2.8 Environmental Aspects

2.8.1 Air Pollution

1) NO_2

Following tables and figures are the analytical results of NO_2 concentration sampled at every monitoring point of location category A, B, C and D in Managua City.

Table 2.8.1 NO_2 Concentration in Managua, 1998

A

Location Category A	NO_2 (ppb) Sun.	Mon.	Tues.	Average
A1	23	23	26	24.00
A2	11	18	17	15.33
A3	22	30	31	27.67
A4	16	20	21	19.00
A5	18	32	30	26.67
A6	8	12	13	11.00
A7	16	17	22	18.33
A8	24	35	43	34.00
A9	29	36	37	34.00
A10	14	17	18	16.33
Average	18.10	24.00	25.80	22.63

B

Location Category B	NO_2 (ppb) Sun.	Mon.	Tues.	Average
B1*	-	22	24	23.00
B2	-	12	11	11.50
B3	10	6	10	8.67
B4	19	23	23	21.67
B5	-	16	-	16.00
B6	8	10	10	9.33
B7	20	15	21	18.67
B8*	-	21	24	22.50
B9	11	15	12	12.67
B10	-	7	9	8.00
Average	13.60	14.70	16.00	15.20

C

Location Category C	NO_2 (ppb) Sun.	Mon.	Tues.	Average
C1	11	13	18	14.00
C2	12	15	22	16.33
C3	1	3	5	3.00
C4	2	3	6	3.67
C5	6	9	15	10.00
C6	8	8	12	9.33
Average	6.67	8.50	13.00	9.39

D

Location Category D	NO_2 (ppb) Sun.	Mon.	Tues.	Average
D1	8	13	17	12.67
D2	14	15	14	14.33
D3	5	3	8	5.33
D4	8	21	16	15.00
D5*	5	8	10	7.67
-				
Average	8.00	12.00	13.00	11.00

Notes: 1) 24-hour exposure for 3 days from Feb. 8 to 10 (* Feb. 15 to 17), 1998
2) Category A: Congested roadside in the central area
B: Along arterial road
C: Along secondary road
D: Residential area in the outskirts

As shown in Figure 2.8.1, the average of the concentration of NO_2 at each sampling point was less than 80 ppb (parts per billion [volume/volume], 80 ppb = 150 $\mu g/m^3$ at 27° C, one atm.) of the daily standard recommended by the WHO (World Health Organization). The highest concentration was observed at A8 (Victoria Brewery, 1 block East, North Road) and A9 (Gancho de Camino, in front of Police Station), and the lowest at C3 (Las Colinas entrance, 100 mt West). It is identified that there is apparently a reduction trend of the concentration as category shifts from A to D.

Daily fluctuation of the average NO_2 concentration monitored at each category shows an increase trend from Sunday to Tuesday at all sampling points as shown in Figure 2.8.2.

Based on the above, it is considered that the concentration of NO_2 is influenced by vehicle exhaust gases in the City.

Figure 2.8.1
NO_2 Concentration

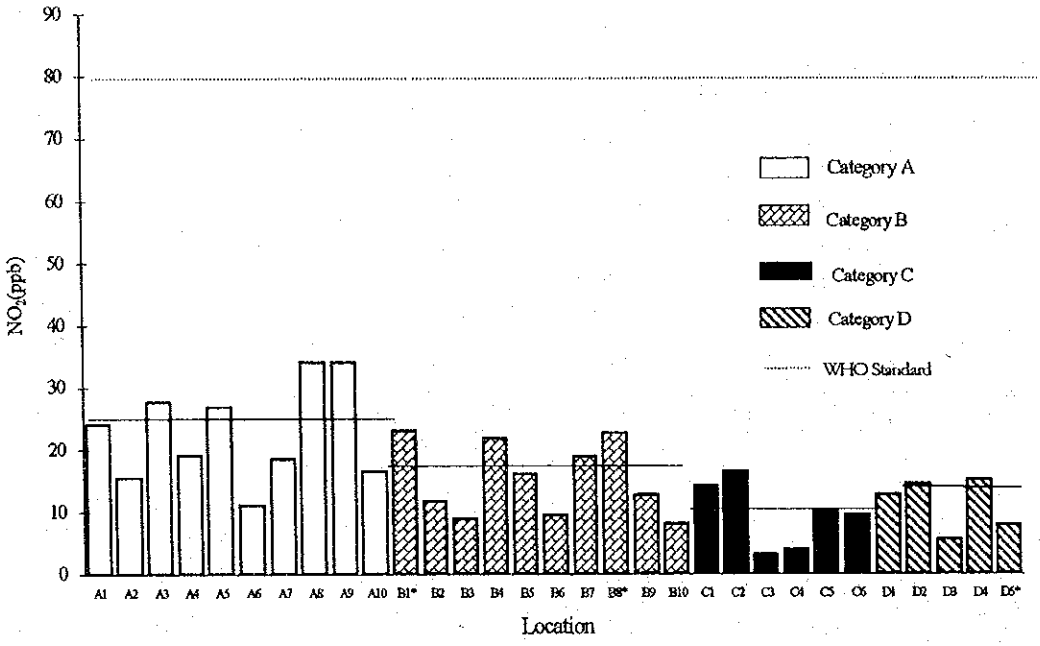
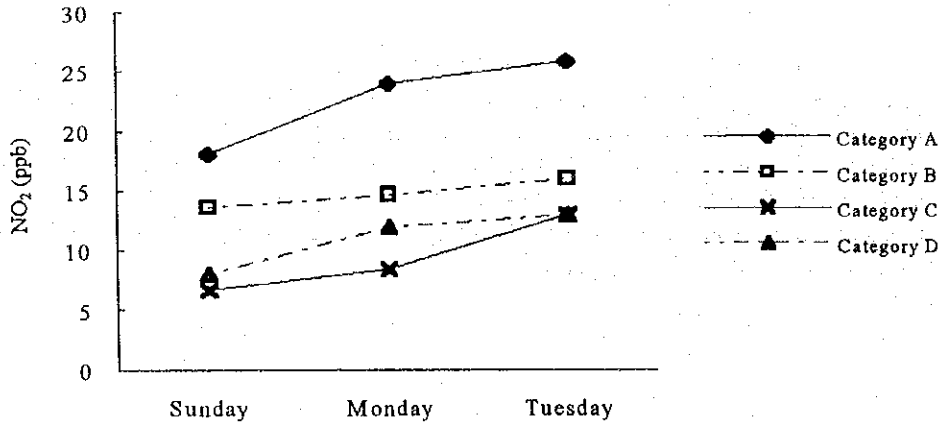


Figure 2.8.2
Trend of NO_2 Concentration from Sunday to Tuesday



2) NO_x

Following tables and figures are the analytical results of NO_x concentration sampled at every monitoring point of Category A, B, C and D in Managua City.

Table 2.8.2 NO_x Concentration in Managua, 1998

A		B	
Location Category A	NO_x (ppb)	Location Category B	NO_x (ppb)
A1	75	B1*	52
A2	33	B2	19
A3	74	B3	9
A4	38	B4	64
A5	58	B5	-
A6	28	B6	13
A7	61	B7	-
A8	111	B8*	35
A9	97	B9	38
A10	63	B10	29
Average	63.80	Average	32.38

C		D	
Location Category C	NO_x (ppb)	Location Category D	NO_x (ppb)
C1	33	D1	28
C2	52	D2	20
C3	6	D3	8
C4	7	D4	26
C5	21	D5*	21
C6	38	-	
Average	26.17	Average	20.60

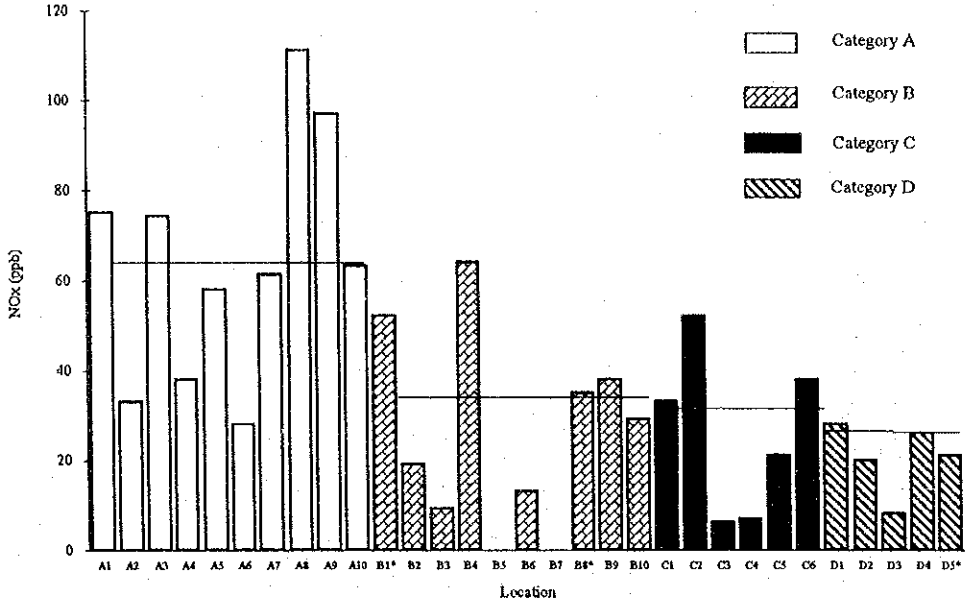
Note: 72hours exposure from 8th to 10th (*from 15th to 17th) Feb. 1998

As shown in Figure 2.8.2, the fluctuation of NO_x concentration shows almost the same trends of NO_2 shown in Figure 2.8.1. The highest concentration was observed at A8 (Victoria Brewer, 1 block East, North Road), and the lowest at C3 (Las Colinas entrance, 100 m West). There is apparently a reduction trend of the concentration as category shifts from A to D.

As NO_x mainly consists of NO and NO_2, it can be predicted that daily fluctuation of the NO_x concentration shows an increasing trend from Sunday to Tuesday at all sampling points as in the case of NO_2.

NO_x is considerated to be also influenced by vehicle exhaust gases in the City.

Figure 2.8.3
NO_x Concentration



3) SO_2

Following tables and figures are the analytical results of SO_2 concentration sampled at every monitoring point in Category A, B, C and D of Managua City.

Table 2.8.3 SO_2 Concentration in Managua, 1998

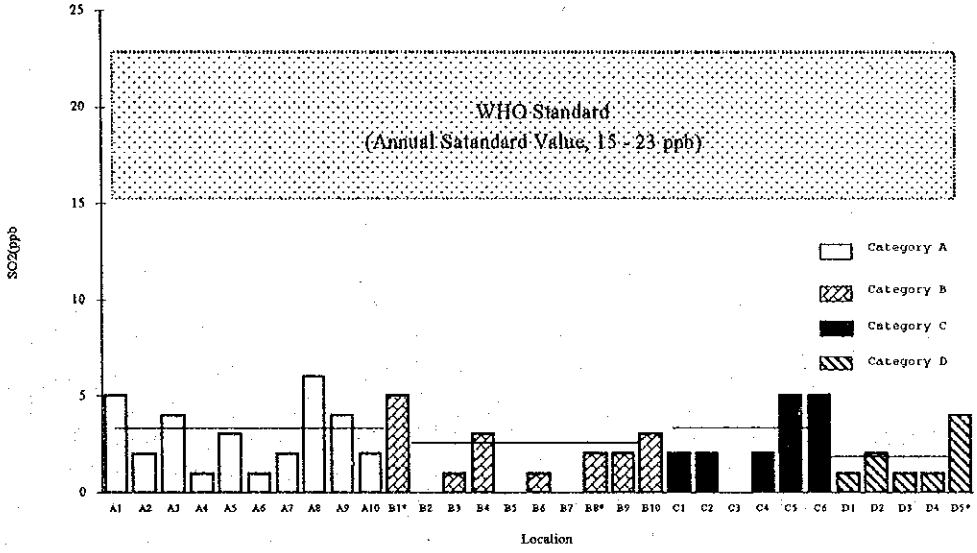
A		B	
Location Category A	SO_2 (ppb)	Location Category B	SO_2 (ppb)
A1	5	B1*	5
A2	2	B2	-
A3	4	B3	1
A4	1	B4	3
A5	3	B5	-
A6	1	B6	1
A7	2	B7	-
A8	6	B8*	2
A9	4	B9	2
A10	2	B10	3
Average	3.00	Average	2.43

A		B	
Location Category C	SO_2 (ppb)	Location Category D	SO_2 (ppb)
C1	2	D1	1
C2	2	D2	2
C3	0	D3	1
C4	2	D4	1
C5	5	D5*	4
C6	5	-	
Average	2.67	Average	1.80

Note: 72hours exposure from 8th to 10th (*from 15th to 17th) Feb. 1998

As shown in Figure 2.8.4, the three-day average of the concentration of SO_2 at all sampling points is below the annual standard of 15 – 23 ppb (40 - 60 μg/m^3 at 27° C, one atm.) recommended by the WHO. The highest concentration is observed at A8 (Victoria Brewery, 1 block East, North Road), and the lowest at C3 (Las Colinas entrance, 100 m West). There is also a reduction trend of the concentration as category shifts from A to D.

Figure 2.8.4
SO_2 Concentration in Managua, 1998



4) SPM

The result of SPM measurement can be summarized as shown in Table 2.8.4 and Figure 2.8.5. In this table, some data were rectified due to the individual characteristics of SPM count meter used in the survey.

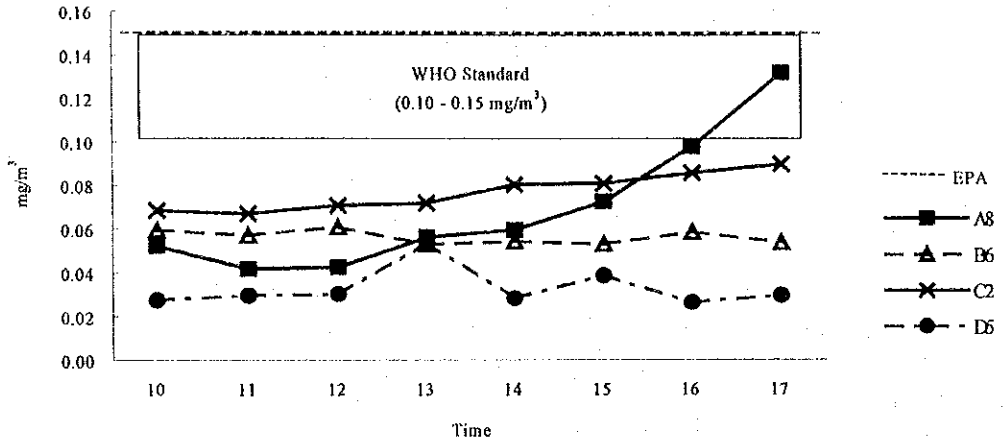
Table 2.8.4
SPM in Managua, 1998

Time	Location (No.)			
	Enabas (A8)	Tenderi (B6)	M. Gutiérrez (C2)	Las Colinas (D5)
10	0.05	0.06*	0.07*	0.03
11	0.04	0.06*	0.07*	0.03
12	0.04	0.06*	0.07*	0.03
13	0.06	0.05*	0.07*	0.05
14	0.06	0.05*	0.08*	0.03
15	0.07	0.05*	0.08*	0.04
16	0.10	0.06*	0.09*	0.03
17	0.13	0.05*	0.09*	0.03
Average	0.07	0.06*	0.08*	0.03

*Note: Due to equipment characteristics, some rectification was made on these data.

SPM measurements were carried out with a timing of two times for two minutes in every 15 minutes of each hour during 10:00 to 17:00 from 8th to 10th Feb. 1998 at location of A8 and B6, and from 15th to 17th Feb. 1998 at location of C2 and D5. Each SPM figure of every hour from 10:00 to 17:00 shown in Table 2.8.4 is the three days average.

Figure 2.8.5
SPM Concentration in Managua, 1998



Daily average of the concentration of SPM at four sampling points was less than the daily (24 hours) standard value of 0.15 mg/ m^3 as PM_{10} (Particulate Matter less than 10μm of its diameter) regulated by U.S. EPA (Environmental Protection Agency of the United States of America), and also the daily (24hours) standard value of 0.1 - 0.15 mg/ m^3 as BS (Black Smoke) recommended by the WHO, except location A8 (Enabas) from 16:00 - 17:00 as three-day average value. However, these exceptions are still within the annual standard of WHO. The highest concentration was observed at A8 (Enabas), and the lowest was D5 (Las Colinas). It was observed that there is an increasing trend of the concentration from 10:00 to 17:00.

The SPM average concentration of C2 (M. Gutiérrez) is higher than that of A8 (Enabas) for most of the time. The reason of this result, besides the vehicle traffic influences, is the dust and particulate matters from the dried-up land surface located near C2.

In addition, open burning of solid waste or domestic waste has been seen often in Managua City. It is considered that this situation may contribute to the increase of the concentration of SPM.

5) Review of ProEco Project Report

The Ecological Program for Central America (ProEco: *Proyecto Ecológico para Centro América*), which is an environmental program in Central America, is executing a monitoring project for air quality in Managua City based on the cooperative agreement signed in 1995 between Engineering University of Nicaragua (UNI: *Universidad Nacional de Ingeniería de Nicaragua*) and the ProEco. Under the agreement, an air pollution monitoring survey called as "Clean Air Project (*Proyecto Aire Puro*)" have been started since March of 1996 for a period of three years. And seven different sampling locations in the City were selected for monitoring air pollutants including NO_2, PM_{10}, O_3, Pb (Atmosphere Lead) and so on. The Annual Report of ProEco gives the monitoring results. It summarizes the analytical results of NO_2, O_3, rain pH, Pb, PM_{10} and Dusts as follows:

1. NO_2

The average concentration of NO_2 during the monitoring in 1996 shows an irregular reaction. The highest concentration of NO_2 was observed in October (64μg/m^3) and the lowest in July (29μg/m^3). The sampling station at MARENA showed the lowest concentration (17μg/m^3) and UNI showed the highest (58μg/m^3). The annual average was 40μg/m^3 at all seven stations in 1996. It is important that even though the monthly average showed a fluctuation, NO_2 concentration level surveyed did not reach its limit (100μg/m^3) as the annual average predicted by ProEco.

2. O_3

The highest concentration of O_3 was shown in December (125μg/m^3) and the lowest in July (42μg/m^3). The sampling station located at MARENA showed, as an annual average, the lowest concentration (73μg/m^3) and *Villa Libertad* showed the highest concentration (97μg/m^3). The annual average of O_3 monitored in Managua in 1996 was 88μg/m^3, which was higher than the limit (60μg/m^3) predicted by ProEco.

3. **Rain acidity**

The rain acidity depends largely on the rainy season. June 1996 showed the average value closest to pH7 (pH6.6) and October showed the most acid average value (pH3.8).

4. **Pb**

The average concentrations of Pb (atmosphere lead) in 1996 were under the limit value (1.0μg/m^3) predicted by ProEco. During the month of June, these contaminants were not detected in the samples analyzed. This situation is explained by the accomplishment of not using *Tetraethyl Lead (TEL)* in the local oil refineries since 1996.

At the same time of the survey on the atmospheric Lead by Clean Air Project, the Nicaraguan Institute of Energy (INE) is carrying out an analysis to determine whether lead is added in the gasoline sold in Nicaragua or not at present. The results, until now, show that the lead levels in the gasoline are found under the permissible limit.

5. PM_{10}

The average of PM_{10} (Particulate Matter less than 10μm of its diameter) concentration shows a regular comportment except June and December. The highest concentration showed in June (89μg/m^3) and the lowest in October (55μg/m^3). October is the highest pluvial precipitation month of the raining season, which allows a constant cleansing of the atmosphere and a lower possibility to capture particles during the samplings.

The station which showed the lowest concentration was *Villa Libertad* (44μg/m^3), and the highest was UNI and *Siete Sur* with a similar value (81μg/m^3). The concentration values observed at UNI and *Siete Sur* could be justified by the higher traffic volume seen in both places. The average contaminant was 66μg/m^3 which was higher than the limit (50μg/m^3) predicted by ProEco as an annual arithmetical average.

6. **Dusts**

In 1996 the average concentration of dusts showed an irregular comportment; its highest concentration in May (0.72g/m^2/d) and the lowest in October (0.25g/m^2/d).

Sampling station at MARENA showed the lowest concentration of dusts (0.180g/m^2/d) and the station at *Gancho de Caminos* the highest concentration (0.853g/m^2/d). The results at *Gancho de Caminos* are explained by the fact that this station is located in a very high traffic zone and at the entrance of the biggest market of the capital (Approximately 20 ha.).

According to the German standards, the limit permissible value for dusts is 0.65g/m^2/d, as annual arithmetical average. The annual average of dusts was 0.42g/m^2/d but in the 60% of the sampling done at *Gancho de Caminos* (5 of 8 monthly sampling) the limit value was exceeded.

Table 2.8.5
Summary of Air Pollution Survey Results (1)
Proyecto Aire Puro by ProEco, 1996

Location	NO_2 (μg/m^3)	O_3 (μg/m^3)	Rain Acidity (pH)	Pb (μg/m^3)
1. MARENA	17	73	3.8	N/D
2. SUBASTA	31	93	N/D	N/D
3. UNI	58	85	N/D	N/D
4. CENTROAMERICA	50	87	3.9	□0.72
5. VILLA LIBERTAD	24	97	5.9	N/D
6. G. DE CAMINO	54	90	6.6	□0.72
7. 7SUR	49	91	N/D	N/D
Minimum	17	73	3.8	□0.70
Maximum	58	97	6.6	□0.80
Average/year 1996	40	88	5.1	□0.72

Note:
- NO_2 : Average of monthly data from March to December 1996
- O_3 : Average of monthly data from July to December 1996
- Rain pH : Average of monthly data from June to November 1996
- Pb : Average of monthly data from July to November 1996

Data Source: *"MONITOREO DE LA CALIDAD DEL AIRE DE LA CIUDAD DE MANAGUA, INFOME ANUAL 1996"*, February 1997, Proyecto Aire Puro, ProEco (Table arranged by JICA Study Team)

Table 2.8.6
Summary of Air Pollution Survey Results (2)
Proyecto Aire Puro by ProEco, 1996

Locations	PM_{10} (μg/m^3) Min.	Max.	Ave.'96	Dust (g/m^3) Min.	Max.	Ave.'96
1. MARENA	9	138	51	0.062	0.607	0.180
2. SUBASTA	34	139	73	N/D	N/D	N/D
3. UNI	43	122	81	N/D	N/D	N/D
4. CENTROAMERICA	44	90	68	0.182	0.580	0.364
5. VILLA LIBERTAD	23	75	44	0.209	0.486	0.308
6. G. DE CAMINO	53	131	69	0.450	1.590	0.853
7. 7 SUR	29	147	81	N/D	N/D	N/D
Minimum	9	90	44	0.062	0.580	0.185
Maximum	53	147	81	0.450	1.590	0.853
Average/year 1996	-	-	66	-	-	0.426

Note:
- PM_{10} : Observation monthly data from June to December 1996.
- Dust : Observation monthly data from May to December 1996.

Data Source: *"MONITOREO DE LA CALIDAD DEL AIRE DE LA CIUDAD DE MANAGUA, INFOME ANUAL 1996"*, February 1997, Proyecto Aire Puro, ProEco (Table arranged by JICA Study Team)

2.8.2 Noise Level

In the noise level survey for the Study, survey time was divided into three time zones; morning (10:00-12:00), daytime (12:00-15:00) and evening (15:00-18:00). The survey results are summarized as follows:

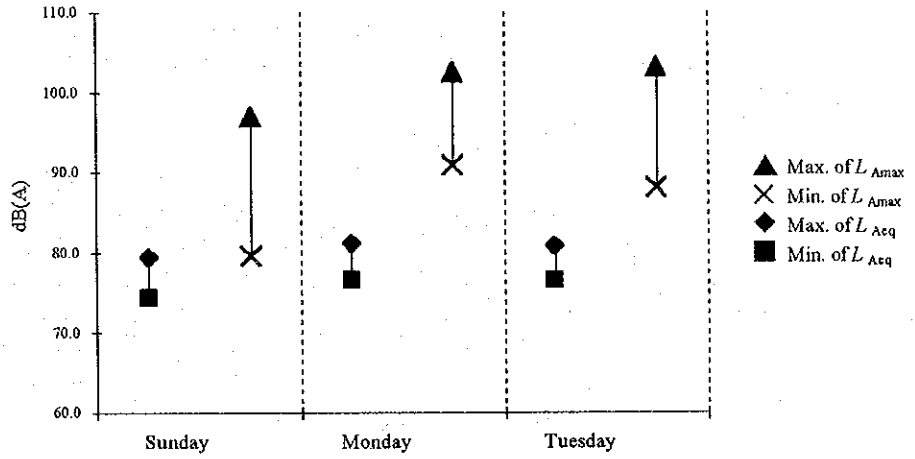
1) Location: **Enabas (A8)** [Traffic Congested Area along a Six-lane Main Road]

Noise level at A8 is quite high with heavy traffic volume. The sound level over 80 dB(A) at L_{Aeq} and over 100 dB(A) at L_{Amax} was observed frequently during the survey.

Table 2.8.7
Noise Level (A8) dB(A)

Location (No.)		Enabas (A8) (Traffic Congested Area along a Six-lane Main Road)					
Date		8th Feb. 1998 (Sun.)		9th Feb. 1998 (Mon.)		10th Feb. 1998 (Tue.)	
Level		L_{Aeq}	L_{Amax}	L_{Aeq}	L_{Amax}	L_{Aeq}	L_{Amax}
Morning	10:00-12:00	76.0	95.4	78.1 - 81.0	98.1 - 104.6	77.8 - 78.0	92.9 - 96.5
Daytime	12:00-15:00	76.5 - 79.4	79.6 - 96.9	76.5	90.9	76.5 - 80.8	88.1 - 103.0
Evening	15:00-18:00	74.3	89.5	79.9 - 81.1	99.2 - 102.4	76.9 - 78.2	88.1 - 93.3

Figure 2.8.6
Maximum and Minimum of Noise Level at Location A8



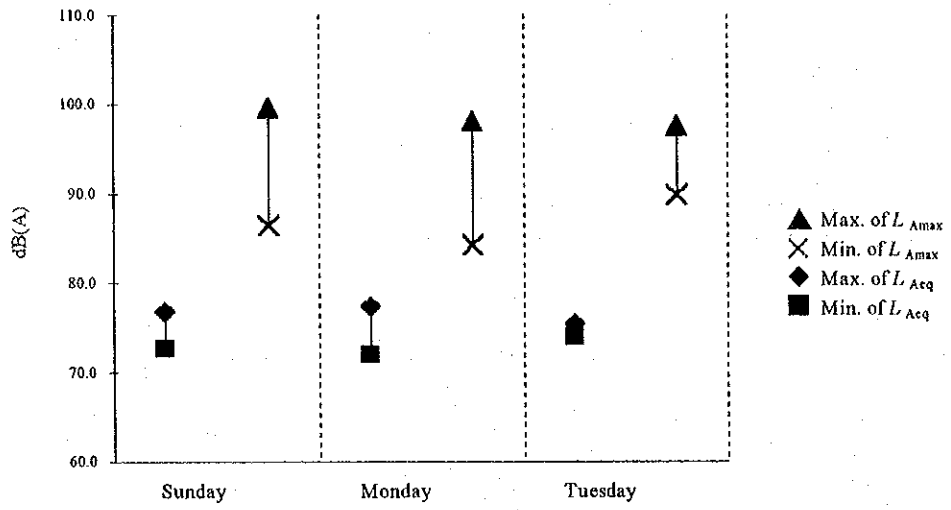
2) Location: **Tenderí (B6)** [Along a four-lane Road near Market and Commercial Area]

The noise level of survey location at B6 near market and commercial area is very high. The sound level from 72.6 dB(A) to 75.4 dB(A) at L_{Aeq} and from 86.4 dB(A) to 99.5 dB(A) at L_{Amax} was observed during the survey.

Table 2.8.8
Noise Level (B6) dB(A)

Location (No.)		Tenderí (B6) (Along a four-lane Road near Market and Commercial Area)					
Date		8th Feb. 1998 (Sun.)		9th Feb. 1998 (Mon.)		10th Feb. 1998 (Tues.)	
Level		L_{Aeq}	L_{Amax}	L_{Aeq}	L_{Amax}	L_{Aeq}	L_{Amax}
Morning	10:00-12:00	73.8 - 76.8	86.4 - 93.8	77.3	98.0	75.4	93.7
Daytime	12:00-15:00	73.4 - 74.5	93.2 - 99.5	71.9 - 73.9	84.1 - 91.6	74.0 - 74.8	91.2 - 97.4
Evening	15:00-18:00	72.6	90.9	76.9	96.2	73.9 - 75.1	89.7 - 91.7

Figure 2.8.7
Maximum and Minimum of Noise Level at Location B6



3) Location: **M. Gutiérrez (C2)** [Residential Area with Relatively High Traffic Volume]

Noise level of survey location at C2 is very high depending on time of the day. The sound level from 67.1 dB(A) to 76.9 dB(A) at L_{Aeq} and from 88.2 dB (A) to 101.5 dB(A) at L_{Amax} was observed during the survey.

Table 2.8.9
Noise Level (C2)-a dB(A)

Location (No.)		M. Gutiérrez (C2) [Residential Area with Relatively High Traffic Volume]					
Date		8th Feb. 1998 (Sun.)		9th Feb. 1998 (Mon.)		10th Feb. 1998 (Tues.)	
Level		L_{Aeq}	L_{Amax}	L_{Aeq}	L_{Amax}	L_{Aeq}	L_{Amax}
Morning	10:00-12:00	67.1	92.8	74.9	92.3	75.1 - 76.9	96.1 - 98.8
Daytime	12:00-15:00	71.7	91.0	73.6 - 73.6	89.7 - 92.8	72.6 - 74.0	89.5 - 89.5
Evening	15:00-18:00	70.6 - 74.0	94.4 - 97.1	72.6 - 75.0	88.0 - 94.4	75.2 - 79.6	95.2 - 101.5

Figure 2.8.8
Maximum and Minimum of Noise Level at Location C2- a

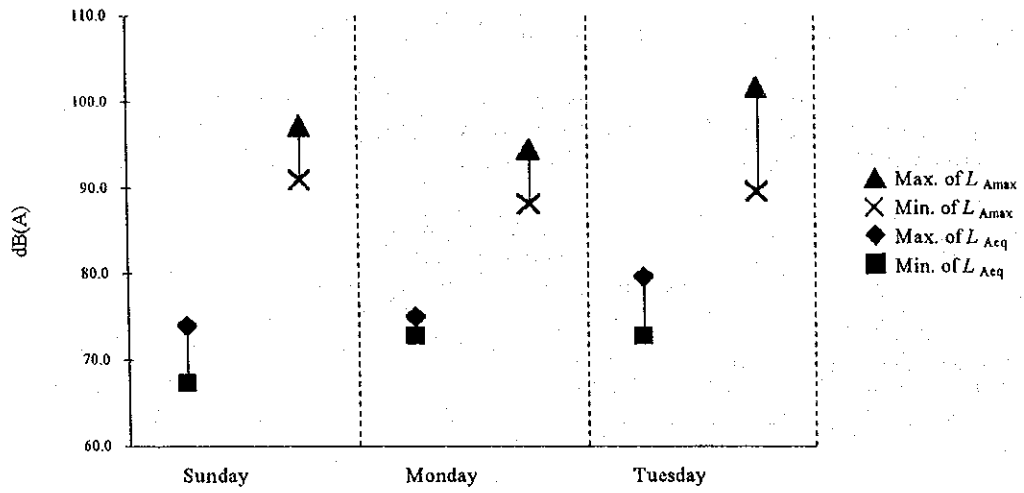
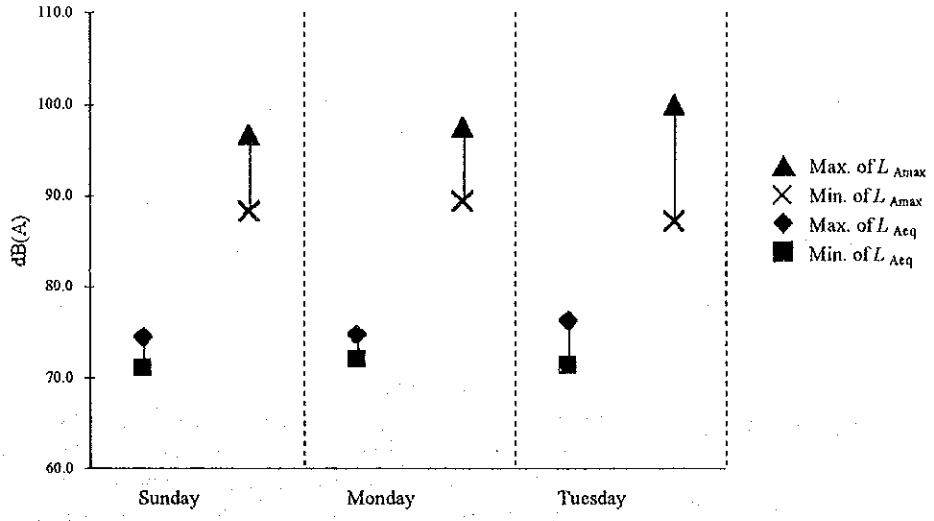


Table 2.8.10
Noise Level (C2)-b dB(A)

Location (No.)		M. Gutiérrez (C2) [Residential Area with Relatively High Traffic Volume]					
Date		15th Feb. 1998 (Sun)		16th Feb. 1998 (Mon)		17th Feb. 1998 (Tus)	
Level		L_{Aeq}	L_{Amax}	L_{Aeq}	L_{Amax}	L_{Aeq}	L_{Amax}
Morning	10:00-12:00	72.7	90.2	72.9 - 73.0	92.1 - 92.7	71.4 - 72.7	87.1 - 93.0
Daytime	12:00-15:00	71.8 - 73.4	89.1 - 95.5	72.0 - 74.4	89.3 - 97.3	73.0 - 74.4	90.4 - 97.5
Evening	15:00-18:00	71.1 - 74.5	88.2 - 96.6	72.2 - 74.7	90.4 - 93.0	72.1 - 76.2	89.6 - 99.8

Figure 2.8.9
Maximum and Minimum of Noise Level at Location C2- b



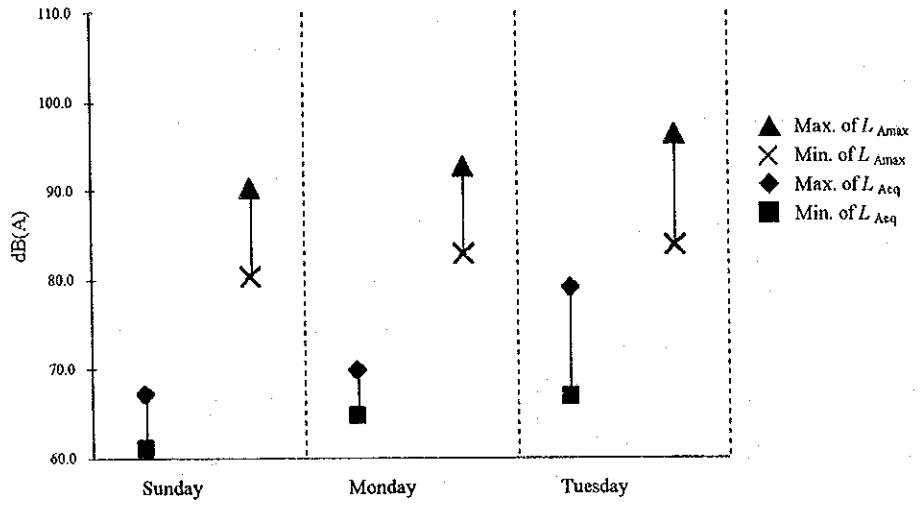
4) Location: **Las Colinas (D5)** [High Class Residential Area with Interlocking Pavement Road]

Noise level of survey location at D5 can be evaluated as not so critical. The sound level from 61.0 dB(A) to 79.1dB(A) at L_{Aeq} and from 80.3 dB(A) to 96.3 dB(A) at L_{Amax} was observed during the survey. The peak levels such as 79.1 at L_{Aeq} and 96.3 dB(A) at L_{Amax} were sometimes observed in this location and the sound source was from off-road type motorcycles and vehicles not well maintained (specially muffler device).

Table 2.8.11
Noise Level (D5) dB(A)

Location (No.)		Las Colinas (D5) [High class Residential Area with Interlocking Pavement Road]					
Date		15th Feb. 1998 (Sun)		16th Feb. 1998 (Mon)		17th Feb. 1998 (Tus)	
Level		L_{Aeq}	L_{Amax}	L_{Aeq}	L_{Amax}	L_{Aeq}	L_{Amax}
Morning	10:00-12:00	62.9 - 65.4	80.3 - 87.1	64.6 - 68.2	82.8 - 89.5	67.0 - 68.2	83.8 - 90.1
Daytime	12:00-15:00	63.6 - 67.1	82.6 - 90.2	67.7 - 69.8	87.1 - 92.6	67.2 - 79.1	84.6 - 90.0
Evening	15:00-18:00	61.0 - 62.8	82.2 - 85.5	67.3 - 68.7	86.4 - 88.2	66.7 - 70.4	84.5 - 96.3

Figure 2.8.10
Maximum and Minimum of Noise Level at Location D5



Through the field survey, it can be said that most of these sound sources at locations of A8, B6 and C2 are gasoline or diesel engines, exhaust system without any muffler devices or out of order, and horns of old and reconditioned cars, buses, trucks and motorcycles. The sources at location D5 are relatively new cars, taxis, 4WD type vehicles and motorcycles with less traffic volume of heavy vehicles like trucks. However, interlocking pavement itself has a potential for arising noise and vibration by vehicle traffic.

Table 2.8.12 shows road traffic noise regulations in different countries, which was presented and prepared by *Dr. Dieter Gottlob*, Federal Environmental Agency, Federal Republic of Germany at "*Inter-Noise 94*" held in Yokohama of Japan, 1994. According to *Dr. D. Gottlob*, L_{Aeq} is the preferred noise index when assessing road traffic noise. In some countries, the percentile level L_{10} or L_{50} are applied. For roads with dense traffic, L_{10} is about 3 dB(A) higher, L_{50} about 1 to 2 dB(A) lower than L_{Aeq} (*Gottlob, 1994*).

By an arithmetical calculation of daytime noise values regulated by different countries shown in Table 2.8.12, approximately 60 dB(A) at L_{Aeq} is given as an average of daytime noise values. The results of the field survey in Managua indicate that the noise level is always over 60 dB(A) at L_{Aeq} as shown in Figure 2.8.7 to Figure 2.8.10.

Table 2.8.12
Road Traffic Noise Regulations in Different Countries, Emission Values for Residential Areas in dB (A)

Country	Noise index	Type of immission values	Day-time	Rest-periods	Night-time
Australia	L_{10},18h	Target values for new roads	60		55
		Reduct. measures at existing roads	65		
Austria	L_{Aeq}	Planning values for new roads	50 - 55		40 - 45
		Remedial measures at federal roads	65		
Canada	L_{Aeq}	Target values for new residential areas	55		50
Denmark	L_{Aeq}, 24h	Target values for new residential areas	55		
France	L_{Aeq}	Limiting values for noise reduction programmes	60		
Germany	$L_r = L_{Aeq} + K$ K = 0...3 dB (A) at traffic lights	Planning values for new residential areas	50 - 55		40 - 45
		Limiting values for new and considerably altered roads	59		49
		Limiting value for remedial measures at federal roads	70		60
Great Britain	L_{Aeq}	Target values for new dwellings	55		42
		Strong presumptions against new dwellings	63		57
	L_{10},18h	Insulation regulations for new roads	68		
Hong Kong	L_{10}	Planning values for new residential areas	70		
Italy	L_{Aeq}	Limiting values in some towns	65		
Japan	L_{50}	Environmental standards (target values) for roads	55 - 60	50 - 55	45 - 50
Republic of Korea	L_{Aeq}	Environmental standards	65		55
Netherlands	L_{Aeq}	Preferred values for new roads	55	50	45
		Maximum allowable level for new roads	63 - 70	58 - 65	53 - 60
		Maximum allowable level for existing roads	73 - 75	68 - 70	63 - 65
Switzerland	L_r	Planning values for new roads	55		45
		Immission impact threshold	60		50
		Alarm value	70		65
USA	L_{DN}	No restrictions for new residential developments at roads	65		

Source: Dr. Dieter Gottlob, *"REGULATIONS FOR COMMUNITY NOISE"* inter-noise 94 at Yokohama, Japan, August 1994.
Note: L_{DN} (Day & Night Level)

3. Urban Transportation Policies

3. URBAN TRANSPORTATION POLICIES

3.1 Review of Existing Plans

In this section, existing future plans to be taken into consideration for the formulation of Master Plan are briefly explained.

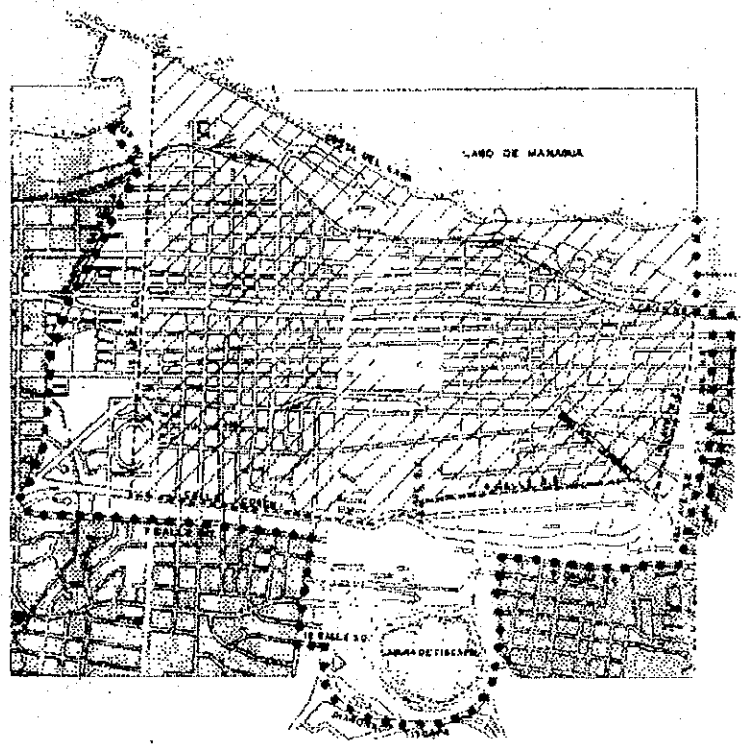
National Plans

The ex-president Chamorro announced a five year National Economic Plan on March 3, 1991 and it was executed. After the termination of the period, no national economic plan has been presented. The Central Bank of Nicaragua, however, is now conducting a study to formulate national economic plans according to the suggestion of the World Bank. The Study Team has obtained from the Central Bank the information about the interim output of the economic plan such as gross domestic product and national population in the future, which are essential for setting the future framework for the Master Plan.

3.1.1 Master Plan of Central Area of Managua

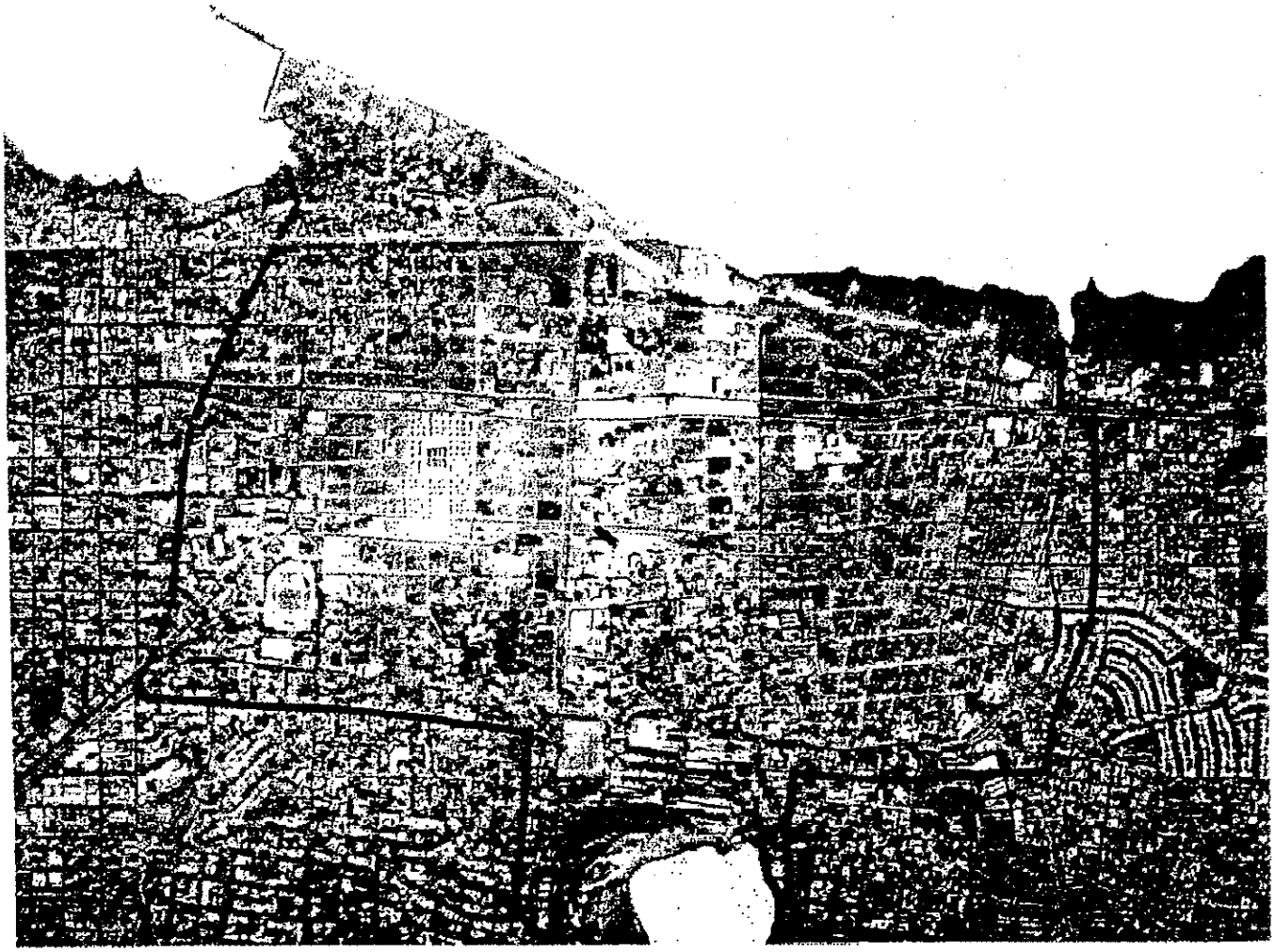
In March, 1994, the Mater Plan of Central Area of Managua was submitted by the General Management of City Planning (Direccion General de Urbanismo) of the Municipality, based mainly on the Regulation Plan (Plan Regurador) published in 1987 and the Urban Development Scheme of Managua (Esquema de Desarrollo Urbano de Managua). The study area is exhibited in Figure 3.1.1.

Figure 3.1.1
Study Area of the Master Plan



Source: ALMA

Figure 3.1.2
Aerial Photo of the Study Area



The Master Plan report consists of the following issues:

- Basis of the plan
- Concept for city planning
- Zoning
- Images and objectives
- Development strategy
- Strategic projects

In the report, two scenarios "medium capacity" and "maximum capacity" are discussed in relation to the zoning of the study area, and the demographic parameters and area of construction are estimated based on these two scenarios as shown in Table 3.1.1.

Table 3.1.1
Demographic Parameters and Area of Construction by Scenario

Items	Unit	Medium capacity	Maximum capacity
Planning Area	Ha.	590	590
Number of Population	Person	59,910	102,500
Density	Person/ha.	102	175
Number of Employee	Person	102,275	170,903
Total Population	Person	162,185	273,403
Construction Area	Square meter	3,842,000	6,251,600
Houses	Ditto	1,080,000	1,845,000
Equipment	Ditto	522,000	862,500
Offices	Ditto	994,000	1,698,000
Commercials/services	Ditto	1,207,000	1,806,100
Others	Ditto	39,000	40,000

Source: ALMA

3.1.2 General Plan of Urban Development of Managua (PGDU)

Based on the regulatory plan mentioned above, the General Directorate of City Planning is carrying out a study of urban development master plan for the whole Municipality. The plan will be submitted by the end of 1998. The JICA Study Team continuously obtained information about urban development policies through closest contact with the officers in charge.

3.1.3 Regulatory Plan of Managua

A city planning system of the Municipality of Managua is described in the Regulatory Plan of Managua (Plan Regulador de Managua) published by the General Directorate of the City Planning (Dirección General de Urbanismo) in 1982 and 1984. The contents of these documents are as follows:

a) Regulatory Plan (1982)

- Regulations of zoning and land use.
- Urban development regulations.
- Regulations for authorization of construction
- Regulations for gas stations.

b) Regulatory Plan (1984)

- Regulations of road structure.
- Regulations of vehicle parking.

3.1.4 Road Projects

Road projects were determined by the General Directorate of the City Planning of the Municipality of Managua in 1983. Most projects, however, have not been realized yet. Therefore, they were reviewed and evaluated in the Study.

The projects mentioned above are shown in Figure 3.1.3. The planned network is basically a combination of radial and circumferential roads.

The project components are listed in Table 3.1.2 and 3.1.3.

Table 3.1.2
Road Projects of Managua
(Not defined in the field)

ROAD NAME	TYPE OF ROAD
Los Saballos Avenue	Secondary Collector
Los Laureles Highway Extension	Primary Collector
Las Cuaresmas Road	Secondary Collector
New Road to Santo Domingo	Secondary Collector
Old Road to Santo Domingo	Primary Collector
Perimeter Las Sierras	Secondary Collector
Road to San Isidro de la Cruz Verde	Secondary Collector
Alternative of South Road	Secondary Collector
Asososca Highway	Primary Collector
Motastepe Highway	Primary Collector
Satelite Avenue	Primary Collector
Open 3 (partially)	Primary Distributor
San Andres de la Palanca Highway	Primary Distributor
Bella Cruz Highway	Primary Distributor

Source: ALMA

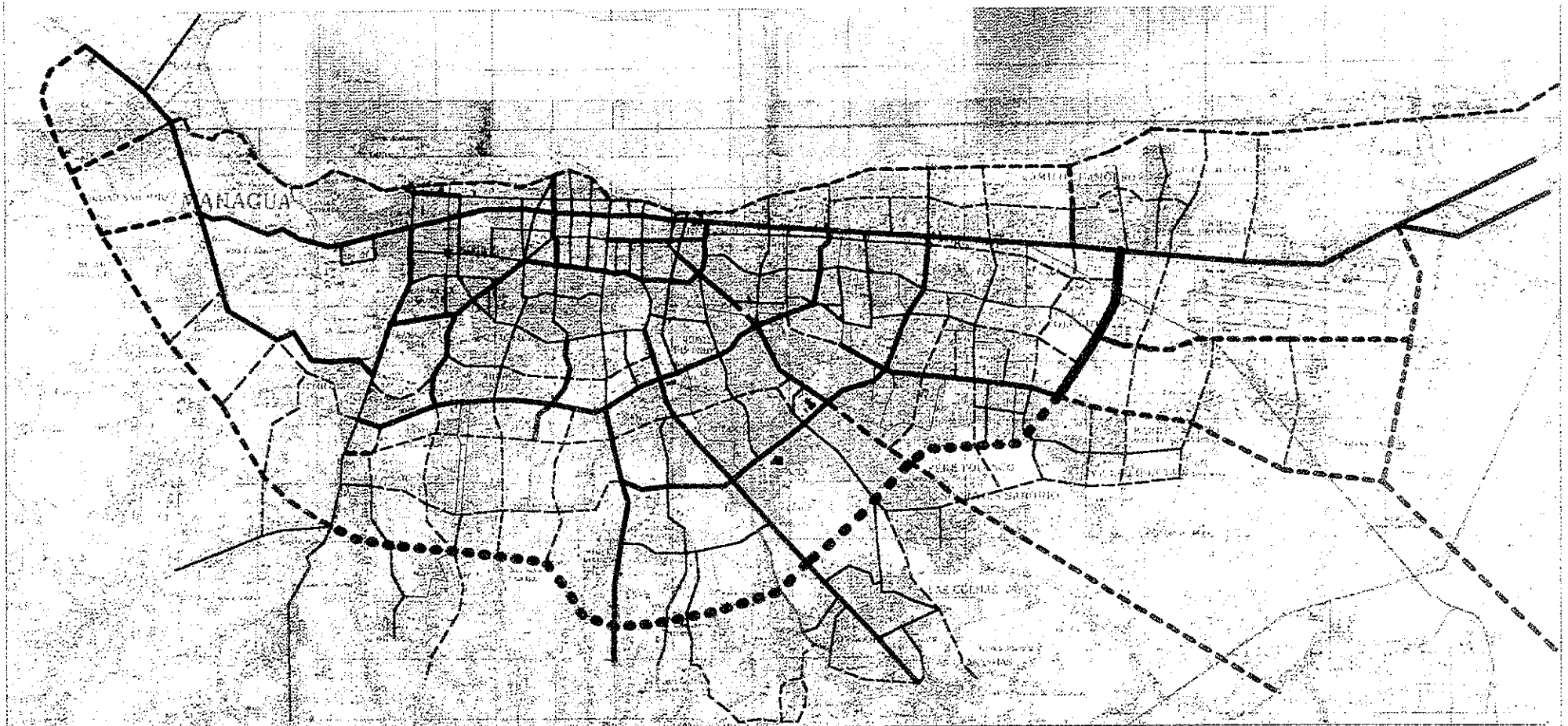


Figure 3.1.3 Urban Road Network Development Plan in Managua (1983)

Source: ALMA

Table 3.1.3
Road Projects of Managua
(Defined in the field)

ROAD NAME	TYPE OF ROAD
San Cristóbal Highway	Primary Distributor
Larreynaga Highway	Primary Distributor
Sabana Grande Highway	Primary Distributor
Airport Avenue	Primary Collector
San Francisco Highway	Secondary Collector
Libertad Highway	Secondary Collector
Los Laureles Highway	Primary Collector
Alternative Highway to Masaya	Arterial Road
Ring Road Rural Highway	Arterial Road (Right of way acquired)
Old Road to Esquipulas	Primary Collector
Los Cortez Avenue	Secondary Collector
Las Américas Highway	Primary Collector
Café Soluble Avenue	Primary Collector
Cost Highway (partially)	Recreational Road
Old Road to Tipitapa	Primary Collector
Solo Road	Primary Collector
Veracruz Highway	Primary Collector
North and South Extension of Buenos Aires Highway	Primary and Secondary Collector
Suburban Highway (projected expansion)	Primary Distributor
Suburban Highway West Extension	Primary Collector
Road to Masaya (projected highway)	Primary Distributor
Jean Paul Genie Boulevard East Extension	Primary Collector
Paseo Rubén Darío (projected expansion)	Primary Distributor
Paseo Rubén Darío South Extension	Primary Collector
Los Duarte's Road	Primary Collector
Camino de Bolas Highway	Primary Collector
Batahola Diagonal Highway	Primary Distributor and Secondary Collector
South Road (projected extension)	Primary Distributor
John Paul II (projected extension)	Primary Distributor
United Nations Radial (projected extension)	Primary Distributor
New Road to Leon (projected extension)	Primary Distributor
Paseo Las Brisas (projected extension)	Primary Distributor
35 Avenue West (projected)	Primary Distributor and Collector
Old Road to León (projected extension)	Primary Distributor
Calle El Triunfo (projected extension)	Primary Dist. And Collector, Sec. Collector
North Road (projected extension)	Primary Distributor
Benjamin Zeledón Highway (projected extension)	Primary Collector
Firefighter Diagonal (projected extension)	Secondary Collector
27 Ave. West (projected extension)	Secondary Collector
Calle Colón (projected extension)	Primary Distributor
Xolotlan Highway (projected extension)	Primary Collector
Nejapa River-bed	Primary Collector
Calle 15 de Septiembre	Secondary Collector
Paseo Las Nubes (projected extension)	Primary and Secondary Collector
Old Road to Masaya	Primary Distributor
Monumental Avenue (projected extension)	Primary Distributor
Suburban Highway North Extension (projected Extension)	Primary Collector
The Rails Diagonal	Secondary Collector
25 Street South	Secondary Collector
Old Road to León	Primary Distributor

Source: ALMA

3.2 Urban Transportation Policies

3.2.1 Overview of Managua's Urban Transportation

This section intending to highlight a range of policy issues in formulating a Comprehensive Transportation Master Plan for the Municipality of Managua has been prepared based on the review of existing/collected data and other references as well as internal and external discussions and field observations.

Characteristics of the urban transportation sector and rising issues in Managua are in summary as follows:

A) Urban transportation system is entirely road based. Therefore, urban structure and development have been implicated closely with road development. As is always the case in large urban areas, interaction between transportation and urban formation is a critical element both in transportation and urban planning. While a Land Use Plan is currently being formulated by ALMA and expected to be finalized soon, the result of this Study should be effectively integrated with the former plan. Future settlement patterns and locations of activity centres are the determinants of basic transport network. .

B) Natural disaster particularly earthquake is also a critical factor which has influenced locations or distributions of socio-economic activities in the City and needs to be duly incorporated in planning framework.

C) Roads are relatively well provided which in many cases have wide right-of-ways. However, network is configured without explicit planning philosophy and functional hierarchy. Existence of missing links in many locations and lack of secondary roads amplify the current network deficiency. Pavements are not adequate and maintenance is also insufficient. Nevertheless, with restructuring of the roads network and strengthening of road management capacity, there is a great opportunity to improve the situation with relatively small amount of resource inputs.

D) Potential role and importance of traffic management is great. In general, available roads space for the current level of vehicular traffic is more than sufficient. Traffic congestions take place only in a limited number of locations under certain conditions which can mostly be solved or mitigated with low cost traffic management measures. There is great opportunities in the City that improved traffic management will contribute to the improvement of traffic flow, reduction in traffic accidents and enhancements of road users comfort. Traffic management should look into both at road links and intersections and for vehicles as well as passengers/pedestrians. Parking will become an increasingly important issue especially in and around activity centres. Efficiency of roundabout intersections needs to be thoroughly assessed.

E) Public transportation services in the City is yet to be improved. Availability of public transportation is the most important area to be addressed by the Government for the benefit of majority of the citizen. Although it is good that public transportation, which comprises basically buses of different sizes and taxi, is operated without any government subsidy, it is at the same time noted that there are many areas with poor accessibilities. Further improvement of public transportation is very much critical to curb the future shift in the modal choice of the people to private cars, as income increases. Therefore, the Government should look into how to further improve the public transportation system without providing direct subsidies. A policy on adequate role sharing between public and private sector is to

be the key concern of the Study. While operation is done solely by private sector, the Government should provide adequate infrastructure and institutional framework to maximize the capability of private sector. Introduction of different types of public transportation services including but not limited to busways, bus exclusive lanes, air-conditioned services, express services, mini buses, other para-transit, shared taxi, etc., will contribute to further improve public transportation system in the City. Not only the trunk services but also the feeder services should be particularly strengthened. Development of rail transit system needs a close and careful look particularly from the financial viewpoint.

F) Roles of non-motorised vehicles such as bicycle and walking should be more duly considered. Availability of relatively ample road space, open space including greenery is a great advantage for the City to develop a reasonable system which will contribute to the City environment and the people's health. Safe and comfortable walking is the most important and fundamental component of urban transportation system.

G) A new element to be injected into the urban transportation system of the City is a concept of transportation nodes or mode interchange function. A good public transportation system always involves an effective function where people can transfer from one mode of transportation to another. Without proper transportation nodes to be located at strategic locations in the urban transportation network, operations of public transportation operators will be adversely affected, convenience of passengers be reduced and efficiency of the network be lowered. Since the transportation nodes are the areas where vehicles and passengers concentrate, there is a large potential for commercial and other urban service development. Thus, the concept of transportation nodes is to be adequately incorporated in the development of the city centres.

H) Another policy element to be looked into is to introduce a set of transportation demand management measures. While conventional traffic management intends to streamline the existing traffic flow, demand management intends to control the demand itself using physical and/or pricing measures. In the context of Managua's situation, the demand management is to be looked into from the two important angles. One is to discourage the use of private car and encourage the shift to public transportation, and the other is to generate additional funds for transportation infrastructure development through various user charges.

I) Environmental concerns will grow more and more in the future. As traffic increases in the City, automobiles will become a major source of air pollution. Although it is not yet a serious concern of the city, the situation should be properly monitored so that adequate countermeasures are implemented timely.

J) Preparation of a comprehensive transportation plan alone is not to be considered as the final output of the Study. Unless the proposed long-term plan is proved with a step by step realistic investment and action plan, the effectiveness of the plan will never be ensured. While the predicted future situation of the City may alter in the course of time, the plan should involve an adequate dynamic mechanism for eventual modifications and necessary revisions. Especially, the plan would be finally viable, taking into account of the current severe constraints in Government budget. Within these constraints, the plan should maximize the benefits of the people.

3.2.2 Concept of Network Structure

1) Assessment of Urban Growth

The existing urban areas of the City are unique compared to other cities in the world; no significant city centres, low density land use, large hollow areas scattered over the City, relatively ample space for roads, and so on. Although this may be largely the results of 1972 earthquake and post-disaster reconstruction, these factors influence the future urban growth of the City. While the current urban development is directed along a couple of major transportation corridors (see Figure 3.2.1) and penetrating gradually into the immediate peripheries, the existing urban area is relatively compact (see Figure 3.2.2) and there is an increasing threat that the urban areas may sprawl due to the availability of ample lands.

On the other hand, the analysis of natural conditions and development potentials clearly indicate that uncontrolled expansion of the urban areas will lead to degradation of environment, danger to disasters, costly infrastructure investment and so on. While the City will have to accommodate future increase in population (approximately 800,000 in the next 20 years), how they will distribute in the existing and potential urban areas is the primary determinant of the future of the City. Although it is difficult to predict, the directions to be guided by the government will be two. One is to intensify the density of existing urban area for effective use of existing resources and to guide the future developments in desirable directions using adequate control measures and incentives. The other is more or less to follow the market trend under the current institutional framework. A danger of the second option is that urban areas may expand further and auto-based development be encouraged. Considering the physical and environmental constraints (see Figure 3.2.3), the first option of controlled / guided urban development is desirable though it is very difficult.

In general, relatively well structured wide roads and rich open space will be advantages to the formulation of balanced urban areas for future Managua City.

2) Preparation of Master Plan by the Municipality of Managua

As it was stated, the transport network plan should be an integral part of the entire urban master plan of the City. For this, a coordination between the Study Team and the Planning Department of Dir. General de Desarrollo Urbano, was made and several meetings have been held in 1998 in the office of the latter.

Planning concepts incorporated in the Master Plan include the following features in relation to formulating the transport network plan:

a) Expansion of urban areas into the environmentally critical areas and those with topographic and natural constraints will be controlled through statutory city planning measures such as zoning and development permits.

b) It is intended to promote relatively compact urban areas through intensification of density in the existing urbanized area and enforcement of planning standards.

c) While the existing city centre will further grow to accommodate institutional and cultural facilities and be integrated with emerging commercial developments along the Masaya corridor which are expected to form a major city centre, a number of sub centers are also being planned in a hierarchical manner. However, the final locations of these sub centres are being studied by the Planning Department (see Figure 3.2.4 and 3.2.5)

d) Network of open space is to be provided in the Master Plan linking major public space and environmentally critical areas. This concept is very important not only from environmental viewpoint but also from disaster prevention aspect.

e) Existing industries located in the urban area, especially the hazardous ones, will be relocated to planned industrial estates in the suburban areas. Otherwise significant changes in the current land use patterns will not be expected.

Figure 3.2.1
Growth Trend

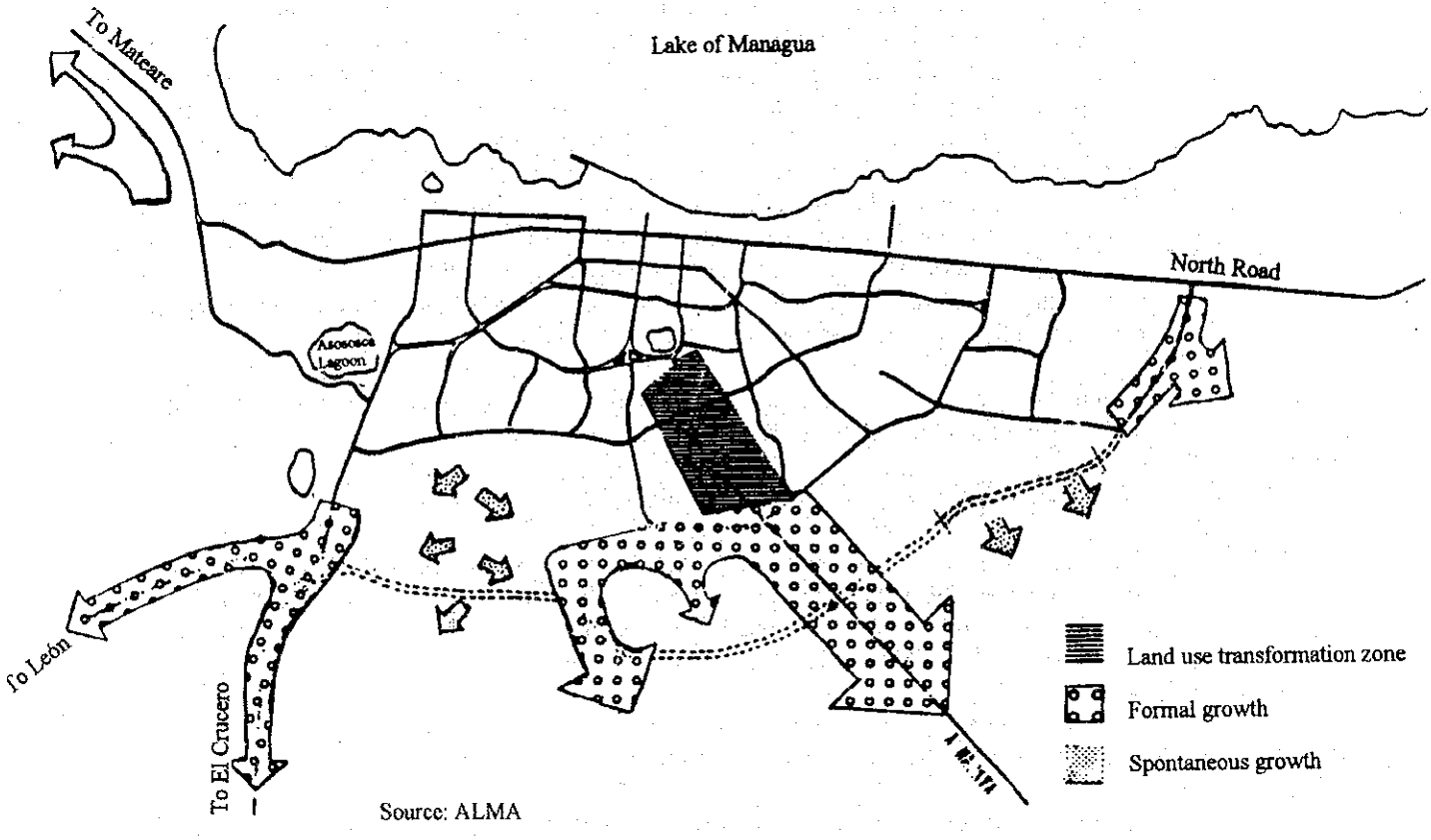
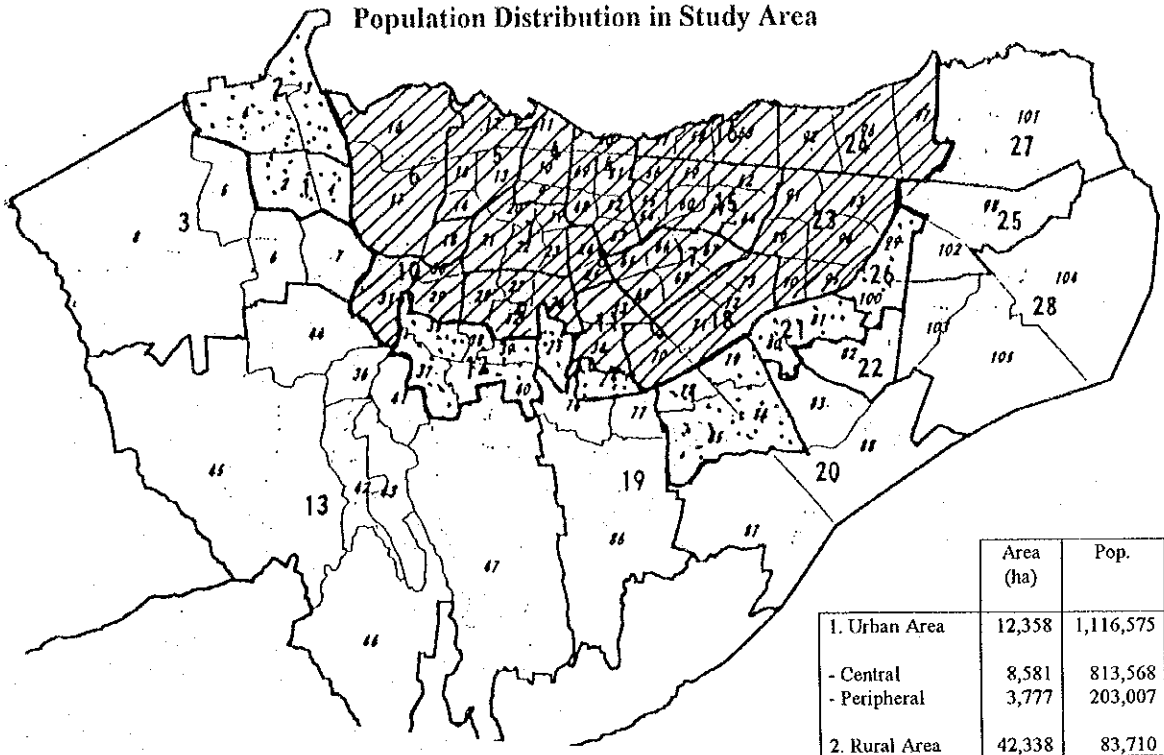
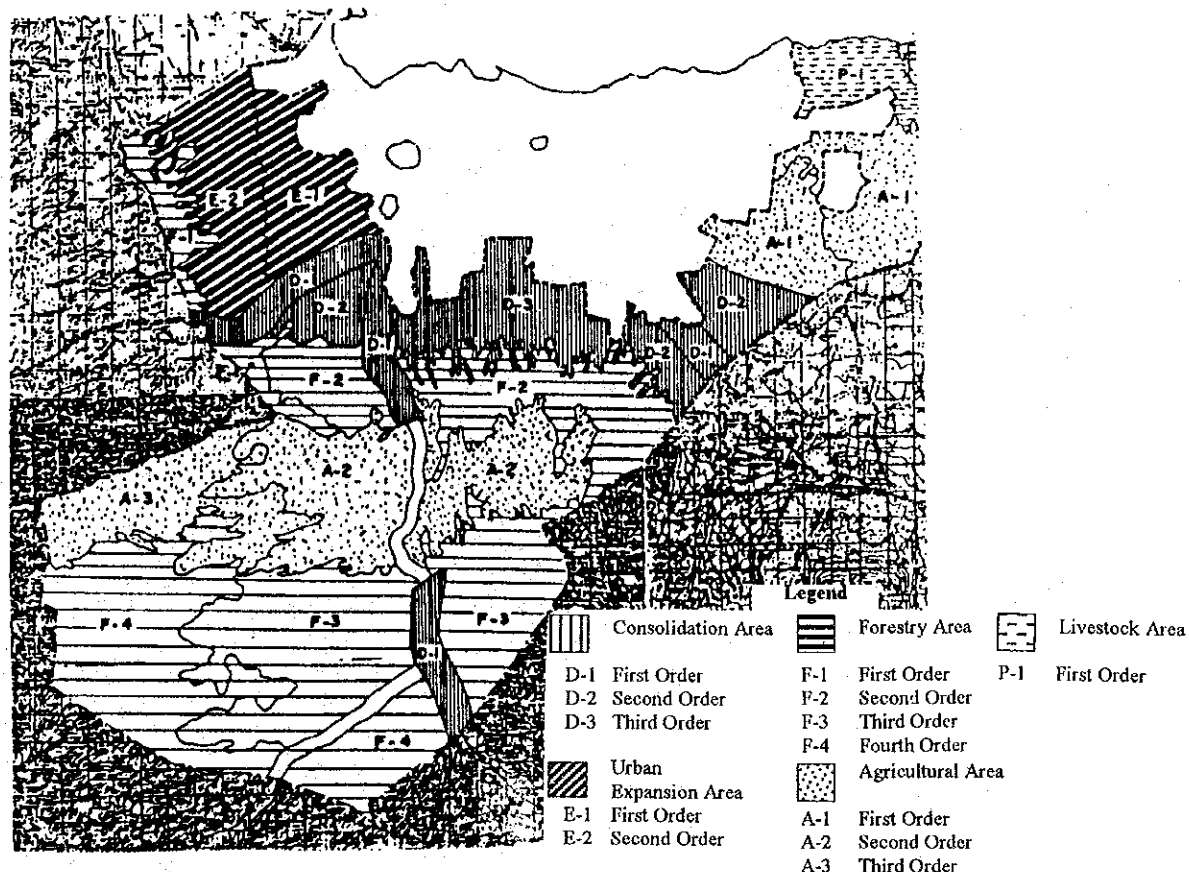


Figure 3.2.2
Population Distribution in Study Area



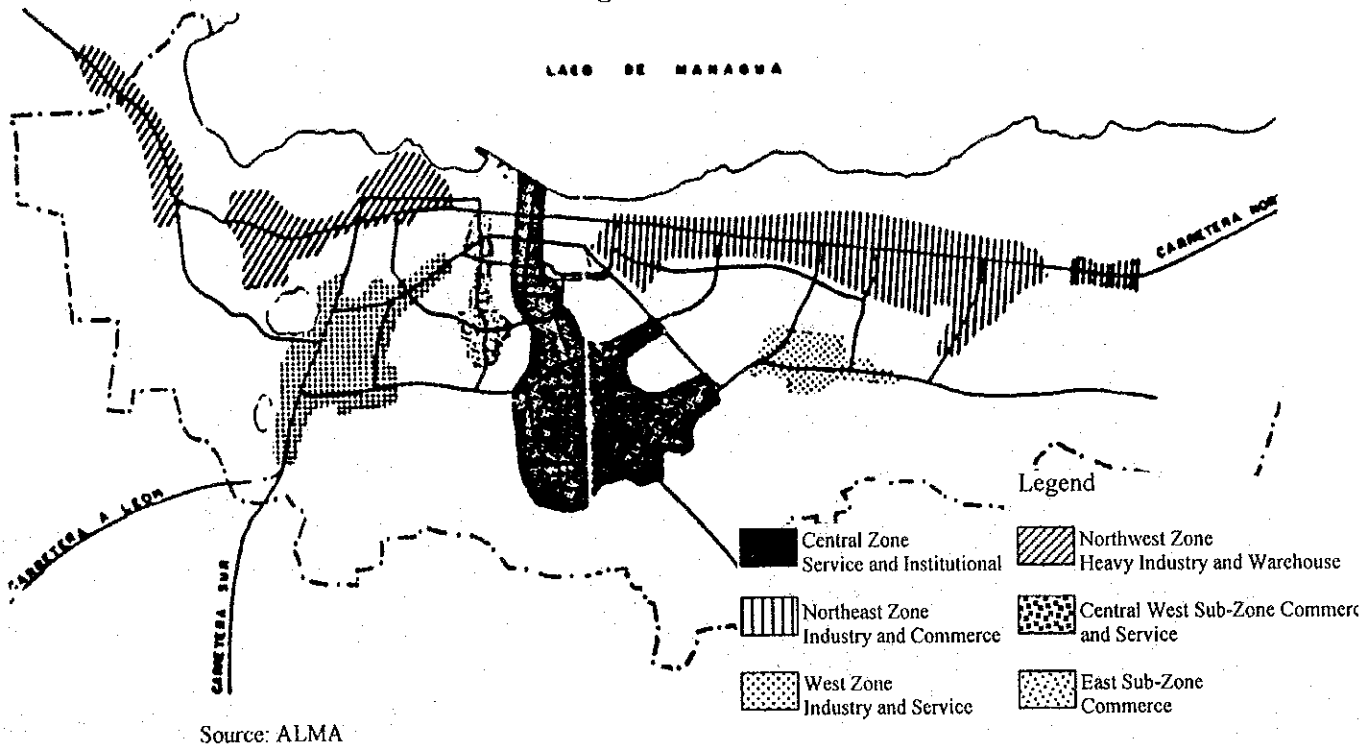
	Area (ha)	Pop.	Pop. Density per/ ha.
1. Urban Area	12,358	1,116,575	100. 0
- Central	8,581	813,568	106.5
- Peripheral	3,777	203,007	53.7
2. Rural Area	42,338	83,710	2.0
Managua Total	54,596	1,200,285	22.0

Figure 3.2.3
Development Potentials in the City



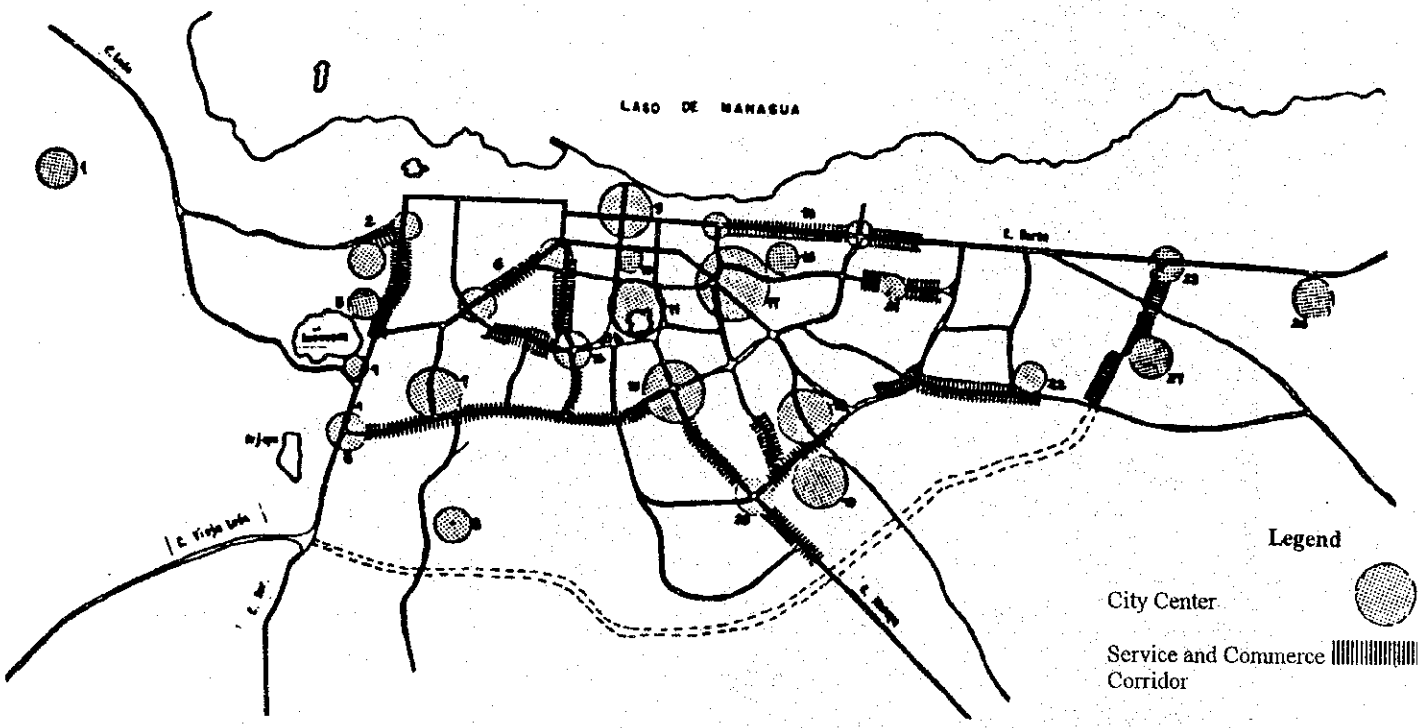
Source: ALMA

Figure 3.2.4
Probable Areas for High Activities Concentrations



Source: ALMA

Figure 3.2.5
Activity Centers and Corridors



Source: ALMA

3) Conceptual Transportation Network Plan

In formulating a transportation network plan, a number of factors to be considered are as follows:

a) Functional hierarchy of the road network has to be clearly defined. The existing roads in the City are largely composed of primary distributor (9% of the total length) and local roads (86% of the same), indicating that the Secondary Roads are absolutely lacking (refer to Table 3.2.1). The other aspect concerned is the integration of inter-city roads which require access controls with the urban road system.

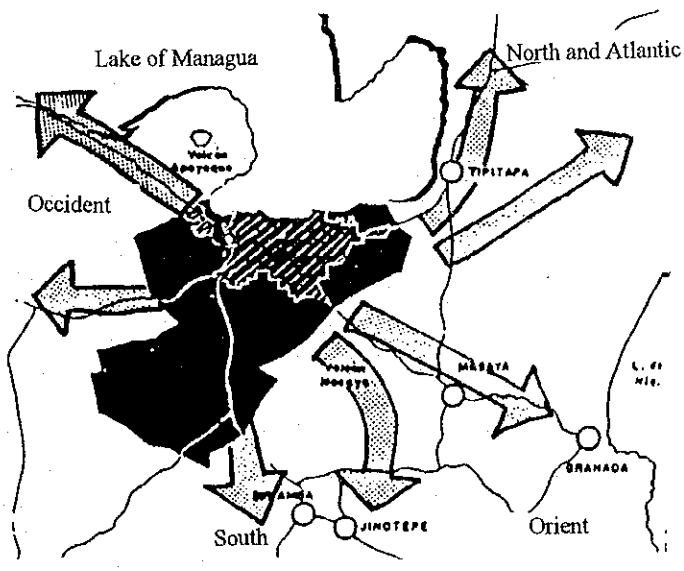
Table 3.2.1
Existing Roads by Classification, 1997

Type of Road	Length (km)	(%)
Thoroughfare (Travesia)	4.52	(0.4)
Prim. Distributor (Distribuidor Primario)	93.29	(8.4)
Prim. Collector (Colector Primario)	34.70	(3.2)
Secondary Collector (Colector Secundario)	18.35	(1.6)
Local Road (calle)	957.86	(86.4)
Total	1.108.72	(100.0)

Source: ALMA

b) Geographical location of Managua City requires to mitigate adverse impact of through-traffic mainly caused by inter-city traffic. Segregating these traffic from intra-urban traffic would become so important in the future that a road which can diversify the traffic at the periphery of the City is to be provided (see Figure 3.2.6). Concurrently, this periphery road with a limited number of access points between city roads should function as a physical barrier to limit the uncontrolled expansion of urban areas.

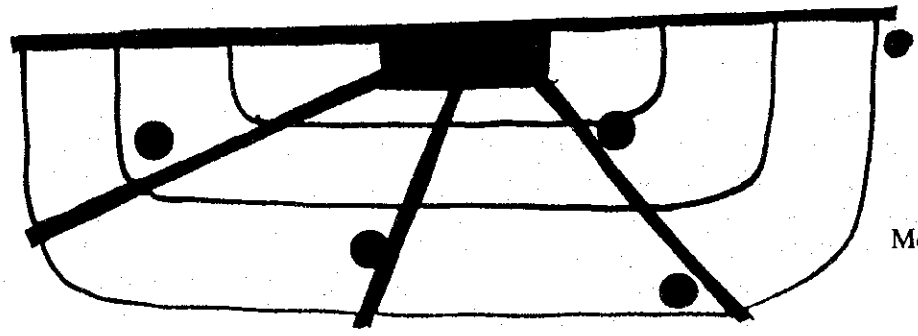
Figure 3.2.6
Inter-city Transport Corridors



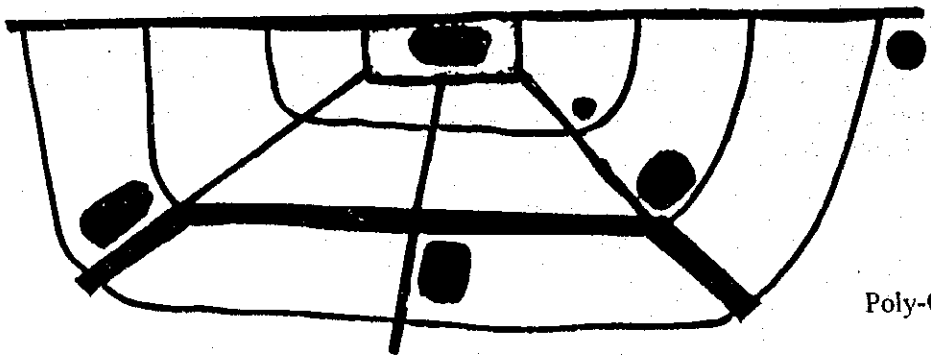
Source: ALMA

c) Network pattern should comply with the envisioned urban development and land use. If strong mono-centric urban area is to be encouraged, radial roads will be of importance, while if poly-centric urban area is intended, grid form of roads may function more effectively (see Figure 3.2.7). Taking into account that land use control is the most unsuccessful undertaking of any governments in the world, realistic scenario on future urban development pattern in an interactive manner between transport network should be worked out.

Figure 3.2.7
Conceptual Understanding of Roads Network Configuration
in Compliance with Urban Development Pattern



Strong Mono-Centric Pattern



Poly-Centric Pattern

On the basis of the above consideration, alternative transport network structure plans have been conceptually formulated. Key factors which have been incorporated in the plans are as follows:

a) Expansion of urban areas needs to be controlled due to physical and environmental constraints as well as to economic efficiency.

b) Network structure should be earthquake disaster-proof to certain extent. This means that alternative paths should be available between major traffic generating centres at city level and for residents between shelter locations. From this view point, urban structure with single strong centre may not be advisable.

c) In reality, it is always difficult for any governments to control numerous individual development activities and land use as planned; market force is usually stronger than administrative enforcement power, and political intervention can also not be avoided totally. Actually, availability of infrastructure particularly transportation facilities strongly affects the land use and urban formation. Knowing the experiences of most of the cities in the world that transportation network is the most critical factor to determine the distribution of socio-economic activities in the City and not the land use plans and population distribution what planners want, transportation network should be designed in a way that the results of these interactions will fall within the acceptable ranges of efficiency, effectiveness and equity of the society.

Figure 3.2.8
Alternative Concepts of Transportation Structure Plan

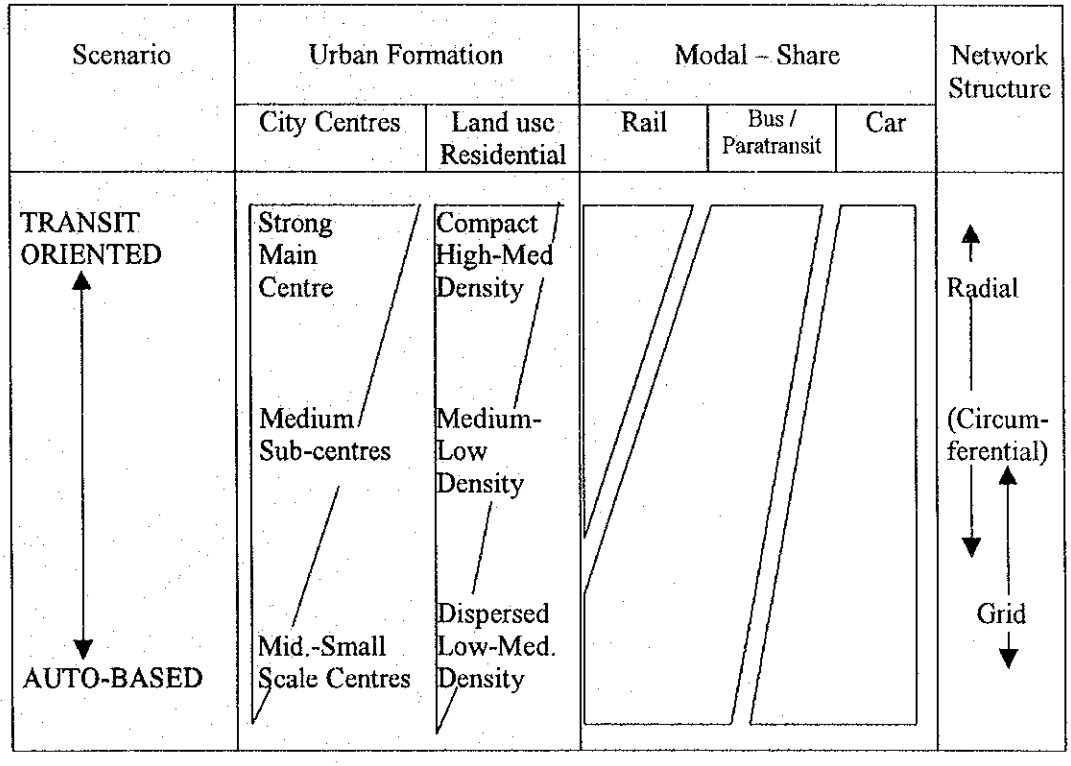
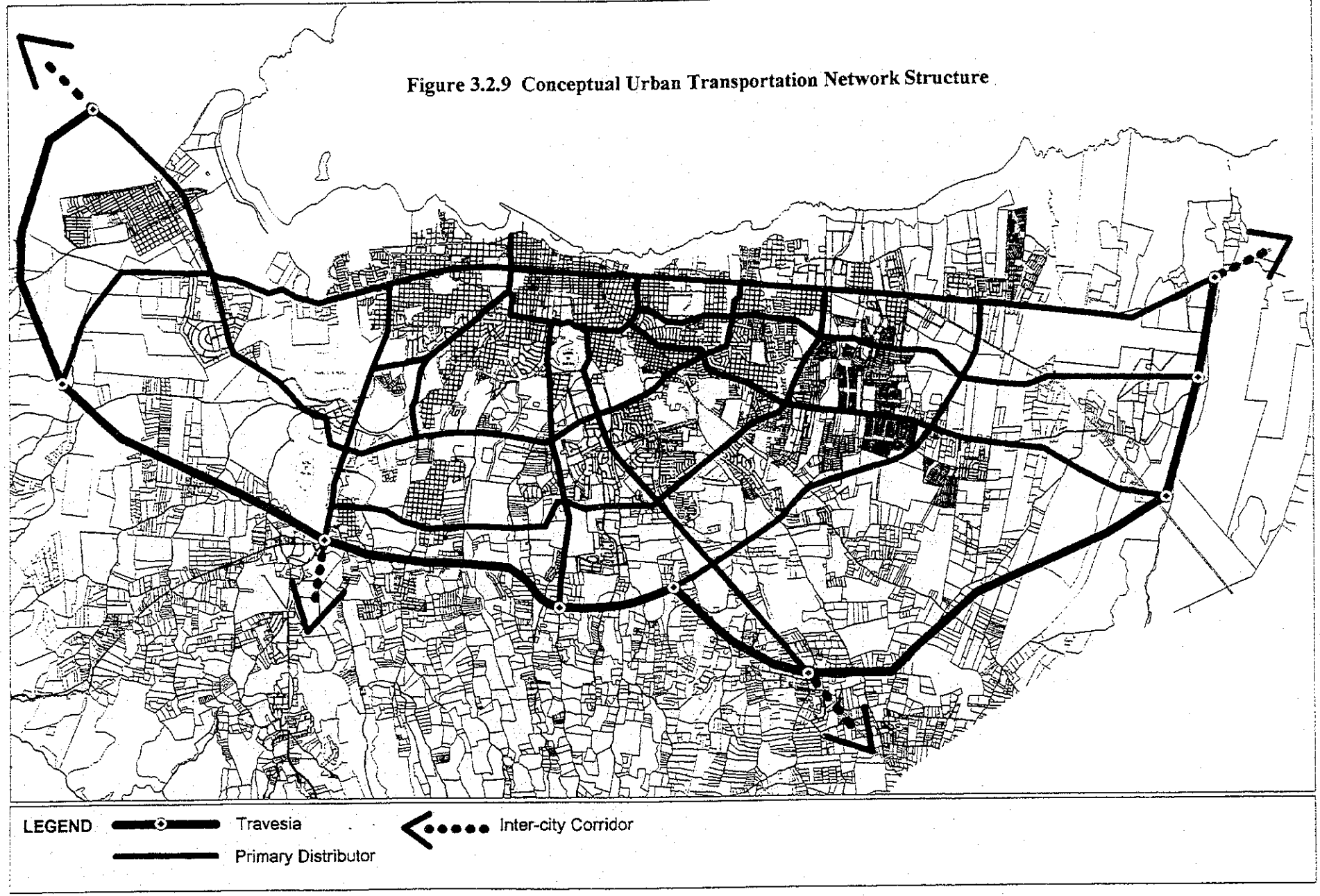


Figure 3.2.9 Conceptual Urban Transportation Network Structure



3.2.3. Urban Transportation Strategies

1) Urban/Urban Transportation Policy Goal

Sustainable urban transportation should be the ultimate policy goal of the Government for the City. However, the term "sustainability" is too vague and has to be defined more clearly in the context of Managua City. Understanding that transportation is only a component of urban system and their interactions are always significant, the sustainability of urban transportation can be ensured only when transportation development contributes to the sustainability of the City as a whole. Needless to say, this is why transportation planning and development should always be undertaken in an integral manner with urban planning and development. Therefore, at first, policy goals of urban development for Managua City should be explicitly set forth. Taking into account the existing problems of the City, policies should be directed broadly towards the following aspects:

a) How to enhance the competitiveness of the City: Creating employment opportunities is considered as the most fundamental development issue for the City. Although many factors are outside the City planning, provision of infrastructure and institutional framework should be directed to encourage national and foreign investments in the City.

b) How to enhance livability of the City: City should be livable. Safety, equity, healthiness and amenity should be provided to the citizen. The City can not escape from earthquake disasters but be ready to tackle the situation and effective, safe and healthy environment should be provided for the citizen especially the urban poor.

c) How to strengthen management capability of the City: Financial sustainability and good municipal management are the key to sustain the City. Municipal financing should be strengthened by seeking ways to introduce the concept of beneficiaries-pay-cost more extensively.

In what way transportation sector should comply with the overall urban development policy goal? From here, the following policy goals have been set forth for the urban transportation sector.

a) Promotion of Public Transportation-Based City

The current trend of urban sprawl along the transportation corridors and into the City peripheries in low density would encourage inefficient and costly auto-based urban structure which also may amplify the disparity between the rich and the poor. Since the existing urban area is structured and directed rather towards auto-based society, it is not an easy task for the Government to redirect the current trend unless all available resources such as strong policy statement, infrastructure development, city planning and development control, etc., are continuously mobilized. However, Managua City still has a good chance to achieve the envisioned goal.

b) Encouragement of Public-Private Partnership

Current public transportation of the City has been operated entirely by the private sector which is not the cases in many other cities. The Government should take advantage of the current situation and refrain from excessive intervention in the future. Therefore, the role of the Government in promoting public transportation-based city is basically to provide with necessary infrastructure for their efficient operation and regulatory framework to encourage entries, competitive operations

and new type of services. For this, transit corridors should be defined clearly and public investments be concentrated into these priority areas.

a) Establishment of Explicit Car Demand Management Policy

To promote transit-oriented city, encouragement of public transportation alone is usually insufficient. Restraining car ownership and use should be implemented concurrently. By charging social costs of car use, not only the demand is restrained but also additional revenue sources can be created for further improvement of public transportation infrastructure.

d) Capacity Building of Urban Transportation Sector

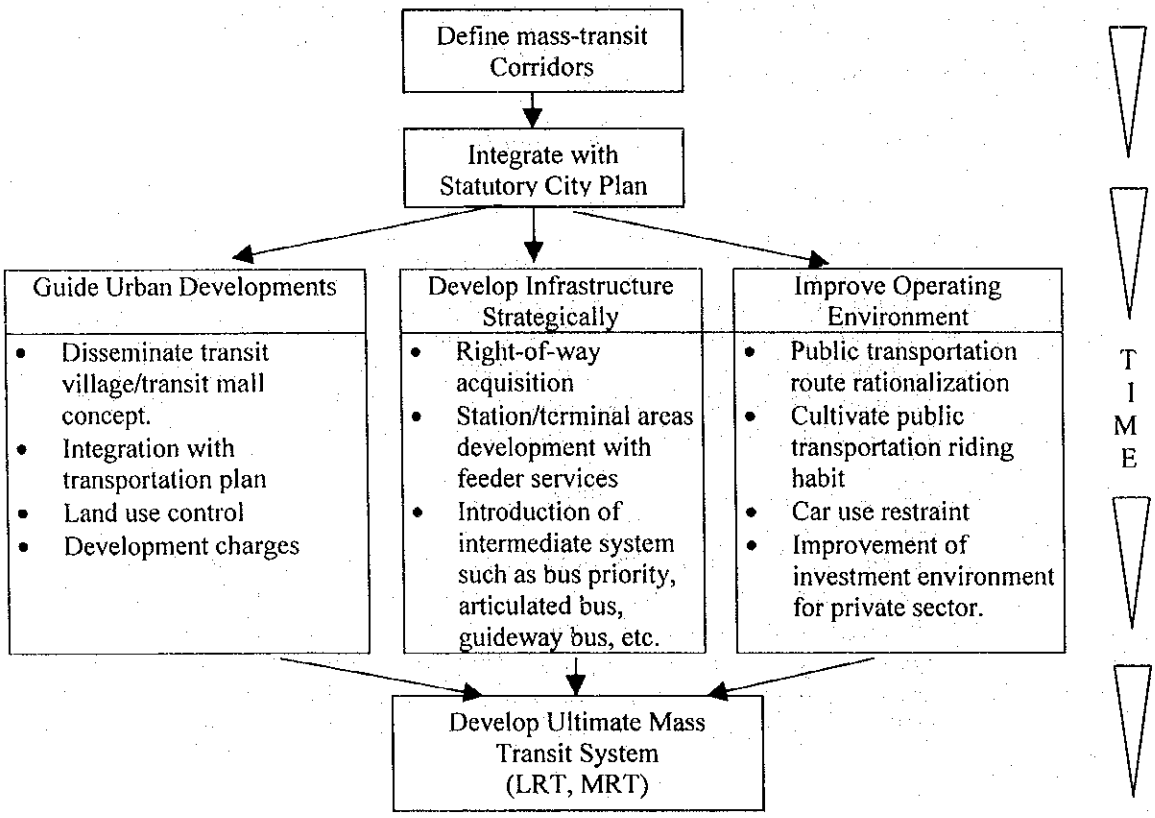
Management is always the core in implementing plans and projects directly or indirectly. The efficiency affects the cost performance of the investment, service level of operations and eventual patronage of users to the public transportation. For this, transportation personnel both in public and private sectors need to be upgraded and equipped with state-of-the-art technical and management tools.

2) Strategies

A) Strategic Approach to Transit Oriented City

Promoting public transportation-based city is not the development of mass transit system such as LRT and MRT along the major corridors but to restructure or guide the urban areas and transportation system in such a way that the people can travel conveniently and economically and operators can work in financially viable manner within the City. Step-by-step approach is strongly recommendable for the situation of Managua City (see Figure 3.2.10).

Figure 3.2.10
Approach to Promoting Public Transportation-Based City



B) Short-term Urban Transportation Strategies

The short-term strategy for the City's urban transportation development should be "Good Housekeeping with Minimum Capital Investment". Since basic transportation infrastructure in the City is relatively well provided, the primary emphasis for the short-term should be placed on how to maximize the performance of existing infrastructure with low-cost physical and management measures. The strategies by sub-sector are as follows:

a) Roads

- Redefinition of roads hierarchy.
- Completion of missing links, roads widening, major repair.
- Fly-overs, grade separation.
- Improvement of maintenance.
- Pedestrian facilities.
- Street lighting, street trees.
- Priority improvement of public transportation roads.
- Improvement of road inventory.

b) Road Traffic Management

- Intersection improvement including channelization, signalization, reassessment of roundabouts.
- Data-base creation including traffic and traffic accidents.
- Pedestrian crossings.
- Parking policy and facilities.
- Control of street and road-side vendors.

c) Public Transportation

- Restructuring of public transportation hierarchy.
- Determining of mass transit corridor and corridor analysis.
- Expansion of feeder services.
- Introduction of differential services.
- Development of public transportation nodes.
- Maximum use of private sector capabilities.

d) Environment

- Improvement/development of transportation facilities and environment for pedestrian and non-motorised transportation.
- Monitoring of transportation-based pollution.

e) Funding source

- Creation of new financial sources to fund transportation development by increasing vehicle registration fee, fuel tax, property tax, etc, and by introducing new charges on car ownership and use, and urban development.
- Strengthening of the collection from existing tax source .
- Improvement of investment environment/guideline for more active private sectors participation in transportation development.

C) **Long-term Strategies**

Long-term transportation strategy is to mobilize available resources to realize the public transit oriented city. It is intended in this Study that practice of short-term strategies shall contribute to the achievement of long-term goal. Long-term strategies should include the following:

a) Consensus building of "Transit-Based City"

Government should prepare clear statement for the public to aware and appreciate the benefits of transit-based city/society in order to obtain their consent and support to the policy.

b) Establishment of effective public-private partnership for the development of major transportation infrastructure.

Major infrastructure such as rail transit including LRT, MRT, Tranvia as well as new primary roads are not needed in the short-term. However, how to mobilize private sector's capabilities in financing and management should be studied and adequate institutional framework be prepared.

c) Development of transit-based urban areas/centres

Integrated urban centres/areas developments with public transportation are implemented in many locations in the world. Concepts of transit villages/residential areas, transit malls, transportation terminals integrated with commercial facilities, etc., should be defined specifically in a way to fit local conditions.

4. Future Socio-Economic Framework

4. FUTURE SOCIO-ECONOMIC FRAMEWORK

4.1 Future Socio-Economic Prospect of Nicaragua

4.1.1 Population

The latest population census in Nicaragua was conducted in 1995 after 24 years of the previous census in 1971. Based on the census, Nicaragua's population was 1.88 million in 1971 and 4.36 million in 1995 with an average growth rate of 3.57% p.a. However, these data were considered an underestimate as stated in "Resumen Censal, VII Censo Nacional de Población y III de Vivienda, 1995" (INEC, 1996). The coverage of the census was 90% in 1971 (CELADE) and 96.5% in 1995 (Encuesta de Covertura y Sesgo). When these deviations are taken into account, 1995 population is 4.54 million and the annual growth rate between 1971 and 1995 is 3.2%.

Although no government agency of Nicaragua has any long-term population projection, CELADE (Centro Latino-Americano de Demografía) has published long-term projections of population for latino-american countries based on their accumulation of demographic data, analyses and researches. According to CELADE, Nicaragua's population will increase from 4.97 million in 1998 to 5.72 million in 2003, 6.5 million in 2008 and 8.11 million in 2018, as shown in Table 4.1.1. The growth rate is assumed to decrease gradually from 3.00% p.a. in 1998 to 2.12% p.a. in 2018.

In this Study, the CELADE projection has been adopted as a basis of socio-economic projections.

Table 4.1.1
Future Population of Nicaragua

	INEC	CELADE [3]		% of INEC to CELADE
		Population	Increase Rate (%)	
1995 (April 25)	4,357,099[1]			
1995 (June 30)	4,382,294[2]	4,539,499		96.5
1996		4,679,735	3.09	
1997		4,822,220	3.04	
1998		4,966,768	3.00	
2003		5,717,471	2.86	
2008		6,503,369	2.61	
2013		7,307,469	2.36	
2018		8,114,842	2.12	

Note: 1) 1995 Population Census
2) INEC Estimate
3) CELADE Estimates/Projections as of June 30 for Each Year

4.1.2 Gross Domestic Product by Sector

According to BCN (Banco Central de Nicaragua), Nicaragua's GDP in 1998 is C$22,781.2 million at 1980 constant prices or C$21,974.7 million at current prices. This is equivalent to US$2,092.8 million (US$1 = C$10.5), and per capita GDP is calculated at US$420. During the period 1995 – 1998, Nicaragua's economy has shown a growth of 5.3% p.a. However, per capita GDP has been almost constant at US$420 due to the yearly devaluation of Córdobas.

At present, there is no national development plan in Nicaragua. However, in January 1998, the Government published the Memorandum on Economic and Financial Policies (Memorándum de Políticas Económicas y Financieras) in order to show the short-term economic policies of the Government up to 2000.

BCN has prepared short-term economic projections by sector for the period 1998-2003. The average annual growth is assumed at 5.4% and the growth engine is considered to be the primary sector. BCN also has long-term projections, though the growth assumed seems to be considerably high.

Table 4.1.2
Short-Term Projections of GDP by BCN, 1998-2003

	GDP (C$ million at 1980 prices)						
	1998	1999	2000	2001	2002	2003	
GDP	22,781.2	24,044.9	25,404.2	26,676.6	28,051.0	29,664.3	
Primary Sector	6,680.5	7,223.6	7,734.2	8,189.2	8,664.9	9,250.7	
Secondary Sector	6,117.8	6,466.4	6,837.5	7,201.9	7,601.9	8,041.4	
Manufacturing	4,649.7	4,790.0	4,959.4	5,141.9	5,345.1	5,590.6	
Construction/Mining	1,468.1	1,676.4	1,878.1	2,060.0	2,256.8	2,450.8	
Tertiary Sector	9,982.9	10,354.9	10,832.5	11,285.5	11,784.2	12,372.2	
	Annual Growth Rates (%)						
		1999	2000	2001	2002	2003	1999-2003
GDP Total		5.5	5.7	5.0	5.2	5.8	5.4
Primary Sector		8.1	7.1	5.9	5.8	6.8	6.7
Secondary Sector		5.7	5.7	5.3	5.6	5.8	5.6
Manufacturing		3.0	3.5	3.7	4.0	4.6	3.8
Construction/Mining		14.2	12.0	9.7	9.6	8.6	10.8
Tertiary Sector		3.7	4.6	4.2	4.4	5.0	4.4

Source: BCN

In this Study, the BCN projections were adopted up to 2003. For the long-term, however, the growth rate was assumed to decrease to 5.3% p.a. for the period 2003-2008 and to 5.0% p.a. for the period 2008-2018. Sectoral projections were done by extrapolation independently and adjusted to the total growth. The result is shown in Table 4.1.3. In 2018, GDP will 2.75 times larger than at present, and per capita GDP will be US$710.

Table 4.1.3
Future Projections of GDP, 1998-2018

	GDP (C$ million at 1980 prices)				Annual Growth Rate (%)		
	1998	2003	2008	2018	1999-03	2004-08	2009-18
GDP Total	**22,781.2**	**29,664.3**	**38,404.0**	**62,556.0**	**5.4**	**5.3**	**5.0**
Primary Sector	6,680.5	9,250.7	12,379.5	19,689.4	6.7	6.0	4.7
Secondary Sector	6,117.8	8,041.4	10,559.7	18,037.5	5.6	5.6	5.5
Manufacturing	4,649.7	5,590.6	6,801.8	10,818.2	3.8	4.0	4.7
Construction/Mining	1,468.1	2,450.8	3,757.9	7,219.3	10.8	8.9	6.7
Tertiary Sector	9,982.9	12,372.2	15,464.8	24,829.1	4.4	4.6	4.8
GDP (US$ million)	2,092.8	2,736.5	3,542.9	5,768.8	5.5	5.3	5.0
GDP per Capita (US$)	420	480	540	710	2.7	2.4	2.8

4.1.3 Labor Force and Employment

According to 1995 census, the Gross Activity Rate (ratio of labor force to total population) was 33.2% and the unemployment rate was 16.9%. The 1995 situation of labor force and employment can be summarized as shown in Table 4.1.4.

Table 4.1.4
Labour Force and Employment, 1995

Total Population	4,539,500
Gross Activity Rate (%)	33.2
Economically Active Pop.	1,507,100
Employed	1,252,400
Unemployed	254,700
Unemployment Rate (%)	16.9

Source: 1995 Population Census and CELADE

Using 1995 sectoral GDP estimated by BCN and employment by sector, labor productivity was calculated by sector as shown in Table 4.1.5. The productivity is high in the secondary sector, particularly manufacturing, followed by the tertiary sector.

Table 4.1.5
Estimated Productivity by Sector (at 1980 prices), 1995

	Labour Force Employed	GDP (million C$)	Productivity (C$/psn)
All Sectors	**1,252,400**	**19,518.3**	**15,600**
Primary Sector	506,900	5,278.2	10,400
Secondary Sector	163,800	5,137.4	31,400
Manufacturing	112,400	4,213.1	37,500
Construction/Mining	51,400	924.3	18,000
Tertiary Sector	581,700	9,102.7	15,600

Regarding the gross activity rate, INEC has a short-term projection up to 2000. According to this projection, the rate will increase from 33.2% in 1995 to 34.0% in 1998 and 34.6% in 2000. If this tendency continues further, the rate will reach 40.0% in 2018, and the EAP (Economically Active Population) will be about 3.25 million as shown in Table 4.1.6.

Table 4.1.6
Future Projection of Labor Force

	Total Population [1]	Economically Active Pop.	Activity Rate (%)[2]
1995	4,539,500	1,507,100	33.2
1996	4,679,700	1,563,000	33.4
1997	4,822,200	1,625,100	33.7
1998	4,966,800	1,688,700	34.0
1999	5,113,200	1,753,800	34.3
2000	5,261,300	1,820,400	34.6
2003	5,717,500	2,029,700	35.5
2008	6,503,400	2,406,300	37.0
2013	7,307,500	2,813,400	38.5
2018	8,114,800	3,245,900	40.0

Note: 1) CELADE estimate
2) 1995-2000: INEC estimate

GDP is calculated as a product of employment and productivity. If labor productivity increases too fast, then the employment is suppressed. In order for economy to grow steadily, the increase in productivity is indispensable to ensure higher per capita income and recurrent reinvestment. However, the increase in employment is also important to lower the current unemployment rate and to maintain social stability. In this Sudy, the employment situation in Nicaragua has been projected as presented in Table 4.1.7.

Table 4.1.7
Future Projection of Employment Situation, 1998-2018

	1998	2003	2008	2018	1999-03	2004-08	2008-18
GDP (million C$, real)	22,781.2	29,664.3	38,404.0	62,556.0	5.4	5.3	5.0
Productivity (C$/person)	16,000	16,800	17,800	20,300	1.0	1.2	1.3
Employed Labour Force	1,423,800	1,765,700	2,157,500	3,081,600	4.4	4.1	3.6
Total Labour Force	1,688,700	2,029,700	2,406,300	3,245,900	3.7	3.5	3.0
Unemployment Rate (%)	15.7	13.0	10.3	5.1			

4.2 Future Socio-Economic Framework of Managua

4.2.1 Population and Vivienda

1) Population

Usually, population of an area is projected by Cohort Method which takes into account the birth rate, death rate and migration rate by sex and by age group. In Managua, however, the statistics on migration (social increase/decrease) is not available. Thus, the total population of Managua was projected by setting the share of Managua to the national total.

According to the census, the share of Managua decreased from 22.9% in 1971 to 20.7% as indicated in Table 4.2.1. However, officers in charge of ALMA have negative opinions to this tendency due to the deficiency in the coverage of the census and to the obvious in-migration of rural population into Managua.

Table 4.2.1
Managua's Share of Population to Nicaragua, 1971 and 1995

	Population		Growth Rate (%)
	1971	1995	
Nicaragua	1,877,952	4,357,099	3.57
Managua Municipality	430,690	903,100	3.13
% of Managua to Nicaragua	22.9	20.7	

Source: 1971 and 1995 Population Census

The population of Managua as of 1998 is estimated at 1.20 million which shares 24.2% of the national total (refer to Appendix 2). Assuming that this share is maintained at the same level, future population of Managua is projected as shown in Table 4.2.2. The growth rate will decline similarly to the national population from 2.9% p.a. for 1998-2003 to 2.6% p.a. for 2003-2008 and to 2.2% for 2008-2018.

Table 4.2.2
Future Projection of Population, 1998-2018

	1998	2003	2008	2018	1998-03	2003-08	2008-18
Nicaragua	4,966,800	5,717,500	6,503,400	8,114,800	2.9	2.6	2.2
Share to Nicaragua (%)	24.2	24.2	24.2	24.2			
Managua	1,200,300	1,383,600	1,573,800	1,963,800	2.9	2.6	2.2

2) Vivienda

Number of persons per vivienda differs by type of housing. The Dirección de Urbanismo of ALMA assumes average number of persons per vivienda as shown in Table 4.2.3 for the purpose of estimating population.

Table 4.2.3
Number of Persons per Vivienda by Type

Housing Type	No. of Persons per Vivienda
Residential	5
Traditional	7
Popular	7
Spontaneous	5
Rural	6

Source: ALMA

The number of viviendas in Managua is estimated at 192 thousand as of 1998. The average number of persons per vivienda is 6.25. It is difficult to forecast the number of viviendas in the future due to a number of factors such as current difficulty in acquiring new houses, continuous pressure for urbanization and increasing income. In this Study, the average number of persons per vivienda was assumed to remain constant as shown in Table 4.2.4

Table 4.2.4
Future Projection of Number of Viviendas, Managua 1998-2018

	1998	2003	2008	2018	1998-03	2003-08	2008-18
Population	1,200,300	1,383,600	1,573,800	1,963,800	2.9	2.6	2.2
Persons per Vivienda	6.25	6.25	6.25	6.25			
Number of Viviendas	192,000	221,400	251,800	314,200	2.9	2.6	2.2

4.2.2 Gross Regional Domestic Product by Sector

1) Estimate of GRDP in 1998

According to the Person-Trip Survey and the Cordonline Survey conducted in 1998 in this Study, the employment size in Managua is at present 383,500, out of which 34,200 come from outside Managua. Of the total employment, nearly 80% belong to the tertiary sector. Particularly commerce and services share about one third each.

Managua's GRDP can be estimated by multiplying labor productivity with employment by sector as shown in Table 4.2.5. The GRDP of Managua in 1998 is calculated at C$8,110.2 million at 1980 constant prices or at C$7,823.1 million at current prices. This is corresponding to 35.6% of the national GDP. In terms of US$, Managua's GRDP accounts for US$745.1/million, and per capita GRDP US$620. The secondary sector which shares only 1/5 of employment contributes to 1/3 of GRDP reflecting the high productivity.

Table 4.2.5
Estimation of GRDP of Managua in 1998

	No. of Employed Persons in Managua			Labour Productivity (C$/person)	GRDP (Million C$)
	Resident of Managua	Resident of Outside*	Total		
All Sectors	349,300	34,200	383,500	21,148	8,110.2
Primary Sector	4,100	300	4,400	10,800	47.5
Secondary Sector	73,500	7,700	81,200	33,061	2,684.5
Manufacturing	54,000	5,500	59,500	38,400	2,284.8
Construction/Mining	19,500	2,200	21,700	18,420	399.7
Tertiary Sector	271,700	26,200	297,900	18,054	5,378.2
Commerce	117,100	13,000	130,100	16,500	2,146.7
Transport/Commun.	22,900	2,500	25,400	23,010	584.5
Financing	7,900	400	8,300	83,780	695.4
Energy/Water	4,500	200	4,700	100,840	473.9
Other Services	119,300	10,100	129,400	11,420	1,477.7

Note: * Estimated based on the results of the "Cordonline Survey"

Table 4.2.6
Comparison between GRDP and GDP, 1998

Nicaragua	
GDP (real, C$ million) (A)	22,781.2
GDP (nominal, C$ million)	21,974.7
GDP (US$ million)	2,092.8
GDP per capita (US$) (B)	420
Managua	
GRDP (real, C$ million) (C)	8,110.2
GRDP (nominal, C$ million)	7,823.1
GRDP (US$ million)	745.1
GRDP per Capita (US$) (D)	620
Share: (C)/(A) (%)	35.6
Difference: (D)-(B) (US$)	200

2) Future Projection of GRDP

In line with the projection of Nicaragua's GDP, the sectoral GRDP in Managua was estimated as presented in Table 4.2.7.

Table 4.2.7
Future Projection of GRDP of Managua by Sector, 1998-2018

	GRDP (C$ million at 1980 prices)				Annual Growth Rates (%)		
	1998	2003	2008	2018	1999-03	2004-08	2009-18
GRDP Total	8,110.2	10,589.9	13,954.5	24,400.3	5.5	5.7	5.7
Primary Sector	47.5	65.8	88.1	140.1	6.7	6.0	4.7
Secondary Sector	2684.5	3620.5	4971.7	9435.2	6.2	6.5	6.6
Manufacturing	2284.8	2916.0	3811.2	6987.7	5.0	5.5	6.2
Construction/Mining	399.7	704.4	1160.5	2447.5	12.0	10.5	7.7
Tertiary Sector	5378.2	6903.6	8894.8	14825.1	5.1	5.2	5.2
Commerce	2146.7	2792.3	3632.2	6145.7	5.4	5.4	5.4
Transport/Commun.	584.5	760.2	988.9	1673.3	5.4	5.4	5.4
Financing	695.4	948.3	1293.1	2416.0	6.4	6.4	6.4
Energy/Water	473.9	604.9	772.0	1257.5	5.0	5.0	5.0
Other Services	1477.7	1797.9	2208.5	3332.6	4.0	4.2	4.2
GRDP (US$ million)	745.1	976.9	1287.3	2250.1	5.6	5.7	5.7
GRDP per Capita (US$)	620	710	820	1150	2.7	2.9	3.4

Basic considerations in this projections are:

A. Growth rate of economy was assumed slightly higher than the national average.
B. Manufacturing and financing were considered to be long-term growth engines for the economic development of Managua.

Per capita GRDP will increase from US$620 in 1998 to 1,150 in 2018 in Managua.

4.2.3 Labor Force and Employment

Based on the Person-Trip Survey and Cordonline Survey conducted in 1998 in this Study, the employment situation of Managua's residents is as shown in Table 4.2.8. Out of the total labor force of 453,900, employed are 357,900 (78.8%) and unemployed 96,000 (21.2%). Of the employed persons, 349,300 (97.6%) have a workplace in Managua.

Table 4.2.8
Employed Persons by Sector and Place of Work, Managua, 1998

	Number (Person)	Composition (%)	Place of Work	
			Managua	Outside
Total (A)	357,900	100.0	349,300	8,600
Primary Sector	4,600	1.3	4,100	500
Secondary Sector	76,500	21.4	73,500	3,000
Manufacturing	56,400	15.8	54,000	2,400
Construction/Mining	20,100	5.6	19,500	600
Tertiary Sector	276,800	77.3	271,700	5,100
Commerce	118,800	33.2	117,100	1,700
Transport/Commun.	23,400	6.5	22,900	500
Financing	7,900	2.2	7,900	0
Energy/Water	4,900	1.4	4,500	400
Other Services	121,800	34.0	119,300	2,500
Total Population (B)	1,200,300			
Pop. 10 Years & Over (C)	889,400			
Labour Force (D)	453,900			
Employed	357,900			
Unemployed	96,000			
Activity Rate (%)				
Gross Rate (D)/(B)	37.8			
Refined Rate (D)/(C)	51.0			
Unempl. Rate (E)/(D) (%)	21.2			

In 1998, the Gross Activity Rate is 37.8%, which is 1.4% higher than that in 1995 census. As mentioned earlier, the rate is supposed to grow continuously in the future. In this Study, the rate is assumed to rise by 1.5% every five (5) years. Then the rate will reach 44.0% in 2018, and the economically active population will be 864,100 as shown in Table 4.2.9.

Table 4.2.9
Future Projection of Labour Force Supply, Managua, 1998-2018

	1998	2003	2008	2018	1998-03	2003-08	2008-18
Total Population	1,200,300	1,383,600	1,573,800	1,963,800	2.9	2.6	2.2
Gross Activity Rate (%)	37.8	39.5	41.0	44.0			
Economically Active Pop.	453,900	546,500	645,300	864,100	3.8	3.4	3.0

As economy grows, the demand for labor force is considered to grow as shown in Table 4.2.10. In 2018, there will be a demand for an employment of about 870 thousand. Assuming the same percentage for the share of non-residents, about 79 thousand will commute to Managua from outside. From Managua to outside, on the other hand, about 20 thousand will go to work, as presented in Table 4.2.11.

Table 4.2.10
Future Projection of Labour Force Demand by Sector, Managua, 1998-2018

	1998	2003	2008	2018	1998-03	2003-08	2008-18
Total	383,500	472,400	581,800	870,000	4.3	4.3	4.1
Primary Sector	4,400	5,700	7,200	10,300	5.3	4.8	3.6
Secondary Sector	81,200	108,400	145,200	247,600	5.9	6.0	5.5
Manufacturing	59,500	72,100	88,800	143,100	3.9	4.3	4.9
Construction/Mining	21,700	36,300	56,400	104,500	10.8	9.2	6.4
Tertiary Sector	297,900	358,300	429,400	612,100	3.8	3.7	3.6
Commerce	130,100	160,800	197,100	292,900	4.3	4.2	4.0
Transport/Commun.	25,400	31,400	38,500	57,200	4.3	4.2	4.0
Financing	8,300	10,800	13,800	22,700	5.4	5.0	5.1
Energy/Water	4,700	5,700	6,900	9,800	3.9	3.9	3.6
Other Services	129,400	149,600	173,100	229,500	2.9	3.0	2.9

Table 4.2.11
Future Projection of Demand/Supply Balance of Labour Force, Managua, 1998-2018

	1998	2003	2008	2018
Labour Force Demand	383,500	472,400	581,800	870,000
Supplied from Managua	349,300	430,000	529,400	791,200
Supplied from Outside	34,200	42,400	52,400	78,800
Labour Force Supply	453,900	546,500	645,300	864,100
Employed in Managua	349,300	430,000	529,400	791,200
Employed Outside	8,600	10,600	13,300	20,000
Unemployed	9,600	105,900	102,600	52,900
Unemployment Rate (%)	21.2	19.4	15.9	6.1

4.2.4 School Enrolment

Table 4.2.12 and 4.2.13 show the past trends of school attendance in Nicaragua. It is obvious that the rate of school attendance is improving and that the rate of initial enrolment at the primary education stage is nearly 100%.

Table 4.2.12
School Attendance in 6-29 Year Group, Nicaragua, 1963, 1971 and 1995

	1963	1971	1995
Nicaragua Total	27.5	34.3	48.8
Urban	45.2	52.6	59.6
Rural	15.6	17.3	35.4

Source: "Resumen Censal, VII Censo Nacional de Población y III de Vivienda, 1995" (1996, INEC)

Table 4.2.13
Rate of Initial Enrolment by Educational Stage, Nicaragua, 1992-1997

	1992	1993	1994	1995	1996	1997 (p)
Preschool	13.1	14.5	17.3	17.2	19.7	22.3
Primary	102.1	103.7	104.4	101.0	98.3	97.8
Secondary	36.5	36.1	38.0	38.7	39.3	39.9
Higher	9.2	10.1	10.3	10.9	11.3	12.5
Ratio: Enrolled Stu./Pop.	25.6	26.1	26.8	26.4	26.3	26.8

Source: MED

Table 4.2.14 compares the ratio of students/pupils to total population between 1995 census and 1998 Person-Trip Survey. The ratio is slightly lower in the latter.

Table 4.2.14
School Enrolment of Managua by Census and P.T. Survey

	Population Census 1995			P.T.
	Total	Urban	Rural	Survey, 1998
Total Population	903,100	864,201	38,899	1,200,300
Population 5 years +	782,935	749,643	33,292	1,042,900
Number of Students	324,589	313,066	11,523	410,700
Students/Pop. 5Y+ (%)	41.5	41.8	34.6	39.4
Students/Total Pop. (%)	35.9	36.2	29.6	34.2

In the future, the ratio of students/pupils to total population is considered to grow mainly due to the increase of school attendance in the higher levels of education. Assuming a 1.5% growth of this ratio every five (5) years, the number of students/pupils has been projected as shown in Table 4.2.15. In 2018, the number of students/pupils residing in Managua will be 795,300. About 3,100 will study outside Managua, and about 8,200 will come from outside to study in Managua.

Table 4.2.15
Future Projection of Number of Students

	1998	2003	2008	2018	1998-03	2003-08	2008-18
Resident of Managua							
Total Population	1,200,300	1,383,600	1,573,800	1,963,800	2.9	2.6	2.2
Ratio of Stu./Pop. (%)	34.2	36.0	37.5	40.5			
No. of Students	410,700	498,100	590,200	795,300	3.9	3.5	3.0
School in Managua (A)	409,100	496,200	587,900	792,200	3.9	3.4	3.0
School outside Managua	1,600	1,900	2,300	3,100			
Resident Outside							
Ratio of Outside Stu. (%)	1.02	1.02	1.02	1.02			
No. of Students (B)	4,200	5,100	6,100	8,200			
Total in Managua (A+B)	413,300	501,300	594,000	800,400	3.9	3.5	3.0

4.2.5 Income Level and Car Ownership

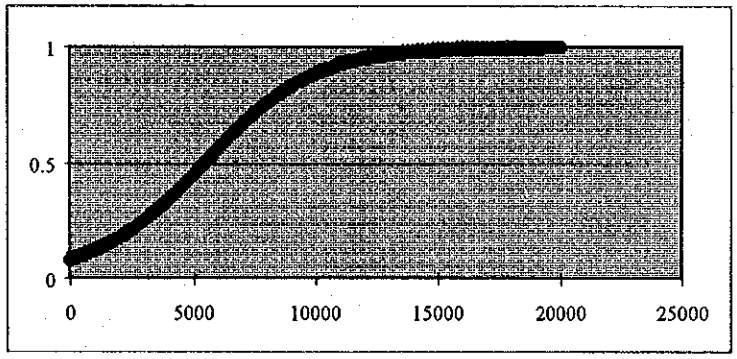
As revealed by the Person-Trip Survey, the average income per vivienda is C$2,470/month as of 1998. This will grow to C$4,570/month at 1998 prices in 2018 in proportion to per capita GRDP.

The interrelation between average income per vivienda and the ratio of car owning viviendas can be expressed by the following equation:

$$p = \frac{1}{1 + \exp(-0.0004459c + 2.422)}$$

Where, p: Ratio of car owning vivienda
c: Average income per vivienda (C$/month)

Figure 4.2.1
Relationship between Monthly Vivienda Income and Percentage of Car Owning Viviendas



According to the equation above, the ratio of car owning viviendas will be 40.5% in 2018.