitored weekly at specific points in the distribution network.

Table J-48: Chlorine Consumption in Chinandega

Months in 1996	Hypochlorite (kg)	Gas chlorine (kg)
January	649	-
February	559	-
March	484	-
April	417	-
May	346	41
June	450	41
Total	2905	-
Monthly Average	484	41

Source: INAA - Region II (July 1996)

a.6 Water Transmission

In most cases, the system does not have independent transmission pipelines connecting the wells to storage tanks. Only the La Mora and La Pila wells are capable of directly transmitting water to the reservoirs. The rest of the wells are connected directly to the distribution network and cannot independently transmit water to the reservoirs.

There are transmission pipelines that may be characterized as sub-transmission pipelines as they are connected to the storage tanks of "La Mora" and "La Pila", which supply water to the distribution network. These transmission pipelines are divided into two parts: the first part is made up of 400 mm pipelines approximately 1.1 km long, and the second part consists of two parallel pipelines (500 mm and 250 m long PVC pipes and 350 mm AC pipes of the same length).

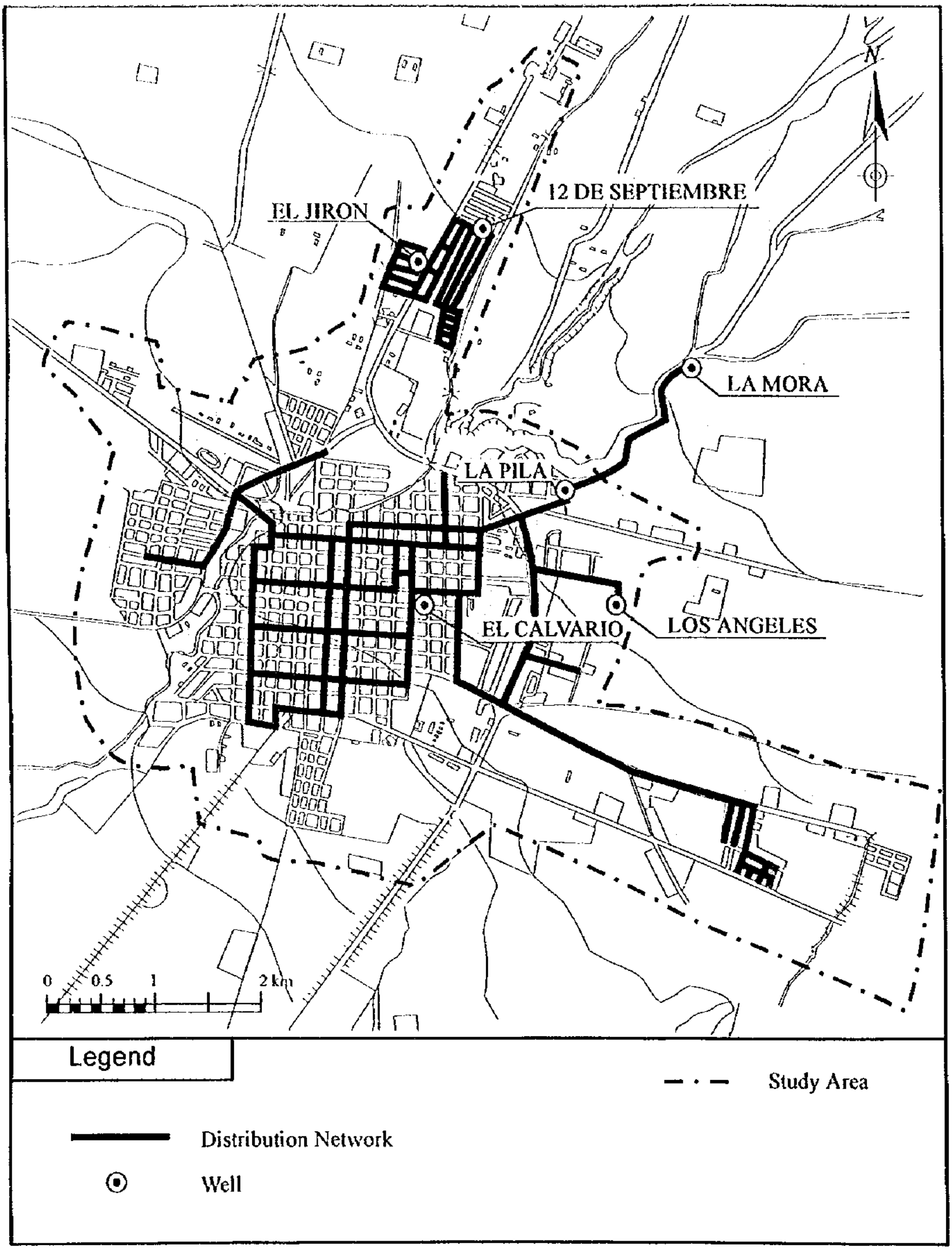

Figure J-9: Present Water Supply and Distribution System

a.7 Storage

According to the "Criteria for the Preliminary Design of the Drinking Water Systems" employed by INAA, storage tanks are necessary for the following reasons.

- To compensate for the difference between instant public demand and actual production.
- To ensure minimal contact time, no less than 20 minutes, for chlorination;
- To provide water in case of interruption of the services.
- To provide water for emergency use (in case of fire).

Water is currently stored in three tanks in the northern part of the city.

These tanks are constructed in not so highly elevated areas, and water pressure at the highest part of the distribution network is low when demand peaks. INAA is believed to be replacing some of the pipes in the net to ease flow.

The existing tanks can store water from the pumping wells but not all of them are connected to the distribution network. In Chinandega, the tanks are constructed mainly for storage because the water pumped up from most of the wells are directly conveyed to the distribution network.

This situation is not a problem because the current flow capacity of the wells is enough to cover the deficiency in storage capacity. This is not, however, an ideal situation from a hydraulic viewpoint, because the hydraulic pressure in the distribution network significantly varies, placing a strain on the pumps of the wells.

The INAA Pre-feasibility Study Report states that the reservoirs do not receive water directly from the wells, and that they initially convey water to the network.

Table J-49: General Data on Existing Storage Tanks

Tank Name	Capacity (m^3)	Max. Elev. (m)	Bottom Elev. (m)	Diameter (m)	Height (m)
La Pila 1	2,840	98.26	82.91	15.35	15.35
La Pila 2	2,650	98.50	83.62	15.06	14.91
La Pila 3	2,650	98.50	83.62	15.06	14.91
La Mora	950	112.80	96.00	8.50	16.80
El Jirón	10	92.70	90.20	2.62	2.50
Total	9,100	-	-	-	-

Source: INAA - Region II (July 1996)

a.8 Distribution Net

The distribution network in Chinandega City has a total of 112.690 km pipelines. More than 70% of the total length is made up of pipelines with a diameter of 100 mm or less.

The system consists of three types of piping: PVC (59.07%), cast iron (4.14%) and asbestos cement (36.79%).

The water pressure in the distribution network is generally acceptable. However, water pressure is not very strong in the elevated parts of the network, and is usually below the required minimal head of 15m because the storage tanks are constructed in areas with a lower elevation.

As a countermeasure and as a part of the drinking water supply system rehabilitation project, INAA is currently changing the pipe diameters at several points of the network.

The current structure of the distribution network is shown in the following table.

Table J-50: Distribution Network Structure

Diameter (mm)	PVC (m)	Cast iron (m)	Asbestos Cement (m)	Total (m)	Ratio (%)
50	43,000	-	-	43,000	38.16
75	6,650	-	17,500	24,150	21.43
100	5,900	1,320	6,900	14,120	12.53
125	-	2,150	-	2,150	1.91
150	2,200	550	5,200	7,950	7.06
200	870	650	4,900	6,420	5.70
250	1,760	-	3,760	5,520	4.89
300	2,400	-	400	2,800	2.48
350	60	-	610	670	0.60
400	1,800	-	2,180	3,980	3.53
500	1,930	-	-	1,930	1.71
Total	66,570	4,670	41,450	112,690	100.00
Ratio (%)	59.07	4.14	36.79	100.00	-

Source: INAA - Region II (July 1996)

b. Institutional System

The service is performed by INAA - Region II - Chinandega Branch that allocates 45 people for water supply and wastewater services.

During 1995, the city was supplied with 4,800,032 m^3 of water, and 2,976,947 m^3 (61,2%) of wastewater was treated.

Table J-51: Economic Data on Water Supply and Sewage for Chinandega in 1995

Unit: C$ 1,000

Income/Expenditure	Water	Sewage	Total
Operational Incomes	12,235	1,530	13,765
Operational Expenditures	3,910	102	4,012
Total Incomes			13,765
Total Expenditures (depreciation included)			4,387
Results			+ 9,378

Source: INAA/General Accounting System