No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

EMPRESA NICARAGÜENSE DE ACUEDUCTOS Y ALCANTARILLADOS SANITARIOS (ENACAL)

THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN MANAGUA IN THE REPUBLIC OF NICARAGUA

FINAL REPORT

Volume III : Supporting Report - Part 1

DECEMBER 2005

NIHON SUIDO CONSULTANTS CO., LTD.
ASIA AIR SURVEY CO., LTD.

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FINAL REPORT

Volume I : Executive Summary (English Version)
Volume II : Main Report (English Version)
Volume III : Supporting Report – Part 1 (English Version)
Volume IV : Supporting Report – Part 2 (English Version)
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Supporting Report No.1	Water Balance Study
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ANNEXES

1.1 THE OBJECTIVES OF WATER BALANCE STUDY

According to the existing water supply condition there are some water shortage areas in high elevation area in Managua. It is, however, not clear that water shortage in such areas is caused by the lack of the water production amount comparing with the water demand, or other reasons.

The objectives of water balance study is to compare the future water demand with the sustainable yield from the existing water sources and to evaluate the necessity of new water resource development in near future up to year 2015.

1.2 SUMMARY OF WATER BALANCE STUDY

Future water demand is projected for domestic and non-domestic separately. For the domestic water consumption, future consumption is calculated from populations, service ratios, the calculated served population and the per capita water consumption. Non-domestic water consumption is projected from past trends. The daily average water demand is calculated from the total water consumption which is obtained from the sum of domestic water consumption and non-domestic water consumption and the effective water ratio. The daily maximum water demand is calculated by multiplying the peak factor of 1.1 to the daily average water demand. As the results the daily maximum water demand in 2015 will be 397,739 m^3/day.

Recently, the population of Zona Alta Superior of Managua, Ticuantepe and Nindiri especially along the Masaya Road has increased rapidly by the housing and commercial area developments. This population increase is mainly caused by movement from Zona Baja and Zona Alta. That means that the demand in Zona Baja and Zona Alta is moving to Zona Alta Superior. It is, therefore, necessary to relocate some water sources from Zona Baja and Zona Alta to Zona Alta Superior, Ticuantepe or Nindiri.

The assessment of the existing water sources detailed in **Supporting Report No.3** suggests that the total sustainable yield from these sources would be 402,950 m^3/day which consists of 372,950 m^3/day from the existing and relocated wells and 30,000 m^3/day from Lake Asososca. **Figure 1.2.1** shows this total yield in relation to the daily average and daily maximum water demands. As shown in **Figure 1.2.1**, water demands will gently decrease in 2010 and 2015 compared with present demand, since the reduction of ineffective water ratio is bigger than the increase of domestic and non-domestic consumptions.

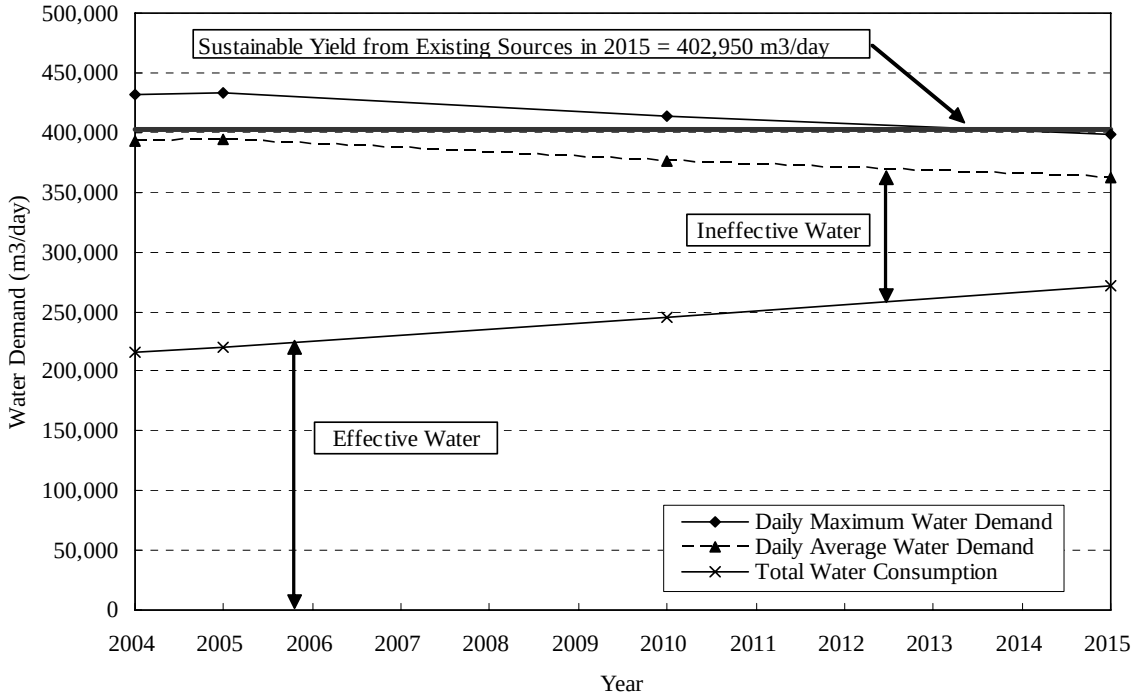

Figure 1.2.1 Sustainable Yield Capacity vs Water Demand

Figure 1.2.1 also shows that the sustainable yield in 2015 from the existing water sources would be able to satisfy the daily maximum demand in the year 2015. However, the daily maximum demand exceeds the sustainable yield in 2015 until the year 2015, and the deficit in the yield capacity to meet the day maximum demand is occurred. Although from the water source's point of view it is recommended that the production amount from Asososca Lake will decrease from the existing amount of about 56,500 m^3/day on average for 3 years from 2001 to 2003 up to 30,000 m^3/day, the production from Asososca until 2010 will be needed at more than 30,000 m^3/day in order to cover the deficit of sustainable yield from the existing sources. All these considerations lead to a conclusion that there is no urgent requirement for development of new water resources until the year 2015.

1.3 FUTURE POPULATION

1.3.1 National Population and Population in the Study Area

(1) National Population

The last national census was conducted in 1995 by INEC (Imstituto Nicaraguense de Estadisticas y Censos). The population of Nicaragua in 1995 was 4,357,099. Various studies by different institutions in Nicaragua have estimated the future population and annual population growth rate. For this Study, however, the future population and annual growth rate in Managua which was estimated by INEC in July 2004 is adopted. The population and annual growth rate for whole country and each departamento is shown in **Table 1.3.1**.

Table 1.3.1 Actual Population and Population Growth Rate in Nicaragua

DEPARTAMENTO	Population				Annual Growth Rate	
	Census 1971	Census 1995	2000	2004	95/71	2000/2005
LA REPUBLICA	1,877,952	4,357,099	4,956,964	5,374,811	3.6	2.0
NUEVA SEGOVIA	65,784	148,492	194,041	207,718	3.5	1.7
MADRIZ	53,423	107,567	122,148	130,976	3.0	1.7
ESTELI	79,164	174,894	192,565	210,657	3.4	2.2
CHINANDEGA	155,286	350,212	396,117	431,962	3.4	2.2
LEON	166,820	336,894	365,214	384,697	3.0	1.3
MANAGUA	485,850	1,093,760	1,234,102	1,350,043	3.4	2.2
MASAYA	92,152	241,354	282,928	310,324	4.1	2.3
GRANADA	71,102	155,683	175,380	187,495	3.3	1.7
CARAZO	71,134	149,407	164,016	174,469	3.1	1.5
RIVAS	74,129	140,432	154,567	164,420	2.7	1.5
BOACO	69,187	136,949	154,400	165,686	2.9	1.8
CHONTALES	68,802	144,635	164,099	178,322	3.1	2.1
JINOTEGA	90,640	257,933	272,204	292,138	4.5	1.8
MATAGALPA	168,139	383,776	439,960	475,657	3.5	1.9
R.A.A.N.		192,716	226,634	244,970	-	1.9
R.A.A.S.	145,508	272,252	333,165	371,829	2.6	2.7
RIO SAN JUAN	20,832	70,143	85,424	93,448	5.2	2.2

Source: INEC: 1995 National Census, 2000-2005 Population projection (July 2004)

(2) Population in the Study Area

The Study Area covers Municipio de Managua, urban area of Municipio de Ticuantepe in the Managua Departamento and urban area of Municipio de Nindiri in the Masaya Departamento. According to the estimation of INEC made in July, 2004, the population of these three Municipalities in 2004 is 1,055,934 as shown in **Table 1.3.2**.

Table 1.3.2 Estimation of Population in Three Municipalities

Municipality	2,000	2,001	2,002	2,003	2,004
Managua	917,004	936,041	955,410	975,062	994,964
Ticuantepe	23,820	24,266	24,719	25,182	25,651
Nindiri	34,832	34,991	35,129	35,241	35,319
Total	975,656	995,298	1,015,258	1,035,485	1,055,934

Source: INEC, Population Estimation, July 2004

As shown in **Table 1.3.3**, Managua, Ticuantepe and Nindiri Municipalities cover 289.78km2, 142.91 km2 and 60.79 km2, respectively. The most densely populated district or municipio is district 4 of Managua with 10,533 persons/km2. Ticuantepe and Nindiri are the least populated district or municipio, which densities are 179 persons/km2 and 581 persons/km2 respectively.

Table 1.3.3 Population and Density by District and Municipios (2004)

District or Municipio	Area (km2)	Population	Density (pers/km2)
District 2	20.26	115,117	5,682
District 3	109.98	213,784	1,944
District 4	15.43	162,521	10,533
District 5	70.62	261,889	3,708
District 6	73.49	241,653	3,288
Subtotal Managua	289.78	994,964	3,434
Munic Ticuantepe	142.91	25,651	179
Munic. Nindiri	60.79	35,319	581
Total	493.48	1,055,934	2,140

Source: 1) Area based on ALMA/JICA Transportation Master Plan
2) District Population estimated by Study Team based on INEC Managua total projection of July 2004, ALMA/JICA Transportation Master Plan and Customer Data of ENACAL in 2004

Note: District 1 is not included in Managua, because District 1 was established as new municipality.

The Study Area does not include all areas of Ticuantepe and Nindiri Municipalities, but includes almost all major populated area. The Study estimates that 90 % of population of each municipality is included in the Study Area as shown in **Table 1.3.4**.

Table 1.3.4 Estimation of Population in the Study Area

Municipality	2,000	2,001	2,002	2,003	2,004	Remarks
Managua	917,004	936,041	955,410	975,062	994,964	
Ticuantepe	21,438	21,839	22,247	22,664	23,086	90% of Total
Nindiri	31,349	31,492	31,616	31,717	31,787	Population
Total	969,791	989,372	1,009,273	1,029,443	1,049,837	

Source: 1) 2004 and 2005 projection estimated by INEC in July 2004

1.3.2 Population Projection for the Study Area

Future population is forecast for the Study Area including Municipio de Managua, urban area of Municipio de Ticuantepe in the Managua Departamento and urban area of Municipio de Nindiri in the Masaya Departamento. In the Study Area, statistics on migration (social increase or decrease) is not available. Thus the total population of the Study Area was projected on basis of estimation of population and annual growth rate for each municipality made by INEC in July 2004.

For Managua Municipality, populations for district level have been projected. The projection of total population in Managua takes into account estimation of population and annual growth rate for each municipality made by INEC in July 2004 and is shown in **Table 1.3.5**.

Table 1.3.5 Estimation of Population in Managua

	2004	2005	2010	2015	% annual growth
Managua	994,964	1,015,066	1,120,715	1,237,360	2.0

Source: 1) 2004 and 2005 projection estimated by INEC in July 2004
2) 2010 and 2015 projection estimated by Study Team based on annual growth of INEC calculation

After forecasting the total population in Managua until 2015, district level population in Managua is forecast considering past JICA study, “Comprehensive Transportation Plan in the

Municipality of Managua, March 1999" and present development activities as detailed in the next section. Growth rate for each district are classified into four categories of the following.

- Growth Rate < 2.0 %: developed area
- Growth Rate = 2.0 %: same as average growth rate in Managua Municipality
- Growth Rate > 2.0 %: developing area
- Growth Rate > 4.0 %: high developing area

District level population is forecast so as to be same as the forecast for the municipal population in total. For Ticuantepe and Nindiri in the Study Area, population estimates are carried out dividing into two area, that is, high developing area where is located at fringe of Managua along Masaya Road and other area. Population growth rates a year are adopted at 4.0 % for high developing area and the same rate as INEC estimate for other area. High developing area in Ticuantepe includes area along the Masaya Road and downtown area of Ticuantepe. High developing area in Nindiri includes Veracrus area and area along the Masaya Road. Populations of Ticuantepe and Nindiri in the Study Area are projected as shown in **Table 1.3.6**.

Table 1.3.6 Estimation of Population in Ticuantepe and Nindiri

	2004	2005	2010	2015	% annual growth	Population Ratio
Ticuantepe	25,651	26,526	31,410	37,266	3.5%	
within the Study Area	23,086	23,912	28,538	34,111	3.6%	90% of Total
High Developing Area	18,469	19,207	23,369	28,432	4.0%	80% of Study Area
Other Area	4,617	4,705	5,169	5,679	1.9%	20% of Study Area
outside the Study Area	2,565	2,614	2,872	3,155	1.9%	10% of Total
Nindiri	35,319	36,366	42,245	49,368	3.1%	
within the Study Area	31,787	32,823	38,649	45,718	3.4%	90% of Total
High Developing Area	25,430	26,447	32,177	39,148	4.0%	80% of Study Area
Other Area	6,357	6,376	6,473	6,570	0.3%	20% of Study Area
outside the Study Area	3,532	3,542	3,596	3,650	0.3%	10% of Total

The result of the estimation is 1,317,189 persons for 2015 in the Study Area as shown in **Table 1.3.7**.

Table 1.3.7 Projection of Population 2004-2015

	2004	2005	2010	2015
Managua	994,964	1,015,066	1,120,715	1,237,360
Ticuantepe Urban	23,086	23,912	28,538	34,111
Nindiri Urban	31,787	32,823	38,649	45,718
Total Study Area	1,049,837	1,107,122	1,223,223	1,317,189

1.3.3 Population Projection for District Zone Level in Managua

Population projection of whole Managua City mentioned in the previous section is the base of the projection for district zone level in Managua. Considering the previous JICA study, "Comprehensive Transportation Plan in the Municipality of Managua, March 1999" and present development activities such as new road constructions and housing area developments, a higher growth rate than the average rate of 2% is expected for areas in Zona Alta Superior especially along Masaya Road and Pista Interurbana Road passing through San Judas Area. On the other hand, Zona Baja is expected a low growth rate. **Figure 1.3.1** shows an annual population growth rate in each area in Managua which was adapted for the population projection in 2010 and 2015 for district zone level.

Based on the population growth rate from 2004 to 2015 which is shown in **Figure 1.3.1**, the

future projected population of each district up to 2015 is estimated as shown in **Table 1.3.8**. **Figure 1.3.1** also shows the population growth rate in Ticuantepe and Nindiri. As shown on the table, population growth rate varies from 0.5 %, to 3.4 %, the highest. Districts 2 and 4 mainly included in Zona Baja show low population growth rates. On the other hand, Districts 3 and 5 show higher population growth rates.

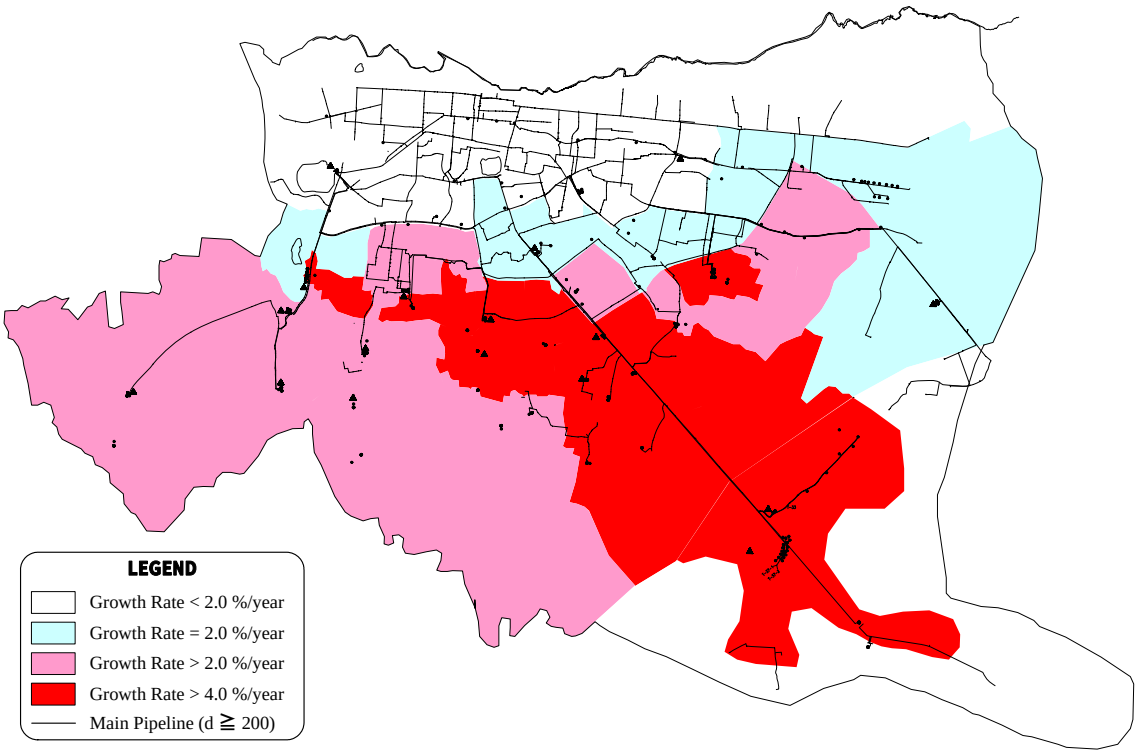

Figure 1.3.1 Annual Population Growth Rate

Table 1.3.8 District Population in 2010 and 2015

District	Population in 2004	Population in 2010	Population in 2015	Annual Growth Rate
District 2	115,117	119,385	123,085	0.6%
District 3	213,784	245,500	276,520	2.4%
District 4	162,521	167,460	171,695	0.5%
District 5	261,889	322,510	378,130	3.4%
District 6	241,653	265,860	287,930	1.6%
Total in Managua	994,964	1,120,715	1,237,360	2.0%

1.4 DOMESTIC WATER DEMAND

1.4.1 Service Ratio

Future domestic water consumption is calculated from the served population and the per capita water consumption. The service ratio of 100% is applied for the future water demand projection. Therefore the population in the study area is equal to the served population and the service area covers the study area.

1.4.2 Per Capita Water Consumption

Under the ANC Survey described in **Supporting Report No.4**, per capita water consumption rates by tariff category were estimated as below:

- High Income Users : 260 lpcd
- Medium Income Users : 175 lpcd
- Low Income Users (Asentamientos) : 160 lpcd

In conclusion, the overall average domestic per capita water consumption rate was estimated at 175 lpcd in the ANC Survey. It was confirmed during the ANC survey that all of the 10 micro sectors subjected to the survey were receiving a continuous supply with relatively high levels of water pressure. Thus, the average per capita consumption rate 175 lpcd obtained from the survey can be regarded as being the unconstrained domestic water demand in Managua. Given that there are currently many areas in the city where water is supplied only on an intermittent basis or with inadequate service pressures, the long-term future domestic water demand until 2015 is projected in this Study with a view to allowing the entire service population in the Study area to receive 175 lpcd of water in the future.

1.4.3 Domestic Water Demand

Projection of the domestic water consumption is as shown in **Table 1.4.1**.

Table 1.4.1 Future Domestic Water Consumption

			2004	2005	2010	2015
Population		(person)	1,049,837	1,071,802	1,187,902	1,317,189
	Managua	(person)	994,964	1,015,066	1,120,715	1,237,360
	Ticuantepe	(person)	23,086	23,912	28,538	34,111
	Nindiri	(person)	31,787	32,823	38,649	45,718
Per Capita Consumption		(lpcd)	175	175	175	175
Total Domestic Demand		(m3/day)	183,721	187,565	207,883	230,508

1.5 NON-DOMESTIC WATER DEMAND

Table 1.5.1 shows the number of connections and water consumption for domestic and non-domestic in 2003. Non-domestic water consumption includes consumption from industrial, commercial, government office, businesses and other institutions. As shown in the table, the percentage of non-domestic consumption was 13.6 %.

Table 1.5.1 Record of Domestic and Non-Domestic Water Consumption in 2003

Classification		Connections		Consumption	
		(Nos.)	(%)	(m3)	(%)
Domestic		163,607	96.3%	52,715,963	86.4%
Non-Domestic		6,236	3.7%	8,322,181	13.6%
	Industrial	277	0.2%	544,529	0.9%
	Commercial & Institutional	5,959	3.5%	7,777,652	12.7%
Total		169,843	100.0%	61,038,144	100.0%

source: ENACAL Commercial Data Base

Water consumption for non-domestic will grow, generally, according to the increase in population and industrial development. **Table 1.5.2** and **Figure 1.5.1** show the past record of percentage for domestic and non-domestic water consumption from 1983 to 2003. There is no big change in the percentage of non-domestic water consumption during past 20 years. Therefore, 15% of the total water consumption is applied to the percentage of non-domestic water consumption for the projection of non-domestic water consumption in the future.

Table 1.5.2 Past Record of Percentage for Domestic and Non-Domestic Consumption

Year	1983	1992	1993	1994	1995	2002	2003
Domestic	84.0	83.6	81.4	83.4	84.3	86.2	86.4
Non-Domestic	16.0	16.4	18.6	16.6	15.7	13.8	13.6

source: Data for 1983-1995; Managua II Basic Design Report, 1998
Data for 2003; ENACAL Commercial Data Base

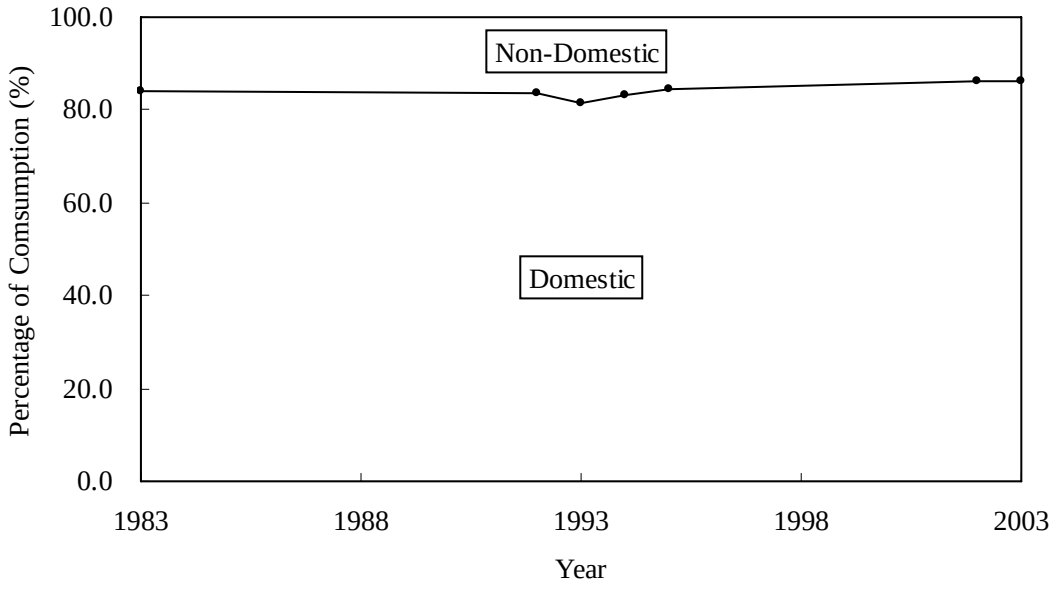

Figure 1.5.1 Percentage for Domestic and Non-Domestic Consumption

As the results total water consumption is summarized in **Table 1.5.3** and **Figure 1.5.2**. The water consumption for district level in Managua is shown in **Table 1.5.4** and **Figure 1.5.3**.

Table 1.5.3 Total Water Consumption

		2004	2005	2010	2015
Population	(person)	1,049,837	1,071,802	1,187,902	1,317,189
Per Capita Consumption	(lpcd)	175	175	175	175
Domestic Water Consumption	(m3/day)	183,721	187,565	207,883	230,508
Non-Domestic Water Consumption (15%)	(m3/day)	32,421	33,100	36,685	40,678
Total Water Consumption	(m3/day)	216,143	220,665	244,568	271,186

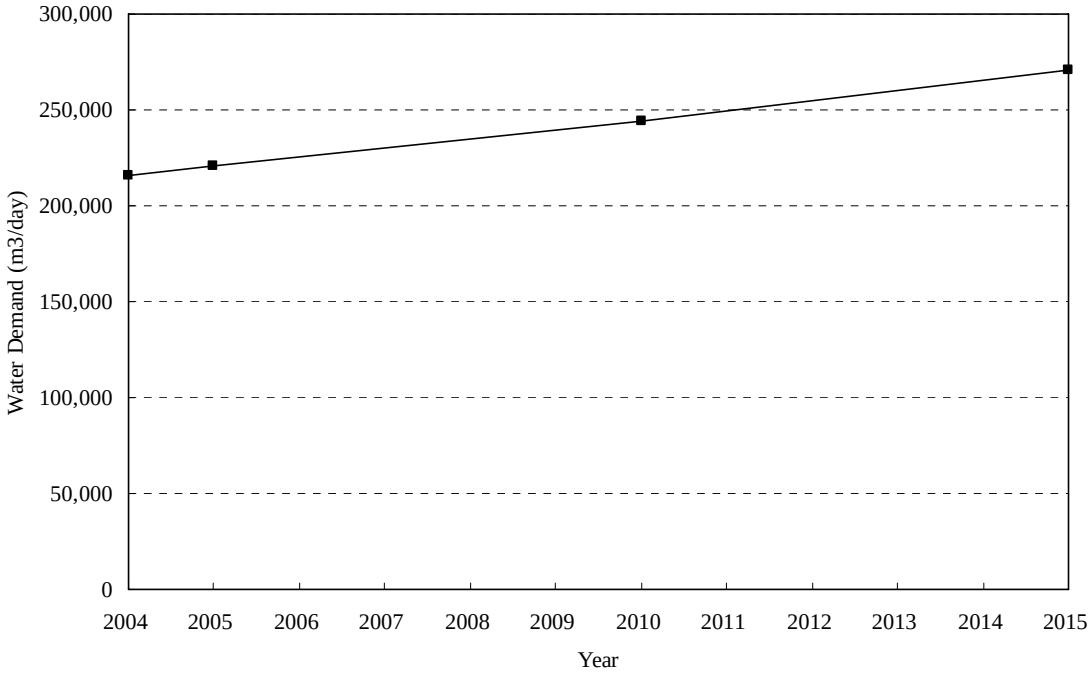

Figure 1.5.2 Total Water Consumption

Table 1.5.4 Total Water Consumption by District Level in Managua

District	Consumption in 2004	Consumption in 2010	Consumption in 2015
District 2	24,244	25,343	26,304
District 3	43,933	50,451	56,807
District 4	36,593	38,415	40,039
District 5	53,840	65,558	76,312
District 6	46,235	50,969	55,289
Total in Managua	204,846	230,735	254,751

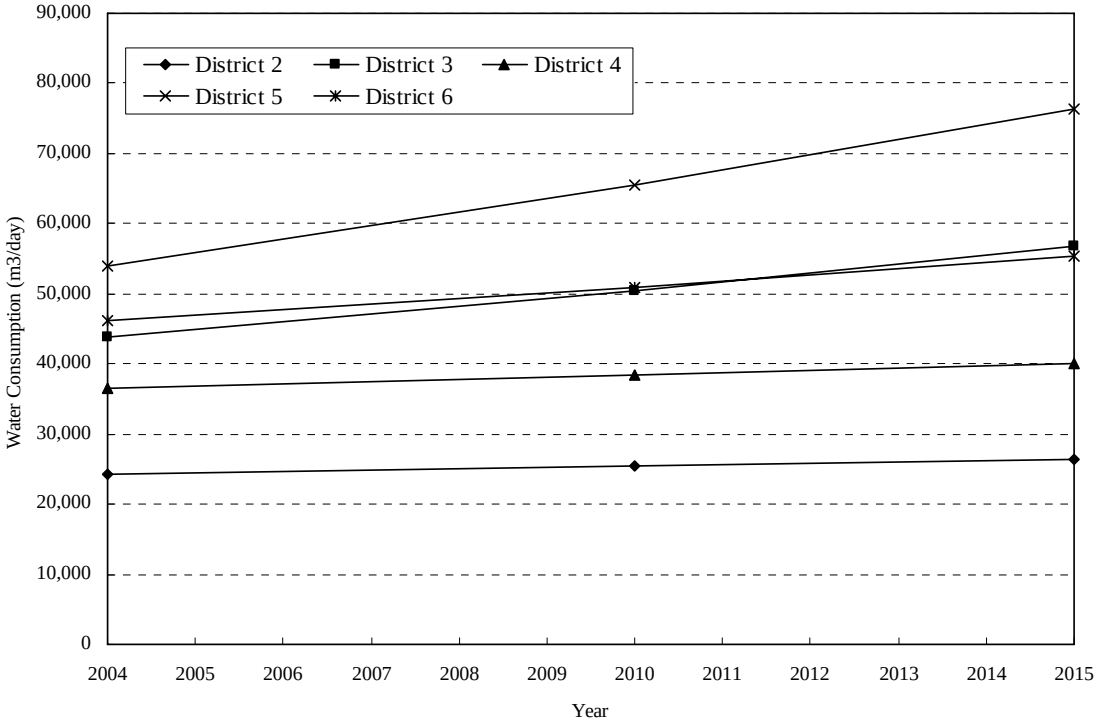

Figure 1.5.3 Total Water Consumption by District Level in Managua

1.6 EFFECTIVE WATER RATIO

The daily average water demand is calculated from the total water consumption which is obtained from the sum of domestic water consumption and non-domestic water consumption and the effective water ratio. The effective water ratio means a ratio of total water consumption (effective water) in the total distribution amount. Based on the ANC survey which was implemented by this Study, the effective water ratio is estimated at 55 % in 2004, which means that 45 % water of total distribution water is ineffective. The ineffective water includes a leakage water and wastage water. The leakage ratio and wastage water ratio were estimated at 35 % and 10 % respectively.

For the demand projection, the effective water ratio will increase to 65% in 2010 and 75% in 2010 as shown in **Table 1.6.1**. Reduction of ineffective water ratio from 45% to 25% for 10 years is rather difficult, but the reduction of leakage ratio from 35 % to 25 % and less is not an impossible plan in view of the results of the leakage ratio reduction after repairing the leakage founded by the ANC survey.

Table 1.6.1 Assumed Effective Water Ratio for Water Demand Projection

Year	2004	2005	2010	2015
Effective Water Ratio	55%	56%	65%	75%

1.7 TOTAL WATER DEMAND

1.7.1 Daily Average Water Demand

Total water demand is calculated from the summation of domestic and non-domestic water demand. The daily average water demand is calculated from the total water consumption and the future effective water ratio as shown in **Table 1.7.1**.

Table 1.7.1 Daily Average Water Demand

		2004	2005	2010	2015
Population	(person)	1,049,837	1,071,802	1,187,902	1,317,189
Per Capita Consumption	(lpcd)	175	175	175	175
Domestic Water Consumption	(m3/day)	183,721	187,565	207,883	230,508
Non-Domestic Water Consumption (15%)	(m3/day)	32,421	33,100	36,685	40,678
Total Water Consumption	(m3/day)	216,143	220,665	244,568	271,186
Effective Water Ratio		55%	56%	65%	75%
Daily Average Water Demand	(m3/day)	392,987	394,045	376,259	361,581

1.7.2 Daily Maximum Water Demand

Peak factor, which is the ratio of daily maximum water demand and the daily average water demand is calculated as 1.1 from the past records of water produced and distributed from the existing wells and Asososca Pumping Station in 2002 and 2003 as shown in **Table 1.7.2**. **Figure 1.7.1** shows daily production amount in 2002 and 2003. In this Study, therefore, the peak factor of 1.1 is adopted for calculation of the daily maximum water demand.

Table 1.7.2 Daily Average and Maximum Productions in 2002 and 2003

			2002	2003
Total Production		(m3/year)	134,809,595	145,562,818
	Daily Average	(m3/day)	368,332	397,713
	Daily Maximum	(m3/day)	405,029	447,288
	Peak Factor		1.10	1.12

Data source: ENACAL Statistic Detp.

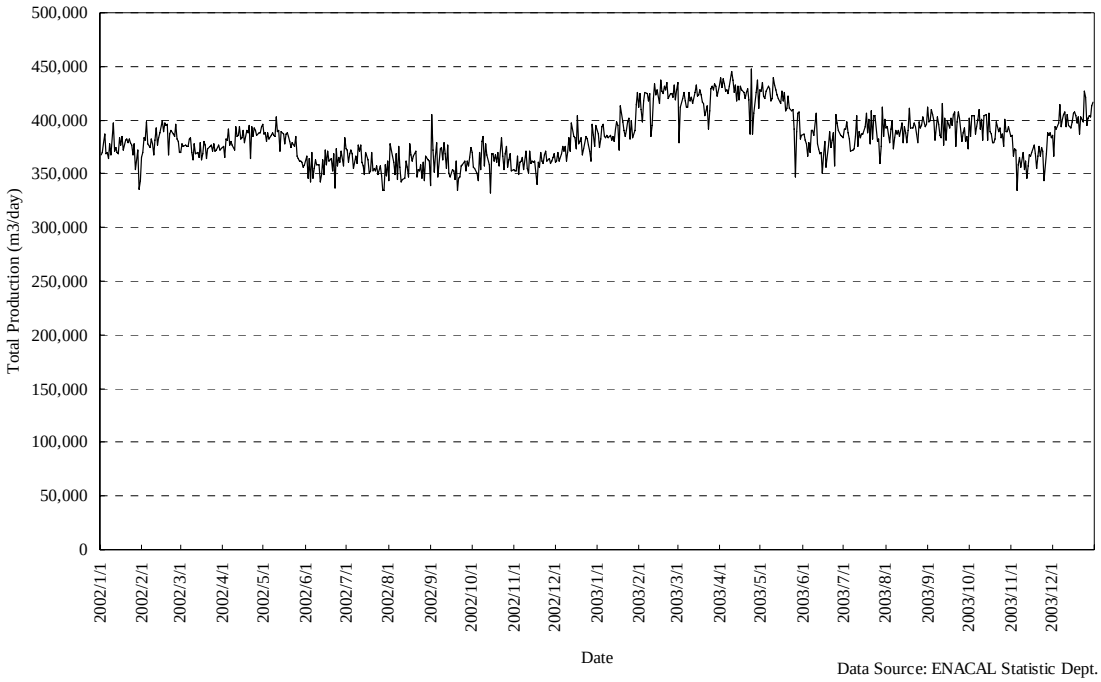

Figure 1.7.1 Daily Production Records in 2002 and 2003

1.7.3 Hourly Peak Factor

Hourly peak factor for domestic demand is estimated at 1.7 based on the ANC survey results as shown in **Figure 1.7.2**. The detailed results of the ANC survey which is the basis of calculations of the hourly peak factor are shown in **Annex 1E**. For the reference the hourly peak factor of 1.25 was used for Managua I and Managua II Projects.

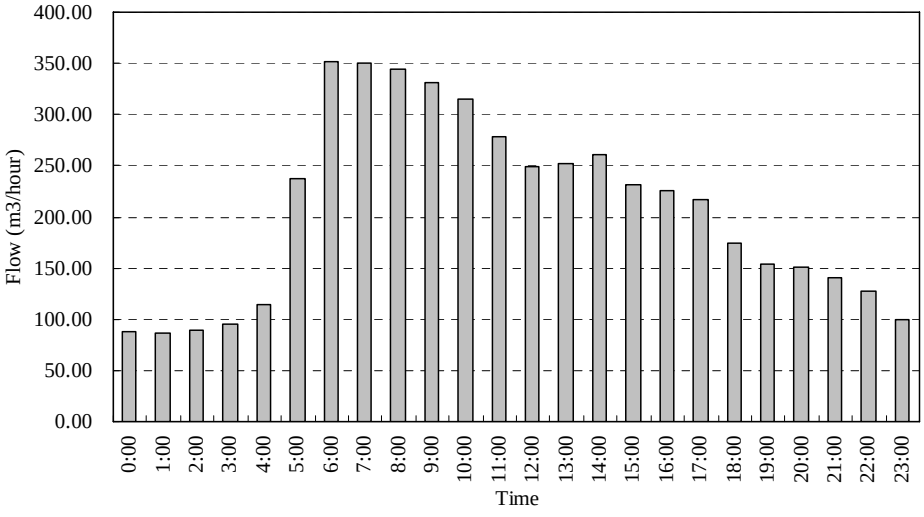

Figure 1.7.2 Hourly Flow Pattern of Total Flow of 13 Micro Sectors

1.8 CAPACITY OF FUTURE WATER SOURCE

As the results of assessment of water sources described in **Supporting Report No.3**, capacity of future water sources in Managua is summarized in **Table 1.8.1**.

Table 1.8.1 Summary of Capacity of Future Water Sources

No.	Water Sources	Production (m^3/day)	Remarks
1	Asososca Lake	30,000	
2	Managua Uno	71,000	15 wells
3	Managua Dos	56,000	16 wells
4	Zona Baja	85,817	20 wells
5	Zona Alta	40,770	14 wells
6	Zona Alta Superior	83,525	35 wells including Veracrus Wells
7	Ticuantepe & Nindiri	6,634	4 wells
8	Sub-total（1 to7）	373,747	
9	Relocated Wells	29,200	12 wells
10	TOTAL	402,947	

1.9 WATER DEMAND PROJECTION

1.9.1 Water Demand Projection in the Study Area

Table 1.9.1 shows the summary of projected water demand in the Study Area. Water demand will gently decrease in 2010 and 2015 compared with present demand, since the reduction of ineffective water ratio is bigger than the increase of domestic and non-domestic consumptions. **Table 1.9.2 and Table 1.9.3** show the projected water demand in Managua and Ticuantepe/Nindiri separately.

Table 1.9.1 Summary of Water Demand Projection in Study Area

		2004	2005	2010	2015
Population	(person)	1,049,837	1,071,802	1,187,902	1,317,189
Per Capita Consumption	(lpcd)	175	175	175	175
Domestic Water Consumption	(m3/day)	183,721	187,565	207,883	230,508
Non-Domestic Water Consumption (15%)	(m3/day)	32,421	33,100	36,685	40,678
Total Water Consumption	(m3/day)	216,143	220,665	244,568	271,186
Effective Water Ratio		55%	56%	65%	75%
Daily Average Water Demand	(m3/day)	392,987	394,045	376,259	361,581
Daily Maximum Water Demand (x 1.1)	(m3/day)	432,286	433,449	413,884	397,739

Table 1.9.2 Water Demand Projection in Managua

		2004	2005	2010	2015
Population	(person)	994,964	1,015,066	1,120,715	1,237,360
Per Capita Consumption	(lpcd)	175	175	175	175
Domestic Water Consumption	(m3/day)	174,119	177,637	196,125	216,538
Non-Domestic Water Consumption (15%)	(m3/day)	30,727	31,348	34,610	38,213
Total Water Consumption	(m3/day)	204,846	208,984	230,735	254,751
Effective Water Ratio		55%	56%	65%	75%
Daily Average Water Demand	(m3/day)	372,446	373,186	354,978	339,667
Daily Maximum Water Demand (x 1.1)	(m3/day)	409,691	410,505	390,475	373,634

Table 1.9.3 Water Demand Projection in Ticuantepe and Nindiri

		2004	2005	2010	2015
Population	(person)	54,873	56,736	67,187	79,829
Per Capita Consumption	(lpcd)	175	175	175	175
Domestic Water Consumption	(m3/day)	9,603	9,929	11,758	13,970
Non-Domestic Water Consumption (15%)	(m3/day)	1,695	1,752	2,075	2,465
Total Water Consumption	(m3/day)	11,297	11,681	13,833	16,435
Effective Water Ratio		55%	56%	65%	75%
Daily Average Water Demand	(m3/day)	20,541	20,859	21,281	21,914
Daily Maximum Water Demand (x 1.1)	(m3/day)	22,595	22,945	23,409	24,105

1.9.2 Water Demand Projection by District Zone in Managua

Water demand projection by district zone in Managua is shown in **Table 1.9.4** and **Figure 1.9.1**. Water demands of District 2 and District 4 will greatly decrease in 2010 and 2015 compared with present demand. On the other hand the demand of District 5 shows increase, since the increase of domestic and non-domestic consumptions for this district is bigger than the reduction of ineffective water ratio.

Table 1.9.4 Water Demand Projection by District in Managua

District	Demand in 2004	Demand in 2010	Demand in 2015
District 2	48,488	42,888	38,580
District 3	87,866	85,379	83,317
District 4	73,186	65,009	58,724
District 5	107,680	110,944	111,924
District 6	92,470	86,255	81,090
Total in Managua	409,691	390,475	373,634

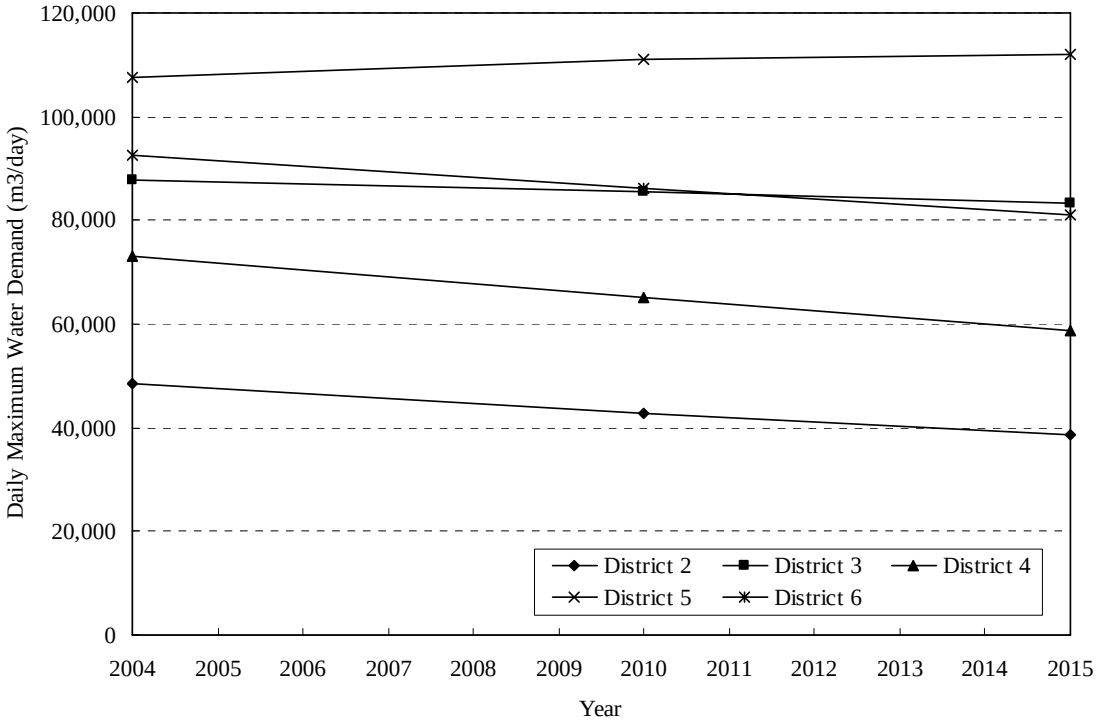

Figure 1.9.1 Water Demand by District in Managua

ANNEX 1A

National Census Data in 1995

REPUBLICA DE NICARAGUA

CENSOS NACIONALES 1995

CIFRAS OFICIALES
FINALES

SEPTIEMBRE 1996

Censos'95

CUADRO 2. SUPERFICIE Y DENSIDAD DE POBLACION POR ZONAS GEOGRAFICAS Y DEPARTAMENTO CENSOS DE 1971 Y 1995

ZONA Y DEPARTAMENTO	Censo 1971			Censo 1995		
	Superficie en Km² (*)	Población	Habitantes Por Km²	Superficie** en Km²(*)	Población	Habitantes Por Km²
LA REPUBLICA	**221 186**	**1 877 952**	**8.5**	**121 428**	**4 357 099**	**35.9**
ZONA DEL PACIFICO	**18 219**	**1 116 473**	**61.3**	**18 429**	**2 467 742**	**133.9**
Chinandega	4 662	155 286	33.3	4 926	350 212	71.1
León	5 234	166 820	31.9	5 107	336 894	66.0
Managua	3 635	485 850	133.7	3 672	1 093 760	297.9
Masaya	543	92 152	169.7	590	241 354	409.1
Granada	964	71 102	73.8	929	155 683	167.6
Carazo	1 032	71 134	68.9	1 050	149 407	142.3
Rivas	2 149	74 129	34.5	2 155	140 432	65.2
ZONA CENTRAL Y NORTE	**136 425**	**595 139**	**4.4**	**35 960**	**1 354 246**	**37.7**
Boaco	4 982	69 187	13.9	4 244	136 949	32.3
Chontales	4 947	68 802	13.9	6 378	144 635	22.7
Jinotega	9 576	90 640	9.5	9 755	257 933	26.4
Matagalpa	6 794	168 139	24.7	8 523	383 776	45.0
Estelí	2 199	79 164	36.0	2 335	174 894	74.9
Madriz	1 758	53 423	30.4	1 602	107 567	67.1
Nueva Segovia	3 341	65 784	19.7	3 123	148 492	47.5
ZONA DEL ATLANTICO	**66 542**	**166 340**	**2.5**	**67 039**	**535 111**	**8.0**
Río San Juan	7 448	20 832	2.8	7 473	70 143	9.4
Zelaya (1)	59 094	145 508	2.5	59 566	464 968	7.8
R.A.A.N.	...	...	...	32 159	192 716	6.0
R.A.A.S.	...	...	...	27 407	272 252	9.9

(1) El antiguo departamento de Zelaya comprende la R.A.A.N y R.A.A.S. actualmente
R.A.A.N. : Región Autónoma Atlántico Norte
R.A.A.S. : Región Autónoma Atlántico Sur
** La cifra de Superficie no incluye tierras bajo aguas.*
*** INETER hará cambios de acuerdo a nuevos límites municipales*

CUADRO 3. POBLACION URBANA Y RURAL DE LA REPUBLICA, POR DEPARTAMENTO Y MUNICIPIO EN LOS CENSOS DE 1971 Y 1995

DEPARTAMENTO Y MUNICIPIO	Censo de 1971			Censo de 1995		
	Total	Urbana	Rural	Total	Urbana	Rural
LA REPUBLICA	**1 877 952**	**896 380**	**981 572**	**4 357 099**	**2 370 810**	**1 986 289**
NUEVA SEGOVIA	**65 784**	**16 742**	**49 042**	**148 492**	**67 023**	**81 469**
Jalapa	15 725	3 604	12 121	41 756	21 668	20 088
Murra	8 540	340	8 200	11 017	508	10 509
El Jicaro	9 729	1 655	8 074	22 000	6 137	15 863
San Fernando	2 263	632	1 631	5 950	2 186	3 764
Mozonte	2 395	391	2 004	5 186	1 398	3 788
Dipilto	1 745	182	1 563	3 879	263	3 616
Macuelizo	2 541	158	2 383	4 768	203	4 565
Santa María	3 082	332	2 750	3 698	408	3 290
Ocotal	8 742	7 734	1 008	26 076	25 264	812
Ciudad Antigua	1 352	421	931	3 421	1 118	2 303
Quilalí	9 670	1 293	8 377	20 741	7 870	12 871
MADRIZ	**53 423**	**11 552**	**41 871**	**107 567**	**27 411**	**80 156**
Somoto	14 412	5 579	8 833	28 821	14 218	14 603
Totogalpa	4 380	781	3 599	8 796	1 489	7 307
Telpaneca	8 075	1 001	7 074	15 113	1 877	13 236
San Juan de Río Coco	4 847	1 140	3 707	15 261	1 854	13 407
Palacagüina	5 774	1 316	4 458	11 843	3 755	8 088
Yalagüina	3 258	532	2 726	7 501	1 677	5 824
San Lucas	6 723	466	6 257	10 464	585	9 879
Las Sabanas	1 717	272	1 445	4 063	835	3 228
San José de Cusmapa	4 237	465	3 772	5 705	1 121	4 584
ESTELI	**79 164**	**30 350**	**48 814**	**174 894**	**93 471**	**81 423**
Pueblo Nuevo	10 552	1 592	8 960	19 532	2 849	16 683
Condega	13 131	3 399	9 732	25 155	7 856	17 299
Estelí	34 828	19 801	15 027	92 988	71 550	21 438
San Juan de Limay	8 652	2 148	6 504	12 501	3 472	9 029
La Trinidad	12 001	3 410	8 591	18 518	7 267	11 251
San Nicolás*	...	...	...	6 200	477	5 723
CHINANDEGA	**155 286**	**74 855**	**80 431**	**350 212**	**203 555**	**146 657**
San Pedro del Norte	3 449	437	3 012	4 048	409	3 639
San Francisco del Norte	4 849	488	4 361	5 980	582	5 398
Cinco Pinos	4 448	466	3 982	6 220	557	5 663
Santo Tomás del Norte	3 142	632	2 510	6 788	369	6 419
El Viejo	24 084	8 480	15 604	69 055	33 607	35 448
Puerto Morazán	3 369	1 608	1 761	11 411	4 368	7 043
Somotillo	11 616	1 853	9 763	24 767	9 891	14 876
Villanueva	7 915	1 349	6 566	22 341	3 090	19 251
Chinandega	45 298	29 922	15 376	117 037	97 387	19 650
El Realejo	2 366	522	1 844	8 154	3 357	4 797
Corinto	14 687	13 371	1 316	17 177	16 926	251
Chichigalpa	22 923	14 596	8 327	41 903	28 823	13 080
Posoltega	7 140	1 131	6 009	15 331	4 189	11 142

CUADRO 3. POBLACION URBANA Y RURAL DE LA REPUBLICA, POR DEPARTAMENTO Y MUNICIPIO EN LOS CENSOS DE 1971 Y 1995

DEPARTAMENTO Y MUNICIPIO	Censo de 1971			Censo de 1995		
	Total	Urbana	Rural	Total	Urbana	Rural
LEON	**166 820**	**81 334**	**85 486**	**336 894**	**185 520**	**151 374**
Achuapa	9 589	1 349	8 240	13 186	2 345	10 841
El Sauce	12 869	3 246	9 623	25 973	7 052	18 921
Santa Rosa del Peñón	4 530	509	4 021	9 129	2 070	7 059
El Jicaral	3 090	434	2 656	10 036	566	9 470
Larreynaga	17 375	4 183	13 192	29 798	5 475	24 323
Telica	10 857	2 338	8 519	22 779	6 221	16 558
Quezalguaque	3 506	364	3 142	7 754	981	6 773
León	75 584	54 841	20 743	161 530	123 865	37 665
La Paz Centro	13 308	6 622	6 686	27 509	17 299	10 210
Nagarote	12 699	7 250	5 449	29 200	19 646	9 554
San Nicolás*	3 413	198	3 215	...	...	...
MANAGUA	**485 850**	**396 281**	**89 569**	**1 093 760**	**974 188**	**119 572**
San Francisco Libre	6 176	685	5 491	8 777	1 479	7 298
Tipitapa	20 315	5 674	14 641	82 808	67 925	14 883
Mateare	3 359	1 331	2 028	17 804	11 417	6 387
Villa Carlos Fonseca	6 816	791	6 025	24 230	2 334	21 896
Managua	430 690	384 904	45 786	903 100	864 201	38 899
Ticuantepe*	...	...	...	19 979	7 749	12 230
San Rafael del Sur	18 494	2 896	15 598	37 062	19 083	17 979
MASAYA	**92 152**	**52 038**	**40 114**	**241 354**	**137 546**	**103 808**
Nindirí	8 242	2 148	6 094	29 026	7 563	21 463
Masaya	45 174	30 796	14 378	117 523	88 971	28 552
Tisma	2 823	1 588	1 235	9 993	3 572	6 421
La Concepción	10 689	2 684	8 005	27 728	8 986	18 742
Masatepe	12 590	7 181	5 409	25 538	13 924	11 614
Nandasmo	3 249	2 659	590	7 879	4 624	3 255
Catarina	2 972	1 964	1 008	7 108	3 307	3 801
San Juan de Oriente	1 119	625	494	3 101	1 366	1 735
Niquinohomo	5 294	2 393	2 901	13 458	5 233	8 225
GRANADA	**71 102**	**46 659**	**24 443**	**155 683**	**96 701**	**58 982**
Diriá	3 200	1 939	1 261	6 075	3 246	2 829
Diriomo	8 910	3 621	5 289	20 102	7 078	13 024
Granada	44 453	35 422	9 031	96 996	71 783	25 213
Nandaime	14 539	5 677	8 862	32 510	14 594	17 916
CARAZO	**71 134**	**32 619**	**38 515**	**149 407**	**85 620**	**63 787**
San Marcos	10 046	3 491	6 555	25 871	16 041	9 830
Jinotepe	18 112	12 461	5 651	37 470	25 132	12 338
Dolores	1 648	1 230	418	5 421	4 938	483
Diriamba	25 575	10 151	15 424	51 191	30 558	20 633
El Rosario	1 791	1 027	764	3 923	2 131	1 792
La Paz de Carazo	1 765	922	843	4 054	1 729	2 325
Santa Teresa	9 337	2 800	6 537	17 555	4 318	13 237
La Conquista	2 860	537	2 323	3 922	773	3 149

CUADRO 3. POBLACION URBANA Y RURAL DE LA REPUBLICA, POR DEPARTAMENTO Y MUNICIPIO EN LOS CENSOS DE 1971 Y 1995

DEPARTAMENTO Y MUNICIPIO	Censo de 1971			Censo de 1995		
	Total	Urbana	Rural	Total	Urbana	Rural
RIVAS	**74 129**	**25 296**	**48 833**	**140 432**	**48 163**	**92 269**
Tola	10 046	987	9 059	19 894	1 708	18 186
Belén	8 621	3 029	5 592	15 967	3 980	11 987
Potosí	4 989	1 054	3 935	10 720	3 348	7 372
Buenos Aires	3 286	1 292	1 994	4 835	1 375	3 460
Moyogalpa	6 152	1 558	4 594	8 758	3 226	5 532
Altagracia	7 351	1 521	5 830	17 616	1 896	15 720
San Jorge	4 128	2 895	1 233	7 064	5 609	1 455
Rivas	20 612	10 007	10 605	37 817	20 868	16 949
San Juan del Sur	6 891	2 432	4 459	13 125	5 438	7 687
Cárdenas	2 053	521	1 532	4 636	715	3 921
BOACO	**69 187**	**15 590**	**53 597**	**136 949**	**39 173**	**97 776**
San José de los Remates	4 746	842	3 904	7 646	1 572	6 074
Boaco	19 498	6 443	13 055	45 188	17 344	27 844
Camoapa	15 559	4 485	11 074	32 297	11 110	21 187
Santa Lucía	5 032	727	4 305	8 173	1 072	7 101
Teustepe	12 373	991	11 382	21 299	2 763	18 536
San Lorenzo	11 979	2 102	9 877	22 346	5 312	17 034
CHONTALES	**68 802**	**20 047**	**48 755**	**144 635**	**71 650**	**72 985**
Comalapa	5 058	512	4 546	10 940	772	10 168
Juigalpa	17 909	8 772	9 137	50 791	36 999	13 792
La Libertad	9 551	1 361	8 190	9 814	2 383	7 431
Santo Domingo	7 406	1 649	5 757	12 543	4 700	7 843
Santo Tomás	6 917	2 320	4 597	15 997	10 167	5 830
San Pedro de Lóvago	4 889	1 107	3 782	7 125	2 824	4 301
Acoyapa	6 883	2 853	4 030	16 882	7 575	9 307
Villa Sandino	10 189	1 473	8 716	20 543	6 230	14 313
JINOTEGA	**90 640**	**14 247**	**76 393**	**257 933**	**48 797**	**209 136**
Wiwilí**	...	...	...	51 985	5 448	46 537
Cuá-Bocay**	...	...	...	57 599	3 039	54 560
Santa María de Pantasma**	...	...	...	29 735	2 198	27 537
San Rafael del Norte	7 150	1 599	5 551	14 066	3 049	11 017
San Sebastián de Yalí	9 557	1 491	8 066	20 277	2 832	17 445
La Concordia	4 014	922	3 092	7 049	1 408	5 641
Jinotega	69 919	10 235	59 684	77 222	30 824	46 398

CUADRO 3. POBLACION URBANA Y RURAL DE LA REPUBLICA, POR DEPARTAMENTO Y MUNICIPIO EN LOS CENSOS DE 1971 Y 1995

DEPARTAMENTO Y MUNICIPIO	Censo de 1971			Censo de 1995		
	Total	Urbana	Rural	Total	Urbana	Rural
MATAGALPA	**168 139**	**40 450**	**127 689**	**383 776**	**122 440**	**261 336**
Rancho Grande**	...	...	...	17 077	656	16 421
Río Blanco**	...	...	...	26 203	9 242	16 961
El Tuma–La Dalia**	...	...	...	43 887	2 876	41 011
San Isidro	6 670	2 471	4 199	15 353	4 779	10 574
Sébaco	9 453	3 200	6 253	24 936	16 102	8 834
Matagalpa	60 325	20 682	39 643	104 381	59 397	44 984
San Ramón	14 523	595	13 928	23 061	1 557	21 504
Matiguás	29 746	2 221	27 525	38 584	7 334	31 250
Muy Muy	5 613	1 632	3 981	13 069	2 811	10 258
Esquipulas	7 138	2 264	4 874	14 746	4 635	10 111
San Dionisio	3 207	744	2 463	16 003	2 215	13 788
Terrabona	8 623	933	7 690	10 605	1 092	9 513
Ciudad Darío	22 841	5 708	17 133	35 871	9 745	26 126
R.A.A.N.	**54 988**	**15 009**	**39 979**	**192 716**	**51 224**	**141 492**
Waspán	13 339	1 204	12 135	35 082	5 301	29 781
Puerto Cabezas	13 466	5 528	7 938	39 771	22 588	17 183
Rosita**	...	...	...	14 599	5 930	8 669
Bonanza**	...	...	...	11 810	4 459	7 351
Waslala**	...	...	...	32 924	4 082	28 842
Siuna**	...	...	...	53 218	8 530	44 688
Prinzapolka	24 321	8 277	16 044	5 312	334	4 978
Cabo Gracias a Dios	3 862	...	3 862	...	...	...
R.A.A.S.	**90 520**	**18 030**	**72 490**	**272 252**	**103 399**	**168 853**
Bocana de Paiwas**	...	...	...	32 911	3 346	29 565
La Cruz de Río Grande	12 605	150	12 455	13 642	1 001	12 641
Laguna de Perlas**	...	...	...	6 253	3 325	2 928
El Rama	49 895	1 432	48 463	54 337	17 138	37 199
Muelle de los Bueyes**	...	...	...	23 252	2 599	20 653
Kukrahill**	...	...	...	7 455	2 839	4 616
Corn Island	2 083	2 042	41	5 336	5 336	0
Bluefields	25 937	14 406	11 531	37 254	33 745	3 509
Nueva Guinea**	...	...	...	79 259	31 359	47 900
El Tortuguero***	...	...	...	9 402	834	8 568
Desembocadura Río Grande***	...	...	...	3 151	1 877	1 274
RIO SAN JUAN	**20 832**	**5 281**	**15 551**	**70 143**	**14 928**	**55 215**
Morrito	5 435	789	4 646	6 093	952	5 141
El Almendro**	...	...	...	11 795	1 450	10 345
San Miguelito	4 959	1 284	3 675	13 534	3 064	10 470
San Carlos	9 717	2 487	7 230	28 733	8 909	19 824
El Castillo**	...	...	...	9 717	315	9 402
San Juan del Norte	721	721	...	271	238	33

R.A.A.N. : Región Autónoma Atlántico Norte
R.A.A.S. : Región Autónoma Atlántico Sur
* Municipios que actualmente pertenecen a otro departamento
** Municipios creados posterior a 1971
*** Municipios creados posterior a Abril de 1995

CUADRO 4. POBLACION SEGUN SEXO, POR DEPARTAMENTO Y MUNICIPIO EN LOS CENSOS DE 1971 Y 1995

DEPARTAMENTO Y MUNICIPIOS	Censo de 1971			Censo de 1995		
	Total	Hombres	Mujeres	Total	Hombres	Mujeres
LA REPUBLICA	**1 877 952**	**921 550**	**956 402**	**4 357 099**	**2 147 105**	**2 209 994**
NUEVA SEGOVIA	**65 784**	**33 503**	**32 281**	**148 492**	**74 311**	**74 181**
Jalapa	15 725	8 072	7 653	41 756	20 957	20 799
Murra	8 540	4 464	4 076	11 017	5 771	5 246
El Jícaro	9 729	4 983	4 746	22 000	11 138	10 862
San Fernando	2 263	1 166	1 097	5 950	3 046	2 904
Mozonte	2 395	1 225	1 170	5 186	2 568	2 618
Dipilto	1 745	952	793	3 879	1 986	1 893
Macuelizo	2 541	1 283	1 258	4 768	2 486	2 282
Santa María	3 082	1 568	1 514	3 698	1 828	1 870
Ocotal	8 742	4 090	4 652	26 076	12 252	13 824
Ciudad Antigua	1 352	712	640	3 421	1 766	1 655
Quilalí	9 670	4 988	4 682	20 741	10 513	10 228
MADRIZ	**53 423**	**26 682**	**26 741**	**107 567**	**54 342**	**53 225**
Somoto	14 412	6 981	7 431	28 821	14 112	14 709
Totogalpa	4 380	2 204	2 176	8 796	4 547	4 249
Telpaneca	8 075	4 075	4 000	15 113	7 766	7 347
San Juan de Río Coco	4 847	2 449	2 398	15 261	7 698	7 563
Palacagüina	5 774	2 888	2 886	11 843	5 988	5 855
Yalagüina	3 258	1 599	1 659	7 501	3 837	3 664
San Lucas	6 723	3 454	3 269	10 464	5 411	5 053
Las Sabanas	1 717	835	882	4 063	2 098	1 965
San José de Cusmapa	4 237	2 197	2 040	5 705	2 885	2 820
ESTELI	**79 164**	**38 594**	**40 570**	**174 894**	**85 561**	**89 333**
Pueblo Nuevo	10 552	5 274	5 278	19 532	9 855	9 677
Condega	13 131	6 452	6 679	25 155	12 655	12 500
Estelí	34 828	16 571	18 257	92 988	44 306	48 682
San Juan de Limay	8 652	4 343	4 309	12 501	6 285	6 216
La Trinidad	12 001	5 954	6 047	18 518	9 230	9 288
San Nicolás*	...	...	...	6 200	3 230	2 970
CHINANDEGA	**155 286**	**77 788**	**77 498**	**350 212**	**173 760**	**176 452**
San Pedro del Norte	3 449	1 735	1 714	4 048	2 028	2 020
San Francisco del Norte	4 849	2 389	2 460	5 980	3 002	2 978
Cinco Pinos	4 448	2 172	2 276	6 220	3 087	3 133
Santo Tomás del Norte	3 142	1 583	1 559	6 788	3 408	3 380
El Viejo	24 084	12 472	11 612	69 055	34 696	34 359
Puerto Morazán	3 369	1 758	1 611	11 411	5 753	5 658
Somotillo	11 616	5 846	5 770	24 767	12 482	12 285
Villanueva	7 915	4 068	3 847	22 341	11 458	10 883
Chinandega	45 298	21 858	23 440	117 037	57 067	59 970
El Realejo	2 366	1 308	1 058	8 154	4 071	4 083
Corinto	14 687	7 158	7 529	17 177	8 321	8 856
Chichigalpa	22 923	11 630	11 293	41 903	20 605	21 298
Posoltega	7 140	3 811	3 329	15 331	7 782	7 549

ANNEX 1B

Population Projection in 2000-2005 by INEC, July 2004

Población Total por año calendario, según Departamento y Municipio. Período 2000-2005.

DEPARTAMENTO Y MUNICIPIO		Ambos Sexos					
		2000	2001	2002	2003	2004	2005
LA REPUBLICA		**5,071,671**	**5,205,023**	**5,341,883**	**5,482,340**	**5,626,492**	**5,774,433**
NUEVA SEGOVIA		**198,531**	**203,103**	**207,778**	**212,557**	**217,444**	**222,440**
5	Jalapa	52,078	53,601	55,166	56,773	58,423	60,118
10	Murra	15,357	15,814	16,285	16,769	17,268	17,782
15	El Jícaro	25,972	26,440	26,914	27,396	27,886	28,381
20	San Fernando	7,412	7,546	7,681	7,819	7,958	8,100
25	Mozonte	6,211	6,291	6,372	6,454	6,536	6,619
30	Dipilto	4,279	4,334	4,390	4,446	4,503	4,561
35	Macuelizo	5,401	5,482	5,564	5,646	5,730	5,815
40	Santa María	4,051	4,103	4,156	4,209	4,264	4,318
45	Ocotal	31,756	32,338	32,927	33,524	34,129	34,743
50	Ciudad Antigua	3,916	3,967	4,018	4,069	4,121	4,174
55	Quilalí	24,397	24,961	25,536	26,123	26,723	27,336
	Wiwili de Abajo	17,700	18,226	18,768	19,327	19,903	20,495
MADRIZ		**124,975**	**127,907**	**130,906**	**133,974**	**137,111**	**140,321**
5	Somoto	33,540	34,365	35,207	36,069	36,949	37,850
10	Totogalpa	9,574	9,736	9,900	10,066	10,235	10,406
15	Telpaneca	16,172	16,446	16,724	17,005	17,290	17,578
20	San Juan de Río Coco	20,610	21,329	22,072	22,840	23,632	24,451
25	Palacagüina	14,009	14,353	14,705	15,065	15,433	15,809
30	Yalagüina	8,461	8,626	8,794	8,964	9,137	9,313
35	San Lucas	11,645	11,842	12,041	12,244	12,449	12,658
40	Las Sabanas	4,858	5,002	5,151	5,303	5,459	5,621
45	San José de Cusmapa	6,105	6,208	6,313	6,419	6,526	6,635
ESTELI		**197,021**	**202,654**	**208,445**	**214,399**	**220,521**	**226,814**
5	Pueblo Nuevo	21,158	21,638	22,125	22,622	23,128	23,643
10	Condega	27,461	28,167	28,889	29,627	30,380	31,150
15	Estelí	109,297	113,235	117,304	121,508	125,853	130,339
20	San Juan de Limay	12,794	12,928	13,062	13,195	13,329	13,464
25	La Trinidad	19,836	20,144	20,455	20,768	21,084	21,403
30	San Nicolás	6,475	6,542	6,611	6,678	6,746	6,815
CHINANDEGA		**405,283**	**416,540**	**428,105**	**439,986**	**452,190**	**464,727**
5	San Pedro	4,380	4,411	4,442	4,473	4,504	4,534
10	San Francisco	6,510	6,555	6,602	6,648	6,693	6,739
15	Cinco Pinos	6,477	6,523	6,569	6,613	6,659	6,704
20	Santo Tomás	7,682	7,853	8,028	8,205	8,387	8,572
25	El Viejo	83,280	85,989	88,783	91,662	94,630	97,687
30	Puerto Morazán	13,418	13,785	14,163	14,548	14,944	15,351
35	Somotillo	27,943	28,709	29,493	30,298	31,122	31,968
40	Villa Nueva	26,846	27,581	28,335	29,108	29,900	30,713
45	Chinandega	137,833	142,319	146,940	151,705	156,617	161,678
50	El Realejo	10,096	10,372	10,656	10,947	11,244	11,550
55	Corinto	17,813	18,118	18,429	18,743	19,062	19,385
60	Chichigalpa	46,511	47,546	48,602	49,680	50,777	51,896
65	Posoltega	16,494	16,777	17,064	17,356	17,650	17,949

DEPARTAMENTO Y MUNICIPIO		Ambos Sexos					
		2000	2001	2002	2003	2004	2005
LEON		**373,665**	**380,731**	**387,925**	**395,251**	**402,710**	**410,304**
5	**Achuapa**	13,595	13,713	13,831	13,950	14,069	14,188
10	**El Sauce**	30,088	30,746	31,417	32,101	32,798	33,510
15	**Santa Rosa del Peñón**	9,412	9,493	9,576	9,658	9,740	9,823
20	**El Jicaral**	12,398	12,733	13,075	13,427	13,788	14,157
25	**Larreynaga**	30,722	30,988	31,256	31,524	31,792	32,062
30	**Telica**	23,546	23,750	23,955	24,160	24,367	24,573
35	**Quezalguaque**	9,054	9,298	9,549	9,806	10,069	10,339
40	**León**	181,927	185,904	189,960	194,095	198,314	202,617
45	**La Paz Centro**	30,759	31,337	31,925	32,523	33,130	33,747
50	**Nagarote**	32,164	32,769	33,383	34,008	34,643	35,288
MANAGUA		**1,262,660**	**1,298,758**	**1,335,871**	**1,374,025**	**1,413,257**	**1,453,587**
5	**San Francisco**	9,683	9,766	9,850	9,933	10,019	10,103
10	**Tipitapa**	108,969	112,687	116,529	120,498	124,601	128,840
15	**Mateare**	23,537	24,218	24,920	25,640	26,381	27,142
20	**Villa Carlos Fonseca**	32,033	32,796	33,577	34,376	35,192	36,027
	Francisco Javier	62,534	64,320	66,155	68,042	69,981	71,975
25	**Managua**	945,562	969,191	1,000,325	1,028,852	1,058,178	1,088,314
	El Crucero	18,470	18,997	19,540	20,097	20,670	21,259
30	**Ticuantepe**	23,820	24,266	24,719	25,182	25,651	26,129
35	**San Rafael del Sur**	38,052	42,516	40,256	41,404	42,584	43,797
MASAYA		**289,475**	**297,947**	**306,663**	**315,630**	**324,855**	**334,346**
5	**Nindirí**	36,651	37,661	38,698	39,761	40,854	41,975
10	**Masaya**	139,611	143,982	148,492	153,139	157,929	162,868
15	**Tisma**	11,450	11,766	12,089	12,421	12,763	13,113
20	**La Concepción**	33,335	34,254	35,196	36,164	37,158	38,177
25	**Masatepe**	30,814	31,716	32,644	33,598	34,580	35,590
30	**Nandasmo**	9,332	9,589	9,853	10,124	10,402	10,688
35	**Catarina**	8,393	8,624	8,862	9,106	9,355	9,612
40	**San Juan de Oriente**	3,785	3,890	3,996	4,106	4,219	4,335
45	**Niquinohomo**	16,104	16,466	16,834	17,211	17,595	17,988
GRANADA		**179,438**	**183,510**	**187,672**	**191,927**	**196,275**	**200,719**
5	**Diriá**	6,471	6,506	6,541	6,577	6,612	6,647
10	**Diriomo**	23,367	23,897	24,439	24,992	25,557	26,133
15	**Granada**	111,886	114,537	117,250	120,023	122,858	125,760
20	**Nandaime**	37,714	38,569	39,443	40,336	41,247	42,179
CARAZO		**167,811**	**171,405**	**175,073**	**178,818**	**182,640**	**186,542**
5	**San Marcos**	30,679	31,503	32,347	33,214	34,103	35,014
10	**Jinotepe**	42,327	43,246	44,184	45,142	46,119	47,116
15	**Dolores**	6,762	6,944	7,130	7,321	7,516	7,718
20	**Diriamba**	55,370	56,403	57,455	58,524	59,611	60,717
25	**El Rosario**	4,487	4,607	4,731	4,857	4,987	5,121
30	**La Paz de Oriente**	4,688	4,814	4,943	5,076	5,211	5,351
35	**Santa Teresa**	19,415	19,778	20,146	20,521	20,902	21,290
40	**La Conquista**	4,083	4,109	4,136	4,163	4,190	4,216

DEPARTAMENTO Y MUNICIPIO		Ambos Sexos					
		2000	2001	2002	2003	2004	2005
RIVAS		**158,144**	**161,531**	**164,988**	**168,517**	**172,119**	**175,796**
5	**Tola**	22,693	23,253	23,826	24,413	25,013	25,627
10	**Belén**	17,942	18,293	18,651	19,015	19,385	19,761
15	**Potosí**	12,451	12,823	13,204	13,597	14,001	14,417
20	**Buenos Aires**	5,165	5,214	5,263	5,312	5,362	5,412
25	**Moyogalpa**	9,288	9,376	9,464	9,552	9,641	9,731
30	**Altagracia**	19,491	19,873	20,261	20,656	21,059	21,468
35	**San Jorge**	7,800	7,953	8,109	8,267	8,428	8,592
40	**Rivas**	42,406	43,323	44,258	45,212	46,184	47,176
45	**San Juan del Sur**	15,145	15,519	15,902	16,293	16,694	17,104
50	**Cárdenas**	5,763	5,905	6,051	6,200	6,352	6,508
BOACO		**157,973**	**161,709**	**165,532**	**169,443**	**173,444**	**177,537**
5	**San José de los Remates**	8,524	8,662	8,803	8,945	9,088	9,234
10	**Boaco**	51,040	52,813	54,644	56,533	58,484	60,497
15	**Camoapa**	36,230	36,930	37,641	38,363	39,097	39,841
20	**Santa Lucía**	10,665	10,871	11,081	11,292	11,509	11,728
25	**Teustepe**	25,104	25,513	25,926	26,344	26,767	27,195
30	**San Lorenzo**	26,410	26,921	27,438	27,965	28,500	29,042
CHONTALES		**167,896**	**172,408**	**177,040**	**181,793**	**186,672**	**191,679**
5	**Comalapa**	11,790	11,987	12,185	12,387	12,591	12,797
7	**S. F. De Cuapa**	6,008	6,219	6,437	6,662	6,895	7,135
10	**Juigalpa**	55,218	57,158	59,163	61,233	63,371	65,582
15	**La Libertad**	10,870	11,029	11,189	11,352	11,516	11,681
20	**Santo Domingo**	13,615	13,842	14,072	14,304	14,540	14,778
25	**Santo Tomás**	19,117	19,690	20,279	20,884	21,505	22,144
30	**San Pedro del Lóvago**	8,317	8,455	8,596	8,738	8,882	9,028
35	**Acoyapa**	19,803	20,295	20,797	21,311	21,836	22,372
40	**Villa Sandino**	16,619	17,031	17,454	17,885	18,325	18,775
45	**El Coral**	6,539	6,701	6,867	7,037	7,210	7,387
JINOTEGA		**278,503**	**285,099**	**291,849**	**298,754**	**305,818**	**313,046**
5	**Wiwilí**	46,112	47,198	48,308	49,444	50,607	51,798
10	**Cuá-Bocay**	39,340	40,384	41,456	42,553	43,678	44,831
15	**Sta. María de Pantasma**	35,650	36,781	37,945	39,145	40,382	41,655
20	**San Rafael del Norte**	15,696	16,113	16,540	16,978	17,427	17,887
25	**San Sebastián de Yalí**	21,716	21,961	22,208	22,457	22,706	22,959
30	**La Concordia**	7,377	7,498	7,620	7,745	7,870	7,997
35	**Jinotega**	85,792	87,632	89,509	91,420	93,369	95,354
	San José de Bocay	26,819	27,533	28,263	29,012	29,778	30,564
MATAGALPA		**450,141**	**461,649**	**473,445**	**485,537**	**497,931**	**510,635**
5	**Rancho Grande**	19,865	20,435	21,020	21,619	22,232	22,861
10	**Río Blanco**	34,096	35,251	36,441	37,667	38,930	40,231
15	**El Tuma-La Dalia**	56,740	58,662	60,643	62,683	64,785	66,950
20	**San Isidro**	15,927	16,093	16,257	16,422	16,586	16,751
25	**Sébaco**	28,714	29,538	30,384	31,250	32,136	33,044
30	**Matagalpa**	130,026	134,431	138,970	143,645	148,462	153,425
35	**San Ramón**	24,898	25,156	25,415	25,671	25,930	26,187
40	**Matiguás**	40,511	40,931	41,350	41,770	42,189	42,608
45	**Muy Muy**	15,048	15,481	15,923	16,377	16,841	17,317
50	**Esquipulas**	16,554	16,860	17,170	17,484	17,800	18,121
55	**San Dionisio**	18,892	19,434	19,990	20,560	21,143	21,741
60	**Terrabona**	11,716	11,838	11,959	12,080	12,202	12,322
65	**Ciudad Darío**	37,154	37,540	37,924	38,309	38,693	39,077

DEPARTAMENTO Y MUNICIPIO		Ambos Sexos					
		2000	2001	2002	2003	2004	2005
R.A.A.N.		**231,879**	**237,794**	**243,857**	**250,071**	**256,440**	**262,968**
5	**Waspán**	35,762	36,265	36,772	37,287	37,806	38,331
10	**Puerto Cabezas**	48,579	50,007	51,475	52,982	54,530	56,122
15	**Rosita**	16,960	17,406	17,863	18,331	18,811	19,302
20	**Bonanza**	13,927	14,293	14,668	15,053	15,447	15,850
25	**Waslala**	41,036	42,241	43,480	44,754	46,063	47,408
30	**Siuna**	70,197	72,115	74,083	76,100	78,169	80,291
35	**Prinzapolka**	5,418	5,467	5,516	5,565	5,615	5,664
R.A.A.S.		**340,875**	**352,378**	**364,265**	**376,548**	**389,240**	**402,355**
5	**Paiwas**	48,657	50,676	52,775	54,955	57,222	59,578
10	**La Cruz de Río Grande**	14,893	15,158	15,427	15,700	15,975	16,254
15	**Laguna de Perlas**	8,938	9,262	9,598	9,944	10,303	10,674
20	**Rama**	53,657	55,162	56,705	58,285	59,906	61,566
	El Ayote	11,360	11,831	12,321	12,831	13,359	13,909
25	**Muelle de los Bueyes**	25,846	26,386	26,935	27,493	28,059	28,635
30	**Kukrahill**	8,188	8,334	8,482	8,631	8,783	8,937
35	**Corn Island**	6,708	6,952	7,203	7,463	7,733	8,011
40	**Bluefields**	45,007	46,408	47,849	49,331	50,855	52,420
45	**Nueva Guinea**	103,674	107,977	112,448	117,096	121,924	126,943
	Tortuguero	10,264	10,446	10,632	10,819	11,010	11,203
	Desembocadura C.Río G	3,683	3,786	3,892	4,001	4,112	4,225
RIO SAN JUAN		**87,401**	**89,900**	**92,469**	**95,110**	**97,825**	**100,617**
5	**Morrito**	6,904	7,051	7,201	7,353	7,509	7,667
10	**El Almendro**	14,464	14,882	15,313	15,756	16,211	16,678
15	**San Miguelito**	15,983	16,405	16,837	17,281	17,735	18,200
20	**San Carlos**	37,570	38,754	39,975	41,232	42,530	43,868
25	**El Castillo**	12,184	12,506	12,834	13,173	13,520	13,875
30	**San Juan del Norte**	296	302	309	316	322	329

FUENTE: Estimaciones Municipales elaboradas en la Dirección de Estadísticas Sociodemográficas. Mayo 2001.
En base a las cifras de los censos de población de 1971 y 1995.

Población Urbana por año calendario, según Departamento y Municipio. Período 2000-2005.

DEPARTAMENTO Y MUNICIPIO		Ambos Sexos					
		2000	2001	2002	2003	2004	2005
LA REPUBLICA		**2,898,641**	**2,992,968**	**3,090,781**	**3,191,670**	**3,295,743**	**3,403,092**
NUEVA SEGOVIA		**93,488**	**97,070**	**100,801**	**104,669**	**108,679**	**112,837**
5	Jalapa	30,311	31,669	33,091	34,574	36,119	37,730
10	Murra	944	987	1,032	1,079	1,128	1,179
15	El Jícaro	8,803	9,097	9,402	9,716	10,040	10,373
20	San Fernando	3,309	3,420	3,534	3,652	3,774	3,899
25	Mozonte	2,034	2,092	2,151	2,212	2,274	2,338
30	Dipilto	407	418	430	442	455	467
35	Macuelizo	322	332	342	353	363	374
40	Santa María	627	644	663	681	701	720
45	Ocotal	28,758	29,727	30,731	31,764	32,829	33,926
50	Ciudad Antigua	1,555	1,599	1,644	1,691	1,738	1,787
55	Quilalí	11,249	11,682	12,134	12,602	13,087	13,590
	Wiwili de Abajo	5,167	5,401	5,646	5,903	6,171	6,451
MADRIZ		**34,278**	**35,442**	**36,651**	**37,898**	**39,185**	**40,514**
5	Somoto	17,137	17,731	18,347	18,983	19,639	20,317
10	Totogalpa	1,984	2,037	2,092	2,148	2,206	2,265
15	Telpaneca	2,459	2,525	2,593	2,663	2,734	2,807
20	San Juan de Río Coco	3,065	3,203	3,348	3,498	3,656	3,820
25	Palacagüina	4,600	4,760	4,925	5,096	5,272	5,454
30	Yalagüina	1,959	2,017	2,077	2,138	2,201	2,265
35	San Lucas	797	818	840	863	886	910
40	Las Sabanas	1,034	1,075	1,118	1,163	1,209	1,257
45	San José de Cusmapa	1,242	1,276	1,310	1,346	1,382	1,419
ESTELI		**112,068**	**116,125**	**120,342**	**124,705**	**129,219**	**133,889**
5	Pueblo Nuevo	4,037	4,146	4,258	4,372	4,489	4,608
10	Condega	9,493	9,777	10,071	10,373	10,682	11,000
15	Estelí	84,623	88,038	91,596	95,287	99,116	103,087
20	San Juan de Limay	4,648	4,717	4,786	4,856	4,926	4,997
25	La Trinidad	8,616	8,786	8,960	9,137	9,316	9,497
30	San Nicolás	652	661	671	681	691	701
CHINANDEGA		**247,471**	**255,702**	**264,237**	**273,039**	**282,120**	**291,485**
5	San Pedro	566	572	578	585	592	598
10	San Francisco	810	819	828	837	847	856
15	Cinco Pinos	741	750	758	767	775	784
20	Santo Tomás	534	548	562	577	593	608
25	El Viejo	47,814	49,576	51,409	53,304	55,264	57,292
30	Puerto Morazán	6,564	6,772	6,988	7,209	7,437	7,671
35	Somotillo	13,165	13,582	14,014	14,458	14,915	15,385
40	Villa Nueva	4,745	4,896	5,051	5,212	5,376	5,546
45	Chinandega	112,753	116,911	121,230	125,699	130,323	135,103
50	El Realejo	5,312	5,480	5,655	5,834	6,018	6,208
55	Corinto	17,256	17,626	18,006	18,391	18,784	19,183
60	Chichigalpa	31,452	32,287	33,147	34,027	34,927	35,848
65	Posoltega	5,760	5,883	6,010	6,139	6,270	6,403

DEPARTAMENTO Y MUNICIPIO		Ambos Sexos					
		2000	2001	2002	2003	2004	2005
LEON		**216,124**	**221,436**	**226,904**	**232,493**	**238,206**	**244,045**
5	**Achuapa**	3,091	3,131	3,173	3,215	3,257	3,299
10	**El Sauce**	10,442	10,719	11,003	11,294	11,592	11,898
15	**Santa Rosa del Peñón**	2,728	2,764	2,801	2,838	2,875	2,913
20	**El Jicaral**	1,238	1,277	1,317	1,359	1,402	1,446
25	**Larreynaga**	7,216	7,311	7,408	7,506	7,604	7,703
30	**Telica**	8,220	8,328	8,439	8,550	8,663	8,776
35	**Quezalguaque**	1,689	1,743	1,798	1,855	1,913	1,974
40	**León**	137,173	140,800	144,538	148,362	152,278	156,286
45	**La Paz Centro**	20,921	21,410	21,912	22,425	22,948	23,481
50	**Nagarote**	23,406	23,953	24,515	25,089	25,674	26,270
MANAGUA		**1,165,656**	**1,201,434**	**1,238,447**	**1,276,525**	**1,315,697**	**1,355,996**
5	**San Francisco**	2,108	2,130	2,152	2,174	2,197	2,219
10	**Tipitapa**	106,593	110,420	114,396	118,507	122,758	127,153
15	**Mateare**	17,999	18,552	19,125	19,713	20,319	20,941
20	**Villa Carlos Fonseca**	4,600	4,717	4,839	4,963	5,089	5,219
	Francisco Javier	60,292	62,121	64,012	65,957	67,956	70,013
25	**Managua**	922,252	950,229	979,157	1,008,903	1,039,488	1,070,937
	El Crucero	14,183	14,613	15,058	15,515	15,985	16,469
30	**Ticuantepe**	11,936	12,180	12,430	12,686	12,945	13,209
35	**San Rafael del Sur**	25,693	26,472	27,279	28,107	28,959	29,836
MASAYA		**172,189**	**178,356**	**184,765**	**191,393**	**198,248**	**205,336**
5	**Nindirí**	11,190	11,564	11,952	12,352	12,765	13,190
10	**Masaya**	108,362	112,396	116,597	120,945	125,449	130,113
15	**Tisma**	4,396	4,543	4,695	4,852	5,015	5,182
20	**La Concepción**	11,603	11,992	12,394	12,809	13,237	13,678
25	**Masatepe**	18,045	18,680	19,339	20,021	20,724	21,452
30	**Nandasmo**	5,882	6,079	6,283	6,493	6,710	6,934
35	**Catarina**	4,194	4,334	4,480	4,630	4,784	4,944
40	**San Juan de Oriente**	1,791	1,851	1,913	1,977	2,043	2,111
45	**Niquinohomo**	6,726	6,916	7,112	7,314	7,521	7,732
GRANADA		**114,660**	**117,684**	**120,800**	**123,992**	**127,261**	**130,608**
5	**Diriá**	3,735	3,768	3,802	3,836	3,870	3,903
10	**Diriomo**	8,887	9,120	9,360	9,605	9,857	10,113
15	**Granada**	83,750	86,029	88,379	90,786	93,253	95,781
20	**Nandaime**	18,288	18,767	19,260	19,765	20,281	20,810
CARAZO		**101,281**	**103,980**	**106,763**	**109,614**	**112,535**	**115,528**
5	**San Marcos**	19,986	20,618	21,271	21,943	22,635	23,347
10	**Jinotepe**	29,829	30,617	31,429	32,261	33,113	33,985
15	**Dolores**	6,048	6,240	6,437	6,641	6,850	7,065
20	**Diriamba**	34,728	35,539	36,373	37,224	38,092	38,977
25	**El Rosario**	2,561	2,642	2,725	2,811	2,900	2,991
30	**La Paz de Oriente**	2,101	2,167	2,236	2,307	2,379	2,454
35	**Santa Teresa**	5,158	5,279	5,403	5,529	5,658	5,789
40	**La Conquista**	869	879	889	899	909	919

DEPARTAMENTO Y MUNICIPIO		Ambos Sexos					
		2000	2001	2002	2003	2004	2005
RIVAS		**56,807**	**58,381**	**60,005**	**61,670**	**63,379**	**65,131**
5	**Tola**	2,262	2,333	2,406	2,481	2,559	2,638
10	**Belén**	4,760	4,885	5,013	5,144	5,278	5,415
15	**Potosí**	4,139	4,290	4,446	4,608	4,776	4,949
20	**Buenos Aires**	1,563	1,588	1,614	1,639	1,665	1,692
25	**Moyogalpa**	3,642	3,699	3,759	3,818	3,879	3,940
30	**Altagracia**	2,436	2,500	2,565	2,632	2,701	2,771
35	**San Jorge**	6,293	6,457	6,626	6,799	6,977	7,158
40	**Rivas**	24,001	24,677	25,375	26,090	26,823	27,575
45	**San Juan del Sur**	6,679	6,888	7,104	7,326	7,555	7,790
50	**Cárdenas**	1,032	1,064	1,098	1,132	1,167	1,204
BOACO		**49,623**	**51,401**	**53,248**	**55,158**	**57,134**	**59,177**
5	**San José de los Remates**	1,856	1,905	1,956	2,007	2,060	2,115
10	**Boaco**	20,743	21,681	22,663	23,686	24,753	25,864
15	**Camoapa**	14,396	14,823	15,263	15,715	16,178	16,653
20	**Santa Lucía**	1,616	1,664	1,713	1,764	1,816	1,869
25	**Teustepe**	3,762	3,862	3,964	4,070	4,177	4,287
30	**San Lorenzo**	7,252	7,467	7,689	7,916	8,150	8,389
CHONTALES		**91,174**	**94,536**	**98,034**	**101,655**	**105,404**	**109,285**
5	**Comalapa**	1,207	1,236	1,266	1,296	1,326	1,357
7	**S. F. De Cuapa**	1,951	2,033	2,120	2,209	2,303	2,400
10	**Juigalpa**	45,305	47,225	49,231	51,316	53,484	55,739
15	**La Libertad**	2,809	2,870	2,932	2,996	3,061	3,127
20	**Santo Domingo**	5,182	5,306	5,432	5,561	5,693	5,827
25	**Santo Tomás**	12,342	12,801	13,278	13,771	14,281	14,809
30	**San Pedro del Lóvago**	3,508	3,591	3,677	3,764	3,854	3,944
35	**Acoyapa**	9,026	9,315	9,614	9,921	10,238	10,563
40	**Villa Sandino**	7,437	7,675	7,922	8,175	8,436	8,704
45	**El Coral**	2,406	2,483	2,563	2,645	2,729	2,816
JINOTEGA		**58,842**	**60,729**	**62,683**	**64,697**	**66,771**	**68,908**
5	**Wiwilí**	4,646	4,801	4,962	5,128	5,299	5,477
10	**Cuá-Bocay**	5,017	5,200	5,390	5,586	5,790	6,000
15	**Sta. María de Pantasma**	3,788	3,945	4,110	4,281	4,459	4,644
20	**San Rafael del Norte**	4,564	4,730	4,903	5,082	5,267	5,458
25	**San Sebastián de Yalí**	4,069	4,154	4,242	4,331	4,422	4,514
30	**La Concordia**	1,977	2,028	2,082	2,136	2,192	2,249
35	**Jinotega**	34,782	35,870	36,995	38,152	39,343	40,567
MATAGALPA		**159,218**	**165,713**	**172,492**	**179,537**	**186,860**	**194,470**
5	**Rancho Grande**	1,362	1,418	1,477	1,538	1,602	1,668
10	**Río Blanco**	13,552	14,185	14,849	15,541	16,264	17,018
15	**El Tuma-La Dalia**	5,587	5,848	6,122	6,407	6,705	7,016
20	**San Isidro**	5,587	5,715	5,846	5,980	6,116	6,254
25	**Sébaco**	19,153	19,948	20,778	21,639	22,532	23,458
30	**Matagalpa**	76,430	80,003	83,747	87,653	91,729	95,983
35	**San Ramón**	2,526	2,584	2,643	2,703	2,765	2,827
40	**Matiguás**	9,400	9,616	9,837	10,062	10,290	10,523
45	**Muy Muy**	3,951	4,116	4,286	4,464	4,648	4,839
50	**Esquipulas**	6,352	6,550	6,754	6,964	7,180	7,401
55	**San Dionisio**	3,192	3,325	3,463	3,606	3,755	3,910
60	**Terrabona**	1,699	1,738	1,778	1,819	1,860	1,902
65	**Ciudad Darío**	10,426	10,666	10,911	11,160	11,414	11,671

DEPARTAMENTO Y MUNICIPIO		Ambos Sexos					
		2000	2001	2002	2003	2004	2005
R.A.A.N.		**64,774**	**66,831**	**68,961**	**71,155**	**73,415**	**75,742**
5	**Waspán**	5,832	5,942	6,055	6,169	6,285	6,403
10	**Puerto Cabezas**	28,425	29,398	30,408	31,450	32,525	33,634
15	**Rosita**	7,097	7,318	7,547	7,782	8,024	8,273
20	**Bonanza**	5,417	5,586	5,760	5,940	6,125	6,315
25	**Waslala**	5,491	5,679	5,874	6,075	6,283	6,498
30	**Siuna**	12,144	12,534	12,939	13,355	13,785	14,226
35	**Prinzapolka**	368	373	378	383	388	394
R.A.A.S.		**141,011**	**147,267**	**153,819**	**160,652**	**167,780**	**175,213**
5	**Paiwas**	6,127	6,443	6,775	7,123	7,489	7,872
10	**La Cruz de Río Grande**	1,458	1,498	1,539	1,582	1,625	1,669
15	**Laguna de Perlas**	5,434	5,685	5,948	6,223	6,510	6,809
20	**Rama**	19,251	19,980	20,739	21,524	22,337	23,178
	El Ayote	4,208	4,424	4,652	4,892	5,143	5,406
25	**Muelle de los Bueyes**	3,578	3,688	3,801	3,918	4,037	4,160
30	**Kukrahill**	3,565	3,663	3,765	3,868	3,974	4,083
35	**Corn Island**	6,708	6,952	7,203	7,463	7,733	8,011
40	**Bluefields**	40,778	42,451	44,194	46,006	47,886	49,837
45	**Nueva Guinea**	46,581	49,047	51,647	54,377	57,243	60,253
	Tortuguero	1,128	1,159	1,191	1,224	1,257	1,292
	Desembocadura C.Río G	2,195	2,278	2,364	2,454	2,546	2,642
RIO SAN JUAN		**19,977**	**20,881**	**21,829**	**22,818**	**23,850**	**24,928**
5	**Morrito**	1,200	1,244	1,291	1,338	1,388	1,439
10	**El Almendro**	2,307	2,411	2,519	2,632	2,750	2,873
15	**San Miguelito**	3,689	3,845	4,008	4,178	4,354	4,537
20	**San Carlos**	11,878	12,441	13,033	13,652	14,299	14,977
25	**El Castillo**	659	687	716	746	778	810
30	**San Juan del Norte**	243	253	262	272	281	292

FUENTE: Estimaciones Municipales elaboradas en la Dirección de Estadísticas Sociodemográficas. Mayo 2001.
En base a las cifras de los censos de población de 1971 y 1995.

Población Rural por año calendario, según Departamento y Municipio. Período 2000-2005.

DEPARTAMENTO Y MUNICIPIO		Ambos Sexos					
		2000	2001	2002	2003	2004	2005
LA REPUBLICA		**2,173,030**	**2,212,055**	**2,251,102**	**2,290,670**	**2,330,749**	**2,371,341**
NUEVA SEGOVIA		**105,043**	**106,033**	**106,977**	**107,888**	**108,765**	**109,603**
5	Jalapa	21,766	21,932	22,075	22,199	22,304	22,387
10	Murra	14,413	14,827	15,253	15,690	16,140	16,603
15	El Jícaro	17,168	17,342	17,512	17,680	17,846	18,008
20	San Fernando	4,103	4,126	4,147	4,167	4,185	4,201
25	Mozonte	4,176	4,199	4,221	4,242	4,262	4,281
30	Dipilto	3,872	3,916	3,960	4,004	4,048	4,093
35	Macuelizo	5,079	5,150	5,222	5,294	5,367	5,440
40	Santa María	3,425	3,459	3,493	3,528	3,563	3,598
45	Ocotal	2,998	2,611	2,196	1,760	1,300	817
50	Ciudad Antigua	2,361	2,368	2,374	2,379	2,383	2,387
55	Quilalí	13,148	13,278	13,402	13,521	13,636	13,746
	Wiwili de Abajo	12,533	12,825	13,122	13,424	13,731	14,043
MADRIZ		**90,697**	**92,465**	**94,255**	**96,076**	**97,926**	**99,807**
5	Somoto	16,403	16,634	16,860	17,086	17,310	17,533
10	Totogalpa	7,590	7,699	7,808	7,918	8,029	8,141
15	Telpaneca	13,714	13,921	14,131	14,342	14,555	14,771
20	San Juan de Río Coco	17,546	18,126	18,725	19,341	19,977	20,631
25	Palacagüina	9,408	9,594	9,780	9,969	10,161	10,355
30	Yalagüina	6,502	6,609	6,717	6,826	6,936	7,048
35	San Lucas	10,848	11,023	11,201	11,381	11,563	11,748
40	Las Sabanas	3,824	3,927	4,033	4,140	4,251	4,364
45	San José de Cusmapa	4,862	4,932	5,002	5,073	5,144	5,216
ESTELI		**84,953**	**86,529**	**88,103**	**89,694**	**91,302**	**92,925**
5	Pueblo Nuevo	17,121	17,492	17,868	18,250	18,639	19,035
10	Condega	17,968	18,390	18,818	19,254	19,698	20,150
15	Estelí	24,674	25,197	25,708	26,221	26,737	27,252
20	San Juan de Limay	8,146	8,212	8,276	8,340	8,404	8,467
25	La Trinidad	11,220	11,358	11,494	11,631	11,769	11,907
30	San Nicolás	5,823	5,881	5,940	5,997	6,055	6,114
CHINANDEGA		**157,812**	**160,838**	**163,868**	**166,947**	**170,070**	**173,242**
5	San Pedro	3,814	3,839	3,863	3,888	3,912	3,936
10	San Francisco	5,700	5,737	5,774	5,810	5,846	5,883
15	Cinco Pinos	5,736	5,773	5,810	5,847	5,884	5,921
20	Santo Tomás	7,148	7,306	7,465	7,628	7,794	7,964
25	El Viejo	35,466	36,413	37,374	38,358	39,365	40,396
30	Puerto Morazán	6,854	7,013	7,175	7,339	7,508	7,680
35	Somotillo	14,778	15,126	15,479	15,840	16,207	16,583
40	Villa Nueva	22,101	22,685	23,284	23,897	24,524	25,167
45	Chinandega	25,080	25,408	25,709	26,006	26,294	26,575
50	El Realejo	4,784	4,892	5,001	5,113	5,226	5,342
55	Corinto	557	493	424	352	278	202
60	Chichigalpa	15,059	15,259	15,455	15,653	15,850	16,048
65	Posoltega	10,734	10,894	11,055	11,217	11,381	11,547

DEPARTAMENTO Y MUNICIPIO		Ambos Sexos					
		2000	2001	2002	2003	2004	2005
LEON		**157,541**	**159,295**	**161,021**	**162,758**	**164,504**	**166,259**
5	**Achuapa**	10,504	10,581	10,658	10,735	10,812	10,889
10	**El Sauce**	19,646	20,027	20,413	20,806	21,206	21,612
15	**Santa Rosa del Peñón**	6,684	6,729	6,775	6,820	6,865	6,910
20	**El Jicaral**	11,160	11,456	11,758	12,068	12,386	12,711
25	**Larreynaga**	23,506	23,678	23,848	24,018	24,188	24,359
30	**Telica**	15,326	15,422	15,516	15,610	15,704	15,797
35	**Quezalguaque**	7,365	7,555	7,751	7,951	8,156	8,365
40	**León**	44,754	45,104	45,422	45,733	46,036	46,331
45	**La Paz Centro**	9,838	9,927	10,012	10,097	10,182	10,266
50	**Nagarote**	8,758	8,816	8,868	8,919	8,969	9,018
MANAGUA		**97,004**	**97,324**	**97,424**	**97,500**	**97,560**	**97,591**
5	**San Francisco**	7,575	7,636	7,698	7,759	7,822	7,884
10	**Tipitapa**	2,376	2,267	2,133	1,992	1,843	1,687
15	**Mateare**	5,538	5,666	5,795	5,927	6,062	6,201
20	**Villa Carlos Fonseca**	27,433	28,079	28,738	29,413	30,103	30,808
	Francisco Javier	2,242	2,199	2,143	2,085	2,025	1,962
25	**Managua**	23,310	22,340	21,168	19,950	18,690	17,377
	El Crucero	4,287	4,385	4,482	4,582	4,684	4,789
30	**Ticuantepe**	11,884	12,086	12,289	12,496	12,706	12,920
35	**San Rafael del Sur**	12,359	12,666	12,977	13,297	13,625	13,961
MASAYA		**117,286**	**119,591**	**121,898**	**124,237**	**126,607**	**129,010**
5	**Nindirí**	25,461	26,097	26,746	27,409	28,089	28,785
10	**Masaya**	31,249	31,586	31,895	32,194	32,480	32,755
15	**Tisma**	7,054	7,223	7,394	7,569	7,748	7,931
20	**La Concepción**	21,732	22,262	22,802	23,355	23,921	24,499
25	**Masatepe**	12,769	13,036	13,304	13,578	13,855	14,138
30	**Nandasmo**	3,450	3,510	3,570	3,630	3,692	3,754
35	**Catarina**	4,199	4,290	4,382	4,476	4,571	4,668
40	**San Juan de Oriente**	1,994	2,039	2,084	2,129	2,176	2,224
45	**Niquinohomo**	9,378	9,549	9,721	9,897	10,075	10,256
GRANADA		**64,778**	**65,826**	**66,872**	**67,935**	**69,014**	**70,111**
5	**Diriá**	2,736	2,738	2,739	2,741	2,742	2,744
10	**Diriomo**	14,480	14,777	15,079	15,386	15,700	16,020
15	**Granada**	28,136	28,508	28,871	29,237	29,605	29,979
20	**Nandaime**	19,426	19,803	20,183	20,571	20,966	21,369
CARAZO		**66,530**	**67,425**	**68,310**	**69,204**	**70,105**	**71,014**
5	**San Marcos**	10,693	10,885	11,077	11,271	11,468	11,667
10	**Jinotepe**	12,498	12,629	12,755	12,881	13,006	13,131
15	**Dolores**	714	704	693	680	667	652
20	**Diriamba**	20,642	20,864	21,082	21,300	21,519	21,740
25	**El Rosario**	1,926	1,966	2,005	2,046	2,087	2,129
30	**La Paz de Oriente**	2,587	2,647	2,707	2,769	2,832	2,897
35	**Santa Teresa**	14,257	14,499	14,744	14,992	15,244	15,500
40	**La Conquista**	3,214	3,231	3,247	3,265	3,281	3,297

DEPARTAMENTO Y MUNICIPIO		Ambos Sexos					
		2000	2001	2002	2003	2004	2005
RIVAS		**101,337**	**103,150**	**104,983**	**106,847**	**108,740**	**110,665**
5	**Tola**	20,431	20,920	21,420	21,931	22,454	22,989
10	**Belén**	13,182	13,409	13,638	13,871	14,108	14,347
15	**Potosí**	8,312	8,533	8,758	8,989	9,225	9,468
20	**Buenos Aires**	3,602	3,626	3,649	3,673	3,696	3,720
25	**Moyogalpa**	5,646	5,676	5,705	5,734	5,762	5,791
30	**Altagracia**	17,055	17,373	17,696	18,024	18,358	18,697
35	**San Jorge**	1,507	1,496	1,482	1,467	1,451	1,434
40	**Rivas**	18,405	18,645	18,883	19,122	19,361	19,601
45	**San Juan del Sur**	8,466	8,631	8,798	8,967	9,139	9,314
50	**Cárdenas**	4,731	4,841	4,953	5,068	5,185	5,305
BOACO		**108,350**	**110,308**	**112,284**	**114,285**	**116,310**	**118,360**
5	**San José de los Remates**	6,668	6,757	6,847	6,937	7,028	7,119
10	**Boaco**	30,297	31,132	31,981	32,847	33,731	34,633
15	**Camoapa**	21,834	22,107	22,378	22,648	22,918	23,188
20	**Santa Lucía**	9,049	9,207	9,367	9,529	9,693	9,859
25	**Teustepe**	21,342	21,651	21,961	22,275	22,590	22,908
30	**San Lorenzo**	19,158	19,454	19,750	20,049	20,350	20,653
CHONTALES		**76,722**	**77,872**	**79,006**	**80,138**	**81,268**	**82,394**
5	**Comalapa**	10,583	10,751	10,920	11,092	11,265	11,440
7	**S. F. De Cuapa**	4,057	4,186	4,318	4,453	4,593	4,735
10	**Juigalpa**	9,913	9,932	9,932	9,917	9,888	9,843
15	**La Libertad**	8,061	8,159	8,257	8,356	8,455	8,554
20	**Santo Domingo**	8,433	8,536	8,640	8,743	8,847	8,951
25	**Santo Tomás**	6,775	6,889	7,001	7,113	7,224	7,335
30	**San Pedro del Lóvago**	4,809	4,864	4,919	4,973	5,029	5,084
35	**Acoyapa**	10,777	10,980	11,183	11,390	11,598	11,809
40	**Villa Sandino**	9,182	9,356	9,532	9,709	9,889	10,071
45	**El Coral**	4,133	4,218	4,304	4,392	4,481	4,571
JINOTEGA		**219,661**	**224,370**	**229,166**	**234,057**	**239,047**	**244,138**
5	**Wiwilí**	41,466	42,397	43,346	44,316	45,308	46,322
10	**Cuá-Bocay**	61,142	62,717	64,329	65,979	67,667	69,395
15	**Sta. María de Pantasma**	31,863	32,835	33,836	34,864	35,923	37,011
20	**San Rafael del Norte**	11,132	11,383	11,637	11,896	12,160	12,429
25	**San Sebastián de Yalí**	17,647	17,807	17,966	18,126	18,285	18,445
30	**La Concordia**	5,401	5,469	5,539	5,609	5,678	5,748
35	**Jinotega**	51,010	51,763	52,514	53,268	54,026	54,787
MATAGALPA		**290,923**	**295,936**	**300,953**	**306,000**	**311,071**	**316,165**
5	**Rancho Grande**	18,503	19,017	19,543	20,081	20,630	21,193
10	**Río Blanco**	20,544	21,065	21,592	22,125	22,666	23,213
15	**El Tuma-La Dalia**	51,153	52,814	54,521	56,276	58,080	59,934
20	**San Isidro**	10,340	10,377	10,411	10,442	10,471	10,497
25	**Sébaco**	9,561	9,590	9,606	9,611	9,604	9,586
30	**Matagalpa**	53,596	54,427	55,223	55,993	56,733	57,442
35	**San Ramón**	22,372	22,572	22,771	22,968	23,165	23,360
40	**Matiguás**	31,111	31,315	31,513	31,708	31,899	32,085
45	**Muy Muy**	11,097	11,365	11,636	11,913	12,193	12,478
50	**Esquipulas**	10,202	10,310	10,415	10,519	10,621	10,720
55	**San Dionisio**	15,700	16,109	16,527	16,954	17,388	17,831
60	**Terrabona**	10,017	10,100	10,181	10,261	10,342	10,420
65	**Ciudad Darío**	26,728	26,874	27,013	27,149	27,280	27,406

DEPARTAMENTO Y MUNICIPIO		Ambos Sexos					
		2000	2001	2002	2003	2004	2005
R.A.A.N.		**167,105**	**170,963**	**174,896**	**178,916**	**183,025**	**187,226**
5	**Waspán**	29,930	30,322	30,718	31,118	31,521	31,928
10	**Puerto Cabezas**	20,154	20,609	21,066	21,532	22,005	22,488
15	**Rosita**	9,863	10,088	10,316	10,549	10,787	11,029
20	**Bonanza**	8,510	8,707	8,908	9,113	9,322	9,535
25	**Waslala**	35,544	36,562	37,606	38,679	39,780	40,910
30	**Siuna**	58,053	59,580	61,144	62,744	64,384	66,064
35	**Prinzapolka**	5,051	5,094	5,138	5,182	5,226	5,271
R.A.A.S.		**199,864**	**205,111**	**210,446**	**215,896**	**221,460**	**227,142**
5	**Paiwas**	42,530	44,233	46,000	47,832	49,733	51,705
10	**La Cruz de Río Grande**	13,435	13,660	13,888	14,118	14,350	14,585
15	**Laguna de Perlas**	3,504	3,577	3,649	3,721	3,793	3,865
20	**Rama**	34,406	35,182	35,966	36,761	37,569	38,388
	El Ayote	7,152	7,407	7,669	7,939	8,217	8,503
25	**Muelle de los Bueyes**	22,268	22,698	23,133	23,575	24,022	24,475
30	**Kukrahill**	4,623	4,670	4,717	4,763	4,809	4,854
35	**Corn Island**	-	-	-	-	-	-
40	**Bluefields**	4,228	3,958	3,654	3,325	2,969	2,583
45	**Nueva Guinea**	57,093	58,930	60,801	62,719	64,681	66,689
	Tortuguero	9,136	9,288	9,441	9,596	9,753	9,911
	Desembocadura C.Río G	1,488	1,508	1,528	1,547	1,565	1,583
RIO SAN JUAN		**67,424**	**69,019**	**70,640**	**72,292**	**73,975**	**75,689**
5	**Morrito**	5,704	5,806	5,910	6,015	6,121	6,228
10	**El Almendro**	12,157	12,471	12,794	13,123	13,460	13,805
15	**San Miguelito**	12,294	12,559	12,829	13,103	13,381	13,663
20	**San Carlos**	25,692	26,313	26,942	27,580	28,230	28,891
25	**El Castillo**	11,525	11,819	12,119	12,427	12,742	13,064
30	**San Juan del Norte**	53	50	47	44	40	37

FUENTE: Estimaciones Municipales elaboradas en la Dirección de Estadísticas Sociodemográficas. Mayo 2001.
En base a las cifras de los censos de población de 1971 y 1995.

ANNEX 1C

Population Estimate by "Comprehensive Transportation Plan in the Municipality of Managua, JICA Study, March 1999"

Table 1C-1 Population Projection in Managua (part 1)

District Zone	Traffic Zone	Integrated Planning	Planning Zone	Area (ha)	Population in 1998	Population in 2003	Population in 2008	Population in 2018
1	1	8	1	152	760	1,200	1,500	1,500
1	2	8	1	262	19,874	27,900	31,400	31,400
1	3	8	2	334	1,350	1,700	1,700	1,700
1	4	8	2	449	50,459	66,500	71,800	71,800
1	5	8	3	336	0	0	12,600	25,200
1	6	8	3	322	0	0	0	48,300
1	7	8	3	309	2,060	2,300	2,500	23,200
1	8	8	3	2,666	2,500	2,700	2,800	3,000
2	9	1	4	73	5,642	5,700	5,800	5,800
2	10	1	4	122	8,582	11,300	13,900	13,900
2	11	1	4	126	13,626	15,600	17,600	17,600
2	12	4	5	232	24,727	25,200	25,500	25,500
2	13	4	5	145	19,052	19,700	20,300	20,300
2	14	4	5	80	11,612	11,800	12,000	12,000
2	15	4	5	75	17,684	17,800	18,000	18,000
2	16	4	6	501	11,072	11,800	12,500	12,500
2	17	4	6	542	8,425	9,600	10,800	10,800
2	18	4	6	130	17,241	17,700	18,200	18,200
3	19	5	7	56	3,226	3,300	3,400	3,400
3	20	5	7	92	10,308	10,700	11,000	11,000
3	21	5	7	162	26,981	28,100	29,200	29,200
3	22	5	7	110	15,914	16,200	16,500	16,500
3	23	5	7	84	13,105	14,100	15,100	15,100
3	24	5	8	90	700	800	900	900
3	25	5	8	63	2,453	2,500	2,500	2,500
3	26	5	9	141	7,746	14,500	21,200	21,200
3	27	5	9	79	4,541	5,200	5,900	5,900
3	28	5	9	128	24,960	25,300	25,600	25,600
3	32	5	9	123	12,290	15,400	18,500	5,300
3	29	5	10	147	6,190	6,800	7,400	18,500
3	30	5	10	50	1,930	2,000	2,000	7,400
3	31	5	10	263	4,555	4,900	5,300	2,000
3	33	5	11	168	8,132	8,200	8,400	8,400
3	34	5	11	165	2,640	3,000	3,300	3,300
3	35	9	12	154	4,389	15,000	23,100	23,100
3	37	9	12	189	10,234	21,000	28,400	9,300
3	38	9	12	62	5,405	8,000	9,300	15,200
3	39	9	12	101	5,146	11,000	15,200	33,800
3	40	9	12	225	14,707	26,400	33,800	16,600
3	36	11	13	166	1,000	4,000	8,300	28,400
3	41	11	13	217	1,500	1,700	1,900	2,200
3	42	11	13	343	5,893	6,200	6,500	17,200
3	43	11	13	368	2,400	2,700	3,000	18,400
3	44	11	13	616	6,000	6,700	7,500	30,800
3	45	11	13	2,766	5,925	6,200	6,500	7,000
3	46	11	13	1,369	1,500	1,600	1,800	2,000
3	47	11	13	2,501	4,000	4,200	4,500	5,000
4	48	1	14	69	434	0	0	0
4	49	1	14	65	7,341	6,100	4,900	4,900
4	50	1	14	76	6,460	5,300	4,200	4,200
4	51	1	14	103	9,560	14,600	19,300	19,300
4	52	1	14	61	5,841	6,000	6,100	6,100
4	53	1	14	89	11,558	11,600	11,600	11,600
4	54	2	15	59	16,952	17,400	17,700	17,700

Table 1C-2 Population Projection in Managua (part 2)

District Zone	Traffic Zone	Integrated Planning	Planning Zone	Area (ha)	Population in 1998	Population in 2003	Population in 2008	Population in 2018
4	55	2	15	55	7,043	7,100	7,200	7,200
4	56	2	15	80	9,284	9,400	9,600	9,600
4	59	2	15	70	4,449	4,700	4,900	21,500
4	60	2	15	78	20,396	20,300	20,300	23,400
4	61	2	15	74	21,728	21,600	21,500	23,200
4	62	2	15	123	23,459	23,400	23,400	3,200
4	64	2	15	145	23,185	23,200	23,200	19,400
4	57	2	16	63	3,000	3,100	3,200	4,900
4	58	2	16	90	13,034	13,200	13,500	20,300
4	63	2	16	243	19,340	19,400	19,400	13,500
5	65	6	17	74	7,671	7,900	8,100	8,100
5	66	6	17	84	24,910	25,000	25,200	25,200
5	67	6	17	131	23,007	23,300	23,600	23,600
5	68	6	17	112	32,995	33,300	33,600	33,600
5	69	6	17	104	8,600	9,000	9,400	9,400
5	70	6	18	215	2,555	12,000	21,500	21,500
5	71	6	18	271	33,721	37,200	40,700	40,700
5	72	6	18	130	23,912	24,300	24,700	24,700
5	73	6	18	163	38,224	38,700	39,100	39,100
5	74	9	19	108	510	3,200	5,400	5,400
5	75	9	19	160	500	4,600	8,000	8,000
5	76	9	19	213	2,000	2,500	10,700	10,700
5	77	9	19	149	400	500	7,500	7,500
5	86	9	19	1,426	3,000	3,500	4,000	30,500
5	78	10	20	121	130	3,400	6,100	5,000
5	79	10	20	165	4,985	7,200	8,300	6,100
5	83	10	20	356	0	1,000	17,800	18,400
5	84	10	20	222	1,055	6,600	11,100	16,500
5	85	10	20	367	4,840	12,600	18,400	18,500
5	87	10	20	996	4,000	4,500	5,000	38,300
5	88	10	20	752	7,000	7,800	8,500	54,200
5	80	3	21	127	29,624	29,800	30,500	8,300
5	81	3	21	255	16,401	32,700	38,300	53,400
5	82	3	22	361	605	2,000	13,800	11,100
6	89	2	23	133	22,971	23,500	23,900	23,900
6	90	2	23	98	27,455	27,400	27,400	27,400
6	91	2	23	142	20,102	20,700	21,300	21,300
6	93	2	23	243	21,475	21,700	21,900	44,400
6	94	2	23	222	37,852	41,100	44,400	31,500
6	95	2	23	105	30,668	31,100	31,500	19,900
6	92	2	24	249	17,731	18,800	19,900	21,900
6	96	2	24	324	21,529	22,100	22,700	22,700
6	97	2	24	291	31,792	31,900	32,000	32,000
6	98	3	25	614	1,150	1,300	1,500	1,800
6	102	3	25	216	3,228	5,000	10,800	6,800
6	99	3	26	167	14,835	22,000	25,100	32,400
6	100	3	26	157	17,803	22,500	23,600	25,100
6	101	3	27	1,367	5,295	5,700	6,100	23,600
6	103	7	28	309	515	700	1,000	46,400
6	104	7	28	1,633	9,239	9,700	10,500	62,000
6	105	7	28	1,079	1,500	1,700	2,000	32,000
7	106	12	29	20,788	13,000	13,500	14,000	15,000
Total				54,596	1,200,285	1,383,600	1,573,800	1,963,800

Figure 1C-1 District Zone Boundary

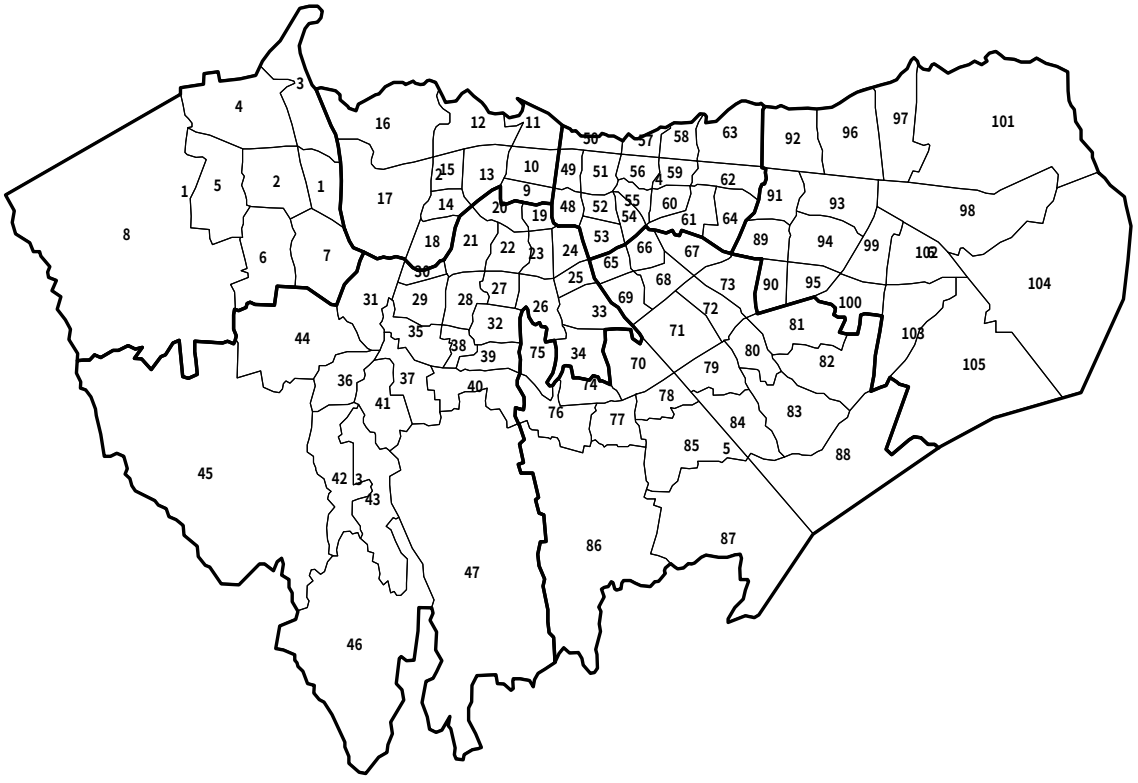

Figure 1C-2 Trafic (Sub-District) Zone Boundary

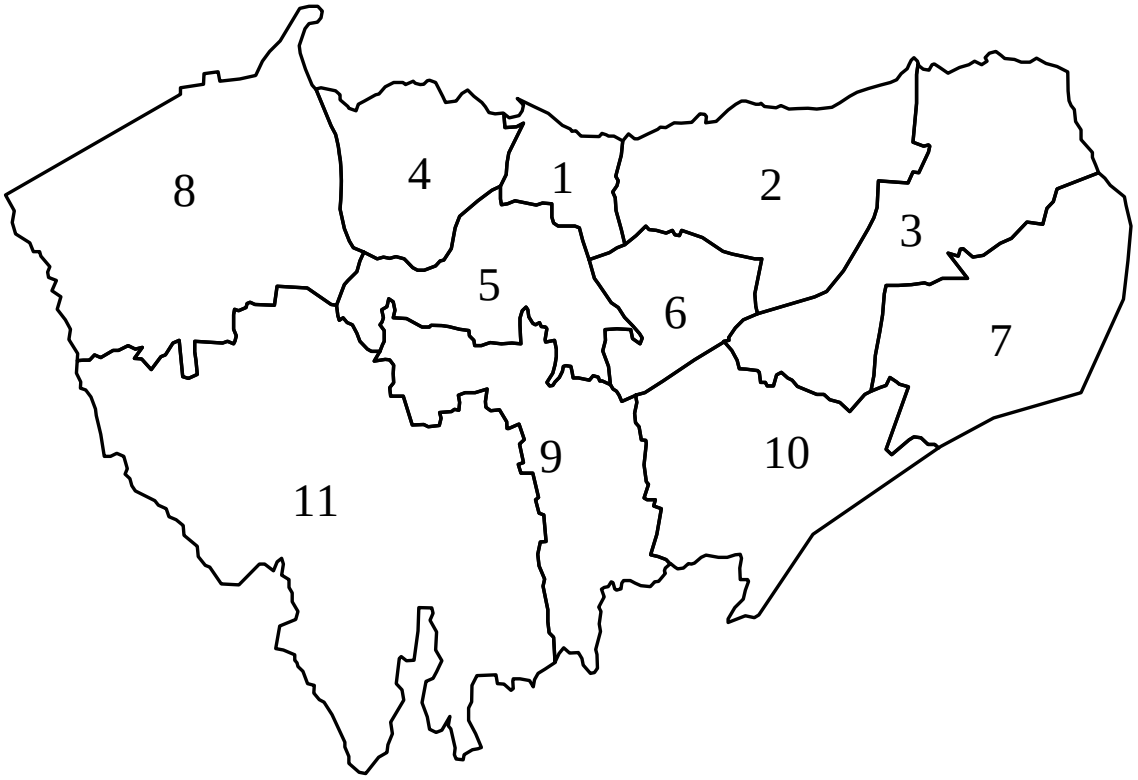

Figure 1C-3 Integrated Planning Zone Boundary

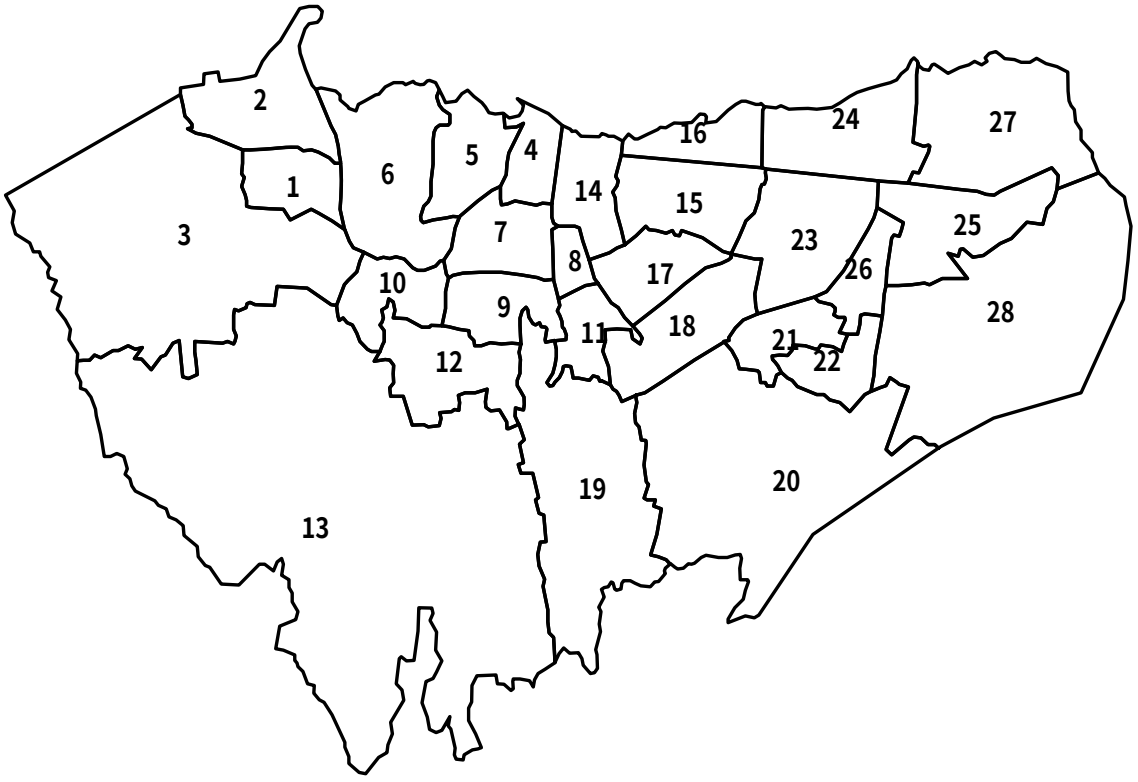

Figure 1C-4 Planning Zone Boundary

ANNEX 1D

Population and Demand Projections in Managua

Table 1D-1 Population Projection in Managua (part 1)

District	Traffic Zone	Population in 2004	Growth Rate 04-10	Population in 2010	Growth Rate 10-15	Population in 2015
2	9	4,488	0.5%	4,625	0.5%	4,740
2	10	8,898	0.5%	9,170	0.5%	9,400
2	11	12,283	0.5%	12,655	0.5%	12,975
2	12	19,842	0.5%	20,445	0.5%	20,960
2	13	15,512	0.5%	15,985	0.5%	16,390
2	14	9,291	0.5%	9,575	0.5%	9,815
2	15	14,016	0.5%	14,440	0.5%	14,805
2	16	9,291	1.0%	9,865	1.0%	10,370
2	17	7,559	1.5%	8,265	1.5%	8,905
2	18	13,937	0.5%	14,360	0.5%	14,725
3	19	2,598	0.5%	2,675	0.5%	2,745
3	20	8,425	0.5%	8,680	0.5%	8,900
3	21	22,126	0.5%	22,800	0.5%	23,375
3	22	12,756	0.5%	13,145	0.5%	13,475
3	23	11,102	1.0%	11,785	1.0%	12,385
3	24	630	2.0%	710	2.0%	785
3	25	1,968	2.0%	2,215	2.0%	2,445
3	26	11,417	2.5%	13,240	2.5%	14,980
3	27	4,094	3.5%	5,035	3.5%	5,980
3	28	19,921	2.5%	23,100	2.5%	26,135
3	32	12,126	3.0%	14,480	3.0%	16,785
3	29	5,354	2.0%	6,030	2.0%	6,660
3	30	1,575	1.5%	1,720	1.5%	1,855
3	31	3,858	2.0%	4,345	2.0%	4,795
3	33	6,457	2.0%	7,270	2.0%	8,025
3	34	2,362	6.0%	3,350	6.0%	4,485
3	35	11,811	4.0%	14,945	4.0%	18,185
3	37	16,535	3.0%	19,745	3.0%	22,890
3	38	6,299	3.5%	7,745	3.5%	9,200
3	39	8,661	4.0%	10,960	4.0%	13,335
3	40	20,787	3.0%	24,820	3.0%	28,775
3	36	3,150	2.5%	3,655	2.5%	4,135
3	41	1,339	2.5%	1,555	2.5%	1,760
3	42	3,905	2.5%	4,530	2.5%	5,125
3	43	1,063	2.5%	1,235	2.5%	1,395
3	44	5,276	2.5%	6,120	2.5%	6,925
3	45	4,882	2.5%	5,660	2.5%	6,405
3	46	0	0.5%	0	0.5%	0
3	47	3,307	3.0%	3,950	3.0%	4,580
4	48	0	0.5%	0	0.5%	0
4	49	4,803	0.5%	4,950	0.5%	5,075
4	50	4,173	0.5%	4,300	0.5%	4,410
4	51	11,496	0.5%	11,845	0.5%	12,145
4	52	4,724	0.5%	4,870	0.5%	4,995
4	53	9,134	0.5%	9,410	0.5%	9,650
4	54	13,701	0.5%	14,115	0.5%	14,470
4	55	5,591	0.5%	5,760	0.5%	5,905
4	56	7,402	0.5%	7,625	0.5%	7,820
4	59	3,701	0.5%	3,815	0.5%	3,910

Table 1D-2 Population Projection in Managua (part 2)

District	Traffic Zone	Population in 2004	Growth Rate 04-10	Population in 2010	Growth Rate 10-15	Population in 2015
4	60	15,984	0.5%	16,470	0.5%	16,885
4	61	17,008	0.5%	17,525	0.5%	17,970
4	62	18,425	0.5%	18,985	0.5%	19,465
4	64	18,268	0.5%	18,825	0.5%	19,300
4	57	2,441	0.5%	2,515	0.5%	2,580
4	58	10,394	0.5%	10,710	0.5%	10,980
4	63	15,276	0.5%	15,740	0.5%	16,135
5	65	6,220	2.0%	7,005	2.0%	7,735
5	66	19,685	0.5%	20,285	0.5%	20,795
5	67	18,346	0.5%	18,905	0.5%	19,380
5	68	26,220	2.0%	29,530	2.0%	32,605
5	69	7,087	2.0%	7,980	2.0%	8,810
5	70	9,449	4.0%	11,955	4.0%	14,545
5	71	29,291	2.5%	33,970	2.5%	38,435
5	72	19,134	2.0%	21,550	2.0%	23,795
5	73	30,472	2.0%	34,315	2.0%	37,885
5	74	2,520	10.0%	4,465	4.0%	5,430
5	75	3,622	4.0%	4,585	4.0%	5,580
5	76	1,968	15.0%	4,550	4.0%	5,535
5	77	396	50.0%	4,445	5.0%	5,675
5	86	2,756	3.0%	3,290	3.0%	3,815
5	78	2,677	17.0%	6,865	7.0%	9,630
5	79	5,669	4.0%	7,175	6.0%	9,600
5	83	787	26.0%	3,150	16.0%	6,615
5	84	5,197	7.0%	7,800	5.0%	9,955
5	85	9,921	4.0%	12,555	4.0%	15,275
5	87	3,543	13.0%	7,375	9.0%	11,345
5	88	6,142	5.0%	8,230	6.5%	11,275
5	80	23,464	3.0%	28,015	3.0%	32,475
5	81	25,748	4.0%	32,580	4.0%	39,640
6	82	1,575	3.5%	1,935	3.5%	2,300
6	89	18,504	0.5%	19,065	0.5%	19,545
6	90	21,575	2.0%	24,295	2.0%	26,825
6	91	16,299	0.5%	16,795	0.5%	17,220
6	93	17,087	2.0%	19,245	1.5%	20,730
6	94	32,362	2.0%	36,445	2.0%	40,240
6	95	24,488	2.0%	27,575	2.0%	30,445
6	92	14,803	1.0%	15,715	1.0%	16,515
6	96	17,401	0.5%	17,930	0.5%	18,385
6	97	25,118	0.5%	25,880	0.5%	26,535
6	98	1,024	2.0%	1,155	2.0%	1,275
6	102	3,937	3.5%	4,840	3.5%	5,750
6	99	17,323	2.5%	20,090	2.5%	22,730
6	100	17,716	3.0%	21,155	3.0%	24,525
6	101	4,488	1.5%	4,905	1.5%	5,285
6	103	551	3.0%	660	3.0%	765
6	104	7,638	2.0%	8,600	2.0%	9,495
6	105	1,339	2.0%	1,510	2.0%	1,665
Total		994,964	2.0%	1,120,715	2.0%	1,237,360

Table 1D-3 Population Projection by Commercial Zone in 2004 (part 1)

District	Traffic Zone	Population in 2004	Population by Commercial Zone in 2004										
			CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	Total
2	9	4,488	0	0	4,488	0	0	0	0	0	0	0	4,488
2	10	8,898	1,780	0	7,118	0	0	0	0	0	0	0	8,898
2	11	12,283	12,283	0	0	0	0	0	0	0	0	0	12,283
2	12	19,842	19,842	0	0	0	0	0	0	0	0	0	19,842
2	13	15,512	1,551	0	13,961	0	0	0	0	0	0	0	15,512
2	14	9,291	0	0	9,291	0	0	0	0	0	0	0	9,291
2	15	14,016	0	0	14,016	0	0	0	0	0	0	0	14,016
2	16	9,291	9,291	0	0	0	0	0	0	0	0	0	9,291
2	17	7,559	0	0	3,780	3,780	0	0	0	0	0	0	7,559
2	18	13,937	0	0	9,756	4,181	0	0	0	0	0	0	13,937
3	19	2,598	0	0	2,598	0	0	0	0	0	0	0	2,598
3	20	8,425	0	0	8,425	0	0	0	0	0	0	0	8,425
3	21	22,126	0	0	22,126	0	0	0	0	0	0	0	22,126
3	22	12,756	0	0	12,756	0	0	0	0	0	0	0	12,756
3	23	11,102	0	0	11,102	0	0	0	0	0	0	0	11,102
3	24	630	0	630	0	0	0	0	0	0	0	0	630
3	25	1,968	0	0	0	0	1,968	0	0	0	0	0	1,968
3	26	11,417	0	0	11,417	0	0	0	0	0	0	0	11,417
3	27	4,094	0	0	4,094	0	0	0	0	0	0	0	4,094
3	28	19,921	0	0	19,921	0	0	0	0	0	0	0	19,921
3	32	12,126	0	0	12,126	0	0	0	0	0	0	0	12,126
3	29	5,354	0	0	2,677	2,677	0	0	0	0	0	0	5,354
3	30	1,575	0	0	788	788	0	0	0	0	0	0	1,575
3	31	3,858	0	0	0	3,858	0	0	0	0	0	0	3,858
3	33	6,457	0	0	0	0	6,457	0	0	0	0	0	6,457
3	34	2,362	0	0	0	0	0	0	2,362	0	0	0	2,362
3	35	11,811	0	0	0	7,087	0	0	0	4,724	0	0	11,811
3	37	16,535	0	0	0	8,268	0	0	0	8,268	0	0	16,535
3	38	6,299	0	0	0	0	0	0	0	6,299	0	0	6,299
3	39	8,661	0	0	6,063	0	0	0	0	2,598	0	0	8,661
3	40	20,787	0	0	10,394	0	0	0	0	10,394	0	0	20,787
3	36	3,150	0	0	0	3,150	0	0	0	0	0	0	3,150
3	41	1,339	0	0	0	1,339	0	0	0	0	0	0	1,339
3	42	3,905	0	0	0	3,905	0	0	0	0	0	0	3,905
3	43	1,063	0	0	0	1,063	0	0	0	0	0	0	1,063
3	44	5,276	0	0	0	5,276	0	0	0	0	0	0	5,276
3	45	4,882	0	0	0	4,882	0	0	0	0	0	0	4,882
3	46	0	0	0	0	0	0	0	0	0	0	0	0
3	47	3,307	0	0	1,323	0	0	0	0	1,984	0	0	3,307
4	48	0	0	0	0	0	0	0	0	0	0	0	0
4	49	4,803	1,441	1,921	1,441	0	0	0	0	0	0	0	4,803
4	50	4,173	4,173	0	0	0	0	0	0	0	0	0	4,173
4	51	11,496	2,299	9,197	0	0	0	0	0	0	0	0	11,496
4	52	4,724	0	4,724	0	0	0	0	0	0	0	0	4,724
4	53	9,134	0	9,134	0	0	0	0	0	0	0	0	9,134
4	54	13,701	0	13,701	0	0	0	0	0	0	0	0	13,701
4	55	5,591	0	5,591	0	0	0	0	0	0	0	0	5,591
4	56	7,402	1,480	5,922	0	0	0	0	0	0	0	0	7,402
4	59	3,701	740	2,961	0	0	0	0	0	0	0	0	3,701

Table 1D-4 Population Projection by Commercial Zone in 2004 (part 2)

District	Traffic Zone	Population in 2004	Population by Commercial Zone in 2004										
			CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	Total
4	60	15,984	0	15,984	0	0	0	0	0	0	0	0	15,984
4	61	17,008	0	6,803	0	0	10,205	0	0	0	0	0	17,008
4	62	18,425	3,685	14,740	0	0	0	0	0	0	0	0	18,425
4	64	18,268	0	9,134	0	0	9,134	0	0	0	0	0	18,268
4	57	2,441	2,441	0	0	0	0	0	0	0	0	0	2,441
4	58	10,394	10,394	0	0	0	0	0	0	0	0	0	10,394
4	63	15,276	15,276	0	0	0	0	0	0	0	0	0	15,276
5	65	6,220	0	0	0	0	6,220	0	0	0	0	0	6,220
5	66	19,685	0	0	0	0	19,685	0	0	0	0	0	19,685
5	67	18,346	0	0	0	0	18,346	0	0	0	0	0	18,346
5	68	26,220	0	0	0	0	26,220	0	0	0	0	0	26,220
5	69	7,087	0	0	0	0	7,087	0	0	0	0	0	7,087
5	70	9,449	0	0	0	0	0	0	9,449	0	0	0	9,449
5	71	29,291	0	0	0	0	0	0	29,291	0	0	0	29,291
5	72	19,134	0	0	0	0	0	0	19,134	0	0	0	19,134
5	73	30,472	0	0	0	0	18,283	12,189	0	0	0	0	30,472
5	74	2,520	0	0	0	0	0	0	2,520	0	0	0	2,520
5	75	3,622	0	0	3,622	0	0	0	0	0	0	0	3,622
5	76	1,968	0	0	590	0	0	0	1,378	0	0	0	1,968
5	77	396	0	0	0	0	0	0	396	0	0	0	396
5	86	2,756	0	0	0	0	0	0	2,756	0	0	0	2,756
5	78	2,677	0	0	0	0	0	0	2,677	0	0	0	2,677
5	79	5,669	0	0	0	0	0	0	5,669	0	0	0	5,669
5	83	787	0	0	0	0	0	0	787	0	0	0	787
5	84	5,197	0	0	0	0	0	0	5,197	0	0	0	5,197
5	85	9,921	0	0	0	0	0	0	9,921	0	0	0	9,921
5	87	3,543	0	0	0	0	0	0	3,543	0	0	0	3,543
5	88	6,142	0	0	0	0	0	0	6,142	0	0	0	6,142
5	80	23,464	0	0	0	0	0	0	23,464	0	0	0	23,464
5	81	25,748	0	0	0	0	0	20,598	5,150	0	0	0	25,748
6	82	1,575	0	0	0	0	0	158	1,418	0	0	0	1,575
6	89	18,504	0	0	0	0	0	18,504	0	0	0	0	18,504
6	90	21,575	0	0	0	0	0	21,575	0	0	0	0	21,575
6	91	16,299	0	11,409	0	0	0	4,890	0	0	0	0	16,299
6	93	17,087	0	1,709	0	0	0	0	0	0	15,378	0	17,087
6	94	32,362	0	0	0	0	0	32,362	0	0	0	0	32,362
6	95	24,488	0	0	0	0	0	24,488	0	0	0	0	24,488
6	92	14,803	10,362	0	0	0	0	0	0	0	4,441	0	14,803
6	96	17,401	0	0	0	0	0	0	0	0	17,401	0	17,401
6	97	25,118	0	0	0	0	0	0	0	0	25,118	0	25,118
6	98	1,024	0	0	0	0	0	0	0	0	1,024	0	1,024
6	102	3,937	0	0	0	0	0	3,150	0	0	787	0	3,937
6	99	17,323	0	0	0	0	0	15,591	0	0	1,732	0	17,323
6	100	17,716	0	0	0	0	0	17,716	0	0	0	0	17,716
6	101	4,488	0	0	0	0	0	0	0	0	4,488	0	4,488
6	103	551	0	0	0	0	0	551	0	0	0	0	551
6	104	7,638	0	0	0	0	0	0	0	0	0	7,638	7,638
6	105	1,339	0	0	0	0	0	1,339	0	0	0	0	1,339
Total		994,964	97,039	113,560	193,871	50,252	123,605	173,110	131,253	34,267	70,370	7,638	994,964

Table 1D-5 Population Projection by Commercial Zone in 2010 (part 1)

District	Traffic Zone	Population in 2010	Population by Commercial Zone in 2010										
			CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	Total
2	9	4,625	0	0	4,625	0	0	0	0	0	0	0	4,625
2	10	9,170	1,834	0	7,336	0	0	0	0	0	0	0	9,170
2	11	12,655	12,655	0	0	0	0	0	0	0	0	0	12,655
2	12	20,445	20,445	0	0	0	0	0	0	0	0	0	20,445
2	13	15,985	1,599	0	14,387	0	0	0	0	0	0	0	15,985
2	14	9,575	0	0	9,575	0	0	0	0	0	0	0	9,575
2	15	14,440	0	0	14,440	0	0	0	0	0	0	0	14,440
2	16	9,865	9,865	0	0	0	0	0	0	0	0	0	9,865
2	17	8,265	0	0	4,133	4,133	0	0	0	0	0	0	8,265
2	18	14,360	0	0	10,052	4,308	0	0	0	0	0	0	14,360
3	19	2,675	0	0	2,675	0	0	0	0	0	0	0	2,675
3	20	8,680	0	0	8,680	0	0	0	0	0	0	0	8,680
3	21	22,800	0	0	22,800	0	0	0	0	0	0	0	22,800
3	22	13,145	0	0	13,145	0	0	0	0	0	0	0	13,145
3	23	11,785	0	0	11,785	0	0	0	0	0	0	0	11,785
3	24	710	0	710	0	0	0	0	0	0	0	0	710
3	25	2,215	0	0	0	0	2,215	0	0	0	0	0	2,215
3	26	13,240	0	0	13,240	0	0	0	0	0	0	0	13,240
3	27	5,035	0	0	5,035	0	0	0	0	0	0	0	5,035
3	28	23,100	0	0	23,100	0	0	0	0	0	0	0	23,100
3	32	14,480	0	0	14,480	0	0	0	0	0	0	0	14,480
3	29	6,030	0	0	3,015	3,015	0	0	0	0	0	0	6,030
3	30	1,720	0	0	860	860	0	0	0	0	0	0	1,720
3	31	4,345	0	0	0	4,345	0	0	0	0	0	0	4,345
3	33	7,270	0	0	0	0	7,270	0	0	0	0	0	7,270
3	34	3,350	0	0	0	0	0	0	3,350	0	0	0	3,350
3	35	14,945	0	0	0	8,967	0	0	0	5,978	0	0	14,945
3	37	19,745	0	0	0	9,873	0	0	0	9,873	0	0	19,745
3	38	7,745	0	0	0	0	0	0	0	7,745	0	0	7,745
3	39	10,960	0	0	7,672	0	0	0	0	3,288	0	0	10,960
3	40	24,820	0	0	12,410	0	0	0	0	12,410	0	0	24,820
3	36	3,655	0	0	0	3,655	0	0	0	0	0	0	3,655
3	41	1,555	0	0	0	1,555	0	0	0	0	0	0	1,555
3	42	4,530	0	0	0	4,530	0	0	0	0	0	0	4,530
3	43	1,235	0	0	0	1,235	0	0	0	0	0	0	1,235
3	44	6,120	0	0	0	6,120	0	0	0	0	0	0	6,120
3	45	5,660	0	0	0	5,660	0	0	0	0	0	0	5,660
3	46	0	0	0	0	0	0	0	0	0	0	0	0
3	47	3,950	0	0	1,580	0	0	0	0	2,370	0	0	3,950
4	48	0	0	0	0	0	0	0	0	0	0	0	0
4	49	4,950	1,485	1,980	1,485	0	0	0	0	0	0	0	4,950
4	50	4,300	4,300	0	0	0	0	0	0	0	0	0	4,300
4	51	11,845	2,369	9,476	0	0	0	0	0	0	0	0	11,845
4	52	4,870	0	4,870	0	0	0	0	0	0	0	0	4,870
4	53	9,410	0	9,410	0	0	0	0	0	0	0	0	9,410
4	54	14,115	0	14,115	0	0	0	0	0	0	0	0	14,115
4	55	5,760	0	5,760	0	0	0	0	0	0	0	0	5,760
4	56	7,625	1,525	6,100	0	0	0	0	0	0	0	0	7,625
4	59	3,815	763	3,052	0	0	0	0	0	0	0	0	3,815

Table 1D-6 Population Projection by Commercial Zone in 2010 (part 2)

District	Traffic Zone	Population in 2010	Population by Commercial Zone in 2010										
			CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	Total
4	60	16,470	0	16,470	0	0	0	0	0	0	0	0	16,470
4	61	17,525	0	7,010	0	0	10,515	0	0	0	0	0	17,525
4	62	18,985	3,797	15,188	0	0	0	0	0	0	0	0	18,985
4	64	18,825	0	9,413	0	0	9,413	0	0	0	0	0	18,825
4	57	2,515	2,515	0	0	0	0	0	0	0	0	0	2,515
4	58	10,710	10,710	0	0	0	0	0	0	0	0	0	10,710
4	63	15,740	15,740	0	0	0	0	0	0	0	0	0	15,740
5	65	7,005	0	0	0	0	7,005	0	0	0	0	0	7,005
5	66	20,285	0	0	0	0	20,285	0	0	0	0	0	20,285
5	67	18,905	0	0	0	0	18,905	0	0	0	0	0	18,905
5	68	29,530	0	0	0	0	29,530	0	0	0	0	0	29,530
5	69	7,980	0	0	0	0	7,980	0	0	0	0	0	7,980
5	70	11,955	0	0	0	0	0	0	11,955	0	0	0	11,955
5	71	33,970	0	0	0	0	0	0	33,970	0	0	0	33,970
5	72	21,550	0	0	0	0	0	0	21,550	0	0	0	21,550
5	73	34,315	0	0	0	0	20,589	13,726	0	0	0	0	34,315
5	74	4,465	0	0	0	0	0	0	4,465	0	0	0	4,465
5	75	4,585	0	0	4,585	0	0	0	0	0	0	0	4,585
5	76	4,550	0	0	1,365	0	0	0	3,185	0	0	0	4,550
5	77	4,445	0	0	0	0	0	0	4,445	0	0	0	4,445
5	86	3,290	0	0	0	0	0	0	3,290	0	0	0	3,290
5	78	6,865	0	0	0	0	0	0	6,865	0	0	0	6,865
5	79	7,175	0	0	0	0	0	0	7,175	0	0	0	7,175
5	83	3,150	0	0	0	0	0	0	3,150	0	0	0	3,150
5	84	7,800	0	0	0	0	0	0	7,800	0	0	0	7,800
5	85	12,555	0	0	0	0	0	0	12,555	0	0	0	12,555
5	87	7,375	0	0	0	0	0	0	7,375	0	0	0	7,375
5	88	8,230	0	0	0	0	0	0	8,230	0	0	0	8,230
5	80	28,015	0	0	0	0	0	0	28,015	0	0	0	28,015
5	81	32,580	0	0	0	0	0	26,064	6,516	0	0	0	32,580
6	82	1,935	0	0	0	0	0	194	1,742	0	0	0	1,935
6	89	19,065	0	0	0	0	0	19,065	0	0	0	0	19,065
6	90	24,295	0	0	0	0	0	24,295	0	0	0	0	24,295
6	91	16,795	0	11,757	0	0	0	5,039	0	0	0	0	16,795
6	93	19,245	0	1,925	0	0	0	0	0	0	17,321	0	19,245
6	94	36,445	0	0	0	0	0	36,445	0	0	0	0	36,445
6	95	27,575	0	0	0	0	0	27,575	0	0	0	0	27,575
6	92	15,715	11,001	0	0	0	0	0	0	0	4,715	0	15,715
6	96	17,930	0	0	0	0	0	0	0	0	17,930	0	17,930
6	97	25,880	0	0	0	0	0	0	0	0	25,880	0	25,880
6	98	1,155	0	0	0	0	0	0	0	0	1,155	0	1,155
6	102	4,840	0	0	0	0	0	3,872	0	0	968	0	4,840
6	99	20,090	0	0	0	0	0	18,081	0	0	2,009	0	20,090
6	100	21,155	0	0	0	0	0	21,155	0	0	0	0	21,155
6	101	4,905	0	0	0	0	0	0	0	0	4,905	0	4,905
6	103	660	0	0	0	0	0	660	0	0	0	0	660
6	104	8,600	0	0	0	0	0	0	0	0	0	8,600	8,600
6	105	1,510	0	0	0	0	0	1,510	0	0	0	0	1,510
Total		1,120,715	100,602	117,235	212,459	58,255	133,707	197,680	175,633	41,664	74,882	8,600	1,120,715

Table 1D-7 Population Projection by Commercial Zone in 2015 (part 1)

District	Traffic Zone	Population in 2015	Population by Commercial Zone in 2015										
			CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	Total
2	9	4,740	0	0	4,740	0	0	0	0	0	0	0	4,740
2	10	9,400	1,880	0	7,520	0	0	0	0	0	0	0	9,400
2	11	12,975	12,975	0	0	0	0	0	0	0	0	0	12,975
2	12	20,960	20,960	0	0	0	0	0	0	0	0	0	20,960
2	13	16,390	1,639	0	14,751	0	0	0	0	0	0	0	16,390
2	14	9,815	0	0	9,815	0	0	0	0	0	0	0	9,815
2	15	14,805	0	0	14,805	0	0	0	0	0	0	0	14,805
2	16	10,370	10,370	0	0	0	0	0	0	0	0	0	10,370
2	17	8,905	0	0	4,453	4,453	0	0	0	0	0	0	8,905
2	18	14,725	0	0	10,308	4,418	0	0	0	0	0	0	14,725
3	19	2,745	0	0	2,745	0	0	0	0	0	0	0	2,745
3	20	8,900	0	0	8,900	0	0	0	0	0	0	0	8,900
3	21	23,375	0	0	23,375	0	0	0	0	0	0	0	23,375
3	22	13,475	0	0	13,475	0	0	0	0	0	0	0	13,475
3	23	12,385	0	0	12,385	0	0	0	0	0	0	0	12,385
3	24	785	0	785	0	0	0	0	0	0	0	0	785
3	25	2,445	0	0	0	0	2,445	0	0	0	0	0	2,445
3	26	14,980	0	0	14,980	0	0	0	0	0	0	0	14,980
3	27	5,980	0	0	5,980	0	0	0	0	0	0	0	5,980
3	28	26,135	0	0	26,135	0	0	0	0	0	0	0	26,135
3	32	16,785	0	0	16,785	0	0	0	0	0	0	0	16,785
3	29	6,660	0	0	3,330	3,330	0	0	0	0	0	0	6,660
3	30	1,855	0	0	928	928	0	0	0	0	0	0	1,855
3	31	4,795	0	0	0	4,795	0	0	0	0	0	0	4,795
3	33	8,025	0	0	0	0	8,025	0	0	0	0	0	8,025
3	34	4,485	0	0	0	0	0	0	4,485	0	0	0	4,485
3	35	18,185	0	0	0	10,911	0	0	0	7,274	0	0	18,185
3	37	22,890	0	0	0	11,445	0	0	0	11,445	0	0	22,890
3	38	9,200	0	0	0	0	0	0	0	9,200	0	0	9,200
3	39	13,335	0	0	9,335	0	0	0	0	4,001	0	0	13,335
3	40	28,775	0	0	14,388	0	0	0	0	14,388	0	0	28,775
3	36	4,135	0	0	0	4,135	0	0	0	0	0	0	4,135
3	41	1,760	0	0	0	1,760	0	0	0	0	0	0	1,760
3	42	5,125	0	0	0	5,125	0	0	0	0	0	0	5,125
3	43	1,395	0	0	0	1,395	0	0	0	0	0	0	1,395
3	44	6,925	0	0	0	6,925	0	0	0	0	0	0	6,925
3	45	6,405	0	0	0	6,405	0	0	0	0	0	0	6,405
3	46	0	0	0	0	0	0	0	0	0	0	0	0
3	47	4,580	0	0	1,832	0	0	0	0	2,748	0	0	4,580
4	48	0	0	0	0	0	0	0	0	0	0	0	0
4	49	5,075	1,523	2,030	1,523	0	0	0	0	0	0	0	5,075
4	50	4,410	4,410	0	0	0	0	0	0	0	0	0	4,410
4	51	12,145	2,429	9,716	0	0	0	0	0	0	0	0	12,145
4	52	4,995	0	4,995	0	0	0	0	0	0	0	0	4,995
4	53	9,650	0	9,650	0	0	0	0	0	0	0	0	9,650
4	54	14,470	0	14,470	0	0	0	0	0	0	0	0	14,470
4	55	5,905	0	5,905	0	0	0	0	0	0	0	0	5,905
4	56	7,820	1,564	6,256	0	0	0	0	0	0	0	0	7,820
4	59	3,910	782	3,128	0	0	0	0	0	0	0	0	3,910

Table 1D-8 Population Projection by Commercial Zone in 2015 (part 2)

District	Traffic Zone	Population in 2015	Population by Commercial Zone in 2015										
			CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	Total
4	60	16,885	0	16,885	0	0	0	0	0	0	0	0	16,885
4	61	17,970	0	7,188	0	0	10,782	0	0	0	0	0	17,970
4	62	19,465	3,893	15,572	0	0	0	0	0	0	0	0	19,465
4	64	19,300	0	9,650	0	0	9,650	0	0	0	0	0	19,300
4	57	2,580	2,580	0	0	0	0	0	0	0	0	0	2,580
4	58	10,980	10,980	0	0	0	0	0	0	0	0	0	10,980
4	63	16,135	16,135	0	0	0	0	0	0	0	0	0	16,135
5	65	7,735	0	0	0	0	7,735	0	0	0	0	0	7,735
5	66	20,795	0	0	0	0	20,795	0	0	0	0	0	20,795
5	67	19,380	0	0	0	0	19,380	0	0	0	0	0	19,380
5	68	32,605	0	0	0	0	32,605	0	0	0	0	0	32,605
5	69	8,810	0	0	0	0	8,810	0	0	0	0	0	8,810
5	70	14,545	0	0	0	0	0	0	14,545	0	0	0	14,545
5	71	38,435	0	0	0	0	0	0	38,435	0	0	0	38,435
5	72	23,795	0	0	0	0	0	0	23,795	0	0	0	23,795
5	73	37,885	0	0	0	0	22,731	15,154	0	0	0	0	37,885
5	74	5,430	0	0	0	0	0	0	5,430	0	0	0	5,430
5	75	5,580	0	0	5,580	0	0	0	0	0	0	0	5,580
5	76	5,535	0	0	1,661	0	0	0	3,875	0	0	0	5,535
5	77	5,675	0	0	0	0	0	0	5,675	0	0	0	5,675
5	86	3,815	0	0	0	0	0	0	3,815	0	0	0	3,815
5	78	9,630	0	0	0	0	0	0	9,630	0	0	0	9,630
5	79	9,600	0	0	0	0	0	0	9,600	0	0	0	9,600
5	83	6,615	0	0	0	0	0	0	6,615	0	0	0	6,615
5	84	9,955	0	0	0	0	0	0	9,955	0	0	0	9,955
5	85	15,275	0	0	0	0	0	0	15,275	0	0	0	15,275
5	87	11,345	0	0	0	0	0	0	11,345	0	0	0	11,345
5	88	11,275	0	0	0	0	0	0	11,275	0	0	0	11,275
5	80	32,475	0	0	0	0	0	0	32,475	0	0	0	32,475
5	81	39,640	0	0	0	0	0	31,712	7,928	0	0	0	39,640
6	82	2,300	0	0	0	0	0	230	2,070	0	0	0	2,300
6	89	19,545	0	0	0	0	0	19,545	0	0	0	0	19,545
6	90	26,825	0	0	0	0	0	26,825	0	0	0	0	26,825
6	91	17,220	0	12,054	0	0	0	5,166	0	0	0	0	17,220
6	93	20,730	0	2,073	0	0	0	0	0	0	18,657	0	20,730
6	94	40,240	0	0	0	0	0	40,240	0	0	0	0	40,240
6	95	30,445	0	0	0	0	0	30,445	0	0	0	0	30,445
6	92	16,515	11,561	0	0	0	0	0	0	0	4,955	0	16,515
6	96	18,385	0	0	0	0	0	0	0	0	18,385	0	18,385
6	97	26,535	0	0	0	0	0	0	0	0	26,535	0	26,535
6	98	1,275	0	0	0	0	0	0	0	0	1,275	0	1,275
6	102	5,750	0	0	0	0	0	4,600	0	0	1,150	0	5,750
6	99	22,730	0	0	0	0	0	20,457	0	0	2,273	0	22,730
6	100	24,525	0	0	0	0	0	24,525	0	0	0	0	24,525
6	101	5,285	0	0	0	0	0	0	0	0	5,285	0	5,285
6	103	765	0	0	0	0	0	765	0	0	0	0	765
6	104	9,495	0	0	0	0	0	0	0	0	0	9,495	9,495
6	105	1,665	0	0	0	0	0	1,665	0	0	0	0	1,665
Total		1,237,360	103,680	120,357	229,726	66,024	142,958	221,329	216,223	49,055	78,515	9,495	1,237,360

Table 1D-9 Population Projection by District (part 1)

District	Traffic Zone	Population in 2004	Growth Rate 04-10	Population in 2010	Growth Rate 10-15	Population in 2015
Total District 2		115,117	0.6%	119,385	0.6%	123,085
2	9	4,488	0.5%	4,625	0.5%	4,740
2	10	8,898	0.5%	9,170	0.5%	9,400
2	11	12,283	0.5%	12,655	0.5%	12,975
2	12	19,842	0.5%	20,445	0.5%	20,960
2	13	15,512	0.5%	15,985	0.5%	16,390
2	14	9,291	0.5%	9,575	0.5%	9,815
2	15	14,016	0.5%	14,440	0.5%	14,805
2	16	9,291	1.0%	9,865	1.0%	10,370
2	17	7,559	1.5%	8,265	1.5%	8,905
2	18	13,937	0.5%	14,360	0.5%	14,725
Total District 3		213,784	2.3%	245,500	2.4%	276,520
3	19	2,598	0.5%	2,675	0.5%	2,745
3	20	8,425	0.5%	8,680	0.5%	8,900
3	21	22,126	0.5%	22,800	0.5%	23,375
3	22	12,756	0.5%	13,145	0.5%	13,475
3	23	11,102	1.0%	11,785	1.0%	12,385
3	24	630	2.0%	710	2.0%	785
3	25	1,968	2.0%	2,215	2.0%	2,445
3	26	11,417	2.5%	13,240	2.5%	14,980
3	27	4,094	3.5%	5,035	3.5%	5,980
3	28	19,921	2.5%	23,100	2.5%	26,135
3	32	12,126	3.0%	14,480	3.0%	16,785
3	29	5,354	2.0%	6,030	2.0%	6,660
3	30	1,575	1.5%	1,720	1.5%	1,855
3	31	3,858	2.0%	4,345	2.0%	4,795
3	33	6,457	2.0%	7,270	2.0%	8,025
3	34	2,362	6.0%	3,350	6.0%	4,485
3	35	11,811	4.0%	14,945	4.0%	18,185
3	37	16,535	3.0%	19,745	3.0%	22,890
3	38	6,299	3.5%	7,745	3.5%	9,200
3	39	8,661	4.0%	10,960	4.0%	13,335
3	40	20,787	3.0%	24,820	3.0%	28,775
3	36	3,150	2.5%	3,655	2.5%	4,135
3	41	1,339	2.5%	1,555	2.5%	1,760
3	42	3,905	2.5%	4,530	2.5%	5,125
3	43	1,063	2.5%	1,235	2.5%	1,395
3	44	5,276	2.5%	6,120	2.5%	6,925
3	45	4,882	2.5%	5,660	2.5%	6,405
3	46	0	0.5%	0	0.5%	0
3	47	3,307	3.0%	3,950	3.0%	4,580
Total District 4		162,521	0.5%	167,460	0.5%	171,695
4	48	0	0.5%	0	0.5%	0
4	49	4,803	0.5%	4,950	0.5%	5,075
4	50	4,173	0.5%	4,300	0.5%	4,410
4	51	11,496	0.5%	11,845	0.5%	12,145
4	52	4,724	0.5%	4,870	0.5%	4,995
4	53	9,134	0.5%	9,410	0.5%	9,650
4	54	13,701	0.5%	14,115	0.5%	14,470
4	55	5,591	0.5%	5,760	0.5%	5,905
4	56	7,402	0.5%	7,625	0.5%	7,820
4	59	3,701	0.5%	3,815	0.5%	3,910
4	60	15,984	0.5%	16,470	0.5%	16,885
4	61	17,008	0.5%	17,525	0.5%	17,970
4	62	18,425	0.5%	18,985	0.5%	19,465
4	64	18,268	0.5%	18,825	0.5%	19,300
4	57	2,441	0.5%	2,515	0.5%	2,580
4	58	10,394	0.5%	10,710	0.5%	10,980
4	63	15,276	0.5%	15,740	0.5%	16,135

Table 1D-10 Population Projection by District (part 2)

District	Traffic Zone	Population in 2004	Growth Rate 04-10	Population in 2010	Growth Rate 10-15	Population in 2015
Total District 5		260,314	3.5%	320,575	3.2%	375,830
5	65	6,220	2.0%	7,005	2.0%	7,735
5	66	19,685	0.5%	20,285	0.5%	20,795
5	67	18,346	0.5%	18,905	0.5%	19,380
5	68	26,220	2.0%	29,530	2.0%	32,605
5	69	7,087	2.0%	7,980	2.0%	8,810
5	70	9,449	4.0%	11,955	4.0%	14,545
5	71	29,291	2.5%	33,970	2.5%	38,435
5	72	19,134	2.0%	21,550	2.0%	23,795
5	73	30,472	2.0%	34,315	2.0%	37,885
5	74	2,520	10.0%	4,465	4.0%	5,430
5	75	3,622	4.0%	4,585	4.0%	5,580
5	76	1,968	15.0%	4,550	4.0%	5,535
5	77	396	50.0%	4,445	5.0%	5,675
5	86	2,756	3.0%	3,290	3.0%	3,815
5	78	2,677	17.0%	6,865	7.0%	9,630
5	79	5,669	4.0%	7,175	6.0%	9,600
5	83	787	26.0%	3,150	16.0%	6,615
5	84	5,197	7.0%	7,800	5.0%	9,955
5	85	9,921	4.0%	12,555	4.0%	15,275
5	87	3,543	13.0%	7,375	9.0%	11,345
5	88	6,142	5.0%	8,230	6.5%	11,275
5	80	23,464	3.0%	28,015	3.0%	32,475
5	81	25,748	4.0%	32,580	4.0%	39,640
Total District 6		243,228	1.6%	267,795	1.6%	290,230
6	82	1,575	3.5%	1,935	3.5%	2,300
6	89	18,504	0.5%	19,065	0.5%	19,545
6	90	21,575	2.0%	24,295	2.0%	26,825
6	91	16,299	0.5%	16,795	0.5%	17,220
6	93	17,087	2.0%	19,245	1.5%	20,730
6	94	32,362	2.0%	36,445	2.0%	40,240
6	95	24,488	2.0%	27,575	2.0%	30,445
6	92	14,803	1.0%	15,715	1.0%	16,515
6	96	17,401	0.5%	17,930	0.5%	18,385
6	97	25,118	0.5%	25,880	0.5%	26,535
6	98	1,024	2.0%	1,155	2.0%	1,275
6	102	3,937	3.5%	4,840	3.5%	5,750
6	99	17,323	2.5%	20,090	2.5%	22,730
6	100	17,716	3.0%	21,155	3.0%	24,525
6	101	4,488	1.5%	4,905	1.5%	5,285
6	103	551	3.0%	660	3.0%	765
6	104	7,638	2.0%	8,600	2.0%	9,495
6	105	1,339	2.0%	1,510	2.0%	1,665
Total		994,964	2.0%	1,120,715	2.0%	1,237,360

Table 1D-11 Demand Projection by District in 2004 (part 1)

District	Traffic Zone	Population in 2004	Demand by District in 2004										
			CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	Total
Total District 2		115,117	18,796	0	26,532	3,161	0	0	0	0	0	0	48,488
2	9	4,488	0	0	1,908	0	0	0	0	0	0	0	1,908
2	10	8,898	748	0	3,026	0	0	0	0	0	0	0	3,774
2	11	12,283	5,159	0	0	0	0	0	0	0	0	0	5,159
2	12	19,842	8,334	0	0	0	0	0	0	0	0	0	8,334
2	13	15,512	652	0	5,935	0	0	0	0	0	0	0	6,587
2	14	9,291	0	0	3,950	0	0	0	0	0	0	0	3,950
2	15	14,016	0	0	5,959	0	0	0	0	0	0	0	5,959
2	16	9,291	3,903	0	0	0	0	0	0	0	0	0	3,903
2	17	7,559	0	0	1,607	1,501	0	0	0	0	0	0	3,107
2	18	13,937	0	0	4,147	1,660	0	0	0	0	0	0	5,808
Total District 3		213,784	0	293	53,484	16,793	3,716	0	944	12,635	0	0	87,866
3	19	2,598	0	0	1,104	0	0	0	0	0	0	0	1,104
3	20	8,425	0	0	3,582	0	0	0	0	0	0	0	3,582
3	21	22,126	0	0	9,406	0	0	0	0	0	0	0	9,406
3	22	12,756	0	0	5,423	0	0	0	0	0	0	0	5,423
3	23	11,102	0	0	4,720	0	0	0	0	0	0	0	4,720
3	24	630	0	293	0	0	0	0	0	0	0	0	293
3	25	1,968	0	0	0	0	868	0	0	0	0	0	868
3	26	11,417	0	0	4,854	0	0	0	0	0	0	0	4,854
3	27	4,094	0	0	1,740	0	0	0	0	0	0	0	1,740
3	28	19,921	0	0	8,469	0	0	0	0	0	0	0	8,469
3	32	12,126	0	0	5,155	0	0	0	0	0	0	0	5,155
3	29	5,354	0	0	1,138	1,063	0	0	0	0	0	0	2,201
3	30	1,575	0	0	335	313	0	0	0	0	0	0	647
3	31	3,858	0	0	0	1,532	0	0	0	0	0	0	1,532
3	33	6,457	0	0	0	0	2,848	0	0	0	0	0	2,848
3	34	2,362	0	0	0	0	0	0	944	0	0	0	944
3	35	11,811	0	0	0	2,814	0	0	0	1,742	0	0	4,556
3	37	16,535	0	0	0	3,283	0	0	0	3,048	0	0	6,331
3	38	6,299	0	0	0	0	0	0	0	2,323	0	0	2,323
3	39	8,661	0	0	2,577	0	0	0	0	958	0	0	3,535
3	40	20,787	0	0	4,419	0	0	0	0	3,832	0	0	8,251
3	36	3,150	0	0	0	1,251	0	0	0	0	0	0	1,251
3	41	1,339	0	0	0	532	0	0	0	0	0	0	532
3	42	3,905	0	0	0	1,551	0	0	0	0	0	0	1,551
3	43	1,063	0	0	0	422	0	0	0	0	0	0	422
3	44	5,276	0	0	0	2,095	0	0	0	0	0	0	2,095
3	45	4,882	0	0	0	1,938	0	0	0	0	0	0	1,938
3	46	0	0	0	0	0	0	0	0	0	0	0	0
3	47	3,307	0	0	562	0	0	0	0	732	0	0	1,294
Total District 4		162,521	17,612	46,431	613	0	8,530	0	0	0	0	0	73,186
4	48	0	0	0	0	0	0	0	0	0	0	0	0
4	49	4,803	605	894	613	0	0	0	0	0	0	0	2,112
4	50	4,173	1,753	0	0	0	0	0	0	0	0	0	1,753
4	51	11,496	966	4,278	0	0	0	0	0	0	0	0	5,244
4	52	4,724	0	2,198	0	0	0	0	0	0	0	0	2,198
4	53	9,134	0	4,249	0	0	0	0	0	0	0	0	4,249
4	54	13,701	0	6,374	0	0	0	0	0	0	0	0	6,374
4	55	5,591	0	2,601	0	0	0	0	0	0	0	0	2,601
4	56	7,402	622	2,755	0	0	0	0	0	0	0	0	3,376
4	59	3,701	311	1,377	0	0	0	0	0	0	0	0	1,688
4	60	15,984	0	7,436	0	0	0	0	0	0	0	0	7,436
4	61	17,008	0	3,165	0	0	4,501	0	0	0	0	0	7,666
4	62	18,425	1,548	6,857	0	0	0	0	0	0	0	0	8,405
4	64	18,268	0	4,249	0	0	4,029	0	0	0	0	0	8,278
4	57	2,441	1,025	0	0	0	0	0	0	0	0	0	1,025
4	58	10,394	4,366	0	0	0	0	0	0	0	0	0	4,366
4	63	15,276	6,417	0	0	0	0	0	0	0	0	0	6,417

Table 1D-12 Demand Projection by District in 2004 (part 2)

District	Traffic Zone	Population in 2004	Demand by District in 2004										
			CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	Total
Total District 5		260,314	0	0	1,791	0	42,275	12,036	50,953	0	0	0	107,056
5	65	6,220	0	0	0	0	2,744	0	0	0	0	0	2,744
5	66	19,685	0	0	0	0	8,683	0	0	0	0	0	8,683
5	67	18,346	0	0	0	0	8,092	0	0	0	0	0	8,092
5	68	26,220	0	0	0	0	11,566	0	0	0	0	0	11,566
5	69	7,087	0	0	0	0	3,126	0	0	0	0	0	3,126
5	70	9,449	0	0	0	0	0	0	3,777	0	0	0	3,777
5	71	29,291	0	0	0	0	0	0	11,708	0	0	0	11,708
5	72	19,134	0	0	0	0	0	0	7,648	0	0	0	7,648
5	73	30,472	0	0	0	0	8,065	4,475	0	0	0	0	12,539
5	74	2,520	0	0	0	0	0	0	1,007	0	0	0	1,007
5	75	3,622	0	0	1,540	0	0	0	0	0	0	0	1,540
5	76	1,968	0	0	251	0	0	0	551	0	0	0	802
5	77	396	0	0	0	0	0	0	158	0	0	0	158
5	86	2,756	0	0	0	0	0	0	1,102	0	0	0	1,102
5	78	2,677	0	0	0	0	0	0	1,070	0	0	0	1,070
5	79	5,669	0	0	0	0	0	0	2,266	0	0	0	2,266
5	83	787	0	0	0	0	0	0	315	0	0	0	315
5	84	5,197	0	0	0	0	0	0	2,077	0	0	0	2,077
5	85	9,921	0	0	0	0	0	0	3,966	0	0	0	3,966
5	87	3,543	0	0	0	0	0	0	1,416	0	0	0	1,416
5	88	6,142	0	0	0	0	0	0	2,455	0	0	0	2,455
5	80	23,464	0	0	0	0	0	0	9,379	0	0	0	9,379
5	81	25,748	0	0	0	0	0	7,562	2,058	0	0	0	9,620
Total District 6		243,228	4,353	6,102	0	0	0	51,513	567	0	27,821	2,739	93,095
6	82	1,575	0	0	0	0	0	58	567	0	0	0	624
6	89	18,504	0	0	0	0	0	6,793	0	0	0	0	6,793
6	90	21,575	0	0	0	0	0	7,920	0	0	0	0	7,920
6	91	16,299	0	5,307	0	0	0	1,795	0	0	0	0	7,103
6	93	17,087	0	795	0	0	0	0	0	0	6,080	0	6,875
6	94	32,362	0	0	0	0	0	11,880	0	0	0	0	11,880
6	95	24,488	0	0	0	0	0	8,990	0	0	0	0	8,990
6	92	14,803	4,353	0	0	0	0	0	0	0	1,756	0	6,108
6	96	17,401	0	0	0	0	0	0	0	0	6,880	0	6,880
6	97	25,118	0	0	0	0	0	0	0	0	9,931	0	9,931
6	98	1,024	0	0	0	0	0	0	0	0	405	0	405
6	102	3,937	0	0	0	0	0	1,156	0	0	311	0	1,468
6	99	17,323	0	0	0	0	0	5,723	0	0	685	0	6,408
6	100	17,716	0	0	0	0	0	6,504	0	0	0	0	6,504
6	101	4,488	0	0	0	0	0	0	0	0	1,774	0	1,774
6	103	551	0	0	0	0	0	202	0	0	0	0	202
6	104	7,638	0	0	0	0	0	0	0	0	0	2,739	2,739
6	105	1,339	0	0	0	0	0	492	0	0	0	0	492
Total		994,964	40,760	52,827	82,420	19,954	54,522	63,549	52,464	12,635	27,821	2,739	409,691

Table 1D-13 Demand Projection by District in 2010 (part 1)

District	Traffic Zone	Population in 2010	Demand by District in 2010										
			CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	Total
Total District 2		119,385	16,728	0	23,333	2,826	0	0	0	0	0	0	42,888
2	9	4,625	0	0	1,672	0	0	0	0	0	0	0	1,672
2	10	9,170	661	0	2,652	0	0	0	0	0	0	0	3,313
2	11	12,655	4,563	0	0	0	0	0	0	0	0	0	4,563
2	12	20,445	7,371	0	0	0	0	0	0	0	0	0	7,371
2	13	15,985	576	0	5,201	0	0	0	0	0	0	0	5,777
2	14	9,575	0	0	3,461	0	0	0	0	0	0	0	3,461
2	15	14,440	0	0	5,220	0	0	0	0	0	0	0	5,220
2	16	9,865	3,557	0	0	0	0	0	0	0	0	0	3,557
2	17	8,265	0	0	1,494	1,384	0	0	0	0	0	0	2,878
2	18	14,360	0	0	3,634	1,443	0	0	0	0	0	0	5,076
Total District 3		245,500	0	286	50,781	16,681	3,570	0	1,111	12,950	0	0	85,379
3	19	2,675	0	0	967	0	0	0	0	0	0	0	967
3	20	8,680	0	0	3,138	0	0	0	0	0	0	0	3,138
3	21	22,800	0	0	8,242	0	0	0	0	0	0	0	8,242
3	22	13,145	0	0	4,752	0	0	0	0	0	0	0	4,752
3	23	11,785	0	0	4,260	0	0	0	0	0	0	0	4,260
3	24	710	0	286	0	0	0	0	0	0	0	0	286
3	25	2,215	0	0	0	0	834	0	0	0	0	0	834
3	26	13,240	0	0	4,786	0	0	0	0	0	0	0	4,786
3	27	5,035	0	0	1,820	0	0	0	0	0	0	0	1,820
3	28	23,100	0	0	8,350	0	0	0	0	0	0	0	8,350
3	32	14,480	0	0	5,234	0	0	0	0	0	0	0	5,234
3	29	6,030	0	0	1,090	1,010	0	0	0	0	0	0	2,099
3	30	1,720	0	0	311	288	0	0	0	0	0	0	599
3	31	4,345	0	0	0	1,455	0	0	0	0	0	0	1,455
3	33	7,270	0	0	0	0	2,737	0	0	0	0	0	2,737
3	34	3,350	0	0	0	0	0	0	1,111	0	0	0	1,111
3	35	14,945	0	0	0	3,003	0	0	0	1,858	0	0	4,861
3	37	19,745	0	0	0	3,306	0	0	0	3,069	0	0	6,375
3	38	7,745	0	0	0	0	0	0	0	2,407	0	0	2,407
3	39	10,960	0	0	2,773	0	0	0	0	1,022	0	0	3,795
3	40	24,820	0	0	4,486	0	0	0	0	3,857	0	0	8,344
3	36	3,655	0	0	0	1,224	0	0	0	0	0	0	1,224
3	41	1,555	0	0	0	521	0	0	0	0	0	0	521
3	42	4,530	0	0	0	1,517	0	0	0	0	0	0	1,517
3	43	1,235	0	0	0	414	0	0	0	0	0	0	414
3	44	6,120	0	0	0	2,049	0	0	0	0	0	0	2,049
3	45	5,660	0	0	0	1,895	0	0	0	0	0	0	1,895
3	46	0	0	0	0	0	0	0	0	0	0	0	0
3	47	3,950	0	0	571	0	0	0	0	737	0	0	1,308
Total District 4		167,460	15,577	41,394	537	0	7,501	0	0	0	0	0	65,009
4	48	0	0	0	0	0	0	0	0	0	0	0	0
4	49	4,950	535	797	537	0	0	0	0	0	0	0	1,869
4	50	4,300	1,550	0	0	0	0	0	0	0	0	0	1,550
4	51	11,845	854	3,814	0	0	0	0	0	0	0	0	4,668
4	52	4,870	0	1,960	0	0	0	0	0	0	0	0	1,960
4	53	9,410	0	3,788	0	0	0	0	0	0	0	0	3,788
4	54	14,115	0	5,681	0	0	0	0	0	0	0	0	5,681
4	55	5,760	0	2,318	0	0	0	0	0	0	0	0	2,318
4	56	7,625	550	2,455	0	0	0	0	0	0	0	0	3,005
4	59	3,815	275	1,228	0	0	0	0	0	0	0	0	1,504
4	60	16,470	0	6,629	0	0	0	0	0	0	0	0	6,629
4	61	17,525	0	2,822	0	0	3,958	0	0	0	0	0	6,780
4	62	18,985	1,369	6,113	0	0	0	0	0	0	0	0	7,482
4	64	18,825	0	3,789	0	0	3,543	0	0	0	0	0	7,332
4	57	2,515	907	0	0	0	0	0	0	0	0	0	907
4	58	10,710	3,861	0	0	0	0	0	0	0	0	0	3,861
4	63	15,740	5,675	0	0	0	0	0	0	0	0	0	5,675

Table 1D-14 Demand Projection by District in 2010 (part 2)

District	Traffic Zone	Population in 2010	Demand by District in 2010										
			CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	Total
Total District 5		320,575	0	0	2,151	0	39,258	12,352	56,546	0	0	0	110,307
5	65	7,005	0	0	0	0	2,637	0	0	0	0	0	2,637
5	66	20,285	0	0	0	0	7,636	0	0	0	0	0	7,636
5	67	18,905	0	0	0	0	7,116	0	0	0	0	0	7,116
5	68	29,530	0	0	0	0	11,116	0	0	0	0	0	11,116
5	69	7,980	0	0	0	0	3,004	0	0	0	0	0	3,004
5	70	11,955	0	0	0	0	0	0	3,964	0	0	0	3,964
5	71	33,970	0	0	0	0	0	0	11,263	0	0	0	11,263
5	72	21,550	0	0	0	0	0	0	7,145	0	0	0	7,145
5	73	34,315	0	0	0	0	7,750	4,261	0	0	0	0	12,011
5	74	4,465	0	0	0	0	0	0	1,480	0	0	0	1,480
5	75	4,585	0	0	1,657	0	0	0	0	0	0	0	1,657
5	76	4,550	0	0	493	0	0	0	1,056	0	0	0	1,549
5	77	4,445	0	0	0	0	0	0	1,474	0	0	0	1,474
5	86	3,290	0	0	0	0	0	0	1,091	0	0	0	1,091
5	78	6,865	0	0	0	0	0	0	2,276	0	0	0	2,276
5	79	7,175	0	0	0	0	0	0	2,379	0	0	0	2,379
5	83	3,150	0	0	0	0	0	0	1,044	0	0	0	1,044
5	84	7,800	0	0	0	0	0	0	2,586	0	0	0	2,586
5	85	12,555	0	0	0	0	0	0	4,163	0	0	0	4,163
5	87	7,375	0	0	0	0	0	0	2,445	0	0	0	2,445
5	88	8,230	0	0	0	0	0	0	2,729	0	0	0	2,729
5	80	28,015	0	0	0	0	0	0	9,289	0	0	0	9,289
5	81	32,580	0	0	0	0	0	8,091	2,160	0	0	0	10,251
Total District 6		267,795	3,966	5,507	0	0	0	49,013	577	0	25,219	2,610	86,892
6	82	1,935	0	0	0	0	0	60	577	0	0	0	637
6	89	19,065	0	0	0	0	0	5,918	0	0	0	0	5,918
6	90	24,295	0	0	0	0	0	7,542	0	0	0	0	7,542
6	91	16,795	0	4,732	0	0	0	1,564	0	0	0	0	6,296
6	93	19,245	0	775	0	0	0	0	0	0	5,833	0	6,608
6	94	36,445	0	0	0	0	0	11,314	0	0	0	0	11,314
6	95	27,575	0	0	0	0	0	8,560	0	0	0	0	8,560
6	92	15,715	3,966	0	0	0	0	0	0	0	1,588	0	5,554
6	96	17,930	0	0	0	0	0	0	0	0	6,038	0	6,038
6	97	25,880	0	0	0	0	0	0	0	0	8,716	0	8,716
6	98	1,155	0	0	0	0	0	0	0	0	389	0	389
6	102	4,840	0	0	0	0	0	1,202	0	0	326	0	1,528
6	99	20,090	0	0	0	0	0	5,613	0	0	677	0	6,289
6	100	21,155	0	0	0	0	0	6,567	0	0	0	0	6,567
6	101	4,905	0	0	0	0	0	0	0	0	1,652	0	1,652
6	103	660	0	0	0	0	0	205	0	0	0	0	205
6	104	8,600	0	0	0	0	0	0	0	0	0	2,610	2,610
6	105	1,510	0	0	0	0	0	469	0	0	0	0	469
Total		1,120,715	36,272	47,187	76,802	19,507	50,330	61,365	58,234	12,950	25,219	2,610	390,475

Table 1D-15 Demand Projection by District in 2015 (part 1)

District	Traffic Zone	Population in 2015	Demand by District in 2015										
			CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	Total
Total District 2		123,085	15,134	0	20,879	2,566	0	0	0	0	0	0	38,580
2	9	4,740	0	0	1,491	0	0	0	0	0	0	0	1,491
2	10	9,400	595	0	2,365	0	0	0	0	0	0	0	2,960
2	11	12,975	4,106	0	0	0	0	0	0	0	0	0	4,106
2	12	20,960	6,633	0	0	0	0	0	0	0	0	0	6,633
2	13	16,390	519	0	4,639	0	0	0	0	0	0	0	5,158
2	14	9,815	0	0	3,087	0	0	0	0	0	0	0	3,087
2	15	14,805	0	0	4,656	0	0	0	0	0	0	0	4,656
2	16	10,370	3,282	0	0	0	0	0	0	0	0	0	3,282
2	17	8,905	0	0	1,400	1,288	0	0	0	0	0	0	2,689
2	18	14,725	0	0	3,242	1,278	0	0	0	0	0	0	4,520
Total District 3		276,520	0	279	48,611	16,537	3,439	0	1,275	13,176	0	0	83,317
3	19	2,745	0	0	863	0	0	0	0	0	0	0	863
3	20	8,900	0	0	2,799	0	0	0	0	0	0	0	2,799
3	21	23,375	0	0	7,351	0	0	0	0	0	0	0	7,351
3	22	13,475	0	0	4,238	0	0	0	0	0	0	0	4,238
3	23	12,385	0	0	3,895	0	0	0	0	0	0	0	3,895
3	24	785	0	279	0	0	0	0	0	0	0	0	279
3	25	2,445	0	0	0	0	803	0	0	0	0	0	803
3	26	14,980	0	0	4,711	0	0	0	0	0	0	0	4,711
3	27	5,980	0	0	1,881	0	0	0	0	0	0	0	1,881
3	28	26,135	0	0	8,219	0	0	0	0	0	0	0	8,219
3	32	16,785	0	0	5,279	0	0	0	0	0	0	0	5,279
3	29	6,660	0	0	1,047	964	0	0	0	0	0	0	2,011
3	30	1,855	0	0	292	268	0	0	0	0	0	0	560
3	31	4,795	0	0	0	1,387	0	0	0	0	0	0	1,387
3	33	8,025	0	0	0	0	2,636	0	0	0	0	0	2,636
3	34	4,485	0	0	0	0	0	0	1,275	0	0	0	1,275
3	35	18,185	0	0	0	3,157	0	0	0	1,954	0	0	5,111
3	37	22,890	0	0	0	3,311	0	0	0	3,074	0	0	6,386
3	38	9,200	0	0	0	0	0	0	0	2,471	0	0	2,471
3	39	13,335	0	0	2,936	0	0	0	0	1,075	0	0	4,010
3	40	28,775	0	0	4,525	0	0	0	0	3,864	0	0	8,389
3	36	4,135	0	0	0	1,196	0	0	0	0	0	0	1,196
3	41	1,760	0	0	0	509	0	0	0	0	0	0	509
3	42	5,125	0	0	0	1,483	0	0	0	0	0	0	1,483
3	43	1,395	0	0	0	404	0	0	0	0	0	0	404
3	44	6,925	0	0	0	2,004	0	0	0	0	0	0	2,004
3	45	6,405	0	0	0	1,853	0	0	0	0	0	0	1,853
3	46	0	0	0	0	0	0	0	0	0	0	0	0
3	47	4,580	0	0	576	0	0	0	0	738	0	0	1,314
Total District 4		171,695	14,017	37,516	479	0	6,712	0	0	0	0	0	58,724
4	48	0	0	0	0	0	0	0	0	0	0	0	0
4	49	5,075	482	722	479	0	0	0	0	0	0	0	1,683
4	50	4,410	1,396	0	0	0	0	0	0	0	0	0	1,396
4	51	12,145	769	3,457	0	0	0	0	0	0	0	0	4,225
4	52	4,995	0	1,777	0	0	0	0	0	0	0	0	1,777
4	53	9,650	0	3,433	0	0	0	0	0	0	0	0	3,433
4	54	14,470	0	5,148	0	0	0	0	0	0	0	0	5,148
4	55	5,905	0	2,101	0	0	0	0	0	0	0	0	2,101
4	56	7,820	495	2,226	0	0	0	0	0	0	0	0	2,721
4	59	3,910	247	1,113	0	0	0	0	0	0	0	0	1,360
4	60	16,885	0	6,007	0	0	0	0	0	0	0	0	6,007
4	61	17,970	0	2,557	0	0	3,542	0	0	0	0	0	6,099
4	62	19,465	1,232	5,540	0	0	0	0	0	0	0	0	6,772
4	64	19,300	0	3,433	0	0	3,170	0	0	0	0	0	6,603
4	57	2,580	816	0	0	0	0	0	0	0	0	0	816
4	58	10,980	3,475	0	0	0	0	0	0	0	0	0	3,475
4	63	16,135	5,106	0	0	0	0	0	0	0	0	0	5,106

Table 1D-16 Demand Projection by District in 2015 (part 2)

District	Traffic Zone	Population in 2015	Demand by District in 2015										
			CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	Total
Total District 5		375,830	0	0	2,277	0	36,810	12,601	59,586	0	0	0	111,274
5	65	7,735	0	0	0	0	2,541	0	0	0	0	0	2,541
5	66	20,795	0	0	0	0	6,831	0	0	0	0	0	6,831
5	67	19,380	0	0	0	0	6,366	0	0	0	0	0	6,366
5	68	32,605	0	0	0	0	10,711	0	0	0	0	0	10,711
5	69	8,810	0	0	0	0	2,894	0	0	0	0	0	2,894
5	70	14,545	0	0	0	0	0	0	4,134	0	0	0	4,134
5	71	38,435	0	0	0	0	0	0	10,923	0	0	0	10,923
5	72	23,795	0	0	0	0	0	0	6,762	0	0	0	6,762
5	73	37,885	0	0	0	0	7,467	4,074	0	0	0	0	11,542
5	74	5,430	0	0	0	0	0	0	1,543	0	0	0	1,543
5	75	5,580	0	0	1,755	0	0	0	0	0	0	0	1,755
5	76	5,535	0	0	522	0	0	0	1,101	0	0	0	1,623
5	77	5,675	0	0	0	0	0	0	1,613	0	0	0	1,613
5	86	3,815	0	0	0	0	0	0	1,084	0	0	0	1,084
5	78	9,630	0	0	0	0	0	0	2,737	0	0	0	2,737
5	79	9,600	0	0	0	0	0	0	2,728	0	0	0	2,728
5	83	6,615	0	0	0	0	0	0	1,880	0	0	0	1,880
5	84	9,955	0	0	0	0	0	0	2,829	0	0	0	2,829
5	85	15,275	0	0	0	0	0	0	4,341	0	0	0	4,341
5	87	11,345	0	0	0	0	0	0	3,224	0	0	0	3,224
5	88	11,275	0	0	0	0	0	0	3,204	0	0	0	3,204
5	80	32,475	0	0	0	0	0	0	9,229	0	0	0	9,229
5	81	39,640	0	0	0	0	0	8,526	2,253	0	0	0	10,779
Total District 6		290,230	3,658	5,026	0	0	0	46,907	588	0	23,063	2,497	81,740
6	82	2,300	0	0	0	0	0	62	588	0	0	0	650
6	89	19,545	0	0	0	0	0	5,255	0	0	0	0	5,255
6	90	26,825	0	0	0	0	0	7,212	0	0	0	0	7,212
6	91	17,220	0	4,289	0	0	0	1,389	0	0	0	0	5,678
6	93	20,730	0	738	0	0	0	0	0	0	5,480	0	6,218
6	94	40,240	0	0	0	0	0	10,819	0	0	0	0	10,819
6	95	30,445	0	0	0	0	0	8,186	0	0	0	0	8,186
6	92	16,515	3,658	0	0	0	0	0	0	0	1,455	0	5,114
6	96	18,385	0	0	0	0	0	0	0	0	5,400	0	5,400
6	97	26,535	0	0	0	0	0	0	0	0	7,794	0	7,794
6	98	1,275	0	0	0	0	0	0	0	0	375	0	375
6	102	5,750	0	0	0	0	0	1,237	0	0	338	0	1,575
6	99	22,730	0	0	0	0	0	5,500	0	0	668	0	6,168
6	100	24,525	0	0	0	0	0	6,594	0	0	0	0	6,594
6	101	5,285	0	0	0	0	0	0	0	0	1,552	0	1,552
6	103	765	0	0	0	0	0	206	0	0	0	0	206
6	104	9,495	0	0	0	0	0	0	0	0	0	2,497	2,497
6	105	1,665	0	0	0	0	0	448	0	0	0	0	448
Total		1,237,360	32,810	42,821	72,246	19,103	46,962	59,508	61,448	13,176	23,063	2,497	373,634

Table 1D-17 Summary of Demand Projection by Commercial Zone

Demand in 2004		Managua											Ticuantepe	Nindiri	Total
		CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	Total			
Population	(person)	97,039	113,560	193,871	50,252	123,605	173,110	131,253	34,267	70,370	7,638	994,964	23,086	31,787	1,049,837
Per Capita Consumption	(lpcd)	175	175	175	175	175	175	175	175	175	175	175	175	175	175
Total Domestic Demend	(m3/day)	16,982	19,873	33,927	8,794	21,631	30,294	22,969	5,997	12,315	1,337	174,119	4,040	5,563	183,721
		11.1%	21.3%	23.7%	3.8%	18.3%	4.8%	10.6%	1.0%	5.2%	0.1%				
Non-Domestic Water Demend	(m3/day)	3,398	6,540	7,282	1,183	5,630	1,480	3,263	321	1,596	33	30,727	713	982	32,421
Total Water Demand	(m3/day)	20,380	26,413	41,210	9,977	27,261	31,774	26,232	6,318	13,911	1,370	204,846	4,753	6,544	216,143
UFW Ratio		45%	45%	45%	45%	45%	45%	45%	45%	45%	45%	45%	45%	45%	45%
Day Average Water Demand	(m3/day)	37,055	48,024	74,927	18,140	49,565	57,772	47,695	11,487	25,292	2,490	372,446	8,642	11,899	392,987
Day Maximum Water Demand (x 1.1)	(m3/day)	40,760	52,827	82,420	19,954	54,522	63,549	52,464	12,635	27,821	2,739	409,691	9,506	13,089	432,286

Demand in 2010		Managua											Ticuantepe	Nindiri	Total
		CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	Total			
Population	(person)	100,602	117,235	212,459	58,255	133,707	197,680	175,633	41,664	74,882	8,600	1,120,715	28,538	38,649	1,187,902
Per Capita Consumption	(lpcd)	175	175	175	175	175	175	175	175	175	175	175	175	175	175
Total Domestic Demend	(m3/day)	17,605	20,516	37,180	10,195	23,399	34,594	30,736	7,291	13,104	1,505	196,125	4,994	6,764	207,883
		11.1%	21.3%	23.7%	3.8%	18.3%	4.8%	10.6%	1.0%	5.2%	0.1%	100%			
Non-Domestic Water Demend	(m3/day)	3,828	7,367	8,203	1,332	6,342	1,667	3,675	361	1,798	37	34,610	881	1,194	36,685
Total Water Demand	(m3/day)	21,433	27,883	45,383	11,527	29,740	36,261	34,411	7,653	14,902	1,542	230,735	5,875	7,957	244,568
UFW Ratio		35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%
Day Average Water Demand	(m3/day)	32,974	42,897	69,820	17,734	45,754	55,787	52,940	11,773	22,926	2,373	354,978	9,039	12,242	376,259
Day Maximum Water Demand (x 1.1)	(m3/day)	36,272	47,187	76,802	19,507	50,330	61,365	58,234	12,950	25,219	2,610	390,475	9,943	13,466	413,885

Demand in 2015		Managua											Ticuantepe	Nindiri	Total
		CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	Total			
Population	(person)	103,680	120,357	229,726	66,024	142,958	221,329	216,223	49,055	78,515	9,495	1,237,360	34,111	45,718	1,317,189
Per Capita Consumption	(lpcd)	175	175	175	175	175	175	175	175	175	175	175	175	175	175
Total Domestic Demend	(m3/day)	18,144	21,062	40,202	11,554	25,018	38,733	37,839	8,585	13,740	1,662	216,538	5,969	8,001	230,508
		11.1%	21.3%	23.7%	3.8%	18.3%	4.8%	10.6%	1.0%	5.2%	0.1%				
Non-Domestic Water Demend	(m3/day)	4,226	8,134	9,056	1,471	7,002	1,841	4,058	399	1,985	41	38,213	1,053	1,412	40,678
Total Water Demand	(m3/day)	22,370	29,196	49,258	13,025	32,019	40,573	41,897	8,984	15,725	1,703	254,751	7,023	9,413	271,186
UFW Ratio		25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
Day Average Water Demand	(m3/day)	29,827	38,928	65,678	17,367	42,692	54,098	55,862	11,978	20,966	2,270	339,667	9,364	12,550	361,581
Day Maximum Water Demand (x 1.1)	(m3/day)	32,810	42,821	72,246	19,103	46,962	59,508	61,448	13,176	23,063	2,497	373,634	10,300	13,805	397,739

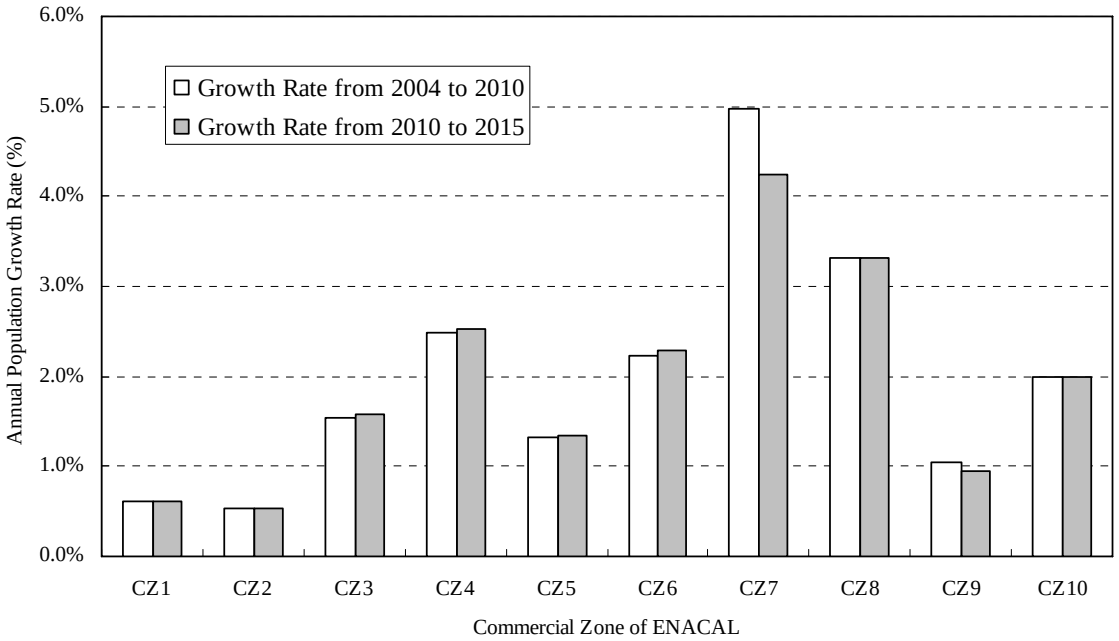

Figure 1D-1 Annual Population Growth Rate by Commercial Zone

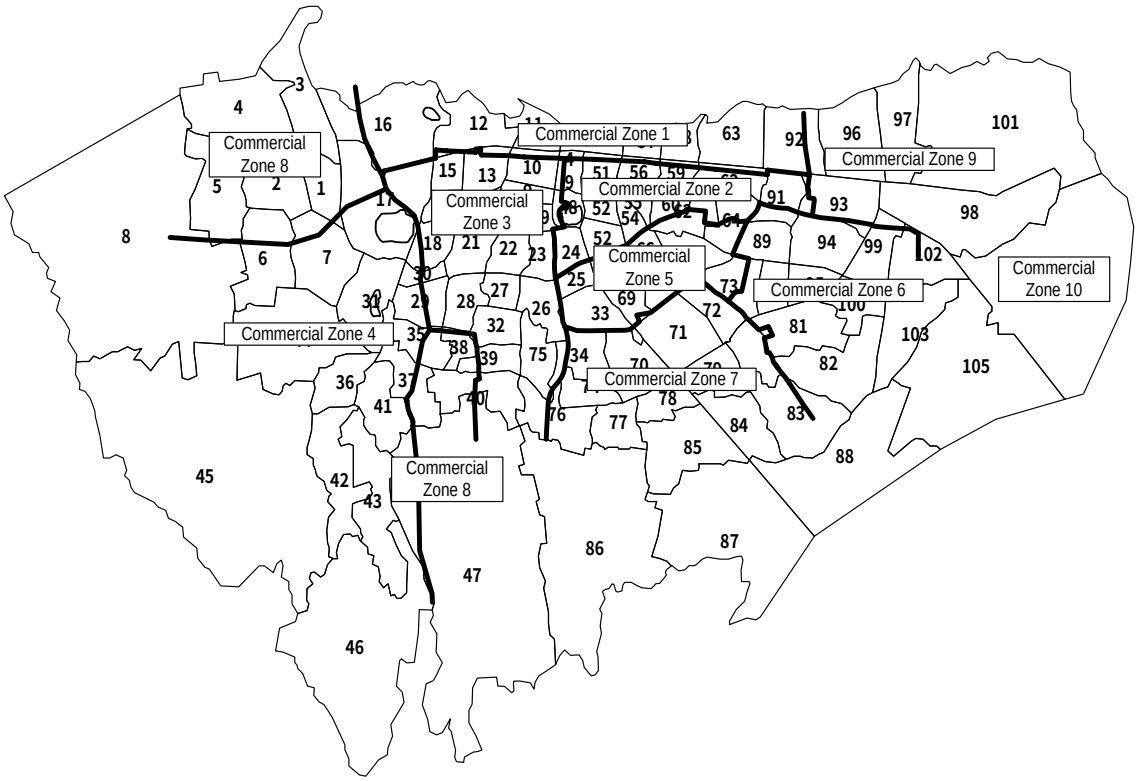

Figure 1D-2 Commercial Zone Boundary

Table 1D-18 Number of Connection by Commercial Zone as of August 2004

Type of User	Tariff Categories	Managua (Commercial Zone No.)										Ticuantepe	Nindiri	TOTAL
		1	2	3	4	5	6	7	8	9	10			
Managua City (Formal)														
Medium Income (UP)	T06/T55/T98	152	183	210	22	69	15	36	18	30	2	0	0	737
Medium Income	T01/T51	10,531	13,623	16,221	1,220	11,717	14,979	7,807	9,762	6,896	767	3,872	1,391	98,786
High Income	T07/T57	39	28	651	3,048	2,737	126	4,647	329	483	0			12,088
Managua Asentamientos		4,221	3,675	12,842	1,079	2,330	12,716	4,887	7,782	7,063	11	81	15	56,702
With meter	T10	10	7	57	4	6	5	13	8	6				116
Without meter	T10	4,211	3,668	12,785	1,075	2,324	12,711	4,874	7,774	7,057				56,479
Total Domestic Users		14,943	17,509	29,924	5,369	16,853	27,836	17,377	17,891	14,472	780	3,953	1,406	168,313
Industrial	T03/T97	70	42	57	12	17	12	9	9	36	1	10	1	276
Commercial	T02/T53/T94	522	1,160	1,322	164	1,044	253	545	154	234	2	23	30	5,453
Institutional	T09/T56/T96/T97	44	72	34	52	46	22	88	41	27	3	8	4	441
Total Non-Domestic Users		636	1,274	1,413	228	1,107	287	642	204	297	6	41	35	6,170
Total Users		15,579	18,783	31,337	5,597	17,960	28,123	18,019	18,095	14,769	786	3,994	1,441	174,483

Source: ENACAL

ANNEX 1E

Peak Factor Observed in ANC Survey

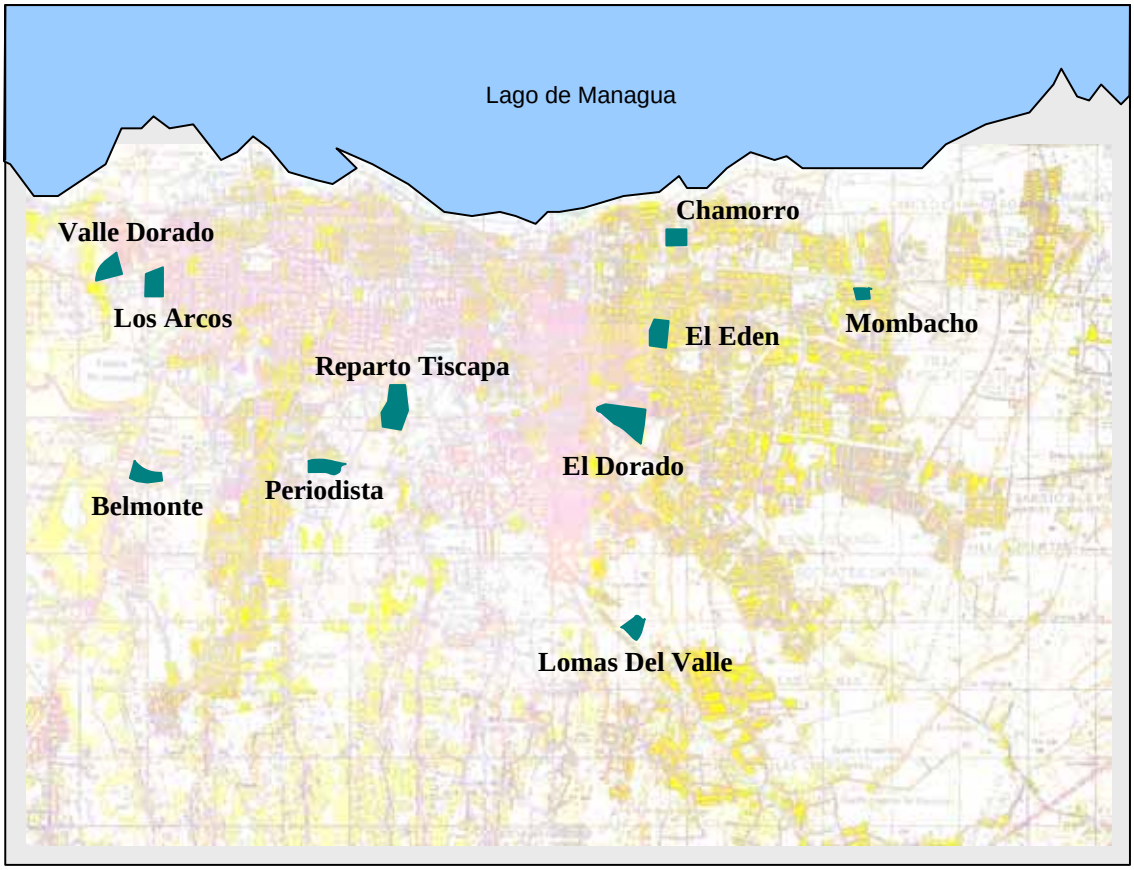

Figure 1E-1 Location of ANC Survey

Time	Flow (m3/h)
0:00	4.94
1:00	5.57
2:00	5.79
3:00	6.48
4:00	11.12
5:00	17.00
6:00	23.34
7:00	21.26
8:00	19.22
9:00	15.71
10:00	19.30
11:00	17.83
12:00	16.04
13:00	17.08
14:00	23.79
15:00	21.52
16:00	18.93
17:00	17.38
18:00	14.89
19:00	9.01
20:00	6.92
21:00	6.33
22:00	5.71
23:00	5.40

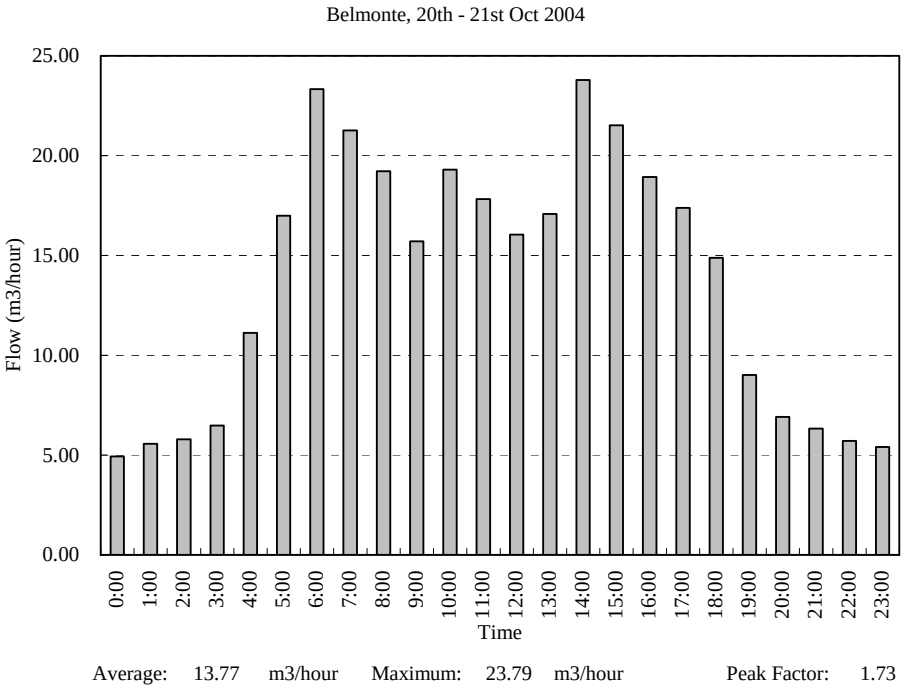

Figure 1E-2 Hourly Flow Pattern to Belmonte on 20th/21st Oct. 2004

Time	Flow (m3/h)
0:00	7.59
1:00	8.44
2:00	7.75
3:00	7.35
4:00	7.90
5:00	18.00
6:00	20.29
7:00	19.59
8:00	19.79
9:00	19.88
10:00	20.99
11:00	17.15
12:00	13.25
13:00	15.88
14:00	17.27
15:00	13.85
16:00	12.84
17:00	10.64
18:00	8.73
19:00	9.41
20:00	9.60
21:00	8.48
22:00	8.97
23:00	7.79

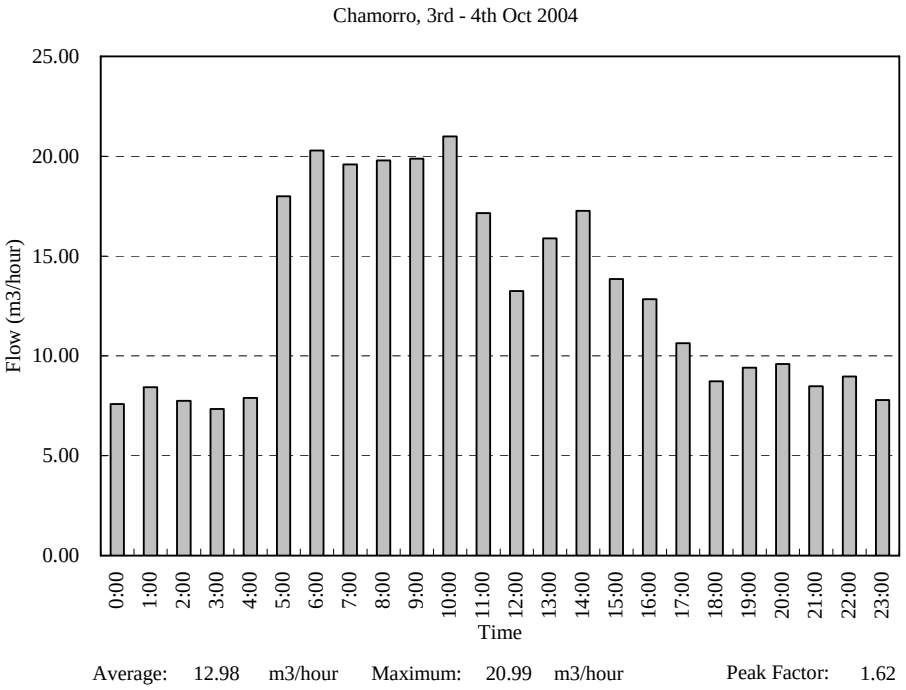

Figure 1E-3 Hourly Flow Pattern to Chamorro on 3rd/4th Oct. 2004

Time	Flow (m3/h)
0:00	4.40
1:00	4.33
2:00	4.36
3:00	4.48
4:00	5.54
5:00	11.85
6:00	15.99
7:00	17.48
8:00	20.39
9:00	19.88
10:00	17.45
11:00	15.45
12:00	12.59
13:00	9.86
14:00	11.36
15:00	12.17
16:00	10.75
17:00	8.99
18:00	7.90
19:00	7.84
20:00	7.90
21:00	6.98
22:00	6.48
23:00	4.56

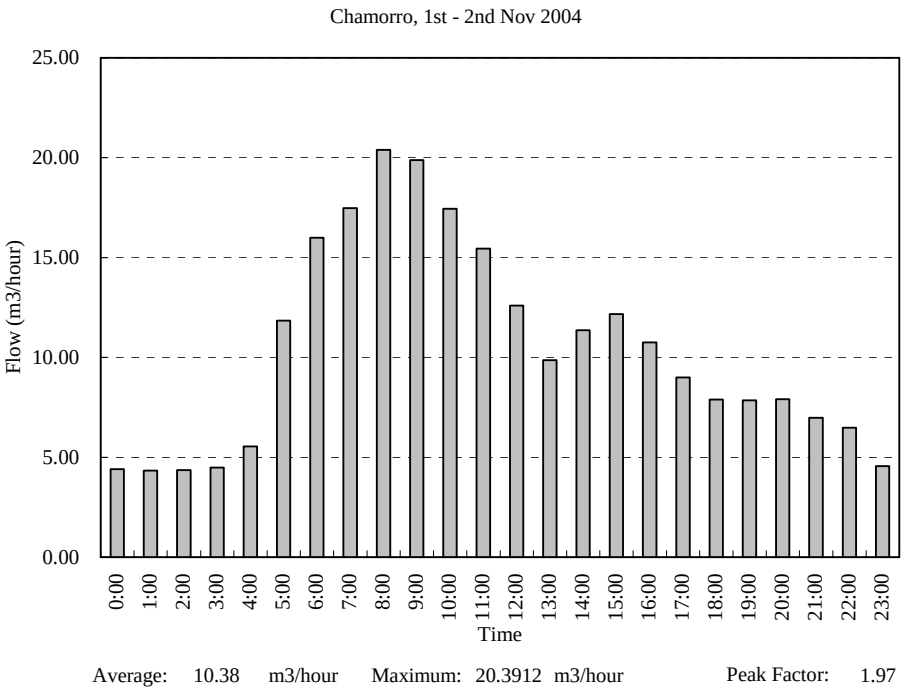

Figure 1E-4 Hourly Flow Pattern to Chamorro on 1st/2nd Nov. 2004

Time	Flow (m3/h)
0:00	18.25
1:00	18.14
2:00	18.78
3:00	20.06
4:00	20.60
5:00	39.55
6:00	64.34
7:00	64.11
8:00	55.63
9:00	53.57
10:00	53.33
11:00	46.76
12:00	43.96
13:00	45.97
14:00	46.83
15:00	39.94
16:00	47.19
17:00	56.90
18:00	44.95
19:00	36.94
20:00	34.59
21:00	31.68
22:00	28.33
23:00	19.79

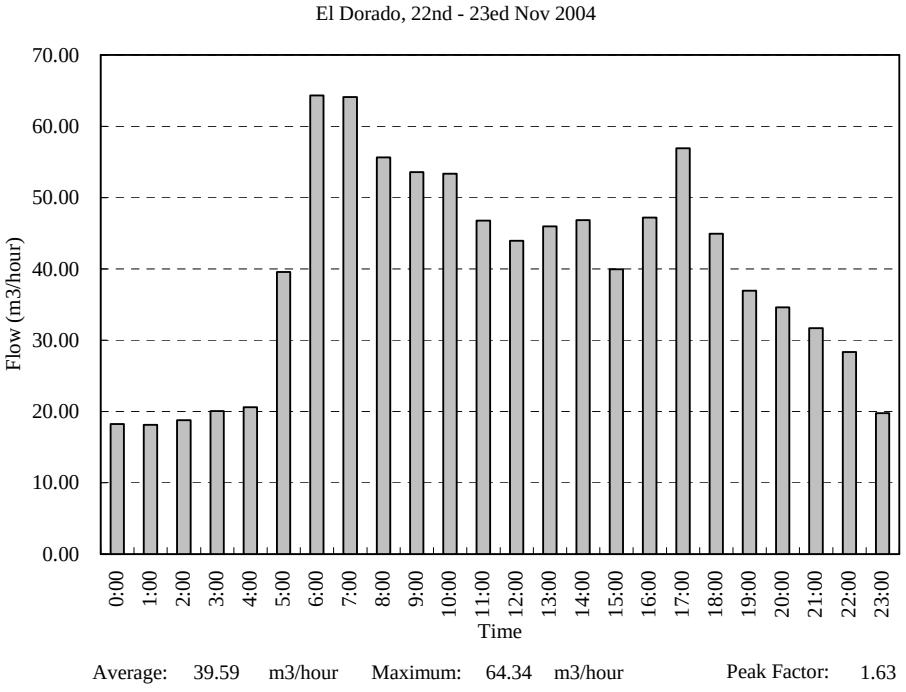

Figure 1E-5 Hourly Flow Pattern to El Dorado on 22nd/23rd Nov. 2004

Time	Flow (m3/h)
0:00	7.27
1:00	6.84
2:00	7.05
3:00	7.40
4:00	10.27
5:00	29.90
6:00	47.20
7:00	45.22
8:00	44.55
9:00	43.02
10:00	40.65
11:00	39.13
12:00	31.00
13:00	34.45
14:00	32.25
15:00	29.30
16:00	28.56
17:00	23.42
18:00	19.06
19:00	14.96
20:00	14.95
21:00	14.03
22:00	12.31
23:00	9.50

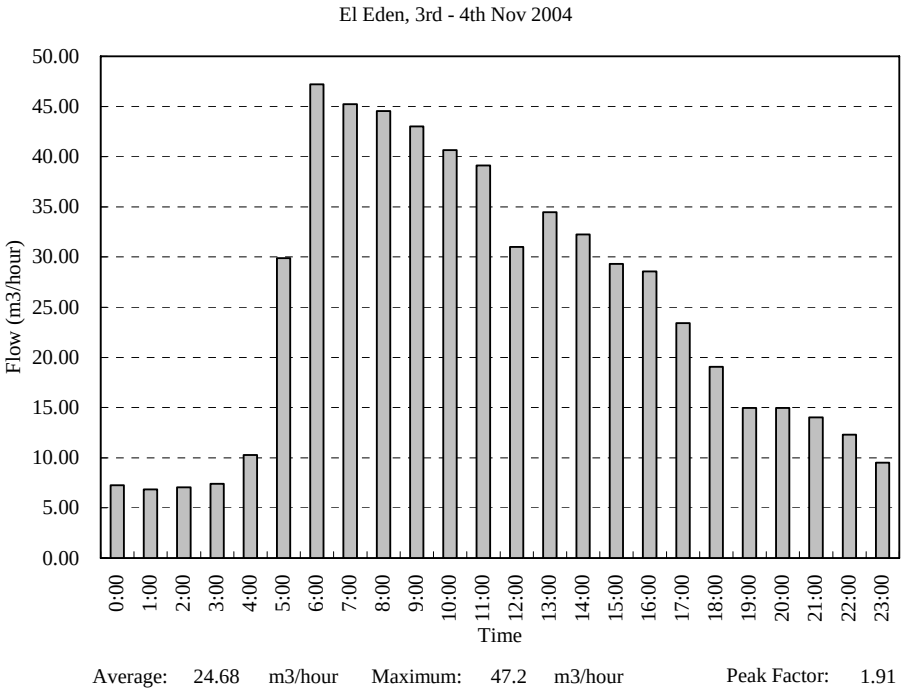

Figure 1E-6 Hourly Flow Pattern to El Eden on 3rd/4th Nov. 2004

Time	Flow (m3/h)
0:00	2.04
1:00	2.30
2:00	2.56
3:00	3.82
4:00	5.60
5:00	20.42
6:00	30.61
7:00	30.47
8:00	28.33
9:00	27.58
10:00	24.66
11:00	18.67
12:00	16.93
13:00	16.44
14:00	17.99
15:00	15.22
16:00	19.47
17:00	16.93
18:00	12.37
19:00	10.30
20:00	10.70
21:00	8.71
22:00	7.05
23:00	1.99

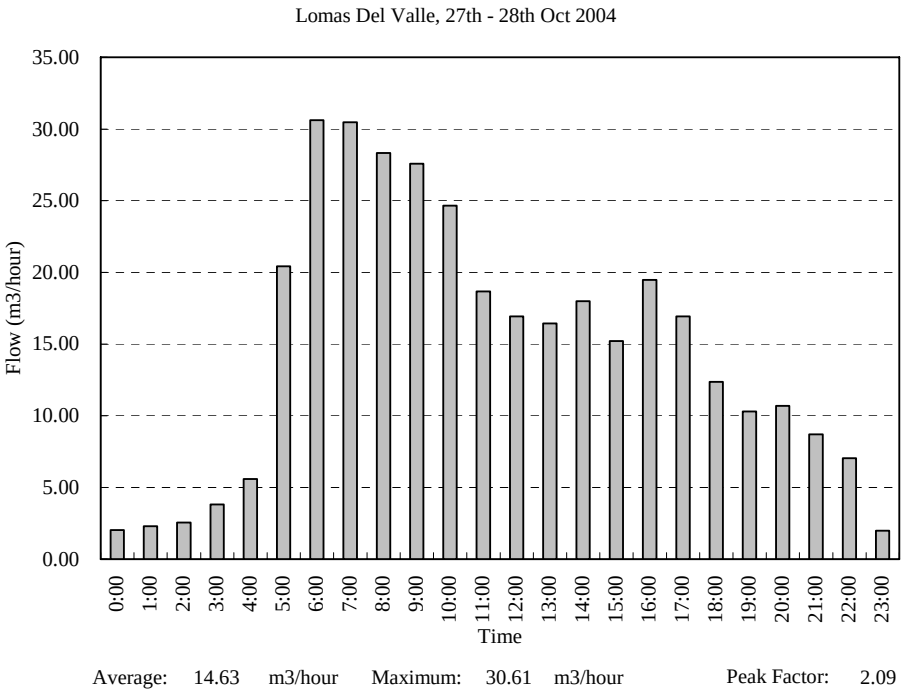

Figure 1E-7 Hourly Flow Pattern to Lomas Del Valle on 27th/28th Oct. 2004

Time	Flow (m3/h)
0:00	14.14
1:00	14.18
2:00	14.38
3:00	15.43
4:00	18.35
5:00	28.04
6:00	33.94
7:00	31.57
8:00	32.99
9:00	30.16
10:00	26.83
11:00	25.43
12:00	25.96
13:00	26.52
14:00	25.28
15:00	21.68
16:00	20.30
17:00	20.30
18:00	11.64
19:00	12.35
20:00	13.69
21:00	15.47
22:00	15.43
23:00	14.92

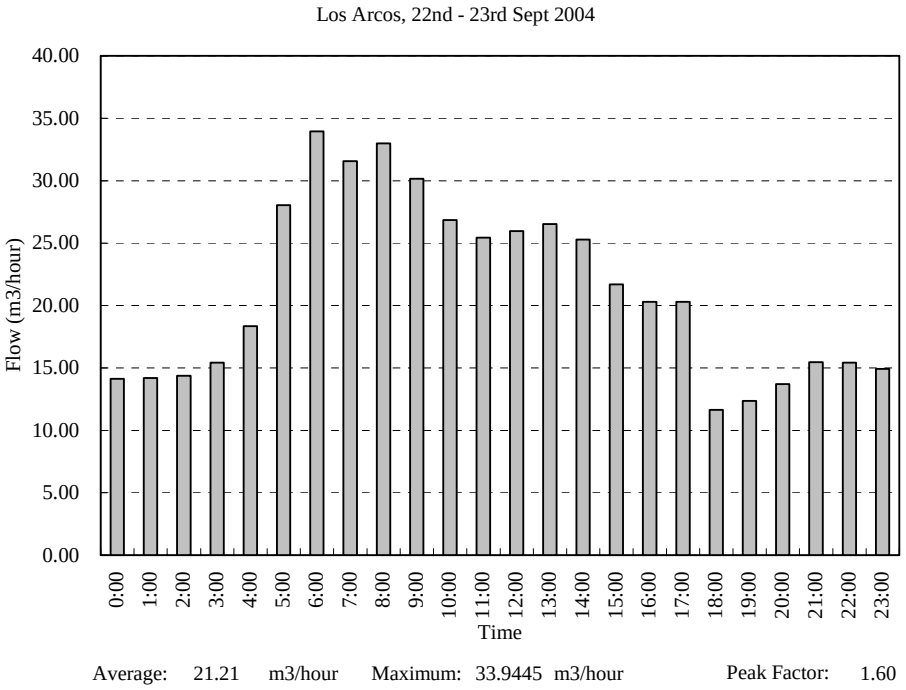

Figure 1E-8 Hourly Flow Pattern to Los Arcos on 22nd/23rd Sept. 2004

Time	Flow (m3/h)
0:00	7.25
1:00	6.88
2:00	6.65
3:00	6.63
4:00	7.74
5:00	14.11
6:00	23.96
7:00	25.71
8:00	27.65
9:00	26.41
10:00	26.13
11:00	25.31
12:00	21.00
13:00	19.80
14:00	18.13
15:00	16.87
16:00	14.65
17:00	14.55
18:00	11.99
19:00	11.11
20:00	9.55
21:00	10.33
22:00	10.08
23:00	8.21

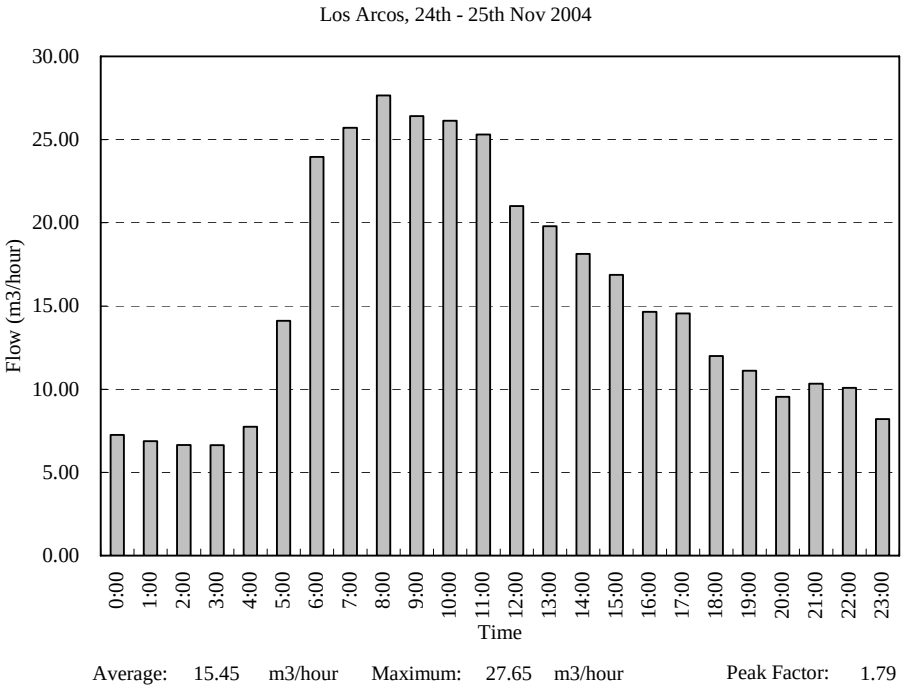

Figure 1E-9 Hourly Flow Pattern to Los Arcos on 24th/25th Nov. 2004

Time	Flow (m3/h)
0:00	1.73
1:00	1.77
2:00	3.11
3:00	2.47
4:00	2.91
5:00	8.97
6:00	11.44
7:00	10.87
8:00	12.25
9:00	15.19
10:00	14.10
11:00	8.76
12:00	8.27
13:00	8.11
14:00	8.19
15:00	6.59
16:00	6.79
17:00	4.46
18:00	4.26
19:00	3.24
20:00	3.33
21:00	3.47
22:00	2.04
23:00	2.35

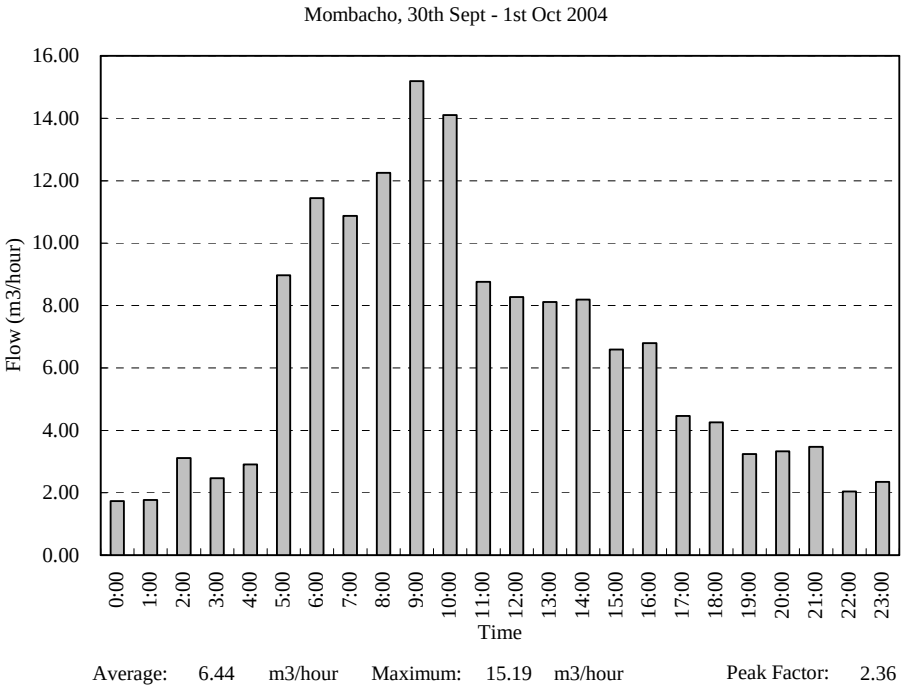

Figure 1E-10 Hourly Flow Pattern to Mombacho on 30th Sept./1st Oct. 2004

Time	Flow (m3/h)
0:00	3.62
1:00	2.91
2:00	3.19
3:00	3.46
4:00	3.81
5:00	11.98
6:00	20.77
7:00	23.26
8:00	19.02
9:00	20.89
10:00	17.35
11:00	13.98
12:00	14.37
13:00	14.51
14:00	14.41
15:00	12.27
16:00	11.41
17:00	9.75
18:00	8.21
19:00	8.91
20:00	9.95
21:00	9.07
22:00	7.65
23:00	4.24

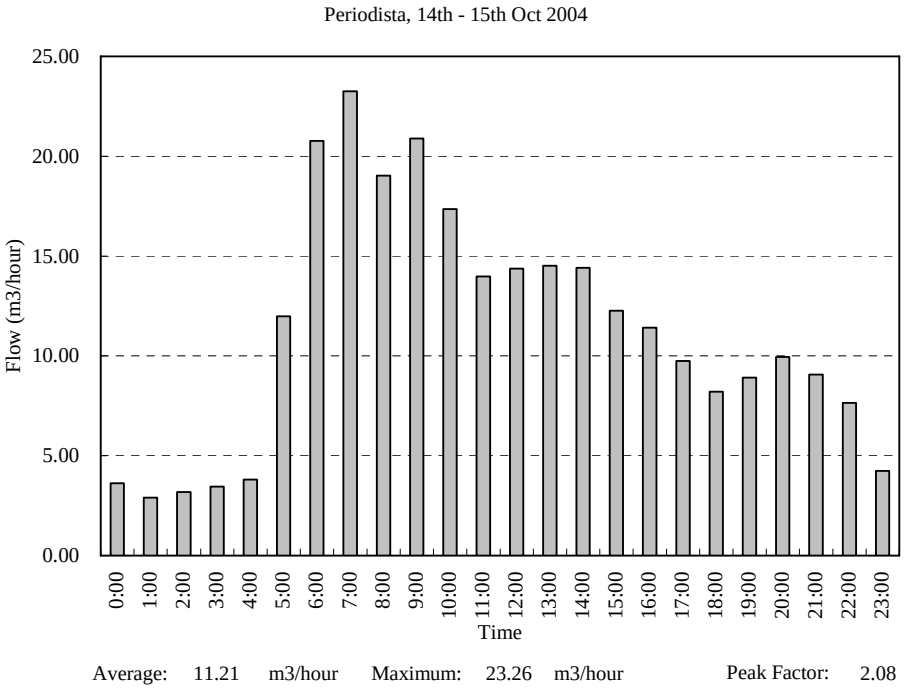

Figure 1E-11 Hourly Flow Pattern to Periodista on 14th/15th Oct. 2004

Time	Flow (m3/h)
0:00	5.72
1:00	5.86
2:00	6.13
3:00	6.84
4:00	8.86
5:00	18.06
6:00	23.47
7:00	23.57
8:00	23.89
9:00	20.24
10:00	18.50
11:00	18.12
12:00	18.07
13:00	17.03
14:00	15.45
15:00	16.17
16:00	16.21
17:00	13.02
18:00	12.73
19:00	13.35
20:00	12.42
21:00	9.72
22:00	7.51
23:00	5.65

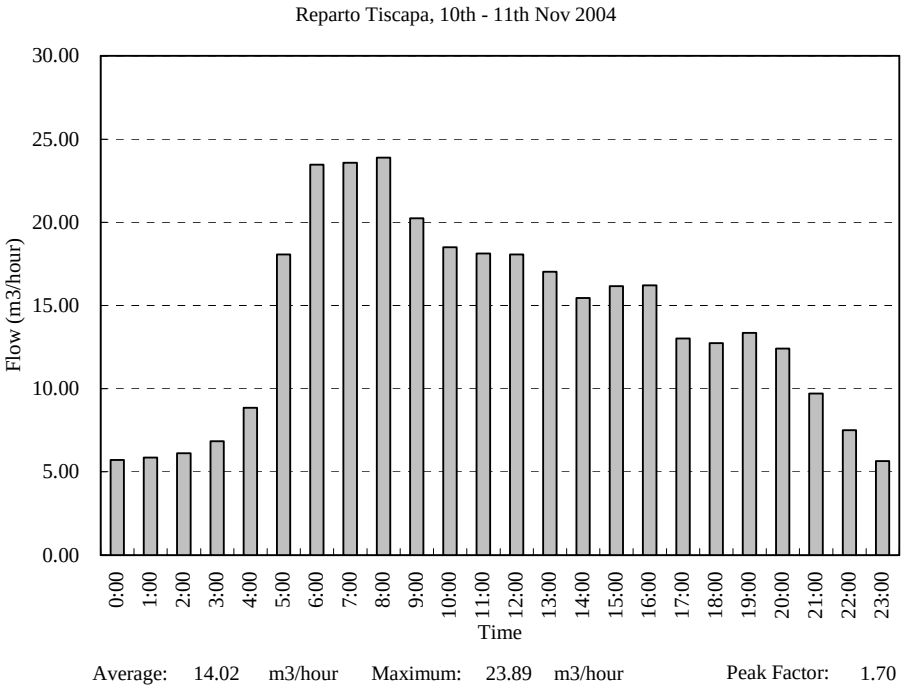

Figure 1E-12 Hourly Flow Pattern to Reparto Tiscapa on 10th/11th Nov. 2004

Time	Flow (m3/h)
0:00	3.70
1:00	2.90
2:00	3.00
3:00	3.12
4:00	3.79
5:00	9.24
6:00	18.58
7:00	19.67
8:00	19.96
9:00	18.11
10:00	16.80
11:00	13.18
12:00	13.77
13:00	12.82
14:00	15.01
15:00	14.19
16:00	11.05
17:00	11.85
18:00	8.49
19:00	6.92
20:00	7.47
21:00	6.04
22:00	5.73
23:00	4.69

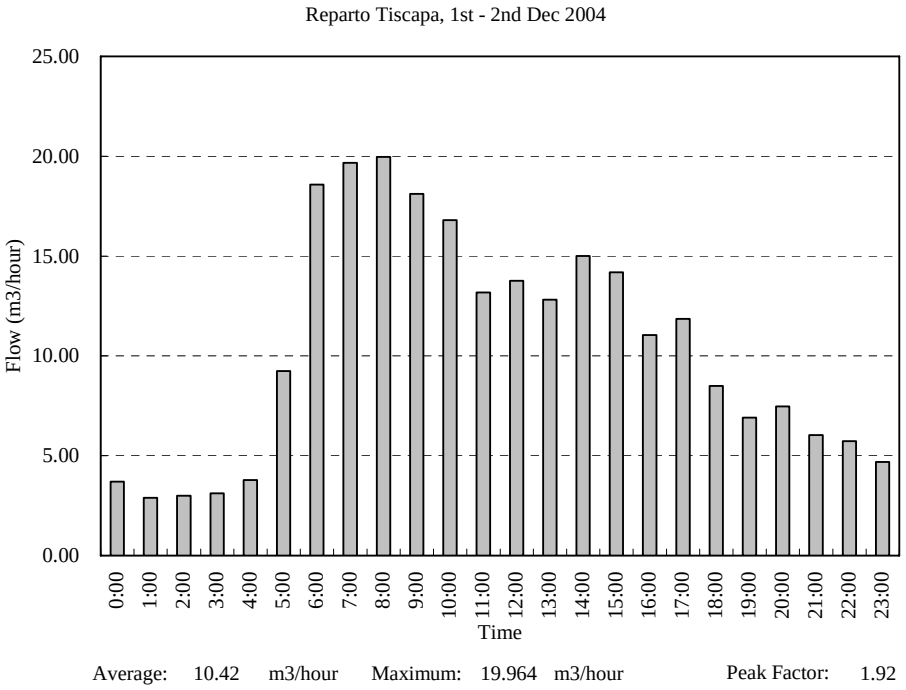

Figure 1E-13 Hourly Flow Pattern to Reparto Tiscapa on 1st/2nd Dec. 2004

Time	Flow (m3/h)
0:00	7.50
1:00	6.73
2:00	6.51
3:00	7.58
4:00	7.32
5:00	10.61
6:00	17.84
7:00	17.85
8:00	20.44
9:00	20.23
10:00	18.87
11:00	18.47
12:00	13.30
13:00	12.95
14:00	14.60
15:00	11.16
16:00	8.07
17:00	8.58
18:00	9.10
19:00	10.23
20:00	9.28
21:00	10.84
22:00	10.45
23:00	9.95

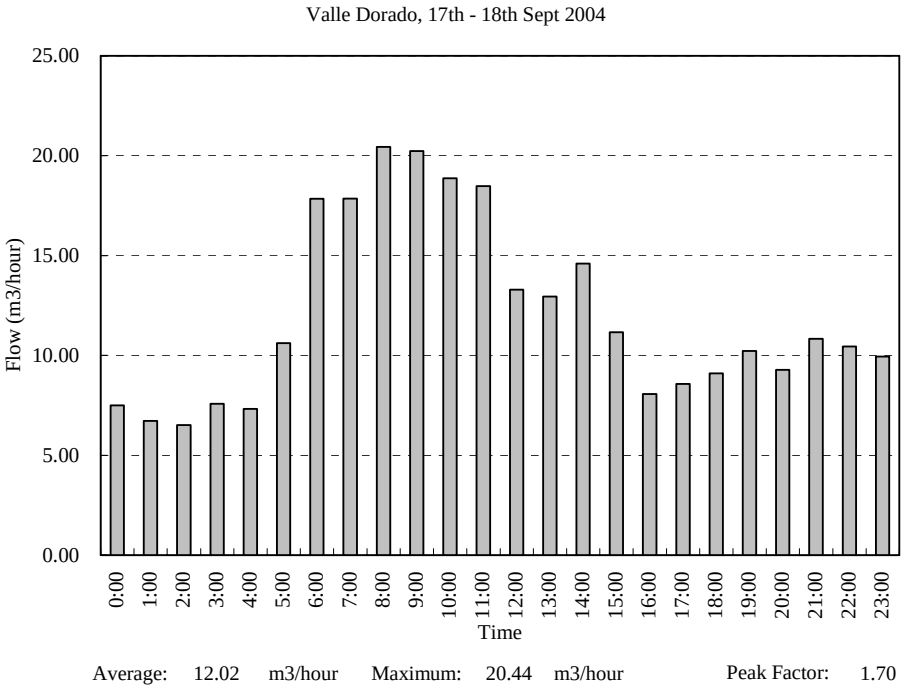

Figure 1E-14 Hourly Flow Pattern to Valle Dorado on 17th/18th Sept. 2004

Time	Flow (m3/h)
0:00	88.15
1:00	86.85
2:00	89.26
3:00	95.12
4:00	113.81
5:00	237.73
6:00	351.78
7:00	350.64
8:00	344.12
9:00	330.86
10:00	314.95
11:00	278.23
12:00	248.51
13:00	251.42
14:00	260.56
15:00	230.93
16:00	226.22
17:00	216.77
18:00	174.31
19:00	154.57
20:00	150.36
21:00	141.15
22:00	127.74
23:00	99.05
Total	4,963.1

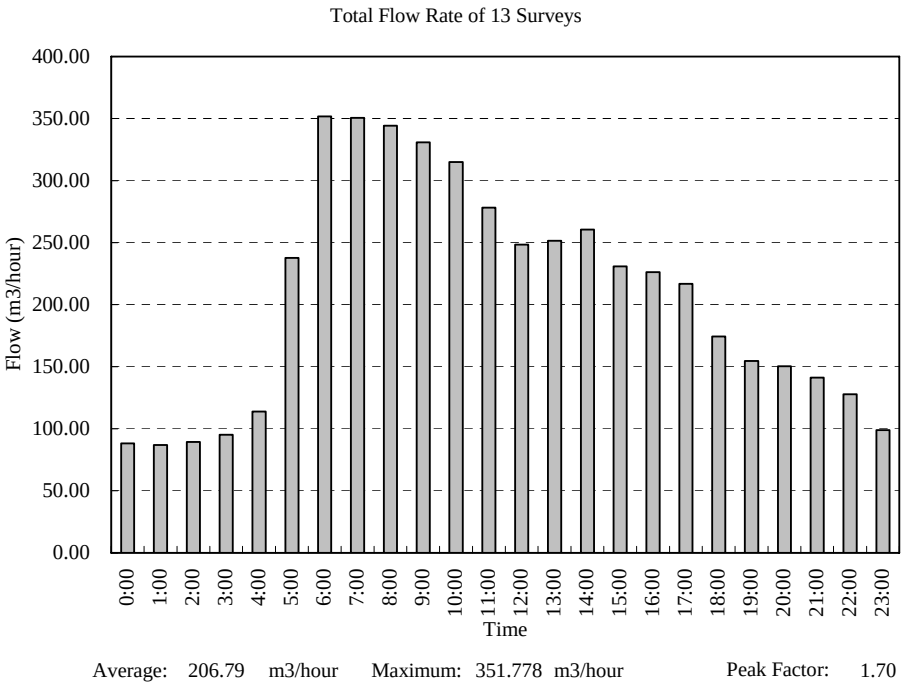

Figure 1E-15 Hourly Flow Pattern of Total Flow of 13 Survey Results

Table 1E-1 Summary of Hourly Flow Pattern

No.	Name of Sector	Survey Date	Flow Rate (m3/hour)		Peak Factor
			average	maximum	
1	Belmonte	20th - 21st Oct 2004	13.8	23.8	1.73
2	Chamorro (1)	3rd - 4th Oct 2004	13.0	21.0	1.62
3	Chamorro (2)	1st - 2nd Nov 2004	10.4	20.4	1.97
4	El Dorado	22nd - 23ed Nov 2004	39.6	64.3	1.63
5	El Eden	3rd - 4th Nov 2004	24.7	47.2	1.91
6	Lomas Del Valle	27th - 28th Oct 2004	14.6	30.6	2.09
7	Los Arcos (1)	22nd - 23rd Sept 2004	21.2	33.9	1.60
8	Los Arcos (2)	24th - 25th Nov 2004	15.4	27.7	1.79
9	Mombacho	30th Sept - 1st Oct 2004	6.4	15.2	2.36
10	Periodista	14th - 15th Oct 2004	11.2	23.3	2.08
11	Reparto Tiscapa (1)	10th - 11th Nov 2004	14.0	23.9	1.70
12	Reparto Tiscapa (2)	1st - 2nd Dec 2004	10.4	20.0	1.92
13	Valle Dorado	17th - 18th Sept 2004	12.0	20.4	1.70
Total			206.8	351.8	1.70

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

EMPRESA NICARAGÜENSE DE ACUEDUCTOS Y ALCANTARILLADOS SANITARIOS (ENACAL)

THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN MANAGUA IN THE REPUBLIC OF NICARAGUA

FINAL REPORT

Supporting Report No.2
Water Quality Analysis

DECEMBER 2005

NIHON SUIDO CONSULTANTS CO., LTD.
ASIA AIR SURVEY CO., LTD.

THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN MANAGUA IN THE REPUBLIC OF NICARAGUA

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Table of Contents

ANNEXES

2.1 OBJECTIVES OF WATER QUALITY ANALYSIS

In order to assess the sustainability of existing water sources, 10 samples were taken and analyzed from major water sources. Further, to evaluate the exploitability of new water sources, 5 samples were taken from prospective water sources. Given the seasonal water variation of water quality, these 15 samples were taken and analyzed twice during the Study. In addition to the analysis, signs of contamination by human activities in water sources were surveyed from ENACAL monitoring data.

2.2 SUMMARY OF ANALYSIS RESULTS

2.2.1 Existing Water Sources

(1) Groundwater

a) Analytical Result of This Study

Groundwater samples for existing water sources were taken from 9 places (except Asososca Lake) in the Study Area.
The analytical results are summarized followed:

- Most of water quality concentrations of the existing water sources are suited for the National Drinking Water Standard in Nicaragua, which is established in 1993. This standard was adapted to Comité Coordinador Regional de Instituciones de Agua Potable y Saneamiento de Centroamerica, Panama y Republica Dominicana (hereinafter called "CAPRE guidelines"), which was referred with WHO Guidelines for drinking-water quality (hereinafter called “WHO guidelines”). These results don't indicate that every groundwater quality in Managua city is safe to drink. There is a need to survey the analysis of all water qualities in Managua city.
- Arsenic concentrations in Las Mercedes No.5, Las Mercedes No.9, Managua II No.15, Sabana Grande No.1, Sabana Grande No.2 and Sabana Grande No 3 are over CAPRE guidelines.
- Lead concentration in Monsenor Lescano, Managua II No7 and Managua II No15 is over CAPRE guidelines, all the high value was detected only in dry season. Monsenor Lezcano Well in the downtown is located near a gas station, it needs careful monitoring for clearing any relationship of high concentration of lead and gas station. For Managua II wells there need more monitoring data for take any evaluation of the quality. Because this wells is mixed with another wells of the group, immediate action isn’t needs.
- Aluminum concentration in Las Mercedes No 5, Las Mercedes No.9 and Managua I E3, is over the guideline. The guideline value is established for color of drinking water and usage of Aluminum treatment, not for health perspectives.
- To confirm safety of the drinking water, Arsenic, Lead and Aluminum concentrations in typical pipelines such as Las Mercedes, Sabana Grande, Managua I and Managua II well fields need to be analyzed. In addition, to figure out distribution of Arsenic concentrations in Managua city, all wells should be analyzed.
- Six of Polycyclic Aromatic Hydrocarbons (hereinafter called "PAHs"), was detected in Las Mercedes No.5. Three PAHs was detected in Las Mercedes No.9, all this detected value is below CAPRE guidelines
- One of pesticides, Heptachlor was detected in Asososca. However, the levels of Heptachlor are under CAPRE guideline.
- Some inappropriate waters are mixed with much volume of suitable water. As a result, supplied water is available for drinking.

b) Review of ENACAL Monitoring Data

- Some wells in ZONA BAJA have been getting high concentration of Nitrate. Because wastewater pipelines are heavily damaged by the past earthquake, there is a possibility that Nitrate comes from wastewater. Nitrate concentrations of Mercado Oriental (No.10) and Olof Palme (No.9) are already over the recommendation value of CAPRE guideline. Nitrate in San Antonio (No.8) doubles in ten years. These wells should stop in near future. When Nitrate concentrations in wells are over recommendation value of CAPRE guideline, these wells should stop and consider relocation.
- Managua I Well Field divides at least three types of groundwater quality.
- Eastern wells are higher concentration of substances than western wells.

(2) Asososca Lake

a) Analytical Result of This Study

Water samples from Asososca Lake were taken from 2 places, pumped water and water after chlorination.
The analytical results are summarized followed:

- One pesticide, Heptachlor, was detected. However, this concentration is less than the guideline. Concentrations of other parameters are under the guideline.
- Any BTEX, Trihalomethanes, and Chlorophenols are not detected. There is no possibility of contamination.

b) Review of ENACAL Monitoring Data

- Groundwater between an Industrial Zone (hereinafter called "IZ") that locates north of Asososca Lake and Asososca Lake is contaminated with high chloride.
- Water circulation and appearance of algae in December or January has recently appeared. Water from bottom of the Lake contains H_2S. It affects taste of water.
- When water level of Asososca Lake falls below 37 meters, high concentration of Chloride is probably caused. Not to flow the contaminated water into Asososca Lake, water level of Asososca Lake should keep no less than 37 meters even though it depends on the relationship between water level of Asososca Lake and groundwater level of IZ.
- Asososca Lake is suited for a good water resource except for input of contaminated water from IZ or occurrence of algae. Therefore, monitor of groundwater between the Lake and IZ and investigation of algae occurrence in the Lake are necessary.

2.2.2 Prospective Water Sources

(1) Analytical Result of This Study

Groundwater samples for prospective water sources were taken from 5 places.
The analytical results are summarized followed:

- Nicaragua Lake: Water has high concentrations of Aluminum and Iron. It is probable that this high concentration comes from soil particle during sampling. The highest turbidity in all samples supports this result. Except for two parameters, water quality of Nicaragua Lake is suited for the drinking guideline.
- Lomas Del Gavilan: Manganese in wet season is over recommendation value of CAPRE guideline; but below CAPRE maximum value. High concentration of Aluminum and Potassium were detected in dry season. There need more information for take any conclusion for this water source.

- Sierras Doradas: Lead, Aluminum, Magnesium and Potassium concentrations are over the guideline. This well probably is influenced by volcanic origins from an active volcano, Mt. Masaya, or locates near a fault. Because there is no PAHs related facility around the well, the detected PAHs, would come from the burning around the well or the volcanic gasses of Mt. Masaya.
- Avinic No.4: This irrigation well has high Arsenic and Iron compared with the guideline. Sulfate is also higher than other samples. There is a possibility the area the well locates has high Arsenic origin.
- Cuatro Esquinas: Water in digging well has high concentrations of Aluminum. Except for Aluminum concentration that probably comes from soil particle during sampling, water quality of the well is suited for drinking.

(2) Review of ENACAL Monitoring Data

- Some of shallow wells in Tisma area have high concentration of Nitrate, more than 100 mg/L. There is a possibility these wells are contaminated by wastewater.

2.2.3 Tap Water

Tap water samples were taken from 10 places. Tap water samples weren't detected any Coliform Organisms. Residual chlorines in samples were under CAPRE guidelines. These results show that drinking water in Managua city is disinfected by chlorine properly.

2.3 WATER SAMPLING METHODOLOGY

2.3.1 Water Sampling Locations

The Study team in close consultation with ENACAL decided to take water samples from the locations shown in **Tables 2.3.1** and **2.3.2**. The geographic distribution of these sampling points is shown in **Figures 2.3.1** and **2.3.2**.

Samples places of existing water sources are selected by 'Remarks' in **Table 2.3.1**. The places of prospective water sources are considered to the other water reservoirs: East of Managua city, little usage of rich groundwater from Masaya volcano region.

Table 2.3.1 Location of Existing Water Sources Samples

No.	Name	Sampling Point	Remarks
1	Asososca	Before and after chlorination	The only surface water source in Managua
2	Las Mercedes	PP No.5	Zona Baja in the east of the city, located north of Managua II
3		PP No.9	
4	Distrito II	PP Monseñor Lezcano	The typical well of the Zona Baja in the west of the city
5	Managua UNO	PP E-3	To assess the implication of water quality on the corrosion of pumps at Managua I Well Field
6		PP W-5	
7	Managua DOS	PP No.15	
8		PP No.7	
9	Veracruz	Veracruz No. 3 (Valle Gothel)	Located between Managua I and Managua II Well Field
10	Distrito III	PP Julio Martínez	The typical well of Zona Alta in the west of the city

Table 2.3.2 Location of Prospective Water Resource Samples

No.	Name	Discharge (gpm)	Ground Level (m)	SWL (m)	Remarks
1	ANIVIC No.4 (SECTOR TISMA)	1100	157	20.8	Irrigation Well
2	CUATRO ESQUINAS (LA PIEDRA)	-	84	25.7	Digging well
3	POZO LOMAS DEL GAVILAN (1.5 KM AL NORTE DE NINDIRI)	160	215	89.8	Water supply
4	POZO SIERRAS DORADAS (TICUANTEPE)	50	287	158	Private water supply
5	SECTOR DEL GUAYABO	-	42	-	Nicaragua Lake

Samples were also taken from 10 service taps within the existing service area (both in the dry season and the rainy season – total 20 samples). **Table 2.3.3** and **Figure 2.3.1** shows the 10 locations from which tap water samples were taken.

Table 2.3.3 Location of Sampling for Tap Water

No	District	Sampling Point	Location
1	D-II Batahola Norte	Colegio Carlos Fonseca	Enacal km 5 Sur 1 C al norte 2 C arriba.
2	D-VI Unidad de Propósito	Colegio Modesto Armijo	De Gasolinera Texaco 6 c. Norte
3	D-VI Mayoreo	Gasolinera Shell Mayoreo	Contiguo a los semáforos Mayoreo
4	D-II Monseñor Lezcano	Contiguo donde fue Gasolinea Esso	Entrada principal del Cementerio 1/2 C Este
5	D-V Veracruz	Escuela Victor Manuel Lazol	Del cruce hacia la Borgoña 2 C al sur
6	D-V Carretera Masaya	Gasolinera Texaco	Gasolinera Texaco Cartra Masaya
7	D-V 14 de Septiembre	Colegio 14 de Septiembre	Colegio 14 de Septiembre
8	D-III Hialeah	Pulpería	De Rotonda el Periodista 6 Sur 1 arriba
9	D-III El Pilar	Colegio el Pilar	De Raspados Loly 1 c abajo 2 c al sur.
10	D-IV Santa Rosa	Colegio Santa Rosa	De semáforos Portezuelo 1 c al sur 3 c abajo.

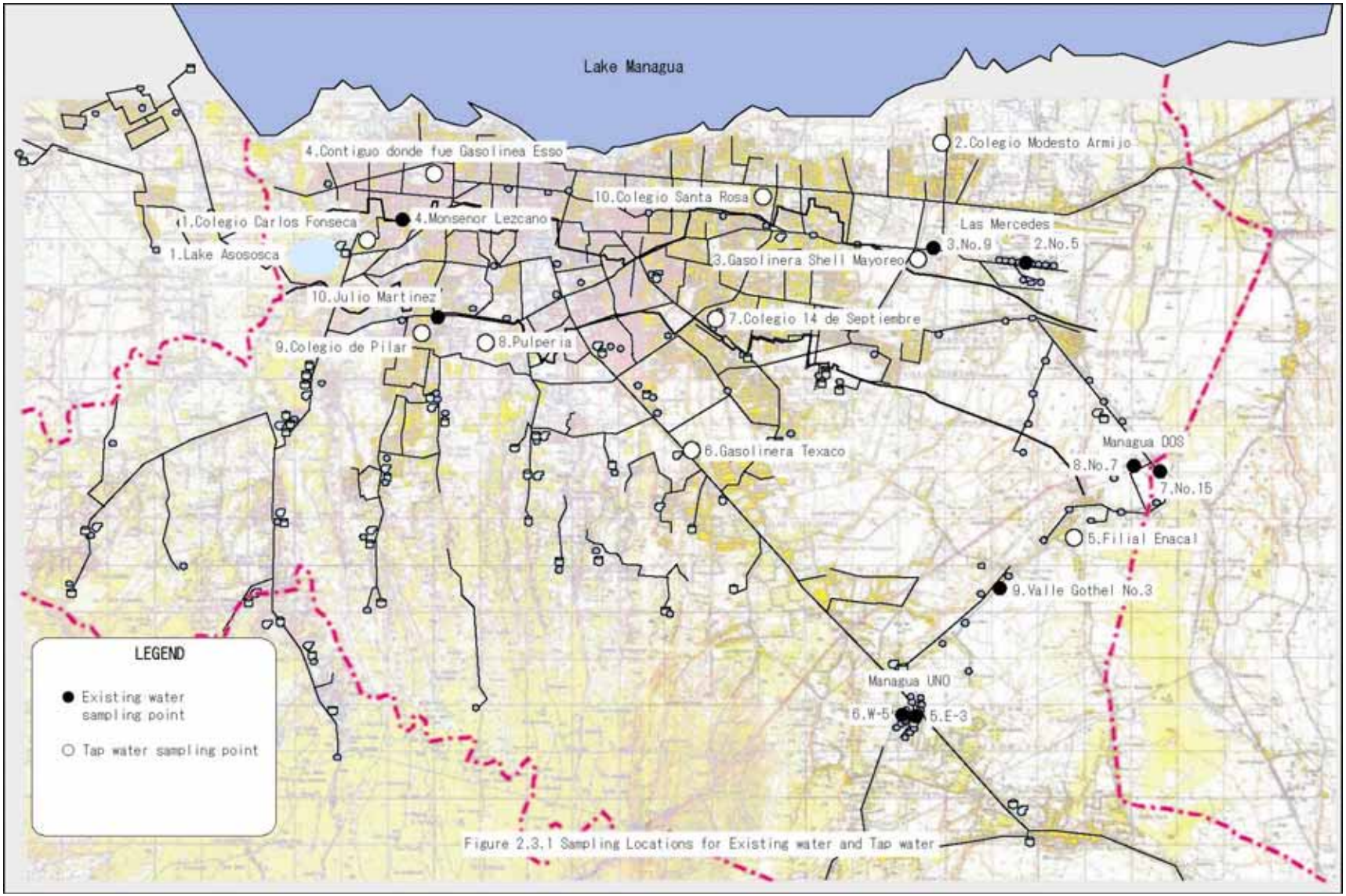


Figure 2.3.1 Sampling Locations for Existing water and Tap water

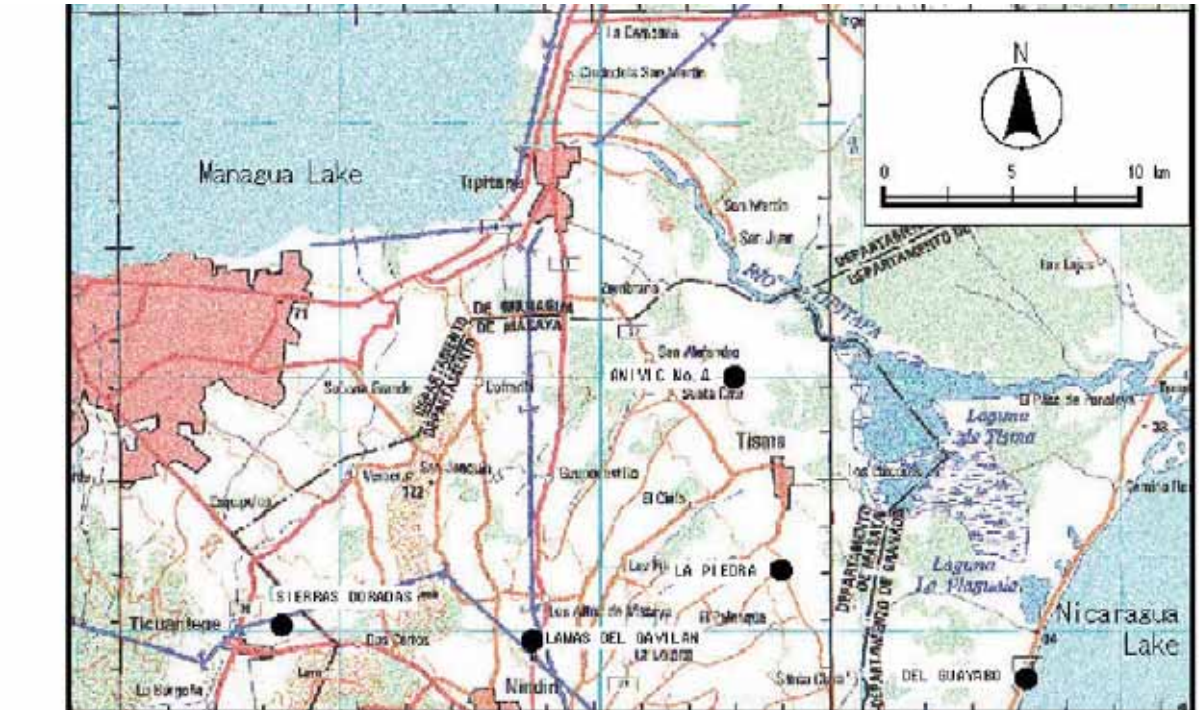


Figure 2.3.2 Locations of Prospective Water Samples

2.3.2 Water Quality Parameters

Water quality parameters were selected to assess the sustainability of existing water sources and to evaluate the exploitability of prospective water sources. In selecting the parameters, ENACAL and the Study team agreed as follow:

- Most physical and inorganic parameters are not required for existing water sources as ENACAL has already accumulated adequate data on them.
- Trihalomethanes and Chlorophenols should be included for Asososca Lake (after chlorination), as there is concern over Phenol contamination from IZ located north of Asososca Lake and overabundance of nutrients.
- Coliform-related parameters are not required for existing and prospective water sources as they are raw water.
- PAHs and BTEX should be included for those water sources that are located near gas station and the international airport.
- Lead is not required for tap water as lead pipes are not used in Managua.
- Plate Count Bacteria for tap water should be deleted, because there is no measurement method established in Nicaragua.

As a result, parameters have been selected as shown in **Table 2.3.4**.

Table 2.3.4 Parameters for Analysis

	Parameter	Existing Source	Prospective Source	Tap Water
1	Arsenic	X	X	
2	Boron	X	X	
3	Cadmium	X	X	
4	Chromium	X	X	
5	Lead	X	X	

	Parameter	Existing Source	Prospective Source	Tap Water
6	Total Mercury	X	X	
7	Manganese	X	X	
8	Hydrogen sulfide	X	X	
9	Aluminum	X	X	
10	Copper	X	X	
11	Cyanide	X	X	
12	Zinc	X	X	
13	Dissolved Oxygen	X	X	
	Physical & Chemical Parameter			
14	pH	X	X	
15	Sodium	X	X	
16	Sulfate	X	X	
17	Total dissolved solids	X	X	
18	Magnesium	X	X	
19	Calcium	X	X	
20	Potassium	X	X	
21	Carbonate	X	X	
22	Bicarbonate	X	X	
23	Color	X	X	
24	Turbidity	X	X	
25	Temperature	X	X	
26	Electrical Conductivity	X	X	
27	Fluoride	X	X	
28	Chlorine	X	X	
29	Nitrates (as NO3-)	X	X	
30	Nitrites (as NO2-)	X	X	
31	Hardness	X	X	
32	Total Iron	X	X	
33	Langelier Index	X	X	
	Pesticide (1)			
34	a-BHC	X	X	
35	b-BHC	X	X	
36	d-BHC	X	X	
37	Lindane	X	X	
38	Heptachlor	X	X	
39	Heptachlor epoxide	X	X	
40	a-Endasulfane	X	X	
41	b-Endasulfane	X	X	

	Parameter	Existing Source	Prospective Source	Tap Water
42	Aldrin	X	X	
43	Dieldrin	X	X	
44	Endrin	X	X	
45	p,p'-DDE	X	X	
46	p,p'-DDD	X	X	
47	p,p'-DDT	X	X	
48	Toxafene	X	X	
49	PAHs (2)	X	X	
50	BTEX (2)	X	X	
51	Trihalomethanes (3)	X		
52	Chlorophenols (3)	X		
53	Coliform Organisms			X
54	Free residual chlorine			X

(1) Except PP Monseñor Lezcano, which isn't danger of pesticides contamination.
(2) Only at Las Mercedes PP No.5 and No.9, PP Monseñor Lezcano, Ticuantepe, and Nindiri, which are dangers of petroleum contamination from gas stations and the international airport.
(3) Only at Asososca, after chlorination.

2.3.3 Laboratory

The sampling and analysis works were conducted by Centro para la Investigacion en Recursos Acuaticos de Nicaragua (hereafter called "CIRA") under a subcontract with the Team. ENACAL has his own laboratory, but parameters that it can analyze are limited to major inorganic compounds. The only reliable laboratory in Nicaragua is CIRA, which belongs to the National University of Nicaragua. However, CIRA cannot analyze 3 parameters, namely BTEX, Trihalomethanes and Chlorophenols. Under the circumstances, analysis of these parameters was subcontracted by CIRA to Severn Trent Laboratories Houston (hereafter called "STL"), a laboratory in the North America.

2.3.4 Schedule of Water Sampling

Sampling work for the rainy season started on September 27 and completed on October 19, 2004. Another sampling work for the dry season was from January 11 to January 18, 2005. The weather during water sampling was fine.

2.4 WATER QUALITY OF EXISTING WATER SOURCES

2.4.1 Drinking Water Standards

Table 2.4.1 is the National Drinking Water Standard in Nicaragua, which is established in 1993. This standard was adapted to CAPRE, which was referred with WHO guidelines.

Table 2.4.1(1) National Drinking Water Standard in Nicaragua

Parameters	CAPRE Recommendation	CAPRE Standard	Parameters	CAPRE Standard
Faecal Coliform	None	None	Carbon tetrachloride	2 μg/L
Total Coliform Bacteria	None	None	Dichloromethane	20 μg/L
Color	1TCU	15TCU	1,1-Dichloroethane	
Turbidly	1NTU	5NTU	1,2-Dichloroethane	30 μg/L
Odor	0	2(12℃),3(25℃)	1,1,1-Trichloroethane	1000 μg/L
Taste	0	2(12℃),3(25℃)	Vinyl chloride	5 μg/L
Temperature	18-30℃		1,1-Dichloroethene	30 μg/L
pH	6.5-8.5		1,2-Dichloroethene	50 μg/L
Chloro residual	0.5-1.0mg/L	5.0mg/L	Trichloroethene	70 μg/L
Chloride	25mg/L	250mg/L	Tetrachloroethene	40 μg/L
Electrical Conductivity	400us/cm		Toluene	700 μg/L
Hardness	400mg/L$CaCO_3$		Xylenes	500 μg/L
Sulfate	25mg/L	250mg/L	Ethyl Benzene	300 μg/L
Aluminum		0.2mg/L	Styrene	20 μg/L
Calcium	100mg/L$CaCO_3$		Benzo (a) Pyrene	0.7 μg/L
Copper	1.0mg/L	2.0mg/L	Monochlorobenzene	300 μg/L
Magnesium	30mg/L$CaCO_3$	50mg/L$CaCO_3$	1,2-Dich1orobenzene	1000 μg/L
Sodium	25mg/L	200mg/L	1,3-Dichlorobenzene	
Potassium		10mg/L	1,4-Dichlorobenzene	300 μg/L
Total Dissolved Solids		1000mg/L	Trichlorobenzene	20 μg/L
Zinc		3.0mg/L	2-ethlyhexyl adipate	80 μg/L
Nitrate(NO_3^-)	25mg/L	50mg/L	2-ethlyhexyl phthalate	8 μg/L
Nitrite(NO_2^-)		3.0mg/L	Acrylamido	0.5 μg/L
Ammonia	0.05mg/L	0.5mg/L	Epichlorohydrin	0.4 μg/L
Iron		0.3mg/L	Hexachlorobutadiene	0.5 μg/L
Manganese	0.1mg/L	0.5mg/L	EDTA	200 μg/L
Fluoride		0.7mg/L (25-30℃) 1.5mg/L (8-12℃)	NTA	200 μg/L
Hydrogen Sulfide		0.05mg/L	Dialkyltins	
Arsenic		0.01mg/L	Tributyltin oxide	2 μg/L
Cadmium		0.05mg/L	PAHs	0.2 μg/L
Cyanide		0.05mg/L	PCB (Polychlorinated biphenyl)	0.5 μg/L
Chromium		0.05mg/L		
Mercury		0.001mg/L		
Nickel		0.05mg/L		
Lead		0.01mg/L		
Antimony		0.05mg/L		
Selenium		0.01mg/L		

Table 2.4.1(2) National Drinking Water Standard in Nicaragua

Parameters	CAPRE Standard	Parameters	CAPRE Standard
Pesticides		Disinfectant	
Alachlor	20 μg/L	Monochloramine	4000 μg/L
Aldicarb	10 μg/L	Disinfectant by products	
Aldrin/Dieldrin	0.03 μg/L	Bromate	25 μg/L
Atrazine	2 μg/L	Chlorate	200 μg/L
Bentazone	30 μg/L	Chlorite	
Carbofuran	5 μg/L	Chloropehnols	
Chlordane	0.2 μg/L	2-chlorophenol	
DDT	2 μg/L	2,4-dichlorophenol	
1,2-Dibromo-3-chloropropane	1 μg/L	2,4,6-trichlorophenol	200 μg/L
2,4-D	30 μg/L	Formaldehyde	900 μg/L
1,2-Dichloropropane	20 μg/L	Trihalomethanes	
1,3-Dichloropropane	20 μg/L	Bromoform	100 μg/L
Hepatachlor/Hepatachlor epoxide	0.03 μg/L	Dibromochloromethane	100 μg/L
Isoproturon	9 μg/L	Bromodichloromethane	60 μg/L
Lindane	2 μg/L	Chloroform	200 μg/L
MCPA	2 μg/L	Chlorinated acetic acids	
Methoxychlor	20 μg/L	Monochloroacetic acid	
Metolachlor	10 μg/L	Dichloroacetic acid	50 μg/L
Molinate	6 μg/L	Trichloroacetic acid	100 μg/L
Pendimethalin	20 μg/L	Trichloroacetaldehyde/ Chloral Hydrate	100 μg/L
Pentachlorophenol	9 μg/L	Chloropropanes	
Permethrin	20 μg/L	Halogenated acetonitriles	
Propanil	20 μg/L	Dichloroacetonitrile	90 μg/L
Pyridate	100 μg/L	Dibromoacetonitrile	100 μg/L
Simazine	2 μg/L	Bromochloroacetonitrile	
Trifluralin	20 μg/L	Trichloroacetonitrile	1 μg/L
Dichlorprop	100 μg/L	Cyanogen chloride (as CN-)	70 μg/L
2,4-DB	100 μg/L		
2,4,5-T	9 μg/L		
Fenoprop (Silvex)	9 μg/L		
Mecoprop	10 μg/L		

2.4.2 Results of Analyses

Summary for the results of water quality of existing water sources are shown in **Table 2.4.2**.

- Most of water quality concentrations of the existing water sources are suited for CAPRE standard.
- Arsenic concentrations in Las Mercedes No.5, Las Mercedes No. 9, Sabana Grande No.1, Sabana Grande No 2, Sabana Grande No.3 and Managua II No.15 are over the guideline.
- Lead concentration in Monsenor Lescano, Managua II No7 and Managua II No15 is over CAPRE guidelines, all the high value was detected only in dry season. Monsenor Lezcano Well in the downtown is located near a gas station, it needs careful monitoring for clearing any relationship of high concentration of lead and gas station. For Managua II wells there need more monitoring data for take any evaluation of the quality. Because

this wells is mixed with another wells of the group, immediate action isn't needs.

- Aluminum concentration in Las Mercedes No.5, Las Mercedes No.9 and Managua I E3 is over the guideline. The guideline value is established for color of drinking water and usage of Aluminum treatment, not for health perspectives.
- Six of PAHs was detected in Las Mercedes No.5 and three PAHs was detected in Las Mercedes No.9. However, concentration is under the guideline.
- One of pesticides, Heptachlor, was detected in Asososca. However, the levels of Heptachlor are under the guideline.

Some inappropriate waters are mixed with much volume of suitable water. As a result, supplied water is available for drinking.

Details of results are shown in **Annex 2A**.

Table 2.4.2 (1) Water Quality of Existing Water Sources

Parameter / Locations		unit	Asososca	Monseñor Lezcano	Julio Martínez	Las Mercedes		Managua I		Valle Gothel No.3	Managua II		CAPRE maximum guideline
						No.5	No.9	E3	W5		No.7	No.15	
Metals	As	ug/L	4.06	5.48	6.28	10.24	10.10	2.37	<ld	3.28	3.90	13.63	10
	Cd	ug/L	0.62	0.82	0.95	2.01	2.10	1.40	140	1.35	2.63	2.08	50
	Cr	ug/L	<ld	<ld	<ld	2.64	<ld	1.81	1.89	<ld	1.87	3.80	50
	Pb	ug/L	<ld	14.28	<ld	<ld	<ld	<ld	<ld	<ld	16.14	12.60	10
	Hg	ug/L	<ld	<ld	<ld	<ld	<ld	<ld	<ld	<ld	<ld	<ld	1
	Mn	ug/L	17.97	<ld	4.32	10.23	12.21	16.20	10.11	8.40	25.05	54.07	500
	Al	ug/L	88.28	131.4	165.1	853.7	346.6	258.3	68.5	43.2	80.2	78.30	200
	Zn	ug/L	64.98	105.8	<ld	91.7	70.6	52.11	37.98	<ld	121.08	92.34	300
	Cu	ug/L	<ld	30.66	<ld	68.10	<ld	10.64	6.39	12.60	9.81	5.91	200
Others	Cyanide	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
	B	mg/L	0.26	0.24	0.21	0.71	0.07	0.68	0.30	0.58	1.78	4.89	-
	DO	mg/L	8.50	3.73	4.14	1.66	3.94	8.67	12.31	1.88	0.84	0.84	-
	Temp. (1)	℃	27.5	28.3	28.0	29.0	29.7	27.4	27.6	27.7	31.8	40.3	-
	PH (1)		8.09	7.59	7.66	7.76	7.71	6.27	6.65	7.11	6.52	5.02	-
	EC (1)	uS/cm	546.0	486.5	429.0	563.0	634.5	900.0	591.0	746.5	1349.0	1921.0	-
PAHs	Naphthalene	ug/L		<ld			0.082	0.14					0.2(3)
Pesticides	Heptachlor	ng/L	0.87	nd	nd	3.02	3.55	nd	nd	8.27	nd	nd	30
Chlorophenols		ug/L	nd(2)										
Trihalomethanes		ug/L	nd(2)										
BTEX		ug/L	nd(2)	nd		nd	nd						

(1) Temperature, pH, and Electric Conductivity (EC) were measured at sites.

(2) Chlorophenols, Trihalomethanes, and BTEX were analyzed the samples after chlorination.

(3) CAPRE guideline for PAHs is a total of PAHs.

Table 2.4.2 (2) Water Quality of Existing Water Sources (Additional, arsenic analysis)

Well	As(ppb)	Well	As(ppb)
Las Mercedes Main Pipeline	9.5	Managua II Pump Station	5.5
Sabana Grande No1	11.8	Los Gauchos	5.7
Sabana Grande No.2	10.0	San Cristobal No.3	5.5
Sabana Grande No3	10.0	Altamira No4	5.3
Sabana Grande No.4	9.4	Hospital Velez Paiz	4.4
Sabana Grande No 5	5.1	Km14.5 C Vieja a Leon	2.1
14 de Setiembres	6.3	Km 11.5 C Sur	3.2
Reparto Schik No.2	6.4	Torres de Molina No.1	3.5
Altos de Santo Domingo	5.1	UNAN	4.5
Managua I Pump Station	3.6	C.Salud Villa Libertad	7.5
Ticuantepe Borgona	3.3	Villa Rafaela Herrera	5.2
Colonia Tenderi	9.9	Villa Reconciliacion	6.1
Rafaela Herrera	7.0		

2.5 WATER QUALITY OF PROSPECTIVE WATER SOURCES

The results of this Study are shown in **Table 2.5.1**. Details of results are shown in **Annex 2B**.

- Nicaragua Lake: Water has high concentrations of Aluminum and Iron. It is probable that this high concentration comes from soil particle during sampling. The highest turbidity in all samples supports this result. Except for two parameters, water quality of Nicaragua Lake is suited for the drinking guideline.
- Lomas Del Gavilan: Manganese in wet season is over recommendation value of CAPRE guideline.High concentration of Aluminum was detected in dry season. There need more information for take any conclusion for this water source.
- Sierras Doradas: Lead, Aluminum, Magnesium and Potassium concentrations are over the guideline. This well probably is influenced by volcanic origins from an active volcano, Mt. Masaya, or locates near a fault. Because there is no PAHs related facility around the well, the detected PAHs, would come from the burning around the well or the volcanic gasses from Mt. Masaya.
- Avinic No.4: This irrigation well has high Arsenic and Iron compared with the guideline. Sulfate is also higher than other samples. There is a possibility the area the well locates has high Arsenic origin.
- Cuatro Esquinas: Water in digging well has high concentrations of Aluminum. Except for Aluminum concentration that probably comes from soil particle during sampling, water quality of the well is suited for drinking. Pp-DDT was detected , but the concentration is below CAPRE guidelines.

Table 2.5.1 Water Quality of Prospective Water Sources

Parameters	Sampling points	unit	Nicaragua Lake El Guayabo	Nindiri Lomas Del Gavilan	Ticuantepe Sierra Doradas	Tisma Avinic No.4	Tisma Cuatro Esquinas	CAPRE maximum guideline
Metals	As	ug/L	<ld	<ld	2.27	23.53	<ld	10
	Cd	ug/L	0.34	1.24	2.40	2.21	0.45	50
	Cr	ug/L	1.14	1.44	1.18	<ld	<ld	50
	Pb	ug/L	<ld	<ld	28.13	<ld	<ld	10
	Hg	ug/L	<ld	<ld	<ld	<ld	<ld	1
	Mn	ug/L	50.0	83.90	48.26	18.80	39.30	500
	Al	ug/L	1497.08	1209.75	662.33	145.95	303.00	200
	Fe	mg/L	0.81	0.04	0.07	0.28	0.17	0.3
	Zn	ug/L	<ld	37.23	342.30	181.26	58.47	300
	Cu	ug/L	6.60	4.44	11.28	<ld	<ld	200
Physical & Chemical Parameter	Temperature	℃	30.1	29.0	28.5	34.8	29.8	
	pH(1)		8.19	7.48	6.66	8.50	7.49	
	pH(2)		8.06	7.21	6.28	8.25	6.87	
	EC(1)	uS/cm	251.5	600.5	1239.5	513.3	433.5	
	EC(2)	uS/cm	249.5	618.5	1236.5	596.0	478.0	
	DO	mg/L	8.45	1.14	0.93	2.28	2.42	
	Langeleir Index		o.53	-0.17	-0.26	-0.26	0.16	
	Turbidity	NTU	12.7	0.32	0.66	2.06	2.45	5
	TDS	mg/L	143.08	394.35	880.05	366.91	307.77	1000
	Color	mg/L-Pt-Co	10.0	<5.0	5.0	<5.0	5.0	15
	Hardness	mg/L	66.53	177.02	499.64	17.71	189.60	
	Alkalinity	mg/L	86.10	306.45	728.80	234.88	219.43	
	Na	mg/L	21.80	69.60	114.50	117.50	18.10	200
	K	mg/L	4.44	10.12	22.85	9.55	7.01	10
	Mg	mg/L	6.54	21.02	55.50	2.05	11.72	50
	Ca	mg/L	15.88	36.29	108.72	3.72	56.67	
	CO3-	mg/L	10.56	< 2.00	< 2.00	21.35	< 2.00	
	HCO3-	mg/L	94.34	373.94	889.31	243.22	267.76	
	SO4	mg/L	8.09	5.58	28.68	22.15	3.34	250
	Cl	mg/L	19.46	10.37	23.66	19.37	7.58	250
	NO3-	mg/L	< 0.05	5.80	3.68	< 0.05	5.98	50
	NO2-	mg/L	< 0.003	0.01	0.00	< 0.003	0.11	
	F	mg/L	0.23	0.28	0.77	0.52	0.21	0.7-1.5
	Ion Balance	%	2.51	1.40	1.66	3.88	1.85	
	SiO2	mg/L	15.00	51.44	84.42	51.15	65.52	
	B	mg/L	0.20	0.35	0.55	0.84	0.18	0.5(WHO)
	CN-	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05
	H2S	mg/L						0.05
PAH	Acenachthylene	ug/L		0.124	0.271			0.2(3)
	Naphthalene	ug/L		0.146	0.076			
	Phenanthrene	ug/L		0.025	<ld			
	Dibenzo(a,h) anthracene	ug/L		0.024	nd			
Pesticides	pp-DDE	ng/L	nd	Nd	nd		1.00	2000
BTEX	Benzene	ug/L		Nd	nd			

(1) Temperature, pH, and Electric Conductivity (EC) were measured at laboratory.

(2) Temperature, pH, and Electric Conductivity (EC) were measured at sites..

(3) CAPRE guideline for PAHs is a total of PAHs.

2.6 WATER QUALITY OF TAP WATER

The results of this Study are shown in **Table 2.6.1**. Details of results are shown in **Annex 2C**. Coliform Organisms are not detected in all samples. Residual Chlorine in CAPRE maximum

guideline is under 5mg/L. Concentrations of residual chlorine are suitable for the drinking guideline in all samples.

Table 2.6.1 Results of Tap Water Quality

No	Sampling Point	Coliform Organisms	Residual Chlorine (mg/L)
1	Colegio Carlos Fonseca	ND	2.3
2	Colegio Modesto Armijo	ND	2.3
3	Gasolinera Shell Mayoreo	ND	1.5
4	Contiguo donde fue Gasolinea Esso	ND	<0.2
5	Escuela Victor Manuel Lazo	ND	<0.2
6	Gasolinera Texaco	ND	3.0
7	Colegio 14 de Septiembre	ND	3.0
8	Pulpería Hialeah	ND	1.0
9	Colegio el Pilar	ND	<0.2
10	Colegio Santa Rosa	ND	2.0

2.7 SUSTAINABILITY OF EXISTING WATER SOURCES

2.7.1 Introduction

The Study team considers the sustainability of existing water sources from the result of the Study and the past ENACAL water quality data. Quality of groundwater is varied seasonal and yearly by precipitation, usage of groundwater, fertilizers, nutrition absorption by plants, penetration of wastewater and etc. However, to delete mistakes and to know the distribution of groundwater and influences of human activities, it is assumed that the quality of groundwater in Managua isn't variable in recent years. On this assumption, if one well has plural data, ENACAL data was checked. Three steps are taken to delete doubtful values as follows before investigation. First, apparent mistakes were deleted. To give an example, the average groundwater temperature in Managua is about 28 degrees Celsius, data less than 25 degrees Celsius were deleted. Second, doubtful values were deleted by statistical methods. Aberrant values of each parameter in one well are checked by statistical methods. Third, each well was chemically checked by the ion balances between cations and anions.

2.7.2 Sustainability of Groundwater in the Study Area

(1) General

Most of water sources of ENACAL in the Study Area rely on wells pumping groundwater. These well are distributed in the whole Study Area. An inventory of the wells is provided in **Annex 2D**. Water quality of each well reexamined the past ENACAL data is shown in **Annex 2E**. Their locations in the Study Area are shown in **Figure 2.7.1**.

(2) Review of Previous Reports

Previous reports were reviewed in order to evaluate water quality in the Study Area. "The study on water supply project in Managua (JICA, 1993)" reported the surface water and groundwater quality in Managua. The results are summarized as follows:

- Most of study areas are high in (CO3+HCO3).
- Samples from upstream area are small Ca+Mg ratio. Samples from downstream are big Na+K ratio (This can be attributed to the ion exchange process).

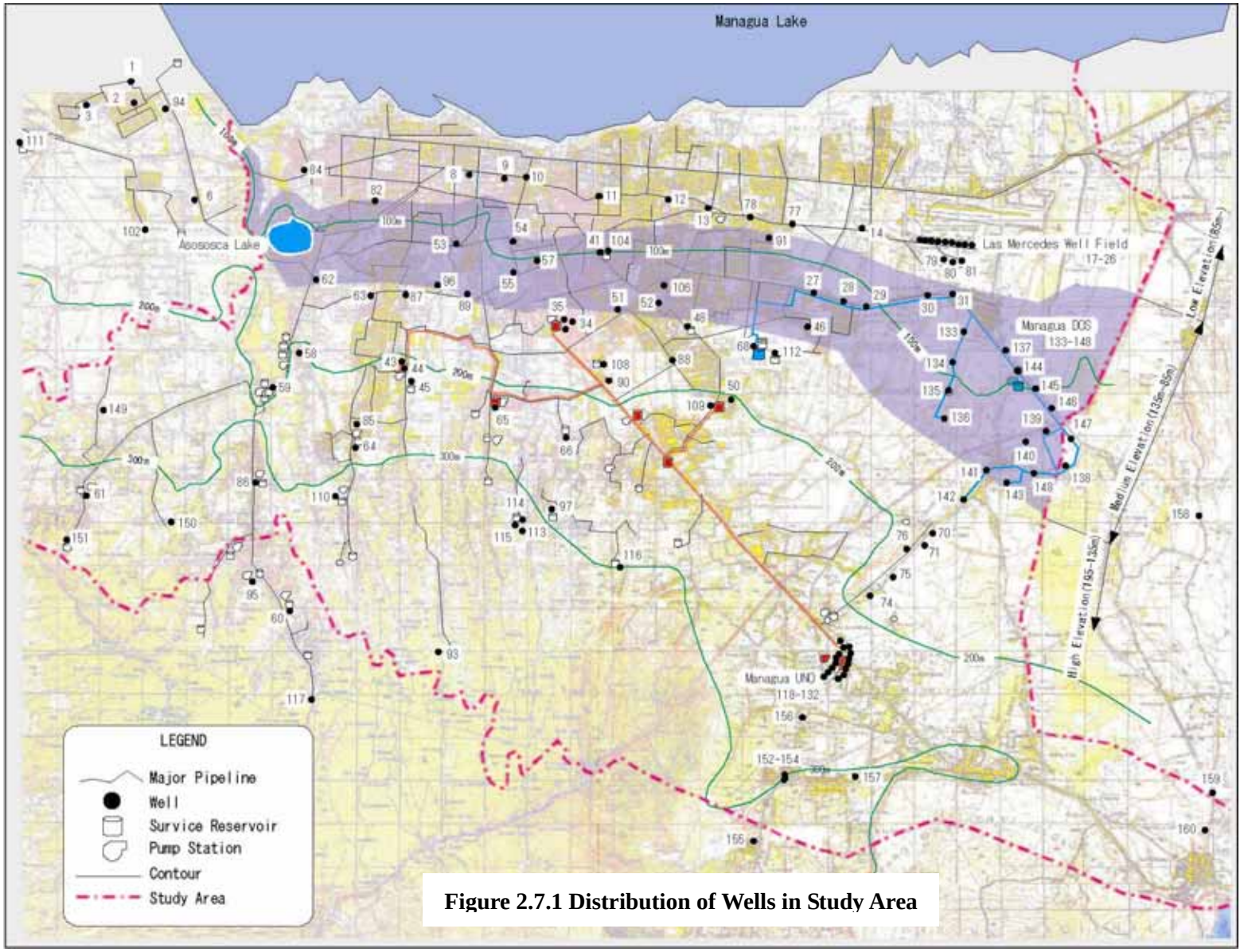


Figure 2.7.1 Distribution of Wells in Study Area

"Industrial Contamination of Laguna de Asososca Managua, Nicaragua (David N. Bethune, et al, 1994)" detected two synthetic organic chemical, methylene chloride and chloroform in Asososca Lake and wells near or in the industrial area located north of Asososca Lake. The report concluded the two substances came from IZ.

"The study on the improvement of the solid waste management system for the city of Managua (JICA, 1995)" analyzed water quality and sediment survey around Managua Lake and Acahualinca Lake. The results of groundwater are summarized as follows:

- Cd, Cr^{+6} and PCB were not detected.
- Pb, As was detected in the boring holes of this study and some wells around Acahualinca Lake.

(3) Review of ENACAL Monitoring Data

ENACAL monitors groundwater quality, not periodically. ENACAL basically analyzes 16 parameters, which are Temperature, pH, Electronic Conductivity (EC), Total dissolved solids (TDS), Sodium, Potassium, Magnesium, Calcium, Total Iron, Bicarbonates, Carbonates, Sulfides, Chlorides, Nitrates, Nitrites, Fluoride and sometimes Aluminum.

Table 2.7.1 shows 121wells of water quality in Managua Area. Because most of water comes from more than 40 meters depth, groundwater in Managua has high Electric Conductivity.

Table 2.7.1 Average of Water Quality (Unit: mg/L)

	Temp.	TDS	EC	Na	K	Ca	Mg	HCO3	SO4	Cl	NO3
Average	29.3	346.7	562.4	69.2	10.7	29.9	13.8	246.3	36.3	31.6	6.9
SD	2.1	131.3	249.8	26.9	4.2	18.4	12.3	146.0	20.5	5.5	4.5
Minimum	25.1	210.4	371.0	16.8	4.0	6.5	3.4	122.6	19.6	21.2	0.6
Maximum	41.7	991.0	1841.4	175.3	29.7	83.4	78.6	831.3	194.3	55.9	38.1

a) Coefficient Relation

Table 2.7.2 shows coefficients of correlation among parameters. Bicarbonates and carbonates correlate with Sodium, Calcium, Magnesium and Sulfate. On the other hand, Nitrate doesn't highly correlates with other elements.

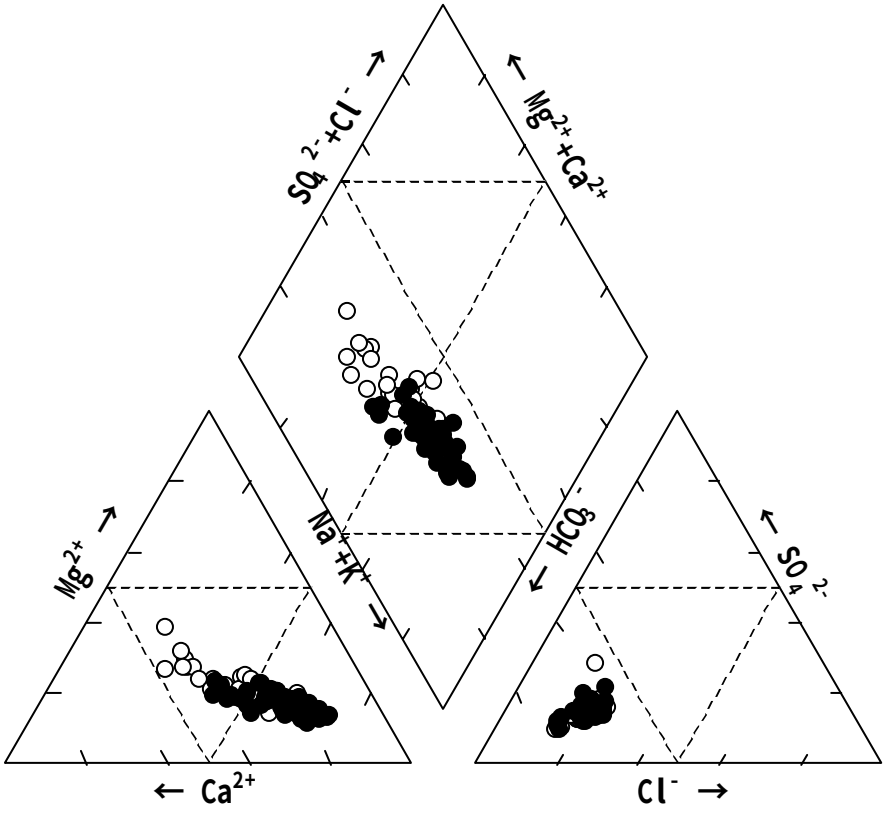
Table 2.7.2 Coefficients of Correlation Among Parameters

	Na	K	Ca	Mg	HCO3+CO3	SO4	Cl	NO3
Na								
K	0.2800							
Ca	0.3341	0.6253						
Mg	0.5042	0.7790	0.8401					
HCO3+CO3	0.7270	0.5557	0.8446	0.8834				
SO4	0.6021	0.6888	0.4132	0.5545	0.7446			
Cl	0.2853	0.4572	0.0781	0.3678	0.2022	0.5528		
NO3	-0.3079	-0.0964	-0.2225	-0.2733	-0.3752	-0.2553	0.2433	

b) Trilinear Diagram

The locations plotted in the trilinear diagram show the characteristics of water with respect to the groundwater flow system. **Figure 2.7.2** shows western and central hydrogeological basin, and **Figure 2.7.3** shows eastern hydrogeological basin.

In **Figure 2.7.2**, white dots that wells locate the south of north latitude 1337, higher than about 200 meters above see level, are distributes upper-left side. Furthermore, most of plots in the left triangle and the middle square figure locate in a straight line. This can be attributed to the ion cations exchange process from upstream where groundwater has big Mg + Ca ratio to downstream where groundwater has big Na + K ratio.



Note: White dots indicate that wells locate the south of north latitude 1337, higher altitude.

Figure 2.7.2 Trilinear Diagram in Western and Central Hydrogeological Basin

Figure 2.7.3 shows different distribution from **Figure 2.7.2**. Compared to **Figure 2.7.2**, plots in **Figure 2.7.3** scatters, water quality can divide some groups. It will be explained other section.

c) Monthly and Yearly trends of groundwater quality

Figure 2.7.4 shows the trends of Electric Conductivity (EC), Chloride (Cl), Sulfate (SO4) and precipitation. From August 1995 to September 1995, levels of EC, Cl and SO4 are decreased. This decrease can be caused by the past heavy precipitation because groundwater supplies from precipitation and dissolved substances are diluted by precipitation. It indicates survey of periodical water analysis combined with survey of water level is very effective to know a residential time of groundwater.

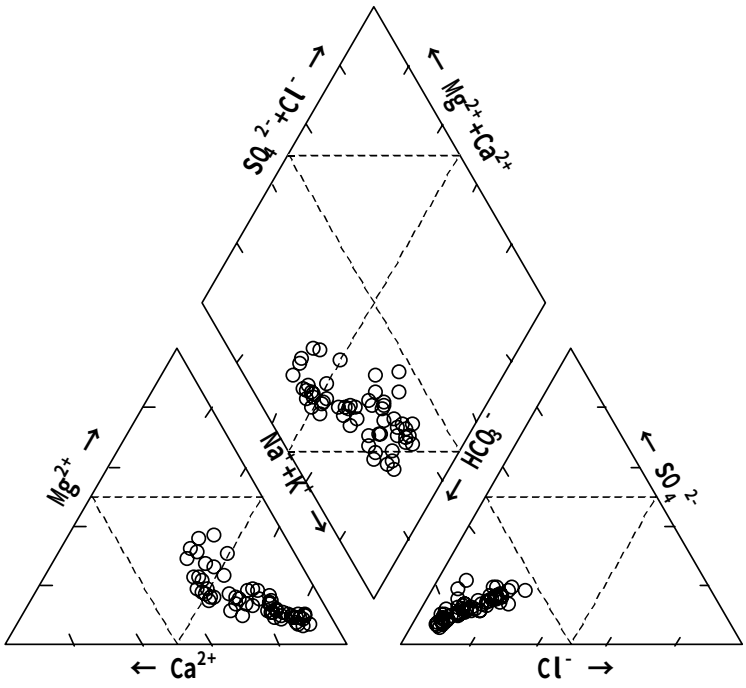
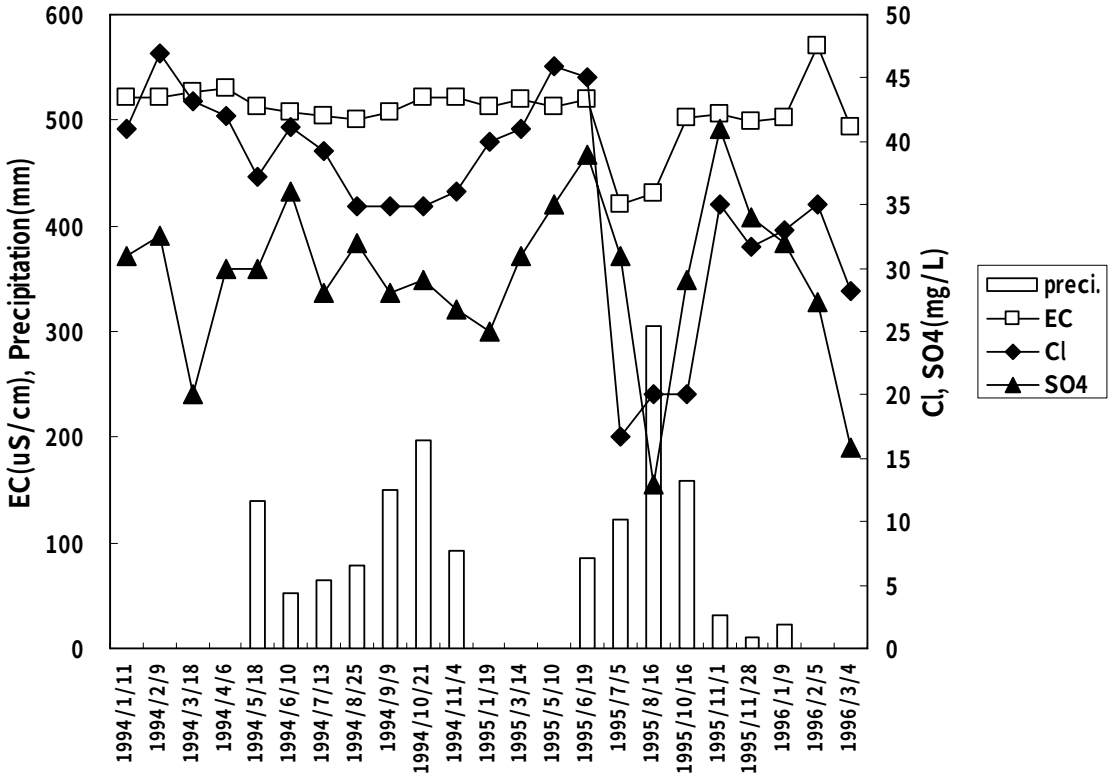


Figure 2.7.3 Trilinear Diagram in Eastern Hydrogeological Basin



Note: these data isn't deleted any doubtful data

Figure 2.7.4 Monthly and Yearly Trends of Groundwater Quality

(4) Distribution of substances in groundwater

a) Substances indicated distribution differences

Figure 2.7.5 shows distribution of EC level from west to east. Eastern area has higher EC than central and western area. This indicates different water source existing between eastern area and central area. The place where Managua I well field locates, east longitude 587, has big range of EC. This can be explained that the well field has several aquifers. Similar trends are shown in Sodium, Potassium, Magnesium, Calcium and Bicarbonates. In central area, there are irregular plots at east longitude 579. These wells are Olof Palme and Mercado Oriental, which can be influenced by human activities.

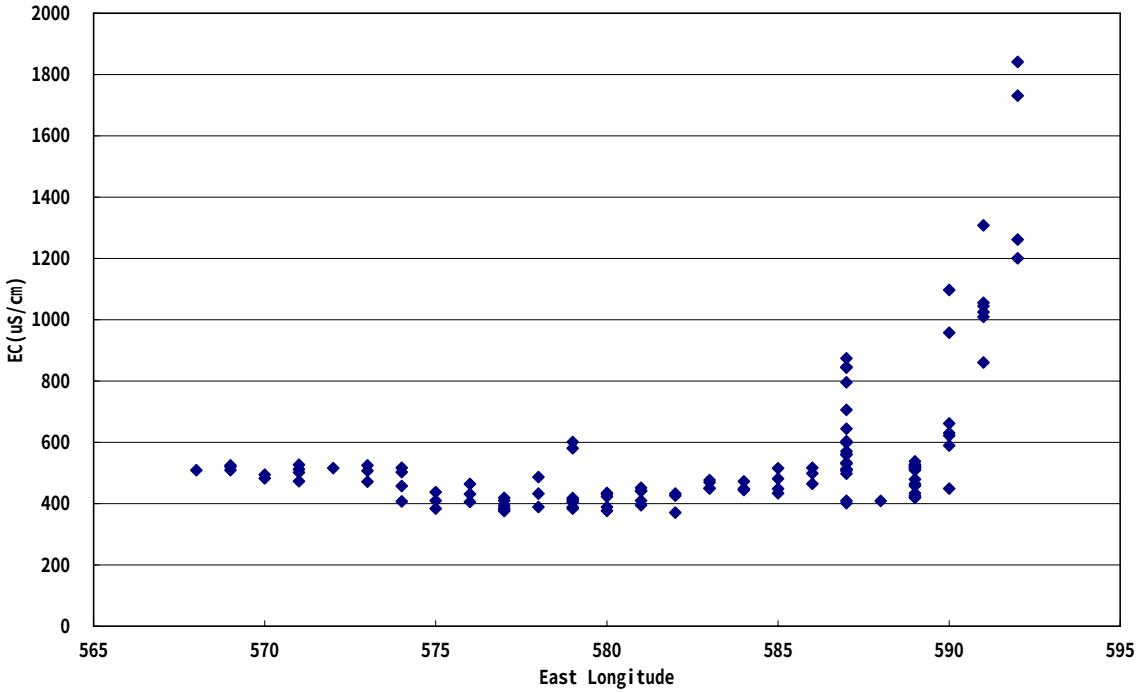


Fig 2.7.5 Distribution of EC

b) Substances Not Indicated Distribution Differences

Figure 2.7.6 shows distribution of Nitrates from west to east. Distribution of Nitrates has much different from **Figure 2.7.5**. There is no higher concentration in Eastern Area. However, we can see higher levels in central area, Olof Palme and Mercado Oriental. This could be caused by wastewater leakage from pipelines that are seriously damaged by the past earthquake. Without influencing from human activities, concentration of Nitrate, Chlorides and Sulfates are almost equal in Managua area.

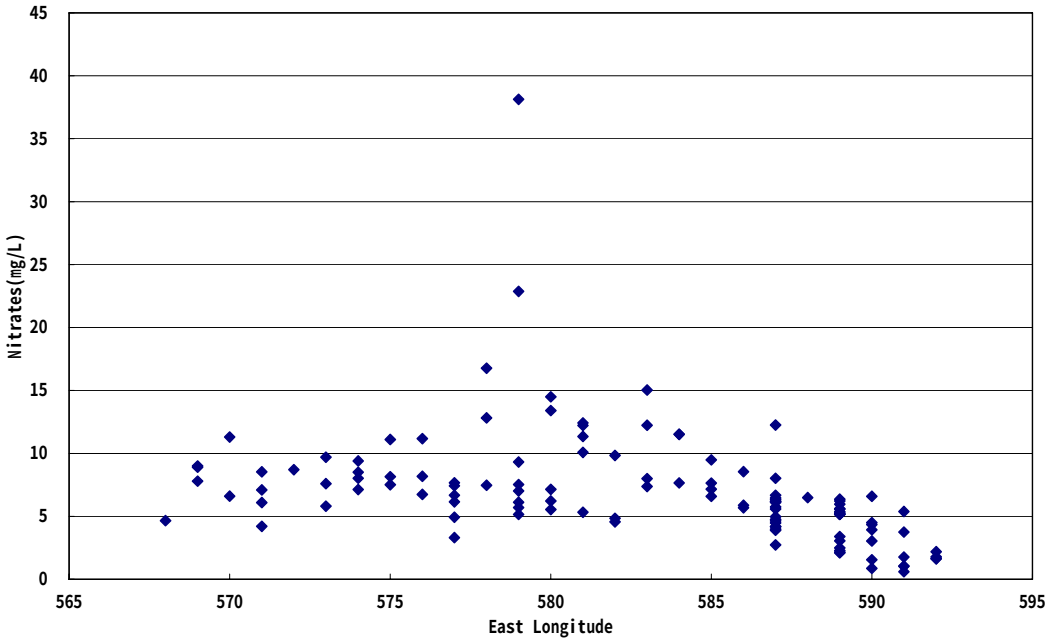


Figure 2.7.6 Distribution of Nitrates

c) Eastern Hydrogeological Basin

Groundwater that comes from some origin groundwater gathers some place in trilinear diagram. Using trilinear diagram, groundwater quality in eastern hydrogeological basin is divided roughly three categories. **Figure 2.7.7** and **Table 2.7.3** shows the type of water quality.
Considering the result of section 3.3.2, this classification has some difference. Because each well has a few aquifer and data of water quality and water level are limited, these differences arise. More detail survey for water quality and water level can reveal this classification.

Table 2.7.3 Classification of Water Quality in Eastern Hydrogeological Basin

	Managua I	Vercruz	Managua II	Sabana Grande	Las Mercedes	Geologic Rock Unit in 1993 JICA Study
1	W1	4, 5, 6	1, 2, 3, 4	2, 4, 5	1,3,4	Las Sierras Group
2	W4, W5, E2, E3, E4, E5, E7		5, 8, 10, 11, 12, 13			Masaya Group Volcano
3	W3, W6, W7, W8, E1, E6	2, 3				Masaya Group Volcano

Note: Wells not in Table can't be classified in three categories.

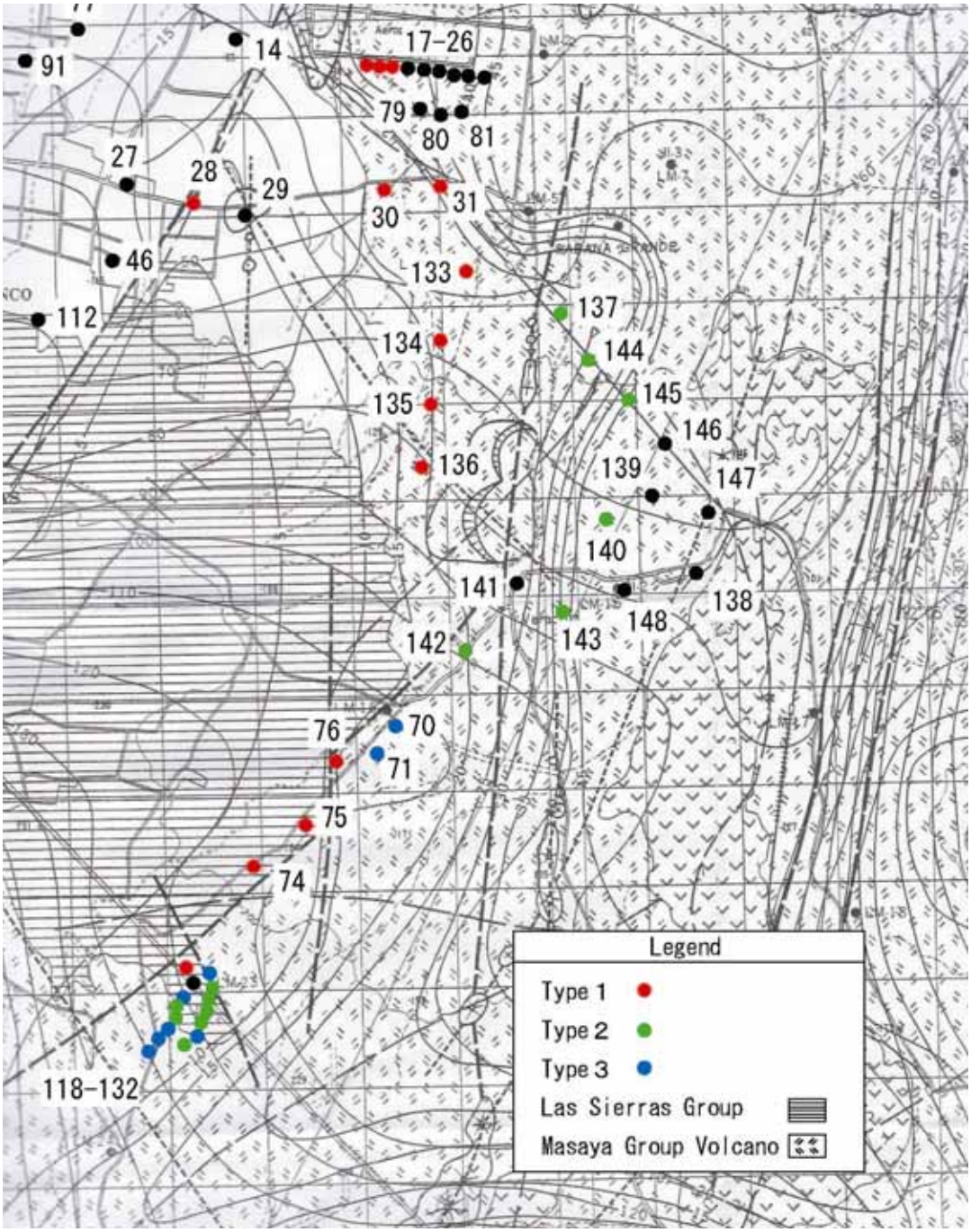
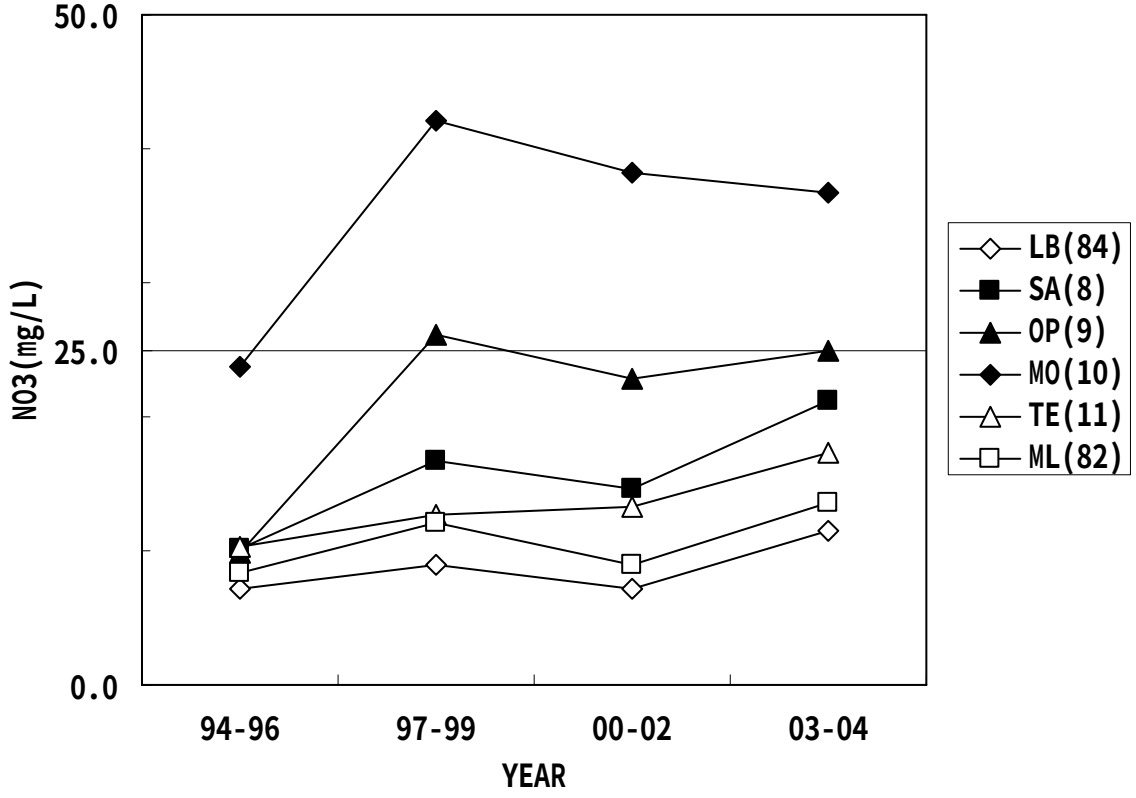


Figure 2.7.7 Classification of Water Quality in Eastern Hydrogeological Basin

d) Influences of Human Activity

As mentioned before, center of Managua is a danger of contaminated by Nitrates. **Figure 2.7.8** shows yearly trend of typical wells in Zona Baja. Nitrates level in CAPRE guidelines is established under 25mg/L for Recommendation, 50mg/L for Maximum admissible value. Mercado Oriental (10) already exceeds the recommendation value. San Antonio (8) and Olof Palme (9) increase in recent 10 years.



Note: (1) Because of deletion of doubtful data, and no available yearly data. Data is arranged in every three years.
(2) Tendri (TE) in 03-04 has only one data.

Figure 2.7.8 Yearly Trends of Nitrates in Zona Baja

(5) Sustainability of Existing Groundwater Sources

a) Influences of Nature Character

Some wells in eastern area have the values over the drinking standard for Arsenic.

Generally speaking, Arsenic is a metalloid widely distributed in the earth's crust and present at an average concentration of 2 mg/kg. It occurs in trace quantities in all rock, soil, water and air. Arsenic can exist in four valency states: –3, 0, +3 and +5. Under reducing conditions, arsenite (As(III)) is the dominant form; arsenate (As(V)) is generally the stable form in oxygenated environments. Elemental arsenic is not soluble in water. Arsenic salts exhibit a wide range of solubilities depending on pH and the ionic environment.

Arsenic is widely distributed in surface freshwaters, and concentrations in rivers and lakes are

generally below 10 µg/L, although individual samples may range up to 5 mg/L near anthropogenic sources. Arsenic levels in groundwater average about 1–2 µg/L except in areas with volcanic rock and sulfide mineral deposits where arsenic levels can range up to 3 mg/L. Mean sediment arsenic concentrations range from 5 to 3000 mg/kg, with the higher levels occurring in areas of contamination. Background concentrations in soil range from 1 to 40 mg/kg, with mean values often around 5 mg/kg. Naturally elevated levels of arsenic in soils may be associated with geological substrata such as sulfide ores. Anthropogenically contaminated soils can have concentrations of arsenic up to several grams per 100 ml.

In nature, arsenic-bearing minerals undergo oxidation and release arsenic to water. This could be one explanation for the problems of arsenic in the groundwater of West Bengal and Bangladesh. In these areas the groundwater usage is very high. It has been estimated that there are about 4–10 million tube wells in Bangladesh alone. The excessive withdrawal and lowering of the water table for rice irrigation and other requirements lead to the exposure and subsequent oxidation of arsenic-containing pyrite in the sediment. As the water table recharges after rainfall, arsenic leaches out of the sediment into the aquifer.

However, recent studies seem to favour the reduction of Fe/As oxyhydroxides as the source for arsenic contamination in groundwater (Nickson et al., 1998; BGS, 2000; BGS & DPHE, 2001). Arsenic forms co-precipitates with ferric oxyhydroxide. Burial of the sediment, rich in ferric oxyhydroxide and organic matter, has led to the strongly reducing groundwater conditions. The process has been aided by the high water table and fine-grained surface layers which impede the penetration of air to the aquifer. Microbial oxidation of organic carbon has depleted the dissolved oxygen in the groundwater. The highly reducing nature of the groundwater explains the presence of arsenite (< 50%) in the water. The "pyrite oxidation" hypothesis is therefore unlikely to be a major process, and the "oxyhydroxide reduction" hypothesis (Nickson et al., 1998; Acharyya et al., 1999) is probably the main cause of arsenic contamination in groundwater. Although the oxyhydroxide reduction hypothesis requires further validation, there is no doubt that the source of arsenic in West Bengal and Bangladesh is geological, as none of the explanations for anthropogenic contamination can account for the regional extent of groundwater contamination. During the past 30 years the use of phosphate fertilizers has increased threefold in this region. The widespread withdrawal of groundwater may have mobilized phosphate derived from fertilizers and from the decay of natural organic materials in shallow aquifers. The increase in phosphate concentration could have promoted the growth of sediment biota and the desorption of arsenic from sediments, and the combined microbiological and chemical process might have increased the mobility of arsenic (Acharyya et al., 1999).
(Source: Environmental Health Criteria 224, WHO, 2001)

b) Influences of Human Activity

Some wells in ZONA BAJA have been getting high concentration of Nitrate. Because wastewater pipelines are heavily damaged by the past earthquake, there is a possibility that Nitrate comes from wastewater. Nitrate concentrations of Mercado Oriental (No.10) and Olof Palme (No.9) are already over the recommendation value of CAPRE guideline. Nitrate in San Antonio (No.8) doubles in ten years. These wells should stop in near future. When Nitrate concentrations in wells are over recommendation value of CAPRE guideline, these wells should stop and consider relocation.

One well of ZONA BAJA (Monsenor Lezcano), has high concentration of lead in dry season, a gas station is located near this well, influence of this station in the aquifer must be study carefully.

2.7.3 Sustainability of Asososca Lake

(1) General

Asososca Lake has a surface area of about 0.8km^2, a maximum depth of about 100m. Asososca Lake is in the west of the city, and its water quality is suited for drinking. Because of this, the lake is the first water source in Managua. Still now, the disinfected water of Asososca Lake is the one of the main water source in Managua city.

(2) Review of Previous Reports

In the 1960's, IZ containing an oil refinery (ESSO Petroleum Ltd.), a pesticide plant (Hercasa Ltd.) and a chlorine plant (Elpesa Ltd.) began operations in the valley between Asososca Lake and Managua Lake. ENACAL minds the influence of IZ to the Lake and is monitoring the water quality of Lake.

"Informe sobre el estudio hidrogeologico del area de las lagunas de Nejapa, Asososca y Acahualinca (Montgomery – Santos and Heileman – Chan, 1979)" analyzed water quality of three lakes. They detected Chloroform, and indicated that minor contamination from IZ may have entered Asososca Lake.

"Industrial Contamination of Laguna Asososca, Managua, Nicaragua (David N. Bethune, et al, 1994) (hereinafter called "1994 report")" pointed out "Laguna Asososca is drawing in contaminated groundwater from the industrial area, and chloride levels in water sampled from MP23, which is the northern lake, were up to thirty times greater than the characteristic chloride value for Laguna Asososca of 50ppm." Methylene Chloride was also detected in Asososca.

"Managua Industrial Zone Site Investigation – Summary Report of Stage II Activities (ERM-SOUTHWEST, INC., 1998) (hereinafter called "1998 report")" was completed by ERM, an American company that is supported by companies in IZ. The principal findings of this report are as follows:

- The flow of groundwater from IZ to the Asososca Lake, on the basis of the current data, does not present a health risk.
- No constituents of potential concern have been detected in excess of health standards at the pump station, the most sensitive location for a health risk.
- Tetrachloroethene, lead, and nickel only slightly exceed their respective standards and as a result, do not present a health risk.
- No distinct impact of IZ groundwater upon the Lake has been identified.
- Shallow groundwater flows to the southeast, from IZ toward the Lake with a relatively flat gradient. The southeast flow direction is interrupted locally by industrial pumping wells in IZ.
- The saturated portion of the overburden (volcanic sediments) and the upper bedrock appear to be in hydraulic communication.

"Evaluación del comportamiento estacional de la laguna de Asososca (CEDEX, 1999) (hereinafter called "1999 report")" analyzed major elements, heavy metals, phenols and pesticides in the surface and bottom water of Asososca Lake. Cyanide, aluminum, manganese, and barium were detected, however, these levels were suited for WHO guidelines. Any pesticides and phenols weren't detected.

Table 2.7.4 shows the results of 1994,1998 and 1999 reports. Considered the data of 1999 report, water quality of Asososca Lake wouldn't be affected from IZ.

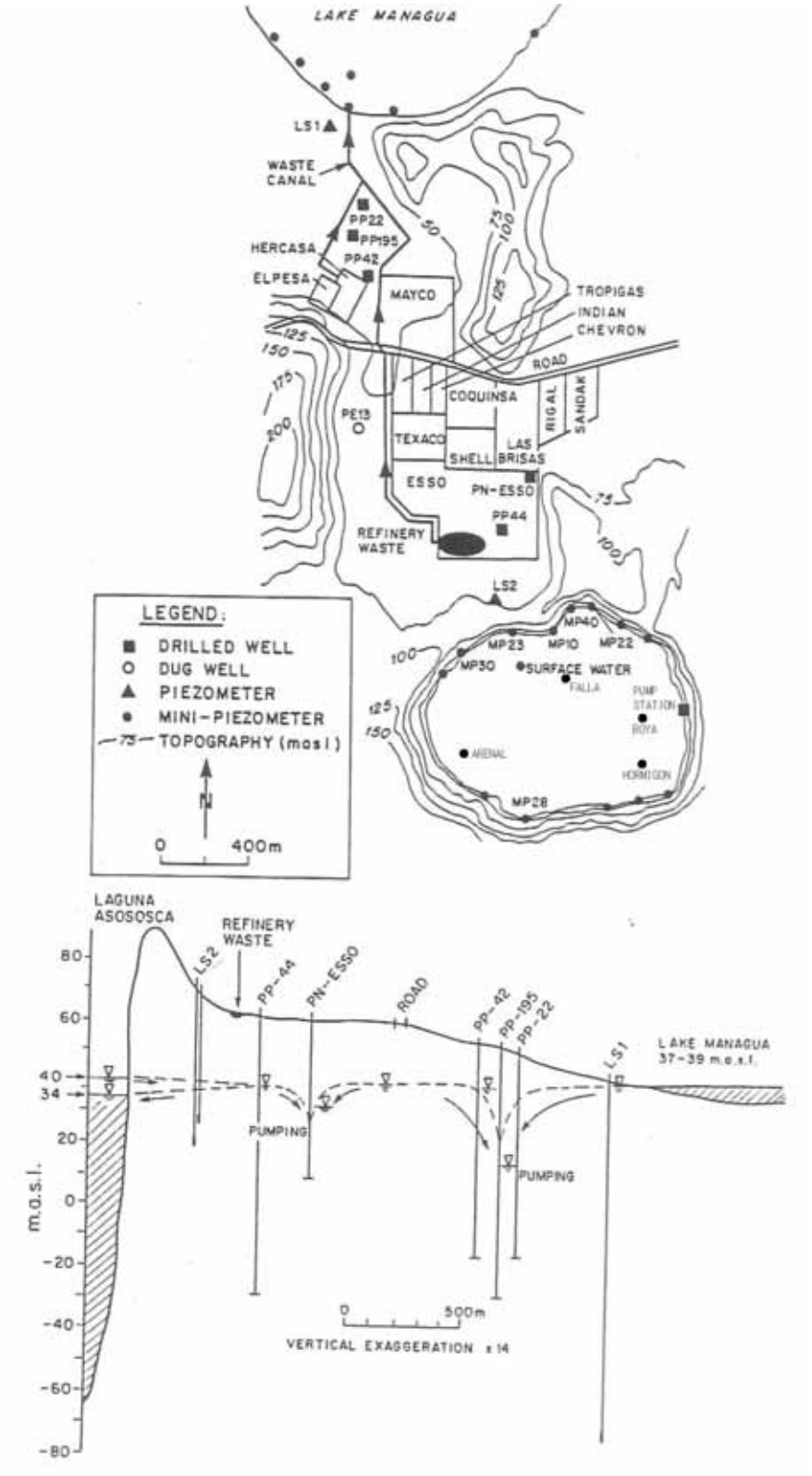
Table 2.7.4 Water Quality Between 1994, 1998 and 1999 Report (All units mg/L)

Data	Place	TDS	Na	K	Ca	Mg	HCO3	SO4	Cl
1999 Report	Center	292	78.4	15.6	16.8	6.8	164.7	34.0	46.2
1998 Report	Center (101m)#	297	56.2	16.8	17.3	7.1	124	35	44.4
1994 Report*	Center	372.6	63	15	18.5	7.7	186	33.7	48.7
1998 Report	Northern (MP23)	294	73.3	17.5	15.1	7.2	112	36	46.1
1994 Report*	Northern (MP23)	**2992.6**	**356**	**50**	**453.6**	**200**	**288**	**697.4**	**947.8**

(*) Water sample of 1994 report was taken in 1989

(#) Water sample was taken in the depth of 101m

Table 2.7.5 shows groundwater quality of the piezometer (LS2-3, 4) located between IZ and Asososca Lake (See: **Figure 2.7.9**). Both 1994 and 1998 report documented the flow of the groundwater between IZ and Asososca Lake moved toward the Lake because the groundwater levels of the piezometer are slightly higher than Asososca Lake. Compared the water quality of Asososca Lake, the groundwater has high TDS and Chloride. In order to avoid the contaminated groundwater moving toward Asososca Lake, reducing the extraction of Asososca Lake would allow recovery of groundwater levels and allow groundwater flow from Asososca Lake to IZ.



Source: Industrial Contamination of Laguna Asososca, Managua, Nicaragua (1994, David N. Bethune, et al)

Figure 2.7.9 Piezometer (LS2-3, 4) and ENACAL Sampling Locations in Asososca Lake

Table 2.7.5 Groundwater Quality of the Piezometer Between IZ and Asososca Lake

Data	Place	TDS	Na	K	Ca	Mg	HCO3	SO4	Cl
1998 Report	LS2-3	476	75.8	23.3	43.1	14.9	196	50.1	105
1994 Report*	LS2-3	709	111	25	64.8	22.4	210	57.9	218
	LS2-4	789	104	16.6	71.7	27.5	357	23.2	189

(*) Water sample of 1994 report was taken in 1989

(3) Review of ENACAL Monitoring Data

a) Distribution of the substances in the lake

Table2.7.6 shows the distribution of Water Quality in Asososca Lake in 1989 (See: **Figure 2.7.9**). The water quality distribution is almost same in the Lake.

Table 2.7.6 Distribution of Water Quality in Asososca Lake (2001/8/2) (All units mg/L)

Sampling site	TDS	Na	K	Ca	Mg	HCO3	SO4	Cl	F
Center	289	65	16	15	13	141	30	65	0.6
Southwestern (Arenal)	287	66	15	18	8	148	34	61	0.6
Eastern (Boya)	289	67	16	18	7	141	34	63	0.6
Southeastern (Hormigon)	284	65	16	17	10	144	31	63	0.6
Northern (Falla)	292	67	16	19	9	139	33	66	0.6

Note: data is reviewed with before and after.

b) Monthly Trends of Water Quality

To grasp the monthly trends of water quality in Asososca Lake, states of past ENACAL data was checked. Data of 1977 and 1994 are selected. (See **Table 2.7.7**)

Table 2.7.7 Asososca Lake Data (1977 and recent 12years)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1977	○	○	○	○	○	○	○	○	○	○	○	
1993	○											
1994	○	○	○	○	○	○	○	○				○
1995					○				○			
1996	○				●		○		○			
1997		○				○			○		●	
1998		○								○	●	
1999	●	○	○	○	○	○			●			
2000	○	○			○							
2001	○	○		○	○			○			○	
2002	○			○				○	○	●	○	
2003	●								○			
2004	○			●	●	●	○	●	●	●		

○：Available data are more than two.

●：Available data is only one.

Figure2.7.10 shows the monthly trend of TDS and precipitation. In 1977, TDS decreases after much precipitation. In 1994, the trend of TDS is different from the 1977, isn't affected with precipitation. Main water source of Asososca Lake can be groundwater. Considering this, decrease of water quality by precipitation in 1977 may be caused the past precipitation. To know

the trends of water quality in Asososca is very effective to grasp residential time around the Lake.

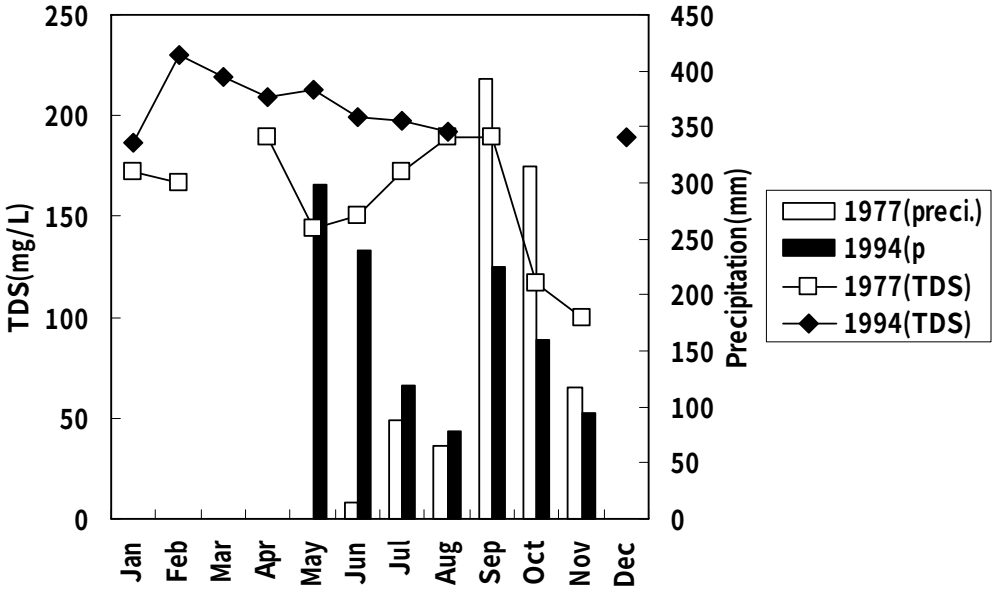


Figure 2.7.10 Monthly Trends of Water Quality in Asososca Lake

c) Yearly Trends of Water Quality

As shown **Table 2.7.7**, to understand year-trend, data of January and February in each year is selected. **Figure 2.7.11** shows year-trend of Asososca Lake in January and February. EC and Chloride increase to 1994, and then decrease. In 2000, after Hurricane Mitch was passed in 1998, EC is decreased, and the water level is higher. EC has increased since 2001. On the other hand, the water level has decreased. This relationship between EC and water level may be attributed to over pumping of water in the Lake.

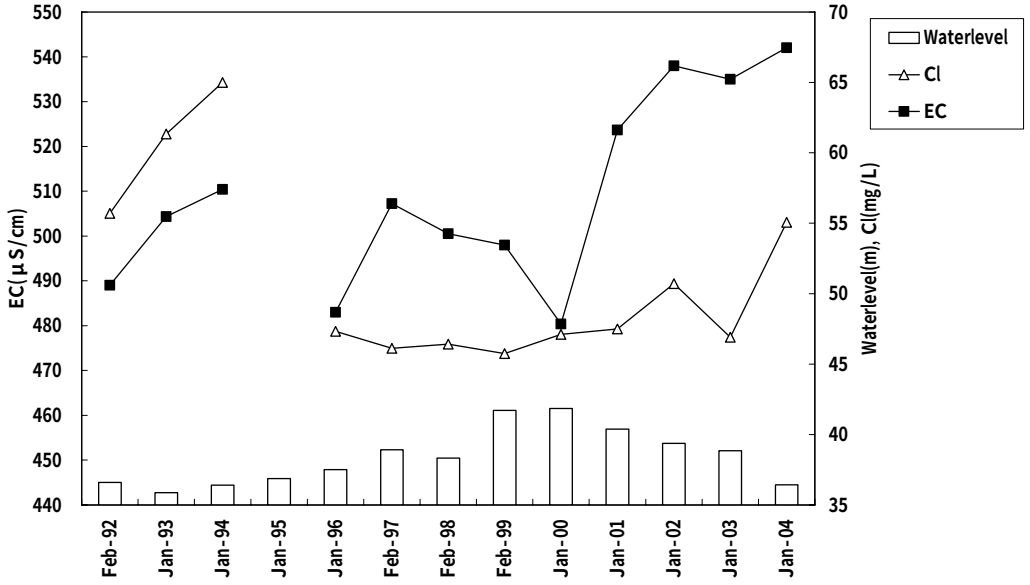


Figure 2.7.11 Yearly Trend of Asososca Lake in January and February

d) Water Circulation

The distribution of water temperature to the depth in Asososca is usually the highest on the surface, decreasing to the bottom. In every December or January, the bottom water flows up to the surface by change of the distribution of water temperature. When this phenomenon appear, water has smell by H_2S. In addition, the surface water becomes green by algae in winter, because the bottom water contains much nutrient. A previous report by the Government of Spain (CEDEX, 1999) confirms that algae of the Lake aren't toxic.
ENACAL studied this phenomenon from 2001 to 2002 and revealed following things:

(a) As shown on the **Figure 2.7.12**, a discrete transition zone occurs at a depth between 10-20m below the surface except 31st of January and 27th of February.
(b) In 2000-2001, when air temperature was down to about 22℃ and surface water temperature decreased 27.2℃, water circulation was caused.

In case cold surface water moves down and the distribution of water temperature in the lake becomes equal, lake circulation causes. This phenomenon has appeared clearly since 1997 by ENACAL record. One of hypothesis is that heavy rain would bring many nutrients to the Lake by surface runoff, because Managua has more than 1,500mm annual-precipitation in 1996 and 1998 for the last 20 years. However, this phenomenon is related to duration of sunshine, precipitation, wind speed, wind direction, etc. In order to know the condition of water circulation, more detail and continuous survey is needed.

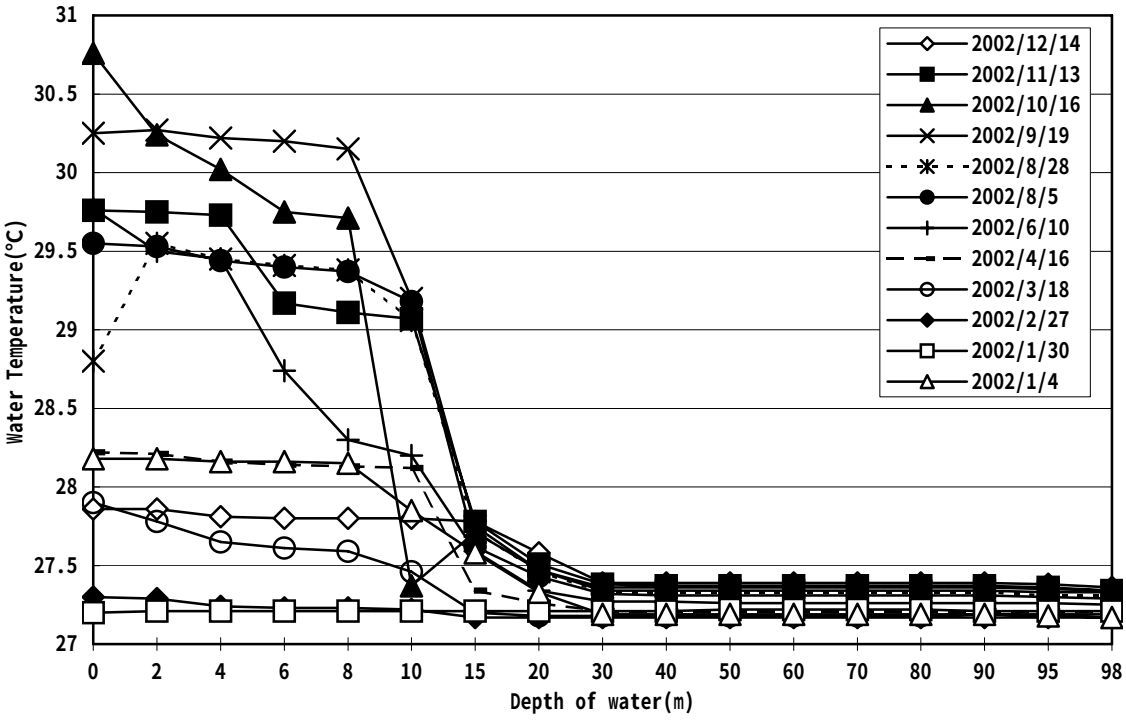


Figure 2.7.12 Water Temperature and Depth of Water (Asososca Lake)

e) Influences of Human Activity

As explained in section "review of previous report", IZ locates near Asososca Lake, and the

groundwater between the Lake and IZ has high concentration of Chloride. To understand the influence of Chloride, season-trend of Chloride is checked. **Figure 2.7.13** shows seasonal trend of Chloride including water level and Sulfates that has no distribution difference in Managua. As shown **Figure 2.7.13**, when water level decreases, Chloride concentration increases. This may be explained that water contained high concentration of Chloride is drawn when water level is lowed by pumping.

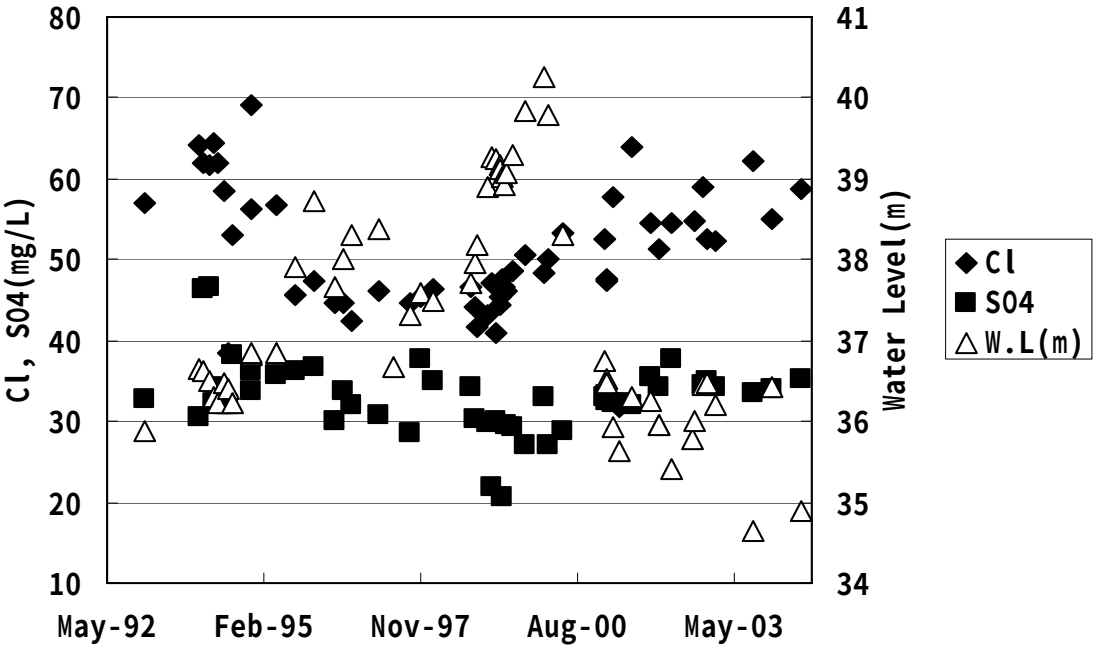


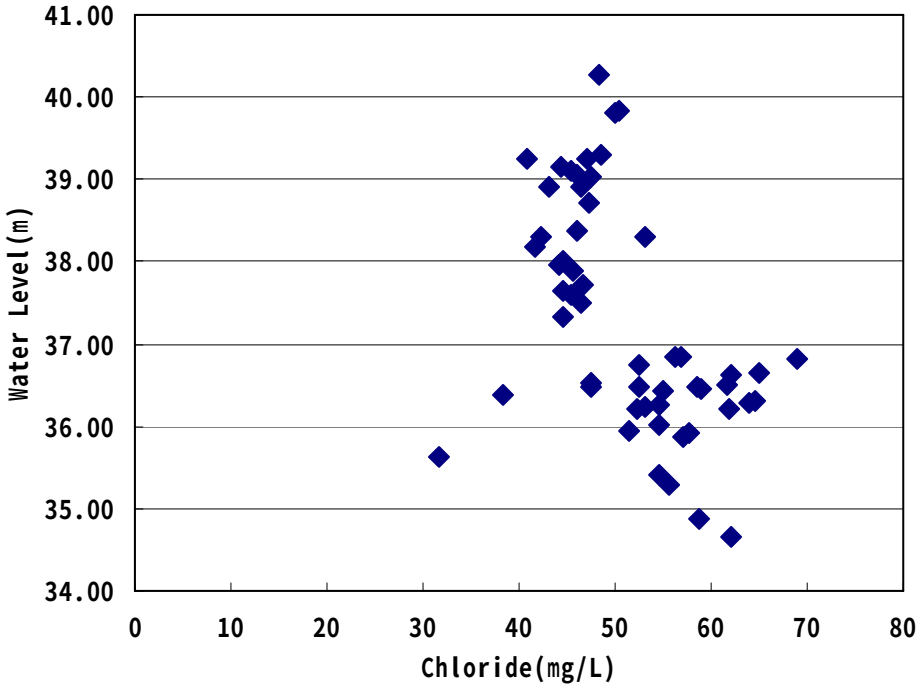
Figure 2.7.13 Seasonal Trend of Chloride

Figure 2.7.14 shows relationship between Chloride and water level of Asososca. This figure suggests that Asososca water becomes high concentration of Chloride when water level lowers 37 meters. This water level is one of the guideline to pump water from the Lake. However, the groundwater level between the Lake and IZ varies by precipitation and the pumping in IZ. The level and water quality of groundwater between the Lake and IZ should monitor periodically. As shown in **Figure 2.7.9**, groundwater samples between the Lake and IZ can be taken from Piezometer (LS2).

It is concluded Asososca Lake is suited for a good water resource except for input of contaminated water from IZ or occurrence of algae. Therefore, monitor of groundwater between the Lake and IZ and investigation of algae occurrence in the Lake are necessary.

(4) Sustainability of Asososca Lake

As shown in **Photograph 2.7.1**, IZ locates near Asososca Lake. Some past reports indicate the possibility of the contamination from IZ. Considering the result of this Study, contamination from IZ isn't detected. However, there is a possibility that Asososca Lake will be contaminated in future. To control the water quality of Asososca Lake, water quality monitoring in Asososca Lake and groundwater around the lake, especially for groundwater between IZ and the Lake, should continue.



Note: Data from 1992 to 2004 is displayed

Figure 2.7.14 Relationship between Chloride and Water Level (Asososca Lake)

Photo 2.7.1 IZ near Asososca Lake

2.8 PRELIMINARY ASSESSMENT OF PROSPECTIVE WATER SOURCES

2.8.1 Review of Previous Reports

ENACAL surveyed Tisma Area, which locates east of Managua city. Detail data shows **Annex 2E**. **Figure 2.8.1** shows trilinear diagram of Tisma area. White dots indicate water is taken from shallow aquifer. These dots located left side in Figure, have big Mg +Ca ratio. Black dots have big Na +K ratio. This can be attributed to the ion cations exchange process. Some of shallow wells have high concentration of Nitrate, more than 100 mg/L. There is a possibility these wells are contaminated by wastewater.

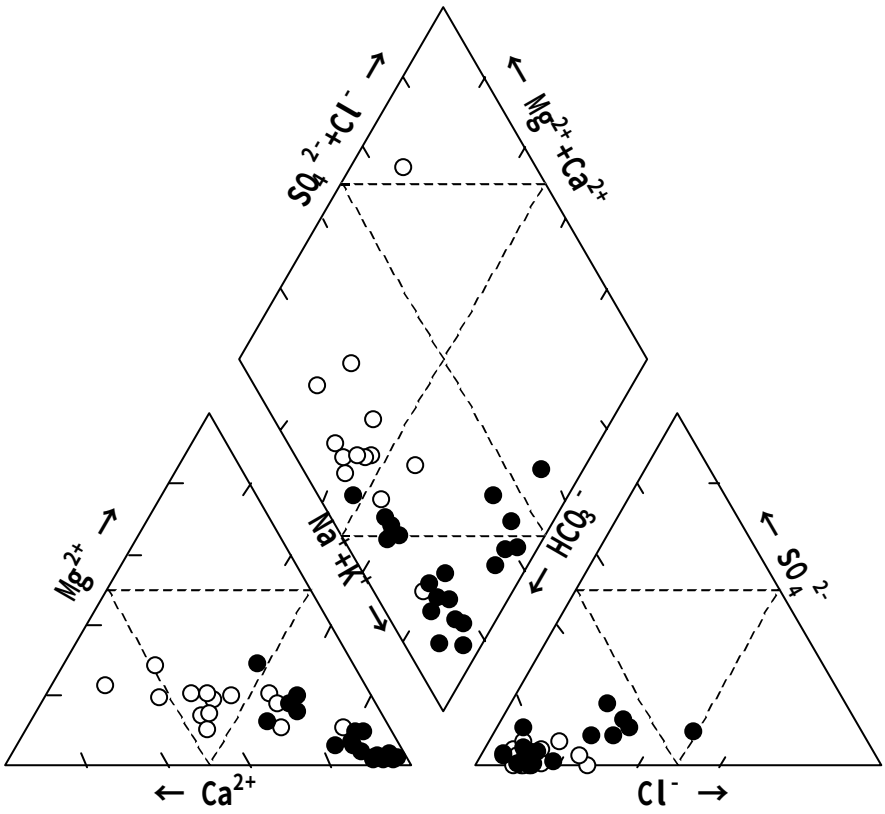
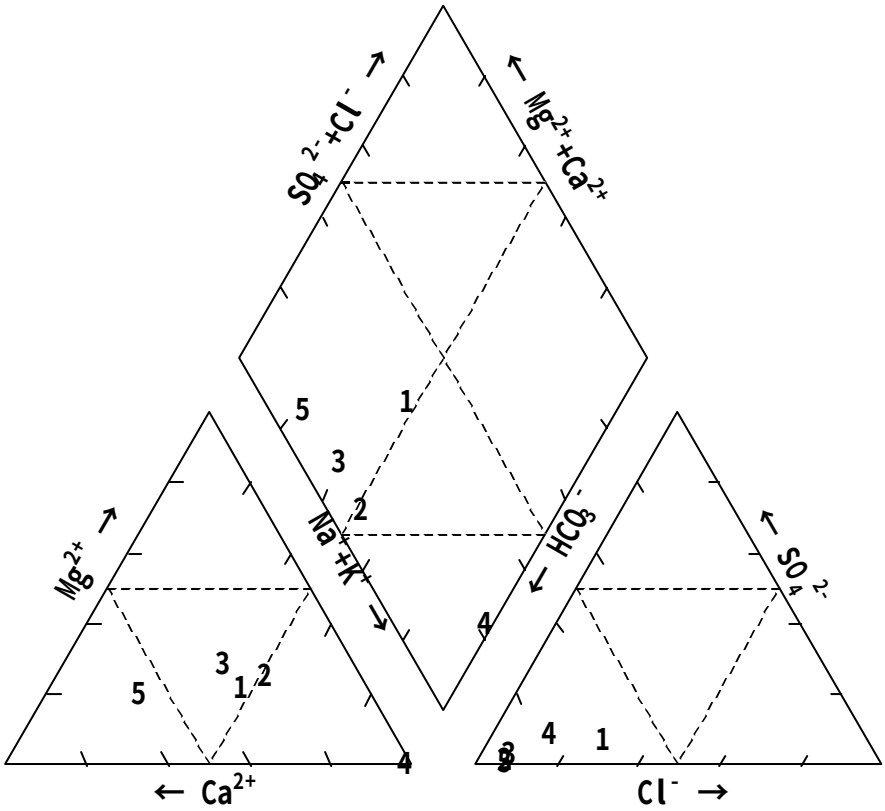


Figure 2.8.1 Trilinear Diagram in Tisma Area

2.8.2 Assessment by This Study

Figure 2.8.2 shows trilinear diagram of prospective water source of this Study. As shown **Figure 2.8.2**, Cuatro esquinas in Tisma whose aquifer is shallow, has big Mg + Ca ratio. On the other hand, Avinic No.4 has long residential time because of its big Na + K ratio.



Note: Number in Figure indicates below;
Nicaragua Lake(1), Lomas Del Gavilan(2), Sierra Doradas(3), Avinic No.4(4), Cuatro Esquinas(5)

Figure 2.8.2 Trilinear Diagram of Prospective Water Sources

Comparison with CAPRE guideline, each prospective water source is summarized below;

- Nicaragua Lake: Water has high concentrations of Aluminum and Iron. When these levels come from soil particle during sampling, water quality of Nicaragua Lake is suited for drinking.
- Lomas Del Gavilan: Manganese in wet season is over recommendation value of CAPRE guideline, but below maximum value of CAPRE. High concentration of Aluminum and Potassium was detected in dry season. There need more information about this water source.
- Sierra Doradas: Lead, Aluminum, Magnesium and Potassium concentrations are over the guideline. High Electric Conductivity also indicate that this water contains much substances.
- Avinic No.4: This irrigation well has high Arsenic and Iron compared with the guideline. Sulfate is also high. There is a possibility the well has high Arsenic origin.
- Cuatro Esquinas: Water has high concentrations of Aluminum. When this level comes from soil particle during sampling, water quality of the well is suited for drinking.

Nicaragua Lake is best suited for prospective water source from the viewpoint of water quality and volume because shallow wells such as Cuatro Esquinas are easily contaminated by wastewater and long-term usage of groundwater will cause leached heavy metal such as Arsenic.

ANNEX 2A

Water Quality of Existing Water Sources

Annex 2A(1) Water Quality of Existing Water Sources

Parameters	Sampling points	unit	Detection Limit	Sampling season	Asososca		PP Monseñor Lezcano	PP Julio Martínez	Las Mercedes		Managua I		Veracruz No. 3	Managua II		CAPRE Standard	
					Surface	After Chlorination			PP No.5	PP No.9	PP E3	PP W5		PP No.7	PP No.15	Recommendation	Maximum
Metals	As	µg/L	2.02	Wet	3.85		5.94	7.17	10.34	9.72	2.37	<dl	3.28	4.43	14.88		10
				Dry	4.27		5.02	5.38	10.14	10.47	<dl	<dl	<dl	3.36	12.38		
				Ave.	4.06		5.48	6.28	10.24	10.10	1.69	<dl	2.15	3.90	13.63		
	Cd	µg/L	0.15	Wet	0.85		1.17	1.13	1.74	1.98	2.17	1.75	1.00	2.28	2.70		50
				Dry	0.39		0.47	0.76	2.28	2.21	0.63	1.05	1.70	2.97	1.46		
				Ave.	0.62		0.82	0.95	2.01	2.10	1.40	1.40	1.35	2.63	2.08		
	Cr	µg/L	0.71	Wet	<dl		<dl	<dl	2.64	<dl	1.92	1.17	<dl	2.52	3.66		50
				Dry	<dl		<dl	<dl	<dl	<dl	1.70	2.60	<dl	1.22	3.94		
				Ave.	<dl		<dl	<dl	1.50	<dl	1.81	1.89	<dl	1.87	3.80		
	Pb	µg/L	4.64	Wet	<dl		<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	9.30		10
				Dry	<dl		14.28	<dl	<dl	<dl	<dl	<dl	<dl	16.14	15.90		
				Ave.	<dl		8.30	<dl	<dl	<dl	<dl	<dl	<dl	9.23	12.60		
	Hg	µg/L	0.009	Wet	<dl		<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl		1
				Dry	<dl		<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl		
				Ave.	<dl		<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl		
	Mn	µg/L	1.4	Wet	<dl		<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	66.84	100	500
				Dry	17.97		<dl	4.32	10.23	12.21	16.20	10.11	8.40	25.05	41.30		
				Ave.	9.34		<dl	2.51	5.47	6.46	8.45	5.41	4.55	12.88	54.07		
	Al	µg/L	3.99	Wet	65.55		95.85	175.35	70.50	70.20	376.80	109.20	51.45	112.50	78.60		200
				Dry	111.00		166.95	154.86	1637.00	623.10	139.80	27.78	34.92	47.88	78.00		
				Ave.	88.28		131.40	165.11	853.75	346.65	258.30	68.49	43.19	80.19	78.30		
	Zn	µg/L	35.95	Wet	<dl		<dl	<dl	<dl	<dl	52.11	<dl	<dl	<dl	<dl		300
				Dry	64.98		105.81	<dl	91.71	70.59	<dl	37.98	<dl	121.08	92.34		
				Ave.	41.48		61.89	<dl	54.84	44.28	35.04	27.98	<dl	69.53	55.16		
	Cu	µg/L	3.84	Wet	<dl		<dl	<dl	<dl	<dl	10.38	<dl	12.60	<dl	<dl	100	200
				Dry	<dl		30.66	<dl	68.10	<dl	10.89	6.39	<dl	9.81	5.91		
				Ave.	<dl		16.29	<dl	35.01	<dl	10.64	4.16	7.26	5.87	3.92		
Phyiscal & Chemical Parameter	Temparature(at site) (5)	℃		Wet	27.5		28.3	27.9	28.9	29.7	27.5	27.8	27.2	31.6	40.3	18-30	
				Dry	29.1		27.5	27.9	30.1	30.3	27.2	27.3	28.1	27.5	40.9		
				Ave.	28.3		27.9	27.9	29.5	30.0	27.4	27.6	27.7	29.6	40.6		
	pH(at site) (5)			Wet	8.18		7.57	7.71	7.72	7.61	6.31	6.72	6.92	6.54	4.03	6.5-8.5	
				Dry	8.08		7.97	7.32	8.10	7.97	6.23	6.57	7.29	6.50	7.04		
				Ave.	8.13		7.77	7.52	7.91	7.79	6.27	6.65	7.11	6.52	5.54		
	Electric Conductivity (at site) (5)	uS/cm		Wet	562.0		481.0	426.0	566.0	634.0	892.0	601.0	748.0	1349.0	1921.0	400	
				Dry	490.0		429.0	441.0	534.0	625.0	908.0	581.0	745.0	1292.0	1866.0		
				Ave.	526.0		455.0	433.5	550.0	629.5	900.0	591.0	746.5	1320.5	1893.5		
	DO	mg/L		Wet	8.50		3.73	4.14	1.66	3.94	8.70	14.51	1.66	0.84	0.84		
				Dry			3.07	3.60	4.10	6.96	8.64	10.10	2.10	1.26	<0.2		
				Ave.	8.50		3.40	3.87	2.88	5.45	8.67	12.31	1.88	1.05	0.84		
	B	mg/L	0.02	Wet	0.26		0.24	0.21	0.71	0.07	0.68	0.30	0.58	1.78	4.89	-	
				Dry			0.13	0.12	0.28	0.21	0.34	0.19	0.29	0.96	2.24		
				Ave.	0.26		0.19	0.17	0.50	0.14	0.51	0.25	0.44	1.37	3.57		
	Cyanides	mg/L	0.05	Wet	<dl		<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl		0.05
				Dry	<dl		<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl		
				Ave.	<dl		<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl		
	H2S	mg/L	1.00	Wet	<dl		<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl		0.05
				Dry	<dl		<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl		
				Ave.	<dl		<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl		
Pestcides(8)	Mocap	ng/L	50.00	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	Naled	ng/L	25.00	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	Terbufos	ng/L	25.00	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	Diazinon	ng/L	25.00	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	Methyl Parathion	ng/L	15.00	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	Malathion	ng/L	25.00	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	Fenthion	ng/L	50.00	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	Ethyl parathion	ng/L	15.00	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	DEF(Tribufos)	ng/L	15.00	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	Ethion	ng/L	20.00	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	Guthion	ng/L	100.00	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	Zolone	ng/L	15.00	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	Co-Ral	ng/L	50.00	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		

Annex 2A(2) Water Quality of Existing Water Sources

Parameters	Sampling points	unit	Detection Limit	Sampling season	Asososca		PP Monseñor Lezcano	PP Julio Martínez	Las Mercedes		Managua I		Veracruz No. 3	Managua II		CAPRE Standard	
					Surface	After Chlorination			PP No.5	PP No.9	PP E3	PP W5		PP No.7	PP No.15	Recommendation	Maximum
PAH(6)	Acenachthylene	µg/L	0.047	Wet			<dl		nd	<dl							0.2(7)
				Dry			nd		0.056	nd							
				Ave.			<dl		0.028	<dl							
	Naphthalene	µg/L	0.050	Wet			<dl		0.081	<dl							0.2(7)
				Dry			<dl		0.083	0.14							
				Ave.			<dl		0.082	0.08							
	Fluorenne	µg/L	0.020	Wet			<dl		<dl	<dl							0.2(7)
				Dry			nd		0.021	<dl							
				Ave.			<dl		0.016	<dl							
	Acenaphthene	µg/L	0.044	Wet			nd		nd	nd							0.2(7)
				Dry			nd		<dl	nd							
				Ave.			nd		nd	nd							
	Phenanthrene	µg/L	0.015	Wet			<dl		<dl	<dl							0.2(7)
				Dry			<dl		0.031	<dl							
				Ave.			<dl		0.019	<dl							
	Anthracene	µg/L	0.001	Wet			<dl		<dl	<dl							0.2(7)
				Dry			nd		0.002	0.001							
				Ave.			<dl		0.001	0.001							
	Fluoranthene	µg/L	0.046	Wet			<dl		<dl	<dl							0.2(7)
				Dry			<dl		0.135	0.058							
				Ave.			<dl		0.079	0.041							
	Pyrene	µg/L	0.016	Wet			<dl		nd	<dl							0.2(7)
				Dry			nd		nd	nd							
				Ave.			<dl		nd	<dl							
	Chrysene	µg/L	0.022	Wet			<dl		<dl	<dl							0.2(7)
				Dry			nd		<dl	nd							
				Ave.			<dl		<dl	<dl							
	Benzo(a)anthracene	µg/L	0.023	Wet			<dl		<dl	<dl							0.2(7)
				Dry			nd		nd	nd							
				Ave.			<dl		<dl	<dl							
	Benzo(a)pyrene	µg/L	0.017	Wet			nd		nd	nd							0.7
				Dry			nd		<dl	nd							
				Ave.			nd		<dl	nd							
	Dibenzo(a,h)anthracene	µg/L	0.024	Wet			nd		nd	nd							0.2(7)
				Dry			nd		<dl	nd							
				Ave.			nd		<dl	nd							
Pestcides (8)	a-BHC	ng/L	0.09	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	b-BHC	ng/L	0.82	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	Lindane	ng/L	0.25	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		2000
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	D-BHC	ng/L	0.13	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	Heptachlor	ng/L	0.16	Wet	3.43			nd	3.02	3.55	nd	nd	8.27	nd	nd		30
				Dry	0.87			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	2.15			nd	1.51	1.78	nd	nd	4.14	nd	nd		
	Aldrin	ng/L	0.41	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		30
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	Heptachlor epoxide	ng/L	0.13	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		30
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	a-Endasulfane	ng/L	0.19	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	Dieldrin	ng/L	0.50	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		30
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	pp-DDE	ng/L	0.25	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		2000
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	Endrin	ng/L	0.38	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	b-Endasulfane	ng/L	0.02	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	pp-DDD	ng/L	1.04	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		2000
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	pp-DDT	ng/L	0.19	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		2000
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		
	Toxafene	ng/L	8.70	Wet	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Dry	nd			nd	nd	nd	nd	nd	nd	nd	nd		
				Ave.	nd			nd	nd	nd	nd	nd	nd	nd	nd		

Annex 2A(3) Water Quality of Existing Water Sources

Parameters	Sampling points	unit	Detection Limit	Sampling season	Asososca		PP Monseñor Lezcano	PP Julio Martínez	Las Mercedes		Managua I		Veracruz No. 3	Managua II		CAPRE Standard	
					Surface	After Chlorination			PP No.5	PP No.9	PP E3	PP W5		PP No.7	PP No.15	Recommendation	Maximun
Chlorophenols (9)	4-Chloro-3-methylphenol	µg/L	9.53	Wet		nd											
				Dry		nd											
				Ave.		nd											
	2-Chlorophenol	µg/L	9.53	Wet		nd											
				Dry		nd											
				Ave.		nd											
	2,4-Chlorophenol	µg/L	9.53	Wet		nd											
				Dry		nd											
				Ave.		nd											
	2,4-Dichlorophenol	µg/L	9.53	Wet		nd											
				Dry		nd											
				Ave.		nd											
	2,4,6-Trichlorophenol	µg/L	9.53	Wet		nd											200
				Dry		nd											
				Ave.		nd											
	2,4,5-Trichlorophenol	µg/L	9.53	Wet		nd											
				Dry		nd											
				Ave.		nd											
	2-Methylphenol	µg/L	9.53	Wet		nd											
				Dry		nd											
				Ave.		nd											
	4-Methylphenol	µg/L	9.53	Wet		nd											
				Dry		nd											
				Ave.		nd											
	Total Cresols, TCEQ	µg/L	48	Wet		nd											
				Dry		nd											
				Ave.		nd											
Trihalomethanes (9)	Bromodichloromethane	µg/L	5	Wet		nd											60
				Dry		nd											
				Ave.		nd											
	Bromoform	µg/L	5	Wet		nd											100
				Dry		nd											
				Ave.		nd											
	Chloroform	µg/L	5	Wet		nd											200
				Dry		nd											
				Ave.		nd											
	Dibromochloromethane	µg/L	5	Wet		nd											100
				Dry		nd											
				Ave.		nd											
	Total Trihalomethanes	µg/L	5	Wet		nd											
				Dry		nd											
				Ave.		nd											
BTEX(6)	Benzene	µg/L	1	Wet			nd		nd	nd							
				Dry			nd		nd	nd							
				Ave.			nd		nd	nd							
	Toluene	µg/L	1	Wet			nd		nd	nd							700
				Dry			nd		nd	nd							
				Ave.			nd		nd	nd							
	Ethylbenzene	µg/L	1	Wet			nd		nd	nd							300
				Dry			nd		nd	nd							
				Ave.			nd		nd	nd							
	Xylenes(Total)	µg/L	3	Wet			nd		nd	nd							500
				Dry			nd		nd	nd							
				Ave.			nd		nd	nd							
	Total BTEX	µg/L	6	Wet			nd		nd	nd							
				Dry			nd		nd	nd							
				Ave.			nd		nd	nd							

Note
(1) nd indicates 'not detected'.
(2) dl indicates ' detection limit'.
(3) Average values including nd or ld are caliculated that nd value is zero or dl value is half of dl.
(4) Average value of nd and dl indicates dl
(5) Temperature, pH, and Electric Conductivity (EC) were measured at sites.
(6) Only at Las Mercedes PP No.5 and No.9, and PP Monsenor Lezcano, which are dangers of petroleum contamination from gas stations and the international airport.
(7) CAPRE guideline for PAHs is a total of PAHs.
(8) Except PP Monsenor Lezcano, which isn't danger of pesticides contamination.
(9) Chlorophenols, Trihalomethanes were analyzed the samples after chlorination only at Asososca.

Annex 2A(4) Water Quality of Existing Water Sources

ANALYSIS REPORT

Sample N°	ID N°.	Well N°.	Sampling Date	Water Temp. (°C)	Arsenic Concentration (ppb)
01	SG-1	Sabana Grande Nº1 (27)	2005/2/2	30.9	11.8
02	SG-2	Sabana Grande Nº2 (28)	2005/2/2	28.8	10.0
03	SG-3	Sabana Grande Nº3 (29)	2005/2/2	32.0	10.0
04	SG-4	Sabana Grande Nº4 (30)	2005/2/2	28.7	9.4
05	SG-5	Sabana Grande Nº5 (31)	2005/2/2	27.8	5.1
06	PZ-48	14 de Septiembre	2005/2/2	27.2	6.3
07	PZ-50	Reparto Schick Nº2 (PZ-49)	2005/2/2	27.9	6.4
08	PZ-116	Altos de Santo Domingo	2005/2/2	26.6	5.1
09	MU-1	Managua I Pump Well	2005/2/2	26.7	3.6
10	TG-1	Ticuantepe Borgoña	2005/2/2	25.4	3.3
11	PZ-11	Colonia Tenderí	2005/2/3	30.1	9.9
12	PZ-13	Rafaela Herrera	2005/2/3	28.6	7.0
13	PZ-54	Los Gauchos (Pizza Hut)	2005/2/2	29.0	5.7
14	PZ-104	San Cristobal Nº3	2005/2/3	28.8	5.5
15	PZ-34	Altamira Nº4 (Nº5)	2005/2/3	28.2	5.3
16	PZ-62	Hospital Velez Paiz	2005/2/3	28.5	4.4
17	PZ-61	Km 14.5 C. Vieja a León	2005/2/3	28.4	2.1
18	PZ-86	Km 11.5 C. Sur	2005/2/3	28.1	3.2
19	PZ-64	Torres Molina Nº1	2005/2/3	27.4	3.5
20	PZ-65	UNAN	2005/2/3	27.3	4.5
21	Net-01	C. Salud Villa Libertad	2005/2/2	28.7	7.5
22	Net-02	Villa Rafaela Herrera	2005/2/3	29.7	5.2
23	Net-03	Villa Reconciliación	2005/2/3	30.2	6.1

ANNEX 2B

Water Quality of Prospective Water Sources

ANNEX 2B(1) Water Quality of Prospective Water Sources

	Sampling Point	unit	Detection Limit	Sampling season	Nicaragua Lake	Nindiri	Ticuantepe	Tisma	Tisma	CAPRE Standard	
					El Guayabo	Lomas Del Gavilan	Sierra Doradas	Avinic No.4	Cuatro Esquinas	Recommendation	Maximum
Metals	Arsenic	µg/L	2.02	Wet	<dl	<dl	2.27	20.80	<dl		10
				Dry	<dl	<dl	<dl	26.25	<dl		
				Ave.	<dl	<dl	1.64	23.53	<dl		
	Cadmium	µg/L	0.15	Wet	<dl	1.59	2.21	1.99	0.32		50
				Dry	0.35	0.98	2.59	2.42	0.57		
				Ave.	0.21	1.29	2.40	2.21	0.45		
	Chromium	µg/L	0.71	Wet	1.14	1.44	<dl	<dl	<dl		50
				Dry	<dl	<dl	1.18	<dl	<dl		
				Ave.	0.75	0.90	0.77	<dl	<dl		
	Lead	µg/L	4.64	Wet	<dl	<dl	50.49	<dl	<dl		10
				Dry	<dl	<dl	5.76	<dl	<dl		
				Ave.	<dl	<dl	28.13	<dl	<dl		
	Total Mercury	µg/L	0.009	Wet	<dl	<dl	<dl	<dl	<dl		1
				Dry	<dl	<dl	<dl	<dl	<dl		
				Ave.	<dl	<dl	<dl	<dl	<dl		
	Manganese	µg/L	1.4	Wet	<dl	107.10	74.16	<dl	46.68	100	500
				Dry	50.00	60.70	22.35	18.80	31.92		
				Ave.	25.35	83.90	48.26	9.75	39.30		
	Aluminium	µg/L	3.99	Wet	2655.60	169.50	511.50	193.05	544.05		200
				Dry	338.55	2250.00	813.15	98.85	61.95		
				Ave.	1497.08	1209.75	662.33	145.95	303.00		
	Total Iron	mg/L	0.04	Wet	0.90	0.04	0.05	0.42	0.25		0.3
				Dry	0.71	0.04	0.08	0.14	0.08		
				Ave.	0.81	0.04	0.07	0.28	0.17		
	Zinc	µg/L	35.95	Wet	<dl	<dl	114.81	<dl	<dl		300
				Dry	<dl	37.72	342.30	181.26	58.47		
				Ave.	<dl	27.85	228.56	181.26	38.22		
	Copper	µg/L	3.84	Wet	<dl	<dl	6,57	<dl	<dl	100	200
				Dry	6.60	4.44	15.99	<dl	<dl		
				Ave.	6.60	3.18	15.99	<dl	<dl		
Phyiscal & Chemical Parameter	Temperature	°C		Wet	32.2	29.0	28.5	34.5	29.6	18-30	
				Dry	28.0	27.9	27.7	33.5	28.5		
				Ave.	30.1	28.5	28.1	34.0	29.1		
	pH(at laboratory)			Wet	9.03	7.60	6.36	8.58	7.75	6.5-8.5	
				Dry	7.35	7.36	6.96	8.41	7.22		
				Ave.	8.19	7.48	6.66	8.50	7.49		
	pH(at site)			Wet	8.15	7.22	6.25	8.25	6.84	6.5-8.5	
				Dry	7.97	7.51	6.44	8.15	6.93		
				Ave.	8.06	7.37	6.35	8.20	6.89		
	Electric Conductivity (at laboratory)	uS/cm		Wet	240.0	617.0	1244.0	505.5	434.0	400	
				Dry	263.0	584.0	1235.0	521.0	433.0		
				Ave.	251.5	600.5	1239.5	513.3	433.5		
	Electric Conductivity (at site)	uS/cm		Wet	254.0	617.0	1233.0	592.0	476.0	400	
				Dry	245.0	599.0	1326.0	599.0	400.0		
				Ave.	249.5	608.0	1279.5	595.5	438.0		
	Dissolved oxygen	mg/L	2.0-25.0	Wet	9.12	1.04	0.62	2.28	1.04		
				Dry	7.78	1.23	1.23	<dl	3.80		
				Ave.	8.45	1.14	0.93	1.64	2.42		
	Langeleir Index			Wet	1.96	-0.04	-0.26	0.18	0.41		
				Dry	-0.90	0.30	-0.60	-0.70	-0.90		
				Ave.	0.53	0.13	-0.43	-0.26	-0.25		
	Turbidity	NTU	0.0-999	Wet	6.72	0.28	0.58	1.78	2.18	1	5
				Dry	18.68	0.36	0.74	2.33	2.72		
				Ave.	12.70	0.32	0.66	2.06	2.45		
	Total Dissolved Solids	mg/L		Wet	147.59	399.01	878.17	358.15	313.84		1000
				Dry	138.57	389.69	881.92	375.67	301.69		
				Ave.	143.08	394.35	880.05	366.91	307.77		
	Color	mg/L-Pt-Co	5.0-70.0	Wet	5.0	<dl	5.0	<dl	5.0	1	15
				Dry	15.0	<dl	<dl	<dl	<dl		
				Ave.	10.0	<dl	3.8	<dl	3.8		
	Hardness	mg/L	0.125	Wet	67.06	176.27	493.27	13.41	191.20	400	
				Dry	66.00	177.76	506.00	22.00	188.00		
				Ave.	66.53	177.02	499.64	17.71	189.60		
	Alkalinity	mg/L	0.62	Wet	92.40	314.65	726.70	217.75	228.85		
				Dry	79.80	298.25	730.90	252.00	210.00		
				Ave.	86.10	306.45	728.80	234.88	219.43		
	Sodium	mg/L	0.18	Wet	22.10	70.20	117.00	121.00	18.10	25	200
				Dry	21.50	69.00	112.00	114.00	18.10		
				Ave.	21.80	69.60	114.50	117.50	18.10		
	Potassium	mg/L	0.10	Wet	4.44	9.51	22.30	9.61	6.81		10
				Dry	4.44	10.72	23.40	9.48	7.20		
				Ave.	4.44	10.12	22.85	9.55	7.01		
	Magnesium	mg/L	0.20	Wet	6.51	21.42	55.10	0.70	12.01	30	50
				Dry	6.56	20.62	55.89	3.40	11.42		
				Ave.	6.54	21.02	55.50	2.05	11.72		

ANNEX 2B(2) Water Quality of Prospective Water Sources

	Sampling Point	unit	Detection Limit	Sampling season	Nicaragua Lake El Guayabo	Nindiri Lomas Del Gavilan	Ticuantepe Sierra Doradas	Tisma Avinic No.4	Tisma Cuatro Esquinas	CAPRE Standard Recommendation	CAPRE Standard Maximum
Phyiscal & Chemical Parameter	Calcium	mg/L	0.08	Wet	16.13	35.33	106.82	4.22	56.83	100	
				Dry	15.63	37.24	110.62	3.21	56.51		
				Ave.	15.88	36.29	108.72	3.72	56.67		
	Carbonates	mg/L	2.00	Wet	10.56	<dl	<dl	14.98	<dl		
				Dry	<dl	<dl	<dl	27.72	<dl		
				Ave.	5.78	<dl	<dl	21.35	<dl		
	Bicarbonates	mg/L	0.75	Wet	91.29	383.96	886.74	235.27	279.24		
				Dry	97.39	363.92	891.87	251.16	256.28		
				Ave.	94.34	373.94	889.31	243.22	267.76		
	Sulfates	mg/L	0.25	Wet	8.48	5.59	28.41	21.21	3.80	25	250
				Dry	7.69	5.56	28.95	23.08	2.87		
				Ave.	8.09	5.58	28.68	22.15	3.34		
	Chlorides	mg/L	0.25	Wet	19.87	10.30	23.16	19.48	7.49	25	250
				Dry	19.04	10.44	24.16	19.25	7.67		
				Ave.	19.46	10.37	23.66	19.37	7.58		
	Nitrates	mg/L	0.05	Wet	<dl	6.10	4.51	<dl	6.47	25	50
				Dry	<dl	5.49	2.84	<dl	5.49		
				Ave.	<dl	5.80	3.68	<dl	5.98		
	Nitrites	mg/L	0.003	Wet	<dl	<dl	0.003	<dl	0.105		
				Dry	<dl	0.007	<dl	<dl	0.118		
				Ave.	<dl	0.004	0.002	<dl	0.112		
	Fluorides	mg/L	0.03	Wet	0.18	0.20	0.59	0.51	0.14		0.7-1.5
				Dry	0.28	0.36	0.94	0.52	0.27		
				Ave.	0.23	0.28	0.77	0.52	0.21		
	Ion Blance	%		Wet	3.38	0.04	2.18	3.88	1.91		
				Dry	1.63	2.75	1.14	7.55	1.79		
				Ave.	2.51	1.40	1.66	5.72	1.85		
	Silicates	mg/L	0.20	Wet	14.44	51.57	84.26	50.77	64.88		
				Dry	15.55	51.31	84.58	51.53	66.16		
				Ave.	15.00	51.44	84.42	51.15	65.52		
	Boron	mg/L	0.02	Wet	0.28	0.47	0.63	1.12	0.20		0.5(WHO)
				Dry	0.11	0.22	0.46	0.55	0.15		
				Ave.	0.20	0.35	0.55	0.84	0.18		
	Cyanides	mg/L	0.05	Wet	<dl	<dl	<dl	<dl	<dl		0.05
				Dry	<dl	<dl	<dl	<dl	<dl		
				Ave.	<dl	<dl	<dl	<dl	<dl		
	H2S	mg/L	1.00	Wet	<dl	<dl	<dl	<dl	<dl		0.05
				Dry	<dl	<dl	<dl	<dl	<dl		
				Ave.	<dl	<dl	<dl	<dl	<dl		
Pestcides	Mocap	ng/L	50.00	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	Naled	ng/L	25.00	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	Terbufos	ng/L	25.00	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	Diazinon	ng/L	25.00	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	Methyl Parathion	ng/L	15.00	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	Malathion	ng/L	25.00	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	Fenthion	ng/L	50.00	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	Ethyl parathion	ng/L	15.00	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	DEF(Tribufos)	ng/L	15.00	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	Ethion	ng/L	20.00	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	Guthion	ng/L	100.00	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	Zolone	ng/L	15.00	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	Co-Ral	ng/L	50.00	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		

ANNEX 2B(3) Water Quality of Prospective Water Sources

	Sampling Point	unit	Detection Limit	Sampling season	Nicaragua Lake	Nindiri	Ticuantepe	Tisma	Tisma	CAPRE Standard	
					El Guayabo	Lomas Del Gavilan	Sierra Doradas	Avinic No.4	Cuatro Esquinas	Recommendatic	Maximum
PAHs(5)	Acenachthylene	µg/L	0.047	Wet		0.124	0.271				0.2(6)
				Dry		nd	<dl				
				Ave.		0.062	0.147				
	Naphthalene	µg/L	0.050	Wet		0.146	0.076				0.2(6)
				Dry		nd	nd				
				Ave.		0.073	0.038				
	Fluorenne	µg/L	0.020	Wet		nd	<dl				0.2(6)
				Dry		nd	<dl				
				Ave.		nd	<dl				
	Acenaphthene	µg/L	0.044	Wet		<dl	<dl				0.2(6)
				Dry		nd	nd				
				Ave.		<dl	<dl				
	Phenanthrene	µg/L	0.015	Wet		0.025	<dl				0.2(6)
				Dry		<dl	<dl				
				Ave.		0.016	<dl				
	Anthracene	µg/L	0.001	Wet		nd	<dl				0.2(6)
				Dry		<dl	<dl				
				Ave.		<dl	<dl				
	Fluoranthene	µg/L	0.046	Wet		<dl	nd				0.2(6)
				Dry		nd	nd				
				Ave.		<dl	nd				
	Pyrene	µg/L	0.016	Wet		<dl	nd				0.2(6)
				Dry		nd	<dl				
				Ave.		<dl	<dl				
	Chrysene	µg/L	0.022	Wet		<dl	<dl				0.2(6)
				Dry		nd	nd				
				Ave.		<dl	<dl				
	Benzo(a)anthracene	µg/L	0.023	Wet		<dl	<dl				0.2(6)
				Dry		<dl	nd				
				Ave.		<dl	<dl				
	Benzo(a)pyrene	µg/L	0.017	Wet		<dl	nd				0.7
				Dry		nd	nd				
				Ave.		<dl	nd				
	Dibenzo(a,h)anthracene	µg/L	0.024	Wet		0.024	nd				0.2(6)
				Dry		nd	nd				
				Ave.		0.012	nd				
Pestcides	a-BHC	ng/L	0.09	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	b-BHC	ng/L	0.82	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	Lindane	ng/L	0.25	Wet	nd	nd	nd	nd	nd		2000
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	D-BHC	ng/L	0.13	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	Heptachlor	ng/L	0.16	Wet	nd	nd	nd	nd	nd		30
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	Aldrin	ng/L	0.41	Wet	nd	nd	nd	nd	nd		30
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	Heptachlor epoxide	ng/L	0.13	Wet	nd	nd	nd	nd	nd		30
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	a-Endasulfane	ng/L	0.19	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	Dieldrin	ng/L	0.50	Wet	nd	nd	nd	nd	nd		30
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	pp-DDE	ng/L	0.25	Wet	nd	nd	nd	4.01	nd		2000
				Dry	nd	nd	nd	nd	1.00		
				Ave.	nd	nd	nd	2.01	0.50		
	Endrin	ng/L	0.38	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	b-Endasulfane	ng/L	0.02	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	pp-DDD	ng/L	1.04	Wet	nd	nd	nd	nd	nd		2000
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	pp-DDT	ng/L	0.19	Wet	nd	nd	nd	nd	nd		2000
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
	Toxafene	ng/L	8.70	Wet	nd	nd	nd	nd	nd		
				Dry	nd	nd	nd	nd	nd		
				Ave.	nd	nd	nd	nd	nd		
BTEX(5)	Benzene	µg/L	1	Wet		nd	nd				
				Dry		nd	nd				
				Ave.		nd	nd				
	Toluene	µg/L	1	Wet		nd	nd				700
				Dry		nd	nd				
				Ave.		nd	nd				
	Ethylbenzene	µg/L	1	Wet		nd	nd				300
				Dry		nd	nd				
				Ave.		nd	nd				
	Xylenes(Total)	µg/L	3	Wet		nd	nd				500
				Dry		nd	nd				
				Ave.		nd	nd				
	Total BTEX	µg/L	6	Wet		nd	nd				
				Dry		nd	nd				
				Ave.		nd	nd				

ANNEX 2C

Water Quality of Tap Water

Annex 2C. Water Quality of Tap Water

Sampling Point	unit	Detection Limit	Sampling season	II	II	VI	III	VI	V	III	V	IV	V
				Colegio Carlos Fonseca Batahola Sur	Contiguo donde fue Gasolinea ESSO Monseñor Lezcano	Colegio Modesto Armijo	Colegio el Pilar	Gasolinera Shell Mayoreo	Escuela Victor Manuel Lazo	Pulperia Hialeah	Colegio 14 de Septienbre	Colegio Santa Rosa	Gasolinera Texaco Las Colinas
Total Coliform Bacteria	CC/100mL	0	Wet	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
			Dry	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
			Ave.	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Thermotolerant Coliform	CC/100mL	0	Wet	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
			Dry	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
			Ave.	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Escherichia coli	CC/100mL	0	Wet	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
			Dry	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
			Ave.	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Residual Chlorine	mg/L	0.2	Wet	3.0	<0.2	3.0	<0.2	1.5	<0.2	<0.2	3.0	3.0	3.0
			Dry	1.5	<0.2	1.5	<0.2	1.5	<0.2	1.0	<0.2	1.0	3.0
			Ave.	2.3	<0.2	2.3	<0.2	1.5	<0.2	1.0	3.0	2.0	3.0
Temperature(2)	°C		Wet	29.6	28.8	29.4	28.9	30.9	28.1	27.3	28.2	29.9	31.1
			Dry				29.4	31.1		27.1			26.1
			Ave.	29.6	28.8	29.4	29.2	31.0	28.1	27.2	28.2	29.9	28.6
pH(2)			Wet	8.1	8.3	7.5	7.7	7.0	7.5	7.1	6.6	7.5	6.5
			Dry				7.6	7.3		6.8			6.5
			Ave.	8.1	8.3	7.5	7.6	7.1	7.5	6.9	6.6	7.5	6.5
Electric Conductivity(2)	uS/cm		Wet	525.0	552.0	575.0	442.0	831.0	622.0	654.0	582.0	575.0	716.0
			Dry				388.0	778.0		638.0			624.0
			Ave.	525.0	552.0	575.0	415.0	804.5	622.0	646.0	582.0	575.0	670.0

(1) Free residual Chlorine

(2) Measurement at site

ANNEX 2D

Inventory of Existing Wells in the Study Area

Annex 2.D (1) Well Inventory in Managua city

No.	Zona BAJA Well Name	Serial Number	Coordinates East	Coordinates North
8	SAN ANTONIO	1	578	1,343
9	OLOF PALME	2	579	1,343
10	MERCADO ORIENTAL	3	579	1,343
11	COL. TENDERI	4	581	1,342
12	BELLO HORIZONTE	5	583	1,342
13	RAFAELA HERRERA	6	584	1,342
14	MERCEDES No.9	7	587	1,341
17	MERCEDES No.1	8	589	1,341
18	MERCEDES No.3	9	589	1,341
19	MERCEDES No.4	10	589	1,341
20	MERCEDES No.5	11	589	1,341
21	MERCEDES No.7	12	589	1,341
22	MERCEDES No.6	13	589	1,341
24	MERCEDES No.8	14	590	1,341
25	MERCEDES No.14	15	590	1,341
26	MERCEDES No.15	16	590	1,341
41	SAN CRISTOBAL No.1	17	581	1,341
77	VILLA FRATERNIDAD	18	586	1,341
78	BUENOS AIRES	19	585	1,342
79	MERCEDES No.16	20	589	1,341
80	MERCEDES No.17	21	589	1,341
81	MERCEDES No.18	22	590	1,341
82	MONSEÑOR LEZCANO	23	576	1,342
84	LAS BRISAS	24	574	1,343
104	SAN CRISTOBAL No.3	25	581	1,341

No.	Zona ALTA Well Name	Serial Number	Coordinates East	Coordinates North
1	SAN FRANCISCO J.(C.SANDINO) No.1	26	570	1,345
2	SAN FRANCISCO J.(C. SANDINO) No.2	27	570	1,344
3	SAN FRANCISCO J.(C.SANDINO) No.3	28	569	1,344
6	SATERITE ASOSOSCA(E.CONTRERAS) No.3	29	572	1,342
27	SABANA GRANDE No.1	30	586	1,340
28	SABANA GRANDE No.2	31	587	1,340
29	SABANA GRANDE No.3	32	587	1,340
30	SABANA GRANDE No.4	33	589	1,340
31	SABANA GRANDE No.5	34	589	1,340
34	ALTAMIRA No.4	35	580	1,339
35	ALTAMIRA No.5	36	580	1,339
46	VILLA LIBERTAD	37	586	1,339
48	14 DE SEPTIEMBRE	38	583	1,339
52	LA MASCOTA(HOSP. DEL NINO LA MASCOTA)	39	582	1,340
53	PARQUE LAS MADRES	40	578	1,341
54	LOS GAUCHOS	41	579	1,341
55	SHELL METROCENTRO	42	579	1,340
57	PLAZA EL SOL(LA CATEDRAL)	43	580	1,340
68	V. AUSTRIA (JICA No.4)	44	585	1,339
89	I.N.E CENTRAL	45	578	1,340
91	LAUREANO MAIRENA	46	585	1,341
94	SAN FRANCISCO J.No.4(SAN CARLOS)	47	571	1,344
96	EL RETIRO(RINE CISNEROS)	48	577	1,340
102	JICA No.5	49	571	1,341
106	NICARAO No.3(COLONIA NICARAO)	50	583	1,340
111	NUEVA VIDA	51	568	1,343
112	ANEXO V. LIVERTAD	52	585	1,338

Colored wells: Water is used in Sandino City

No.	Zona ALTA Superior Well Name	Serial Number	Coordinates East	Coordinates North
43	SAN JUDAS No.1	53	577	1,338
44	SAN JUDAS No.2	54	577	1,338
45	SAN JUDAS No.3(V. HERMOSA)	55	577	1,338
50	REPTO. SHICK No.2(VILLA CUBA No.2)	56	584	1,337
51	MANOLO MORALES	57	582	1,339
58	KM 8.5 C. SUR(SAN PATR.)	58	574	1,338
59	KM 9.2 C. SUR	59	573	1,337
60	KM 14.5 C. SUR	60	574	1,332
61	KM 14.5 C. VIEJA A LEON	61	569	1,335
62	(HOSP.) VELEZ PAIZ	62	574	1,340
63	(HOSP.) BERTA CALDERON(TORRES MOLINA)	63	576	1,340
64	TORRES MOLINA No.1	64	575	1,336
65	UNAN	65	579	1,337
66	VILLA PANAMA	66	580	1,337
70	VERACRUZ(VALLE GOTHEL) No.2	67	589	1,335
71	VERACRUZ(VALLE GOTHEL) No.3	68	589	1,334
74	VERACRUZ No.4	69	589	1,334
75	VERACRUZ No.5	70	588	1,333
76	VERACRUZ No.6	71	587	1,333
85	LOMA LINDA(SIERRA MAESTA)	72	576	1,337
86	KM 11.5 C. SUR	73	573	1,335
87	JULIO MARTINEZ	74	577	1,340
88	REPARTO. SHICK No.3	75	583	1,339
90	KM 7 C. MASAYA	76	581	1,338
93	PADRE FABRETO	77	577	1,332
95	KM 13.5 C. SUR	78	573	1,333
97	SAN ISIDRO DE LA CRUZ VERDE 2	79	580	1,335
108	CENTROAMERICA No.4	80	581	1,338
109	REPARTO. SHICK No.4	81	584	1,337
110	TORRES MOLINA No.2	82	575	1,335
113	ALPES No.1	83	579	1,335
114	ALPES No.2(LOS ALPES)	84	579	1,335
115	ALPES No.3	85	579	1,335
116	ALTOS DE SANTO DOMINGO	86	582	1,333
117	KM 17 C. SUR	87	575	1,331

No.	Zona ALTA Superior Well Name	Serial Number	Coordinates East	Coordinates North
118	MANAGUA I W-1	88	587	1,332
119	MANAGUA I W-2	89	587	1,332
120	MANAGUA I W-3	90	587	1,332
121	MANAGUA I W-4	91	587	1,331
122	MANAGUA I W-5	92	587	1,331
123	MANAGUA I W-6	93	587	1,331
124	MANAGUA I W-7	94	587	1,331
125	MANAGUA I W-8	95	587	1,331
126	MANAGUA I E-1	96	587	1,331
127	MANAGUA I E-2	97	587	1,331
128	MANAGUA I E-3	98	587	1,331
129	MANAGUA I E-4	99	587	1,331
130	MANAGUA I E-5	100	587	1,331
131	MANAGUA I E-6	101	587	1,331
132	MANAGUA I E-7	102	587	1,331
133	MANAGUA II P-1	103	590	1,339
134	MANAGUA II P-2	104	589	1,338
135	MANAGUA II P-3	105	589	1,338
136	MANAGUA II P-4	106	589	1,337
137	MANAGUA II P-5	107	591	1,339
138	MANAGUA II P-6 (stop)	108	592	1,336
139	MANAGUA II P-7	109	592	1,337
140	MANAGUA II P-8	110	591	1,336
141	MANAGUA II P-9	111	590	1,336
142	MANAGUA II P-10	112	590	1,335
143	MANAGUA II P-11	113	591	1,335

Annex 2.D (2) Well Inventory in Ticuantepe and Nindiri

No.	Zona Nindri and Ticuantepe	Serial	Coordinates		Management
	Well Name	Number	East	North	Organization
152	SANTA MATILDE No.1	122	586	1,329	ENACAL
153	SANTA MATILDE No.2	123	586	1,329	ENACAL
154	SANTA MATILDE No.3	124	585	1,329	ENACAL
155	LA BORGONA	125	585	1,327	ENACAL
156	LAS CONCHITAS	126	586	1,330	ENACAL
157	LOS LARIOS	127	587	1,329	ENACAL
158	SAN JOAQUIN	128	595	1,335	Nindiri City
159	EL GAVILAN / CAMPUZANO	129	596	1,328	ENACAL
160	NINDIRI No.3	130	596	1,327	Nindiri City

ANNEX 2E

Water Quality of Wells - ENACAL's Past Data

Annex 2 E(1) Water Quality Based on ENACAL Data

No.	Name	Coordinates		TEMP.	TDS	EC	pH	Ca	Mg	Fe	Na	HCO3	CO3	Cl	K	SO4	NO3	F
		East	North	°C	mg/L	uS/cm		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	SAN FRANCISCO No.1/C. SANDINO No.1	570	1345	31.2	313.1	482.9	8.0	32.70	10.80	0.07	49.40	217.5	2.4	24.80	11.00	27.60	11.30	0.26
2	SAN FRANCISCO No.2/C. SANDINO No.2	570	1345	30.8	334.7	494.7	8.1	35.90	13.20	0.04	41.90	221.6	2.7	26.20	11.10	26.10	6.60	0.32
3	Ciudad Sandino No.3	569	1344	31.5	359.9	525.0	7.9	43.60	16.90	0.05	46.70	239.6	1.0	30.20	13.90	24.40	9.00	0.32
6	S.ASOSOSCA No.3/E CONTRERAS No.3	572	1342	30.9	361.7	516.3	7.7	40.20	12.00	0.10	48.70	210.6	0.0	37.30	15.80	38.40	8.70	0.48
8	SAN ANTONIO	578	1343	30.0	283.9	487.3	8.0	21.51	8.50	0.02	59.74	176.8	1.8	32.85	11.81	29.12	16.77	0.50
9	Olof Palme	579	1343	29.9	343.4	581.2	8.1	26.32	10.67	0.05	81.39	223.6	2.8	42.44	12.62	32.02	22.87	0.52
10	Mercado Oriental	579	1343	30.0	367.3	601.1	7.9	27.82	10.78	0.03	86.09	202.0	1.4	45.39	12.65	34.90	38.13	0.47
11	Tenderi	581	1342	29.6	292.7	451.9	8.2	14.61	7.87	0.03	80.28	151.9	6.5	36.41	9.19	30.09	12.22	0.64
12	BELLO HORIZONTE	583	1342	29.7	296.7	476.8	8.0	17.96	9.44	0.04	74.93	176.0	2.1	31.77	9.16	30.06	15.03	0.64
13	Rafaela Herrera	584	1342	29.6	327.0	472.7	8.1	14.21	8.43	0.02	82.70	173.1	0.8	37.97	9.05	33.89	11.51	0.56
14	Las Mercedes No.9	587	1341	29.7	314.1	559.9	8.1	16.21	7.22	0.04	86.26	233.9	2.0	34.38	8.19	30.11	12.25	0.69
17	Las Mercedes No.1	589	1341	30.5	341.0	518.0	7.7	14.60	7.70	0.03	69.90	201.6	3.6	34.60	7.65	37.40	5.61	0.00
18	Las Mercedes No.3	589	1341	31.3	307.0	526.0	7.6	14.50	6.90	0.02	87.10	187.6	9.5	36.00	8.60	39.78	2.15	0.00
19	Las Mercedes No.4	589	1341	29.8	342.4	516.3	8.2	17.90	7.23	0.01	86.45	204.7	4.1	33.37	9.89	36.45	5.17	0.60
20	Las Mercedes No.5	589	1341	30.4	356.0	528.0	7.8	10.40	5.10	0.02	85.05	210.5	8.3	30.45	7.20	33.92	2.28	0.00
21	Las Mercedes No.7	589	1341	29.8	345.7	524.7	8.1	10.37	3.75	0.02	97.67	226.1	6.7	29.57	7.19	29.78	3.05	0.80
22	Las Mercedes No.6	589	1341	29.8	356.2	538.0	8.1	11.70	4.60	0.02	92.43	232.9	8.8	28.56	7.79	29.66	2.10	0.62
24	Las Mercedes No.8	590	1341	29.5	371.0	622.0	7.8	19.71	6.81	0.17	110.00	280.0	13.0	24.03	9.10	37.74	0.86	0.00
25	Las Mercedes No.14	590	1341	29.6	427.2	630.0	8.0	19.42	9.34	0.13	101.38	308.5	2.8	29.81	10.63	39.20	4.35	0.70
26	Las Mercedes No.15	590	1341	29.1	415.1	661.6	7.9	22.99	8.80	0.09	98.74	319.0	3.8	31.04	11.17	45.98	1.54	0.66
27	Sabana Grande No.1	586	1340	30.8	321.9	499.0	8.2	17.39	6.63	0.06	79.93	158.7	5.0	37.79	8.98	42.40	5.68	0.64
28	Sabana Grande No.2	587	1340	29.9	389.8	511.8	8.0	22.16	8.30	0.41	73.78	179.7	5.0	32.37	9.90	36.19	6.20	0.42
29	Sabana Grande No.3	587	1340	34.6	298.2	497.6	8.4	11.90	8.19	0.07	59.72	133.8	14.2	43.64	9.28	38.85	2.72	0.78
30	Sabana Grande No.4	589	1340	29.8	301.3	464.4	8.1	14.84	7.85	0.09	69.99	172.9	6.2	36.49	7.39	31.12	5.37	0.61
31	Sabana Grande No.5	589	1340	29.0	309.1	479.4	8.2	14.92	9.40	0.12	60.57	196.1	5.2	31.87	7.47	30.63	5.57	0.77
34	Altamra No.4	580	1339	28.9	316.9	435.3	8.4	19.96	10.90	0.04	49.40	177.0	6.4	33.45	12.17	27.39	13.41	0.55
35	Altamra No.5	580	1339	29.2	285.1	423.2	8.0	21.53	10.81	0.25	54.70	168.6	3.3	31.30	8.53	29.40	6.22	0.44
41	San Cristobal No.1	581	1341	29.3	282.7	441.0	8.1	19.04	6.77	0.02	62.40	164.3	3.0	32.95	10.52	35.98	11.34	0.68
43	SAN JUDAS No.1	577	1338	28.9	268.6	385.6	8.0	23.44	9.10	0.04	48.60	162.2	0.0	31.33	11.17	30.24	4.93	0.44
44	SAN JUDAS No.2	577	1338	28.5	264.1	381.1	8.0	24.39	9.67	0.06	38.50	160.5	0.9	25.59	11.34	28.34	6.15	0.55
45	SAN JUDAS No.3	577	1338	29.4	215.9	375.9	8.1	21.50	11.05	0.01	40.43	160.8	0.0	28.70	12.02	29.31	3.31	0.48
46	Villa Libertad	586	1339	30.0	329.7	465.0	8.2	12.11	6.06	0.13	89.70	177.6	7.2	37.88	5.57	36.91	5.88	0.65
48	14 de Septiembre	583	1339	30.0	299.2	450.0	8.0	15.87	9.01	0.08	77.52	168.1	5.5	38.40	8.27	31.92	12.24	0.54
50	REPTO. SHICK No.2	584	1338	28.5	282.2	448.3	7.9	22.45	7.70	0.11	58.10	158.1	0.0	34.40	12.35	46.04	7.65	0.59
51	HOSP. MANOLO MORALES	582	1339	28.9	280.5	426.8	8.2	24.55	9.62	0.07	51.73	157.2	6.1	29.55	10.06	31.47	9.83	0.59
52	Hosp La Mascota	582	1340	28.7	292.6	433.1	8.1	16.89	9.40	0.28	67.50	138.9	5.5	33.02	10.18	33.93	4.84	0.72
53	Parque Las Madres	578	1341	30.1	288.0	432.7	8.2	22.52	10.38	0.02	62.72	182.9	4.4	32.61	9.98	32.42	12.82	0.58
54	Los Gauchos	579	1341	29.6	283.9	418.2	8.2	17.19	6.68	0.05	65.10	156.3	5.1	33.06	11.35	30.25	9.32	0.69
55	Shell Metrocentro	579	1340	30.1	262.0	412.4	8.3	14.78	6.68	0.05	66.31	140.1	6.7	31.08	10.12	30.42	7.01	0.62

Annex 2 E(2) Water Quality Based on ENACAL Data

No.	Name	Coordinates		TEMP.	TDS	EC	pH	Ca	Mg	Fe	Na	HCO3	CO3	Cl	K	SO4	NO3	F
		East	North	℃	mg/L	uS/cm		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
57	Plaza el Sol	580	1340	30.0	303.6	430.8	8.2	20.16	9.18	0.09	60.85	172.3	2.3	35.63	9.70	31.02	14.50	0.57
58	KM 8.5 C. SUR/San Patricio	574	1339	29.0	249.8	407.4	8.1	31.80	10.50	0.07	41.50	171.1	0.0	37.70	11.90	29.10	8.50	0.54
59	KM 9.5 C. SUR	573	1337	29.0	278.5	471.9	7.9	23.70	7.40	0.51	48.00	164.1	0.9	34.40	14.10	38.80	5.80	0.44
60	KM 14.5 C. SUR	574	1332	27.8	313.6	517.2	7.8	44.20	17.40	0.16	31.60	200.2	6.7	34.00	9.90	35.30	9.40	0.54
61	KM 14.5 C. VIEJA A LEON	569	1335	28.2	331.0	520.0	7.6	44.20	18.10	0.05	35.60	220.2	0.0	36.00	8.70	32.00	8.90	0.22
62	HOSP. VELEZ PAIZ	574	1340	29.0	284.2	457.2	7.9	28.95	11.79	0.10	47.37	173.9	1.8	31.79	10.98	31.14	7.12	0.57
63	HOSP. BERTHA CALDERON	576	1340	28.8	277.8	431.8	7.9	22.32	12.14	0.16	44.60	155.6	5.4	33.87	12.60	26.35	6.74	0.47
64	TORRES MOLINA No.1	575	1336	29.1	299.3	409.8	7.9	32.45	12.77	0.03	47.60	151.6	5.1	30.50	11.33	33.09	7.51	0.46
65	UNAN	579	1337	28.3	286.6	404.4	8.0	26.30	14.16	0.27	42.05	138.8	8.0	35.26	13.30	30.89	7.52	0.50
66	Villa Panama	580	1337	28.8	251.9	389.1	8.3	24.20	12.83	0.03	41.20	142.2	6.4	28.56	13.44	28.54	5.54	0.63
68	Villa Autsria/JICA No.4	585	1339	29.7	316.4	448.8	8.2	15.07	9.05	0.13	72.60	167.9	8.8	36.45	8.60	33.86	7.64	0.53
70	VERACRUZ/VALLE GOTHEL No.2	589	1335	28.5	369.5	513.1	8.1	26.05	13.97	0.11	85.63	242.4	4.5	28.64	10.75	32.51	5.96	0.82
71	VERACRUZ/VALLE GOTHEL No.3	589	1335	29.4	392.2	521.5	7.9	34.23	13.71	0.21	80.90	314.6	0.9	29.01	9.77	30.09	6.22	0.91
74	VERACRUZ No.4	587	1333	29.0	287.7	401.8	8.0	11.63	6.01	0.02	83.10	149.0	9.2	28.11	5.17	30.77	8.02	0.95
75	VERACRUZ No.5	588	1333	28.6	266.2	409.0	8.3	18.87	9.43	0.03	75.88	158.5	6.9	25.83	5.93	26.48	6.48	0.90
76	VERACRUZ No.6	589	1334	29.0	301.7	420.8	8.4	9.24	5.18	0.02	89.05	124.0	26.8	33.72	4.88	36.74	5.26	0.77
77	VILLA FRATERNIDAD	586	1341	29.7	343.1	517.1	8.0	18.70	11.19	0.08	67.23	187.8	3.2	44.54	9.03	33.42	8.55	0.47
78	Buenos Aires/Martires de ayapal	585	1342	29.8	317.3	515.3	8.0	19.70	10.40	0.06	60.45	180.8	1.7	41.57	10.00	34.10	9.48	0.55
79	Las Mercedes No.16	589	1341	30.0	295.5	458.3	8.2	7.93	4.52	0.03	83.00	169.7	12.2	33.69	6.12	33.86	3.39	0.94
80	Las Mercedes No.17	589	1341	29.6	296.9	509.0	8.1	9.89	3.76	0.11	81.87	213.1	7.3	31.64	6.63	27.67	2.49	1.85
81	Las Mercedes No.18	590	1341	29.5	348.0	589.7	7.9	16.66	6.32	0.33	91.40	271.9	4.1	26.12	10.30	36.75	3.04	0.72
82	MONSEÑOR Lezcano	576	1342	28.9	282.1	464.2	8.0	27.72	9.59	0.06	52.67	184.6	1.5	33.07	12.10	27.26	11.18	0.65
84	Las Brisas	574	1343	29.4	315.6	503.0	8.2	24.88	8.81	0.18	62.53	187.1	3.3	40.66	13.30	30.06	8.02	0.55
85	SIERRA MAESTRA/LOMA LINDA	576	1337	28.1	310.0	405.9	7.9	34.26	11.14	0.04	34.10	176.8	0.0	29.04	11.73	27.57	8.17	0.47
86	KM 11.5 C. SUR	573	1335	28.2	354.5	507.1	8.0	44.00	13.60	0.06	47.90	207.4	2.0	34.70	12.20	29.42	9.70	0.45
87	JULIO MARTINEZ	577	1340	28.9	261.2	419.1	8.0	27.33	8.38	0.04	42.28	159.9	8.1	29.60	13.28	27.85	6.67	0.69
88	REPTO. SHICK No.3	583	1338	28.1	261.1	450.4	8.3	19.22	10.11	0.01	52.67	162.7	0.8	36.38	13.32	32.12	7.99	0.66
89	Ine Central	578	1340	27.5	262.0	389.5	8.2	19.33	8.75	0.01	48.06	164.8	3.0	28.90	13.02	24.56	7.47	0.60
90	KM 7 C.MASAYA	581	1338	28.4	276.9	394.8	8.0	20.26	10.96	0.07	50.38	153.7	2.1	28.35	12.73	30.32	5.33	0.66
91	Laureano Mairena	585	1341	29.9	342.5	481.6	8.1	23.32	9.15	0.04	59.93	163.8	3.8	37.95	11.25	34.98	7.15	0.60
93	PADRE FABRETO	577	1332	26.4	229.2	393.8	8.0	38.13	12.82	0.06	19.14	179.7	1.3	23.08	8.57	19.58	7.67	0.59
94	SAN CARLOS No.4/SAN FRANCISCO No.4(s	571	1344	33.9	333.1	502.5	8.2	18.53	6.46	0.07	67.38	191.4	5.6	30.94	10.80	39.29	4.20	0.53
95	KM 13.5 C. SUR (#95)	573	1334	28.3	294.6	525.2	8.1	40.10	15.80	0.01	43.40	208.3	0.0	35.20	10.10	38.00	7.60	0.36
96	RENE CISNEROS/EL RETIRO	577	1340	28.6	287.0	409.8	7.8	22.33	11.77	0.93	50.75	151.4	1.9	28.38	11.70	35.10	7.42	0.60
97	SAN ISIDRO DE L.C.VERDE	580	1335	28.3	210.4	376.5	8.0	25.28	12.52	0.00	37.64	161.8	1.8	23.71	10.96	24.63	7.14	0.79
102	JICA No.5	571	1341	31.5	302.2	526.5	7.8	36.16	9.70	0.02	60.20	211.9	2.3	30.94	14.90	36.10	8.52	0.63
104	San Cristobal No.3	581	1341	28.8	262.7	442.3	8.3	15.80	9.41	0.04	65.68	168.7	4.1	32.33	8.77	31.89	12.43	0.78
106	COLONIA NICARAO/NICARAO No.3	583	1340	30.0	317.2	469.3	8.3	18.20	7.80	0.01	66.67	184.2	2.3	28.94	10.40	45.77	7.36	0.80
108	C. America No.4	581	1338	28.6	265.9	410.3	8.3	25.04	10.36	0.05	50.93	157.8	6.2	28.99	12.08	30.13	10.08	0.60

Annex 2 E(3) Water Quality Based on ENACAL Data

No.	Name	Coordinates East	Coordinates North	TEMP. °C	TDS mg/L	EC uS/cm	pH	Ca mg/L	Mg mg/L	Fe mg/L	Na mg/L	HCO3 mg/L	CO3 mg/L	Cl mg/L	K mg/L	SO4 mg/L	NO3 mg/L	F mg/L
109	REPTO. SHICK No.4	584	1337	28.6	257.5	444.5	8.0	16.53	10.47	0.01	56.10	168.9	0.0	33.77	11.11	34.19	11.51	0.76
110	TORRES MOLINA No.2	575	1335	27.5	224.2	384.5	7.6	32.55	11.50	0.00	26.85	182.8	0.0	21.15	11.20	23.54	8.14	0.75
111	Nueva Vida(Stopped)	568	1343	35.2	298.8	509.0	7.1	41.76	12.22	0.00	41.25	244.2	0.0	28.97	15.10	34.08	4.66	0.00
112	ANEXO VILLA LIVERTAD	585	1338	30.5	272.5	434.3	8.1	14.74	8.99	0.01	76.47	163.8	7.8	30.58	6.07	32.28	6.59	0.70
113	ALPES No.1	579	1335	28.8	233.7	384.5	7.7	24.37	8.10	0.00	31.00	141.2	13.2	26.17	13.10	28.78	5.69	0.90
114	LOS ALPES/ALPES No.2	579	1335	29.1	226.8	388.3	7.6	26.69	10.21	0.02	30.43	165.1	2.4	25.85	12.90	28.48	5.15	0.83
115	ALPES No.3	579	1335	25.1	243.1	409.0	7.9	25.40	10.07	0.05	42.90	152.7	4.2	29.31	13.20	32.05	6.12	0.90
116	ALTOS DE SANTO DOMINGO	582	1333		240.2	371.0	8.1	20.64	10.59	0.61	39.10	145.0	0.0	23.64	10.60	58.29	4.55	0.02
117	KM 17 C. SUR	575	1331	27.9	249.0	438.0	6.9	39.30	22.00	0.00	16.80	186.1	0.0	33.80	8.00	26.11	11.10	0.01
118	Managua I W-1	587	1332	28.2	243.3	409.3	8.5	6.54	3.41	0.01	79.40	141.8	5.0	27.92	4.37	31.73	4.47	1.12
119	Managua I W-2	587	1332	27.9	299.8	512.3	7.9	18.14	6.02	0.16	90.96	218.0	2.5	28.33	4.02	35.86	4.64	1.05
120	Managua I W-3	587	1332	27.6	318.8	507.5	7.4	28.30	10.62	0.04	72.97	251.4	2.3	26.19	6.58	27.31	6.18	0.99
121	Managua I W-4	587	1331	26.9	322.5	571.3	7.7	34.79	10.96	0.10	56.80	282.0	1.5	26.52	6.41	29.72	4.97	0.84
122	Managua I W-5	587	1331	27.7	374.5	645.0	7.4	45.02	11.81	0.02	76.48	336.9	2.5	25.85	7.15	30.98	6.35	0.74
123	Managua I W-6	587	1331	28.1	333.6	561.8	7.4	30.61	7.18	0.03	70.71	269.1	0.0	25.44	6.90	38.79	6.68	0.69
124	Managua I W-7	587	1331	27.6	310.3	529.8	7.8	27.82	6.11	0.00	76.68	243.8	1.9	26.11	5.58	30.38	6.46	0.66
125	Managua I W-8	587	1331	26.9	314.3	533.8	7.6	26.74	10.35	0.01	73.66	258.6	2.1	27.11	6.24	30.93	4.76	0.69
126	Managua I E-1	587	1331	27.8	356.6	603.5	7.6	32.47	9.97	0.01	81.90	304.7	1.0	27.18	6.60	31.06	3.97	0.91
127	Managua I E-2	587	1331	27.4	525.6	874.3	7.6	61.56	25.62	0.00	98.98	505.7	0.7	28.90	9.17	39.73	3.89	0.80
128	Managua I E-3	587	1331	27.3	474.2	846.2	7.1	55.41	17.29	0.01	105.70	458.0	0.0	27.73	6.70	29.59	4.19	0.65
129	Managua I E-4	587	1331	27.7	503.3	796.4	7.1	65.61	21.15	0.01	96.36	497.5	0.0	25.87	9.41	29.29	5.58	0.73
130	Managua I E-5	587	1331	28.5	476.8	844.2	7.6	60.72	19.20	0.00	94.13	461.3	1.4	29.28	9.32	31.15	4.17	0.75
131	Managua I E-6	587	1331	27.3	353.9	598.7	7.5	29.83	10.38	0.02	91.10	297.3	0.5	25.03	5.79	32.89	6.10	0.94
132	Managua I E-7	587	1331	28.0	425.6	706.0	7.4	51.41	15.46	0.03	90.68	381.7	0.0	25.23	7.85	29.39	5.75	0.91
133	Managua II No.1	590	1339	26.6	286.4	449.3	8.1	11.06	5.16	0.04	83.73	159.6	13.5	27.35	7.06	34.36	6.59	1.01
134	Managua II No.2	589	1338	27.1	260.0	419.3	8.4	7.26	5.38	0.03	84.09	167.6	1.2	28.95	5.57	41.17	5.17	1.00
135	Managua II No.3	589	1338	28.5	266.1	434.3	8.3	7.05	5.81	0.03	85.44	162.9	4.4	27.31	5.14	39.52	5.15	0.98
136	Managua II No.4	589	1337	27.4	264.4	425.6	8.3	8.80	5.81	0.07	85.64	122.6	16.6	28.16	4.12	29.38	6.35	1.04
137	Managua II No.5	591	1339	27.8	496.0	860.6	7.5	59.87	21.46	0.01	98.16	441.7	13.8	26.60	15.46	23.80	5.38	0.57
138	Managua II No.6	592	1336	41.7	926.0	1841.4	7.3	66.61	62.18	0.75	175.34	797.4	0.0	55.91	29.72	194.29	2.18	0.41
139	Managua II No.7	592	1337	31.7	703.2	1200.5	7.1	67.35	57.84	0.42	105.95	653.9	12.0	38.59	20.97	63.52	1.62	0.57
140	Managua II No.8	591	1336	31.3	574.6	1025.5	7.4	53.13	30.73	0.09	119.02	512.4	11.2	36.61	18.17	42.14	1.05	0.47
141	Managua II No.9	590	1336	29.1	655.3	1097.2	7.6	79.48	42.03	0.02	98.94	623.0	8.4	29.35	13.88	39.23	3.93	0.47
142	Managua II No.10	590	1335	26.1	579.2	957.8	7.6	71.06	29.01	0.04	97.91	524.4	11.2	27.91	15.50	34.99	4.50	0.50
143	Managua II No.11	591	1335	30.8	582.8	1044.6	7.4	74.23	31.57	0.06	111.44	543.4	10.2	30.07	14.68	39.61	1.76	0.53
144	Managua II No.12	591	1338	30.3	599.3	1009.2	7.7	65.16	38.87	0.11	111.20	549.5	6.6	30.22	17.41	47.70	3.75	0.43

Annex 2 E(4) Water Quality Based on ENACAL Data

No.	Name	Coordinates East	Coordinates North	TEMP. °C	TDS mg/L	EC uS/cm	pH	Ca mg/L	Mg mg/L	Fe mg/L	Na mg/L	HCO3 mg/L	CO3 mg/L	Cl mg/L	K mg/L	SO4 mg/L	NO3 mg/L	F mg/L
145	Managua II No.13	591	1338	31.1	635.8	1055.6	7.5	60.75	37.45	0.01	117.92	618.2	0.0	31.42	19.17	57.88	1.02	0.41
146	Managua II No.14	592	1337	31.2	719.1	1262.0	7.2	83.37	54.06	0.28	110.04	680.6	0.0	37.65	19.27	76.66	1.64	0.50
147	Managua II No.15	592	1337	38.8	991.0	1731.1	7.3	72.62	78.63	0.30	153.33	831.3	6.8	49.68	27.98	165.74	1.78	0.48
148	Managua II No.16	591	1336	26.3	665.5	1308.5	7.4	82.43	55.03	0.72	121.40	510.5	0.0	36.09	20.51	81.40	0.60	0.01
149	CHIQUILISTAGUA	569	1337	31.1	281.9	509.3	7.8	45.10	17.50	0.45	29.60	244.0	0.0	28.50	11.40	25.00	7.80	0.45
150	Cedro Galán	571	1334	29.1	264.0	512.0	7.8	38.55	16.70	0.01	26.63	202.6	0.0	30.76	8.50	32.50	7.10	0.50
151	Planetanium	571	1334	29.9	263.0	473.5	8.1	39.95	18.67	0.01	26.65	209.5	0.0	33.46	7.10	29.58	6.09	0.35
155	p-5	585	1327	25.4	251.0	425.5	8.1	29.87	15.97	0.07	35.85	163.5	0.0	31.14	10.88	38.49	6.85	1.31
156	PP La borgoña	585	1328	25.9	245.9	430.4	7.8	31.23	12.69	0.02	36.00	171.5	0.0	29.74	9.32	29.34	8.94	1.36
157	PP Las Conchitas	586	1330	26.4	261.6	469.3	7.5	28.56	12.23	0.01	49.91	186.7	0.3	28.54	7.73	28.77	8.21	1.19
158	Los Larios	587	1329	27.5	589.0	1001.8	7.3	85.00	40.20	1.48	72.20	608.1	0.0	24.53	22.04	31.26	0.55	0.54
162	Jard. Barranca	597	1325	28.2	371.8	585.4	8.0	17.73	15.35	0.01	81.23	263.8	31.7	22.66	15.62	12.10	3.48	0.48
	Average			29.2	346.2	561.5	7.9	29.8	13.9	0.1	69.1	245.7	4.3	31.6	10.8	36.1	6.9	0.6
	SD			2.1	130.5	248.1	0.3	18.3	12.2	0.2	26.9	145.0	5.0	5.5	4.2	20.5	4.5	0.3
	Minimum			25.1	210.4	371.0	6.9	6.5	3.4	0.0	16.8	122.6	0.0	21.2	4.0	12.1	0.6	0.0
	Maximum			41.7	991.0	1841.4	8.5	85.0	78.6	1.5	175.3	831.3	31.7	55.9	29.7	194.3	38.1	1.9

ANNEX 2F

Water Quality of Wells in Tisma Area (Previous Reports)

Annex 2 F Water Quality of Wells in Tisma Area (Previous Reports)

Well Name	Coordinates		Date	Temp.	TDS	EC	pH	Ca	Mg	Fe	Na	HCO3	CO3	Cl	K	SO4	NO3	F
	East	North		°C	mg/L	uS/cm		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PP-1	595	1322	1979/4/5	26	470	788	7.19	32	24		76	324	0	22	13	8	0	0.01
			1980/7/24	25.5	416	724	7.4	38	27		74	342	0	18	13	9	0	0.21
			1980/8/1	25.5	442	687	7.6	37.3	27.4	3.7	72	431.7	0.5	0.2	14.5	10.2	0	0.4
PP-2	596	1324	1979/4/24	28	316	675	8.75	20	13		69	246	4	16	14	1	0	0.001
PE-72	602	1339	1979/11/8		324	405	7.5	47	13		35	228	0	17	14	0.3	1.9	0.32
PP.Tisma No.1	602	1339	1999/2/10	29	317	520	8.5	27.9	9.7	0	83.4	286.6	2.99	18.44	17.4	12.75	6.49	0
			2001/8/31	30.7	277.102	473	8.23	23.107	9.863	0.025	60	269.065	0	18.953	16.2	6.087	6.151	0.314
			2003/4/2	30.2	301	458	7.49	17.8	11.3	0	71.6	190.4	28.8	18.1	16	0.86	14	0.3
PP-7	602	1339	1979/11/8	32	314	405	8.4	5.6	1.4		102	202	8	9.2	13	21	0	0.45
PE.Santa Cruz	603	1338	2001/8/31	30.3	266.807	468	8.02	51.891	18.317	0.065	21.4	259.541	0	20.848	10.6	7.415	8.307	0.211
			2001/9/4	30.1	281.64	467	8.51	7.598	1.382	0.0068	92.5	221.66	16.234	17.532	12	8.57	0	0.479
PE.La Concha	604	1339	2001/9/3	30.8	289.018	528	8.05	25.558	12.681	0.007	63.9	269.065	0	17.058	0.3	12.904	23.655	0.538
PE.Las Conchas	604	1340	2001/9/3	27.9	323.566	594	8.05	29.431	12.916	0.139	67.4	101.925	0	22.744	22.5	0	14.084	0.786
PE-21	606	1333	1979/2/22	27.2	339	523	8.2	42	12		43	245	0	15	14	0	5.54	0.001
PO-4-4	606	1333	1979/3/13	32	280	418	8.69	9	2		75	170	12	16	14	6	0.84	0.001
PE. El Porvenir	608	1330	2001/8/30	28.7	477.276	807	7.83	68.155	12.681	0.023	59.8	285.733	0	37.906	20	20.269	117.41	0.2
PE.San Jose	608	1332	2001/8/30	30.6	260.244	431	7.85	36.401	11.272	0.013	32.5	285.733	0	13.267	14.2	11.399	0.278	0.291
PE-47	608	1332	1979/5/15		314	510	7.8	24	6		56	200	0	16	15	0	0.16	0.001
PP-4	608	1332	1979/5/14	33	302	410	8.1	14	3		73	190	0	18	11	1	0	0.001
PP-4A	608	1332	1979/2/22	28	288	403	8.3	18	9		52	194	0	18	12	0	3.8	0.001
PE.M.LA Chabela	608	1333	2001/8/30	29.3	414.669	690	7.79	49.568	16.908	0.21	63.7	235.73	0	23.691	19.4	9.482	115.255	0.231
PE.LA Esperanza	608	1334	2001/9/4	29.9	566.94	1013	7.66	107.89	23.499	0.0006	52.5	339.567	0	65.86	22.8	9.609	117.41	0.205
PE-29	609	1330	1980/1/15	28.3	368	533	7.65	43	6		46	210	0	24	5	1	30	0.1
PO-5	609	1330	1979/4/17	33.3	274	571	8.4	2	1		86	168	10	13	8	4	0	0.05
PE.Finca El Cerrito	609	1335	2001/8/30	31	229.868	395	8.26	10.068	5.636	0.011	70.2	221.443	0	13.267	14	5.394	1.927	0.386
PE-30	610	1327	1979/12/5	29	766	890	7.25	102	22		18	110	0	119	10	19	0.69	0.25
PP-5	610	1327	1979/12/5	34	290	325	8.3	5	4		59	140	30	10	10	0.5	0	0.45
			1980/8/1	34	198.3	362	8.1	5.9	0.9		65.9	203	1.4	7	11.4	5.3	0.1	
PP-5A	610	1327	1979/2/22	27.2	277	460	8.3	24	6		48	180	0	16	10	0	5.62	0.001
PE-19	611	1326	1980/1/26	26	290	420	7.35	33	7		33	183	0	11	9	11	0	0.5
PO-6	611	1326	1980/1/26	33.5	262	372	8	7	2		50	168	0	11	10	8	0	0.32
PO-8	615	1327	1979/11/22	37	381.6	725	8.05	11.4	1.3	0.14	127.2	166.6	1	114.3	12.9	30	0	1.4
PO-7	617	1330	1980/4/16	37	370	537	8.3	7	1		109	191	0	41	7	19	0	0.95
PO-3	618	1332	1979/11/20	34.4	342	410	8.25	4	2		99	172	0	49	6	18	0	0.01
			1979/11/20	33.3	358	410	8.1	10	6		95	238	0	33	6	2	0	0.001
			1980/8/1	34.4	350.2	552	8.2	4.6	1.2		130	210.8	1.9	50.3	8.4	49	0.04	0.41
			1980/7/11	34.4	386	589	8.3	8	2		110	162	16	55	6	24	0	0.1
PP-3A	618	1332	1979/3/13		838	1452	8.3	35	12		271	456	0	140	16	82	0	1.4

ANNEX 2G

Water Quality of High Nitrate Concentration Wells

ANNEX 2G(1) WATER QUALITY OF HIGH NITRATE CONCENTRATION WELLS

NOMBRE DE LA FUENTE	FECHA CAPTA	TEMPERATURA ° C	ASPECTO	COLOR UC	TURBIEDAD UNT	SOLD DIS mg/L	COND ELECT µ g/L	PH	ALCALINIDAD mg/L	DUREZA TOTAL mg/L	CALCIO mg/L	MAGNESIO mg/L	HIERRO TOTAL mg/L	SODIO mg/L	BICARBONATOS mg/L	CARBONATOS mg/L	CLORUROS mg/L	POTASIO mg/L	SULFATOS mg/L	NITRATOS mg/L	NITRITOS mg/L	FLUOR mg/L
NORMAS CAPRE		**18 - 32**	**Transparente**	**15**	**5**	**1000**	**No Esp**	**6.5 - 8.5**	**No Esp**	**400**	**100**	**50**	**0.3**	**200**	**No Esp**	**No Esp**	**250**	**10**	**250**	**50**	**0.1**	**0.7 - 1.5**
	1997/9/24	30	CLARO	0	0.5	359.2	626	7.75	188.7	81.6	25.1	4.6	0	88	230.2	0	43.7	14.2	32.9	37	0	0.53
	1997/10/24	30	CLARO	0	0.1	350.2	616	7.94	171.6	137.3	24.8	18.3	0	83	209.2	0	43.7	13.6	33.3	29.9	0	0.67
	1997/11/24	30	CLARO	0	0.2		622	7.68												43.4	0.01	
	1998/1/7	30	Claro	0	0	289.01	605	7.83	168.43	102.355	26.84	8.6	0	48.8	205.39	0	43.77	13.6	29.9	46.3	0	0.65
	1998/2/26	30	Claro	0	0		616													67.1		
	1998/3/6	30																		104.2		
	1998/3/20	30	Claro	0	0.3		611	8.29					0						76.6	101.6		
	1998/3/27	30	Claro	0	0.56		593	8.14												79		
	1998/4/3	30	Claro	0	1.78		603	8.2												76.9		
	1998/4/20	30																		46.76		
	1998/5/8	30											0.007							34.1		
	1998/5/15	30	Claro	0	1.18		596	7.98												49		
	1998/6/19	30																		48.4		
	1998/8/3		Claro	0	0.152	408	758	8.26	168.4	98.08	25.1	8.6	0	86.7	205.4	0	43.1	13.4	76.3	53.9	0	0.08
	1998/8/21	25																		39.1		
	1998/9/8	25	Claro																	33.94		
	1998/9/8	25																		33.94		
	1998/9/8		Claro	0	0															29.88		
	1998/10/23	30																		48.61		
	1998/11/24	25																		31.3		
	1999/2/17	30	Claro	0	0.4	324.39	621	8.45	132.11	108.49	26.22	10.45	0	85.2	161.09	1.2	45.39	13.3	23.13	38.9	0.016	0.518
	1999/4/19	30	claro	0	0.47	361	627	8.43	164.1	121.3	25.4	14.03	0.02	83.5	200.14	8.4	44.42	13.7	34.54	46.8	0.016	0.58
	1999/5/21	30	claro	0	0.33	401	635	8.33	192.15	122.44	29.58	11.81	0	99.7	234.32	3.6	45.08	12.1	39.84	47.4	0.005	0.358
	1999/7/16	30	Claro	0	0.22	397	630	8.47	174.37	135.29	29.8	14.82	0	93.1	212.64	3.56	44.2	13.5	15.48	50.8	0.01	0.755
Mercado Oriental/Manag	1999/9/6	29	Claro	0	0.22	363	612	8.46	167.14	108.83	27.24	9.91	0	77.6	196.67	3.5	45.53	12.1	33	53.4	0.0038	0.357
	2000/1/17	29	Claro	0	0.17	393	620	8.22	174.41	114.1	30.46	9.24		85.3	212.65	0	57.46	12.1	54.52	38.57	0.011	0.527
	2000/5/26	29	Claro	0	0.3	377.686	650	8.43	174.411	116.934	28.572	11.07		79.5	207.817	2.377	46.989	11.1	63.154	29.794	0.007	0.477
	2000/6/30	30	Claro	0	0.17		648	8.06								0				26.565		
	2000/8/18	30	Claro	0	0.84		654										45.534			47.02		
	2001/1/30	29	Claro	3.2	0.08	358.928	627	8.18	174.411	121.26	26.206	13.555	0.017	78.47	212.649	0	44.544	13.2	37.301	40.53	0.006	0.452
	2001/5/3	29																18.8		35.58		
	2001/9/3	29					620	8.057										12.6		39.951	0.009	
	2001/10/12																	12.2		42.917		
	2000/10/9	30	Claro	0	0.14	398.415	640	8.19	168.465	127.731	32.064	11.574	0	85.2	205.4	0	49.264	11.1	65.288	42.363	0.004	0.479
	2002/2/8	30.5	Claro	<LD	0.26		396	7.48														
	2003/7/16	31.7	Claro				636	8.04												36.2		
	2003/7/25	31.6					632	7.34												33.9		
	2003/7/1	31.3	Claro				608	8.15								0				32.8		
	2003/7/9	32					493	7.66												39.4		
	2003/5/29	31.8	Claro	<LDM	0.43	393	585	7.5	163.3	122.4	31.9	10.4	<LDM	93.4	199	0	47.2	13.2	36.7	61.9	0.008	0.46
	2003/12/3	30.7																		44.4		
	2004/4/23	30.4	Claro	<LDM	<LDM	419	647	7.19	169.4	114.1	26	11.9	<LDM	80.9	189.8	8.2	52.2	12.6	37.34	87.63	0.004	0.5
	2004/5/7	29.6					712	7.42												37.807	0.005	
	2004/5/11	30																		37.014		
	2004/6/11	30					567	7.09												38.312	0.01	
	2004/7/27	31.1					546	7.06												36.6	0.004	
	2004/8/12	30.2					590	7.7												37.332	0.006	
	2004/10/12	30.2					548	7.24												37.207	<LDM	
	2005/1/14	29.6	claro	1.0	<LDM	356	664	8.17	176.6	102.7	29.5	7.0	<LDM	74.8	215.4	0.0	49.7	13.3	37.28	37.61	0.004	0.53

ANNEX 2G(2) WATER QUALITY OF HIGH NITRATE CONCENTRATION WELLS

	1998/1/12	30	Claro	0	0.6	307	571	7.88	178.7	104.8	33.4	5.2	0	65.2	217.9	0	41.5	12.4	31.2	10.7	0.007	0.46
	1998/6/19	30	Claro	0	0.95	368	551	8.24	180.32	105.3	24.2	10.9	0	74.1	219.9	0	39.6	12.4	68.04	30.9	0.02	0
	1999/2/17	30	Claro	0	0.37	344.18	582	8.43	204.16	104.75	26.97	9.09	0	86	248.96	6.6	41.52	13.7	21.45	22.1	0.015	0.832
	1999/3/26	28	Claro	0	0.22	301	552	8.55	182.1	103	24.9	9.92	0.007	80	222.1	4.8	5.74	13.5	34.04	22.6	0.02	0.85
	1999/5/21	30	Claro	0	0.2	363	591	8.56	198.16	115.8	26	12.4	0	91.1	241.64	8.4	43.68	14	33.93	22.4	0.005	0.582
	1999/7/16	30	Claro	0	0.28	357	585	8.39	184.28	110.52	27.47	10.18	0	82.8	224.72	4.75	39.4	13.4	13.78	28.6	0.007	0.497
	1999/9/6	30	Claro	0	0.17	338	576	8.42	178.8	104.95	25.68	9.91	0	73	206.15	5.83	41.58	13.5	31.27	29.69	0.0043	0.335
	2000/1/17	29	Claro	0	0.21	354.56	580	8.21	186.3	108.09	28.06	9.24		80.9	227.15	0	49.41	11.7	39.45	23.48	0.012	0.538
	2000/5/26	29	Claro	0	0.35	360.369	607	8.39	182.339	122.88	26.985	13.476		78.2	217.482	2.377	47.989	11.9	47.598	21.948	0.009	0.485
	2000/6/30	30	Claro	0	0.17		600	8.13								0				17.183		
	2000/8/18	30	Claro	0	0.23		618										42.565			20.753		
	2001/1/30	29	Claro	3.2	0.22	350.413	610	8.16	196.212	113.561	26.977	11.218	0.021	75.47	239.231	0	43.555	13.3	35.205	26.469	0.007	0.465
	2001/5/3	29																18.4		22.737		
PP Olof Palme/Managua	2001/9/3	29					599	8.021										13		24.172	0.013	
	2001/10/12																	12		24.716		
	2000/10/9	30	Claro	1	0.19	359.358	602	8.12	186.302	102.948	25.957	9.259	0	78.7	227.148	0	45.4	9.86	53.348	24.546	0.006	0.501
	2002/2/8	30.8	Claro	<LD	0.09		499	8.24														
	2003/7/17	29					625	7.3												24.4		
	2003/7/25	31.9					622	7.34												22.7		
	2003/7/1	30.7	Claro				611	8.2								0				21.9		
	2003/7/9	32.2					596	7.44												26.7		
	2003/5/29	31.4	Claro	<LDM	0.45	381	587	7.35	190.5	139.9	31.9	14.6	<LDM	83.8	232.2	0	47.2	13	34.75	41.1	0.01	0.48
	2003/12/3	30.3																		32.7		
	2004/6/11	29.8					572	7.27												26.208	0.013	
	2004/7/27	30.7					541	7.1												25.336	0.005	
	2004/8/12	29.5					588	7.6												26.102	0.011	
	2004/10/12	29.7					547	7.18												25.853	0.004	
	2005/1/14	29.6	claro	2.0	<LDM	354	675	8.13	188.4	145.8	28.0	18.4	<LDM	74.3	229.7	0.0	44.9	13.5	34.52	26.94	0.014	0.52
	1997/11/14	35	CLARO	0	0.1	239	454	7.68	132.8	48.1	12.3	4.2	0	68.8	162	0	33.6	8.9	21	9.9	0	0.96
	1998/3/6	30	Claro	0	0	374	472	8.41	141	63.41	16.16	5.6	0	78.9	171.94	3.47	31.82	10.2	76.14	44.7	0	0.68
	1999/2/19	28	Claro	1	1.06	230	398	8.02	124.8	101.5	19.9	12.6	0	51.9	152.3	0	25.2	11.8	25.2	6.9	0.03	0.99
	1999/11/16	29	Claro	0	0.08	278.93	427	8.46	128.11	40.81	10.12	3.78		77.7	148.88	3.6	41.6	7.06	36.55	21.22	0.009	0.423
PP Tenderi/Managua	2000/3/15	30	Claro	0	0.33	291.61	450	8.32	144.13	70.65	13.36	9.06	0	89.4	165.96	4.8	40.97	7.14	26.39	13.29	0.012	0.723
	2000/10/27	30	Claro	0	0.32	297.68	443	8.31	126.844	64.207	11.343	8.713	0	76.5	140.155	7.13	36.885	7.21	58.98	14.023	0.01	0.779
	2001/5/23	24	Claro	0	0.32	275.063	456	8.36	130.808	41.621	12.699	2.406		84.3	149.821	4.753	37.19	8.4	33.293	12.723	0.014	0.8
	2003/5/29	32.2	Claro	<LDM	0.97	334	452	7.93	153.5	68	15.6	7.1	<LDM	89.6	149.3	18.6	41.7	8.4	31.25	29	0.01	0.67
	2004/6/17	28.8	Claro	3	0.11	287	497	7.9	134.6	52.4	16	3	<LDM	73.9	143.3	10.2	44.9	7.5	32.94	17.25	0.008	0.72
	1998/1/12	30	Claro	0	0.2	269	472	8	163.3	69.9	21	4.3	0	58.9	199.2	0	33.8	11	33.3	8.4	0.01	0.51
	1998/6/19	30	Claro	0	0.71	322	460	8.26	142.7	79.93	18	8.53	0	68.7	174	0	32.7	12.3	73	23.7	0.03	0
	1999/2/17	30	Claro	0	0.41	285.07	438	8.29	146.11	87.91	20.97	8.64	0	78.5	178.18	0	27.04	11.9	15.11	34.4	0.015	0.83
	1999/3/26	30	Claro	0	0.22	271.13	455	8.19	144.11	64.14	17.12	5.2	0	74.8	175.74	0	33.5	12.6	33.07	7.6	0.025	0.772
	1999/5/18	30	claro	0	0.23	290	498	8.24	180.14	134.1	36.58	10.4	0	53	219.7	0	26.5	14	31.4	9.54	0.002	0.58
	1999/9/6	29	Claro	0	0.54	277	470	8.46	137.98	66.08	17.9	5.19	0	65.4	161.13	3.5	33.66	11.5	28.44	27.79	0.01	0.549
	2000/1/17	29	Claro	0	0.12	308.72	487	8.26	144.68	76.07	20.84	5.83		71.4	176.4	0	52.86	11.7	38.87	19.75	0.015	0.64
	2000/5/26	29	Claro	0	0.21	296.777	508	8.36	142.7	87.205	19.048	9.626		74.7	169.153	2.377	30.993	11.3	47.598	14.908	0.015	0.593
	2000/8/18	29	Claro	0	0.13		528									0	37.615			17.8		
	2001/5/23	22.8	Claro	0	0.1	280.361	504	8.29	127.835	71.35	20.635	4.813	0	73.6	155.862	0	37.19	12.4	34.302	20.058	0.015	0.647
	2001/9/3	29					498	8.253										12		19.775	0.016	
	2001/10/12																	11.6		19.561		
	2000/10/9	30	Claro	0	0.18	312.514	500	8.21	146.664	85.79	22.139	7.407	0	70.1	178.819	0	35.741	10	57.12	21.396	0.01	0.602
PP San Antonio/Managua	2002/7/23	22.1	Claro	<LDM	<LDM	288.625	526	8.096	178.3559	146.9891	41.0481	10.8022		52.8	217.4595	0	30.0903	15.56	25.802	5.505	<LDM	
	2002/2/8	29.9	Claro	<LD	0.1		600	7.56														
	2003/7/16	31.1					523	7.73												18.9		
	2003/7/25	30.8					518	7.6												19.2		
	2003/7/1	32.9	Claro				498	8.39								0				19.2		
	2003/7/9	32.3					598	7.42												21.4		
	2003/5/29	31.3	Claro	<LDM	0.86	316	477	7.19	151.6	101.1	22.6	10.9	<LDM	76	184.8	0	38	12.5	32.55	31.8	0.012	0.55
	2003/12/3	30.2																		28.4		
	2004/4/23	30.2	Claro	<LDM	<LDM	289	527	7.36	140.3	82.5	19	8.5	<LDM	68.4	158.5	6.2	33.8	12	34.06	22.33	0.007	0.61
	2004/6/11	29.6					471	7.3												22.786	0.015	
	2004/7/27	30.3					455	7.27												22.104	0.01	
	2004/8/12	29.8					482	7.79												22.909	0.011	
	2004/10/12	29.5					448	7.24												22.498	0.006	
	2005/1/14	29.6	Claro	0.0	< LDM	295	547	8.25	141.3	102.7	19.7	13.0	<LDM	67.2	172.3	0.0	39.2	13.0	34.58	22.92	0.012	0.64

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

EMPRESA NICARAGÜENSE DE ACUEDUCTOS Y ALCANTARILLADOS SANITARIOS (ENACAL)

THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN MANAGUA IN THE REPUBLIC OF NICARAGUA

FINAL REPORT

Supporting Report No. 3
Evaluation of Water Sources

DECEMBER 2005

NIHON SUIDO CONSULTANTS CO., LTD.
ASIA AIR SURVEY CO., LTD.

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ANNEXES

3.1 OBJECTIVES OF EVALUATION OF WATER SOURCES

Water sources managed by ENACAL for Managua City currently consist of 116 wells and Lake Asososca. Most of these sources have been used for long years, and the facilities located at these sources have been deteriorated. The main objective of the assessment is to evaluate the current and future production capacity of each source and to estimate the volume of water that can continuously be produced until 2015. This also includes the setting out of the scope and timings of the maintenance, rehabilitation and renewal works of existing sources, as well as of the long-term monitoring program required for sustaining the estimated future production capacity.

3.2 SUMMARY OF THE EVALUATION RESULTS

Water sources managed by ENACAL and used to supply water to Managua City are 116 wells and Asososca Lake. Six wells (**Table 3.3.1(a)**) are supplying water to Sandino City and three wells (No.60, 95,117) were not the subject of this evaluation. In addition, four wells in Ticuantepe and Nindiri are considered in this study (**Table 3.3.1(c)**). An inventory of the wells is provided in **Annex 3A**. Their locations are shown in **Figure 3.3.1**.

The total volume of production in 1993 was about 100.8 million m^3 (276,000 m^3/day). The volume in 2003, however, increased to 143.6 million m^3 (397,700 m^3/day), 44% more than that of 1993. ENACAL estimates the production volume from each well by two methods.

- Measurement with a flow meter (Method A)
- Estimate with capacity of pumps and their working hours (Method B): this method is applied to wells that are not equipped with a flow meter.

Water flow estimated by the Method B was found to be larger than that of the result of measurement by Method A by 5%. Therefore, the results of Method B estimation were adjusted by a parameter of 100/105.

(1) Evaluation of Wells

a) Evaluation of Wells Based on Variation of Groundwater Level

Total 76 wells have been monitored of their water flow for more than 3 years. As the results of calculating dynamic water level by eliminating the effect of pumping volume and analyzing the type of variation in water level, the following things become clear.

- Water level of the wells varies seasonally. The range of the variation is from a few meters to over ten meters.
- It is possible that the water level of each well is affected by the amount of rainfall occurred within 1 – 2 years. Further, the variation of dynamic water level is large and may reach 30m.

These observations can be supported by the rise in water level observed in 10 - 15 wells in Managua City after Hurricane Mitch (Oct 1998). Although limited to the wells having sufficient data, it was observed that variation in water level occurs 1-2 years after the rainfall. It was estimated from this fact that the lowering in water level observed in some of the existing wells between 2000 and 2003 was caused by the effect of rainfall rather than by the aging of the wells. Therefore, as the results of analyzing water level variation in which the time required for ground water recharge is considered, it is concluded that all the wells evaluated are in good condition except for the 23 wells for which sufficient data for analysis do not exist. Also, as for Managua Uno and Managua Dos, the well condition is considered to be good judging from the restored water level when pumping is stopped.

b) Evaluation of Sustainability of Asososca Lake as a Water Source

Past data indicate that when the extraction volume from Asososca Lake was in the range from 30,000 to 40,000 m^3/day, the water level of the lake was stable. As described before, lowering of the water level at Asososca Lake increases the risk of intrusion of contaminated groundwater into the lake from the industrial zone. Therefore, in this study, it is estimated that the sustainable extraction volume from Asososca Lake is 30,000m^3/day for a certain period after a drought year. Incidentally, the Hurricane Mitch (October 1998) case indicated that it would take 4 to 15 months before rainwater can infiltrate into each aquifer and give some effect on the water level of the lake. And also that time lag between the rainfall and the raise of water level is approximately one year.

As discussed in the above, Asososca Lake is considered to be a sustainable water source both in terms of water level and quality if the extraction volume is kept at 30,000m^3/day for a period that is one year after the period of low annual precipitation. Since this standard is for the period after a drought year, larger volume of extraction is possible for a period, which is one year after normal or high annual precipitation. But if extraction volume is increased, actual volume should be determined by analyzing the result of the monitoring of both water level and quality.

c) Evaluation of Wells from the Point of View of Corrosion of Facilities

Three types of metal plates (iron, cast iron and stainless steel) were placed for 2 months in the water in the 4 wells. The result of this corrosion test was as follows:

- In ordinary ground water, corrosion or oxidation rarely happens
- Oxidation tends to occur in the water of Well E-4 and JICA-1 of Managua Uno group
- Temperature of water of Managua Dos P-6 was high compared to other wells in the same area.
- Stainless steel resists corrosion and oxidation regardless of the type of water in this region, for high temperature wells, high temperature resistant material must be used in pump materials.

(2) Estimation of Future Water Supply Capacity of Each Water Source

Since no big problems are found, at least for now, on the sustainability of existing water sources, the average volume of supply for the last four years (2000 to 2004) was used as the volume of the supply in the future. Supply from the existing sources in 2015 is estimated to be 402,000 m^3/day.

(3) Replacement and Relocation of Existing Wells

a) Well Relocation Plan

Eleven wells with water quality problem and the decrease of water supply from Asososca Lake for control water level will be replaced by new wells for Zona Alta Superior located south of San Judas where the most severe water shortage is happening. In addition, wells in Esquipulas/Veracruz/Las Jaguitas area can be developed.

b) Well Renewal Plan

Existing wells supplying tap water for Managua City have been used for long time after construction and some of them are expected to become difficult to use due to aging in 2015.

Therefore, it is proposed that 18 wells need to be renewed.

c) Replacement of Pumps

Most of the pumps being used in existing wells are old and not working at their optimum capacity. Level of urgency for replacement was classified according to the length of their use and replacement schedule was proposed. Total 58 pumps were identified as the pumps necessary to be replaced.

(4) Maintenance Plan of Existing and New Wells

The principle of water source management is to have the correct information on the current situation of ground water and pumping facilities and also to take every necessary measure to keep the equipment and machines functioning properly.

The following points are important for the management of ground water.

- Periodical monitoring of extraction volume, ground water level and water quality.
- Evaluation of the capacity of wells by comparing present data with past data and analyzing water levels by taking rain falls into consideration.

For the maintenance of equipment and machines the following points are important.

- Periodical renewal of wells (Once every 30 years)
- Overhaul of pumps (once every 10 years) and replacement (once every 20 years)

(5) Monitoring Plan for Water Source Management (Volume, Water Level, Water Quality and Corrosion)

It is proposed to conduct long term monitoring of extraction, water level and water quality in order to use water sources for long period in good conditions.

Table 3.2.1 Scope of the Monitoring Plan

Item	Contents	Target	Frequency
Volume of Production	Records of operating of wells	All wells Asososca Lake	Every Day
Water level	Manual measurement	All wells	Each 3 Month
	Measure of water level	Asososca Lake	Every Day
	Recorder Type Water Level Gauge（with pressure gauge）	Shown in **Table 3.7.2**	Constantly （one day）
Water Quality	Basic Parameters such as pH, EC, etc.	All wells Asososca Lake	Every Year
	Normal Parameters such as Major Ions, Heavy Metals, etc.	All wells Asososca Lake	Every 2 – 3 Years
	Advance Parameters such as Pesticides, Chlorination by-products, etc	Major 20 wells Asososca Lake	Every 5 Years
Corrosion	Weight of test pieces	Shown in **Table 3.3.9**	March/2005 June/2005