7. Master Plan

7. MASTER PLAN

7.1 Land Use Plan

7.1.1 Development Concept

In order to materialize the concept identified in Section 5.5, the following strategies have been determined:

Short-Term (2003)

- Taking into account the existing developments and currently ongoing projects, the basis for creating urban axes should be formed in terms of land use and transportation infrastructure development.

- Urbanization should be confined in the existing urban area to make maximum use of the existing resources.

Medium-Term (2008)

- A clearly defined structure for urban axes of Managua should be constructed.

- Similarly to the short-term strategies, the existing resources should be utilized to the maximum extent. However, controlled expansion of urbanization mainly towards the east and the west could be admitted.

Long-Term (2018)

- Urbanization will be expanded considerably. It must be controlled in the defined urban areas, and roads should not be developed outside the urban area with a few exceptions that were necessarily proposed to avoid anticipated traffic congestion of the urban road network.

- Urban axes should be extended to the newly urbanized area by creating urban activity centers.

The strategies above are summarized in Figure 7.1.1. Table 7.1.1 shows quantitatively the planned land use and population.

7.1.2 Land Use Plan

Figure 7.1.2, 7.1.3 and 7.1.4 show the land use plan for the short, medium and long-term, respectively. In these plans, the following points should be noted:

A. Land Use Restriction

- In the planned business/commercial/institutional area to be created as the urban axes, low-density residential use should be restricted. For this purpose, a relatively high floor/area ratio (FAR) of about 150 to 200% should be specified. In the application of this restriction, the base FAR should be the minimum at 150%. Then the bonus FAR of up to 200% is given to the developer depending on the land provided for public use in the frontage area of the site. In any case, however, the building structure should be controlled to be earthquake-resistant.

Figure 7.1.1
Managua's Development Strategies

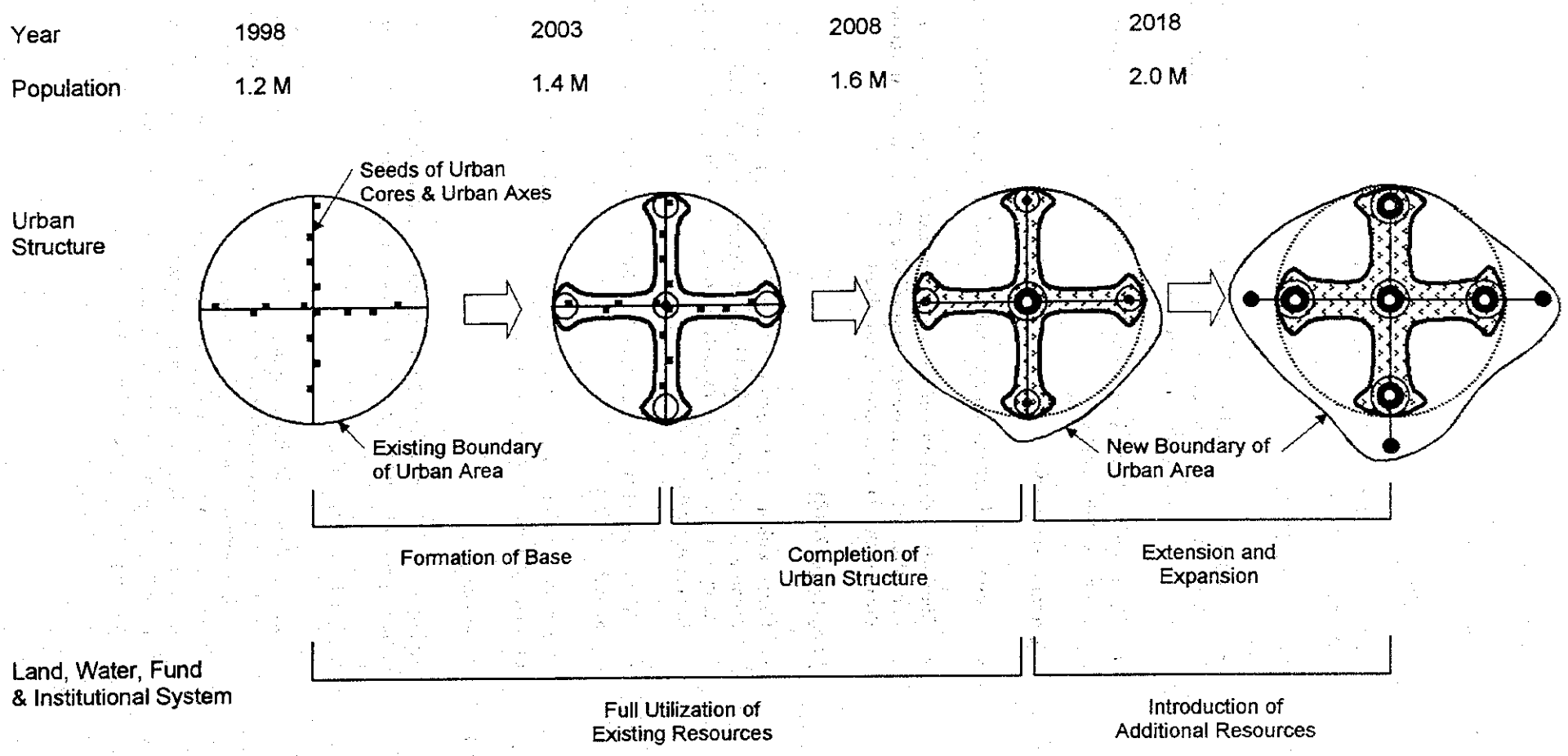


Table 7.1.1
Land Use and Population, 1998, 2003, 2008 and 2018

	1998			2003			2008			2018		
	Area (ha)	Population	Density (psn/ha)	Area (ha)	Population	Density (psn/ha)	Area (ha)	Population	Density (psn/ha)	Area (ha)	Population	Density (psn/ha)
1. Urban Area	12,358	1,116,575	90.4	12,358	1,285,900	104.1	15,536	1,493,700	96.1	19,447	1,902,800	97.8
1.1 Existing Urban Area	12,358	1,116,575	90.4	12,358	1,285,900	104.1	12,358	1,402,700	113.5	12,358	1,402,700	113.5
- Central	8,581	913,568	106.5	8,581	962,600	112.2	8,581	1,011,700	117.9	8,581	1,011,700	117.9
- Residential/Others	7,586			7,494			7,311			7,281		
- Commercial/Service	635			727			910			940		
- Industrial	360			360			360			360		
- Peripheral	3,777	203,007	53.7	3,777	323,300	85.6	3,777	391,000	103.5	3,777	391,000	103.5
- Residential/Others	3,777			3,768			3,754			3,732		
- Commercial/Service				9			23			45		
1.2 New Urbanization							3,178	91,000	28.6	7,089	500,100	70.5
- Residential							602	78,500	130.4	3,713	478,300	128.8
- Commercial/Service							3			30		
- Industrial							168			350		
- Others							2,405	12,500	5.2	2,996	21,800	7.3
2. Rural Area	42,338	83,710	2.0	42,338	97,700	2.3	39,060	80,100	2.1	35,149	61,000	1.7
Managua Total	54,596	1,200,285	22.0	54,596	1,383,600	25.3	54,596	1,573,800	28.8	54,596	1,963,800	36.0

Note: 1) Commercial/Service does not include neighborhood type land use.
2) Traffic Zone 98 (Airport Area) and Traffic Zone 101 are included in New Urbanization after 2008.

Figure 7.1.2 Planned Land Use, 2003

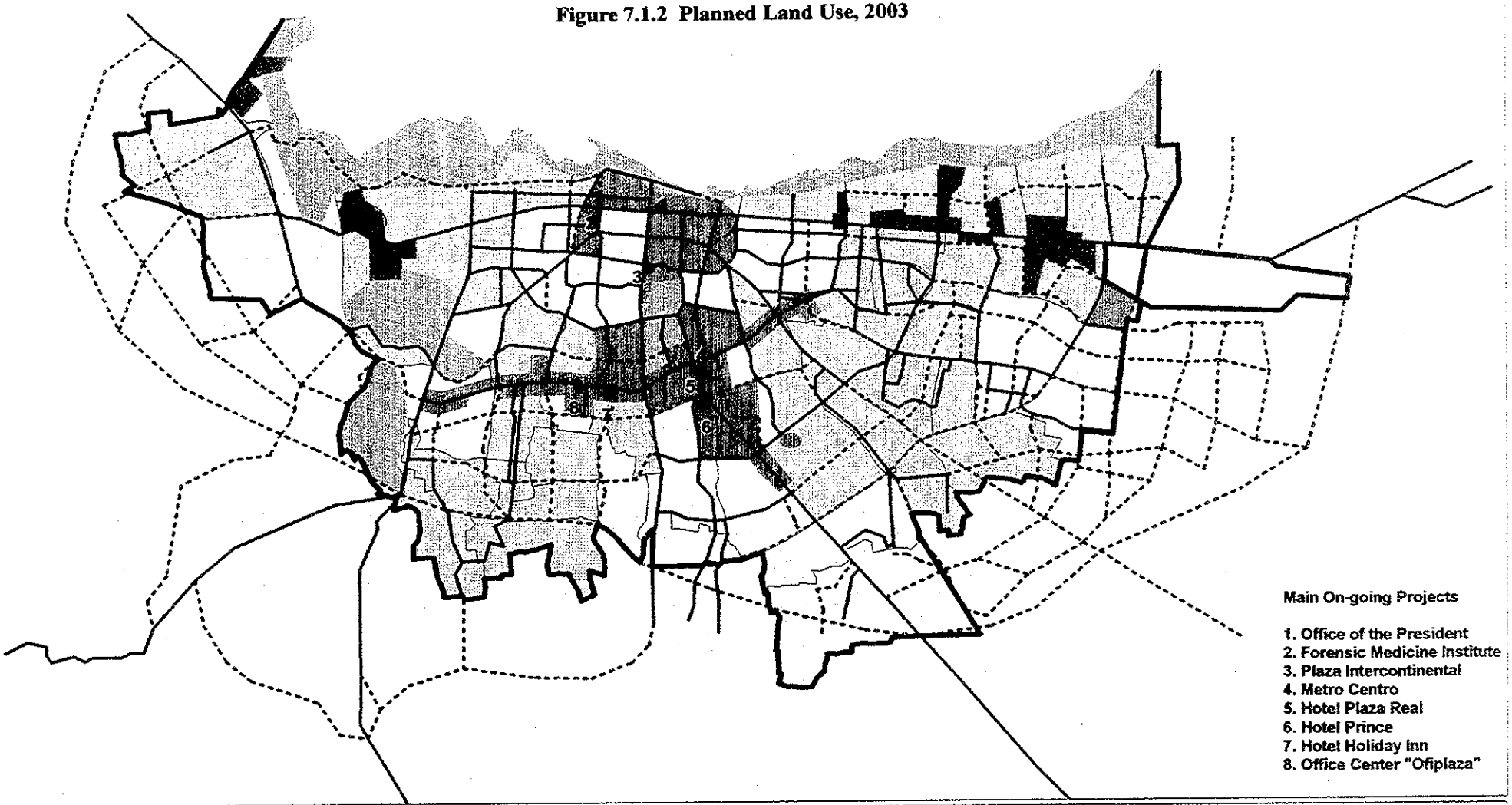


Figure 7.1.3 Planned Land Use, 2008

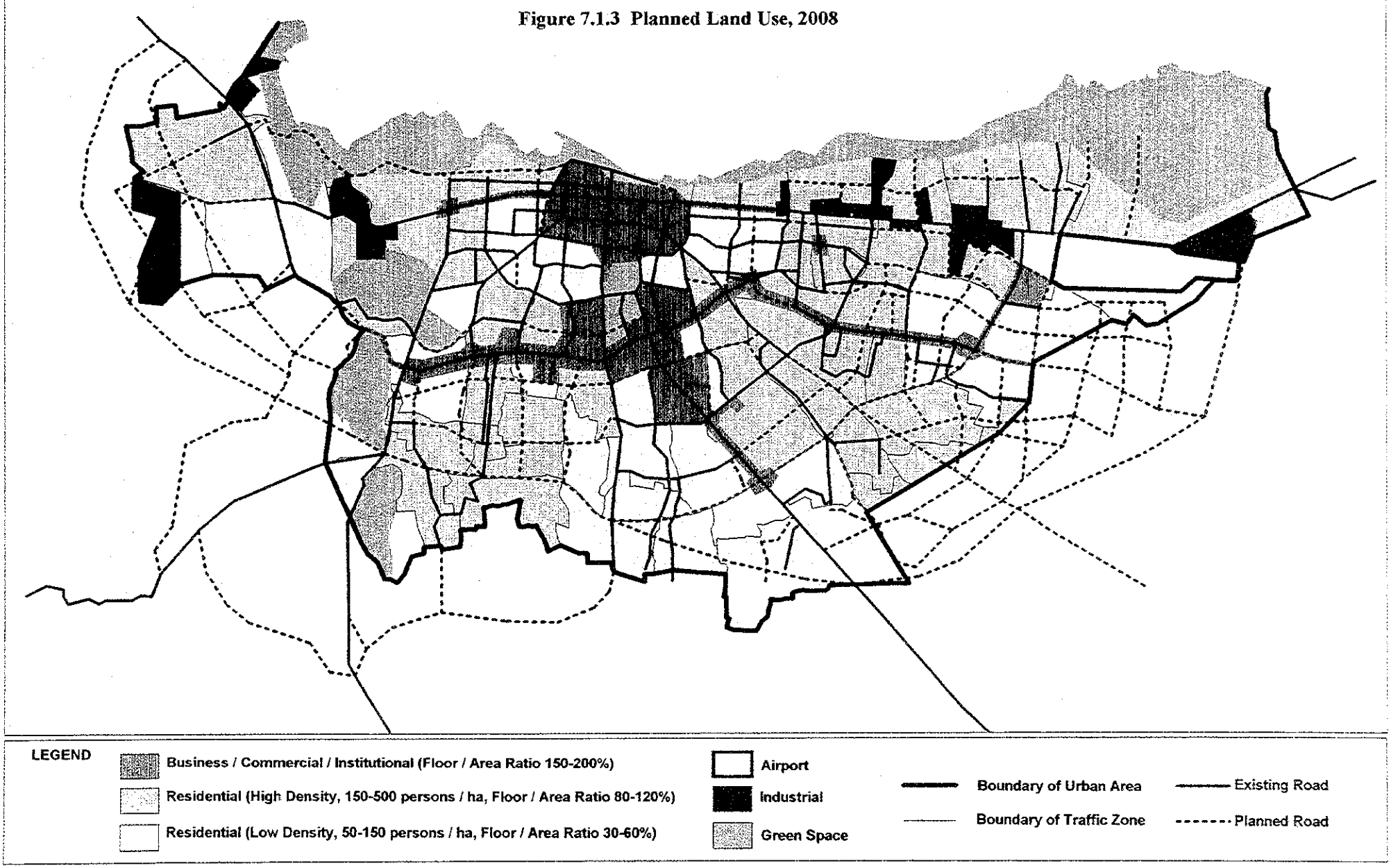
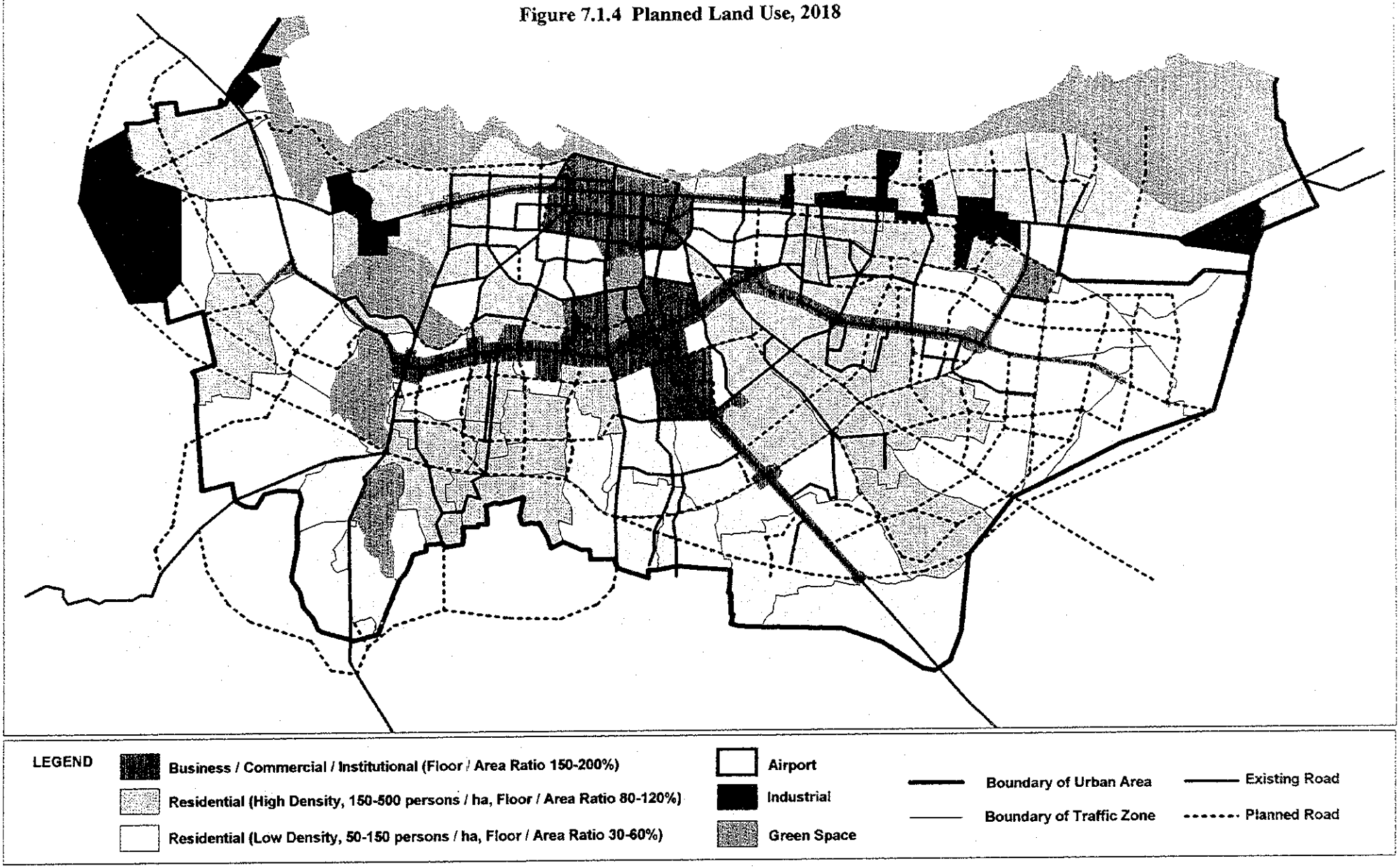


Figure 7.1.4 Planned Land Use, 2018



- There are two types of residential areas: high-density and low-density. High-density residential area allows a FAR of 80-120%, which is suitable for two-story structure. The population density of this area is 150 to 500 persons/ha. Low-density residential area allows a FAR of 30-60% assuming one-story structure and a population density of 50 to 150 persons/ha. Considering the possibility of earthquakes, high-rise structure of more than three stories is not recommendable unless the structure is earthquake-resistant.

- Outside the planned urbanization, a strict land use control should be imposed to prohibit disorderly urban sprawl towards suburban areas.

B. Restriction due to Airport.

- The existing Managua International Airport imposes a restriction on land use around Villa Libertad in the eastern part of Managua's urbanization, and the restricted area will expand considerably if new runway is constructed as proposed by MTI. This proposal, however, casts the following questions:

  - The existing houses and buildings in the restricted area are removed?
  - The existing airport is already used to the maximum extent?
  - There is no possibility to relocate the airport outside Managua?

- The land use plan of this study is not affected much in the short-term and medium-term by this restriction. In the long-term, however, some adjustments may be needed in terms of land use and road network, if airport expansion is to be implemented as proposed. This Study recommends to further study the pros and cons of various alternatives for airport development.

7.2 Road Network Development

7.2.1 General

As analyzed in Section 7.2.2, the road network of Managua will soon be congested due to the increase of number of vehicles as a result of economic growth and population increase. Hence, the development of new roads as well as the improvement and maintenance of existing roads becomes essential for the future of Managua.

However, the problem of traffic congestion has never been solved in the world merely by constructing the road one after another. It is not only a waste of resources but a profanation to the living environment of the city. Road development must be executed in a balance with other measures of public transportation improvement, traffic management, and transportation demand management. In other words, traffic problem cannot be solved by supply-side measures alone, and demand-side measures should be taken into account.

Another important fact in this regard is that road development is always followed by urbanization where population is rapidly increasing. A vicious circle tends to be created between urban sprawl and road development. The development of roads in Managua should be strictly controlled in a well planned manner in accordance with the land use plan. This, however, requires an enhanced planning capacity and a strong enforcement capability in the City's administration.

The outline of the proposed actions is summarized as follows:

I. Immediate Actions

1. Arrange a legal and institutional set-up to ensure the stability of land use plan including road network.
2. Establish social and financial systems to relocate existing squatters.
3. Start negotiations with citizen in relation to the improvement of bottleneck sections.

II. Short-Term Actions

1. Complete the identified bottleneck sections in the existing road network.
2. Widen and improve the road sections in relation to the Public Transportation Corridors identified in Section 7.3 of this Report.

III. Medium-Term Actions

1. Develop the roads in the planned urbanization area, taking into account the identified Public Transportation Corridors.
2. Consider the possibility of constructing toll roads.

IV. Long-Term Actions

1. Develop the roads in the planned urbanization area, taking into account the identified Public Transportation Corridors.

7.2.2 Evaluation of Existing Road Network

Figure 7.2.1 presents the forecasted traffic volume in the future on the existing road network of Managua. Namely, this figure shows the Do-Nothing situation where no investment is made for new road development. This exercise assumes the following in calculating the modal split:

1. The cost of private car trips was assumed at C$0.60 per passenger-km. This is 20% higher than at present considering the currently proposed Road Maintenance Fund (Fondo Vial de Mantenimiento). For bus trips, the cost was assumed at C$0.50 plus C$0.40 per km (determined in the calibration of traffic assignment for the year 1998). This is distance-related in contrast to the current flat fare at C$1.40 (refer to Section 7.3.3 of this Report).

2. The travel speed of bus is set constant at 20 km/h. This is the same level as at present and assumed to be maintained in the future due to the various priority measures proposed in this Study (excluding Public Transportation Corridor of which effect is evaluated separately).

The following can be pointed out based on this exercise (refer to Table 7.2.1):

1. Total number of trips will increase from 1998 by 34% in 2003, by 58% in 2008 and by 119% in 2018.

2. The modal share of private mode will increase continuously. Public transportation will lose its share from 50% in 1998 to 40% in 2018 by 10%.

3. Average trip length will increase gradually as urbanization proceeds. The rate of increase is higher for private mode.

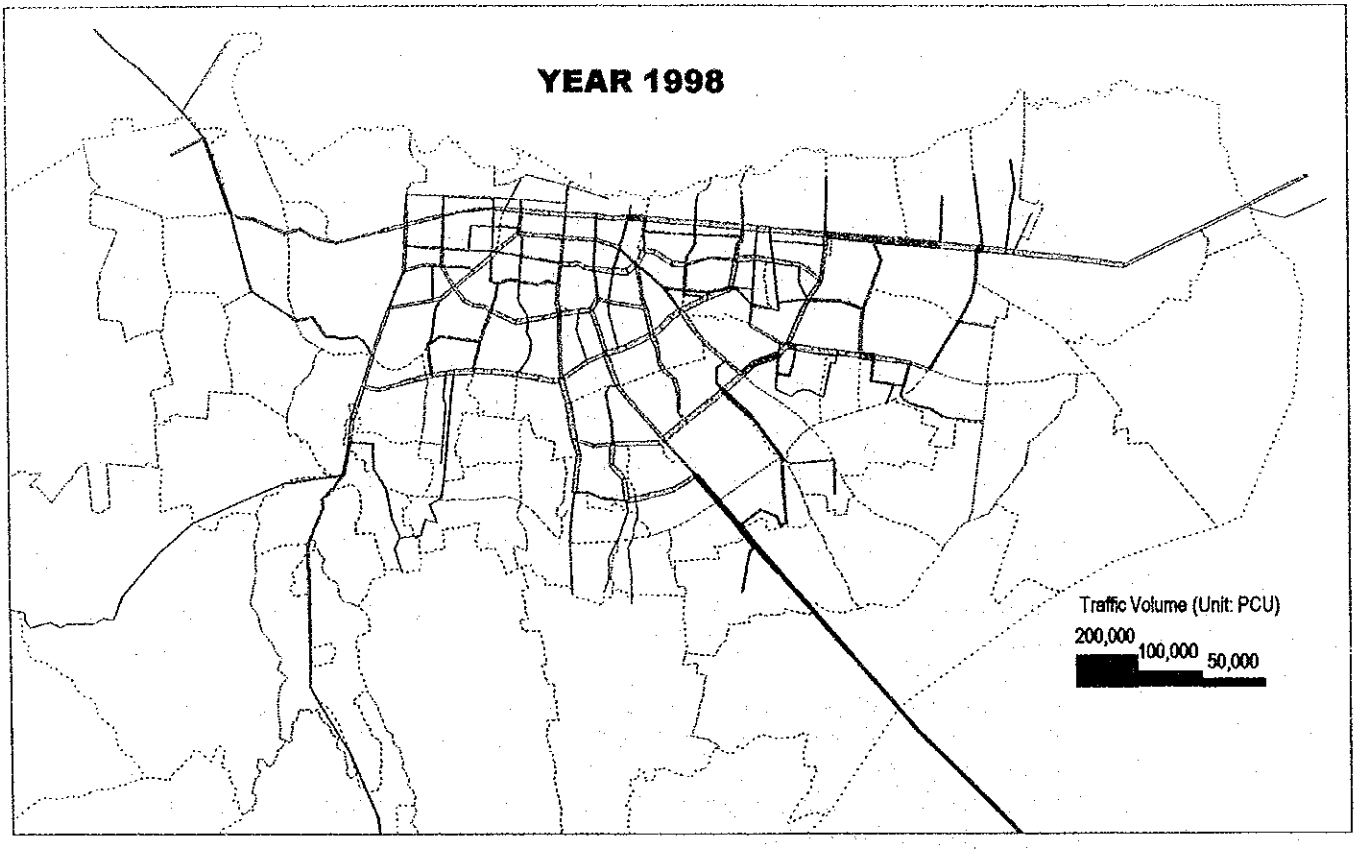
4. As of 1998, the average volume/capacity ratio is 0.59 for the entire road network of Managua. Before 2003, however, it will reach its capacity, and the travel speed will decrease to below 20 km/h. Since this is an average, traffic congestion will become extremely serious on many road sections as shown in Figure 7.2.1. In 2008 and 2018, the average volume/capacity ratio is calculated at 1.38 and 2.20, respectively. But this is already an imaginary situation which never happens.

   Namely, if road is not developed in Managua, traffic congestion will become intolerable within a few years. The following section proposes the necessary actions.

Table 7.2.1
Results of Traffic Assignment for Do-Nothing Situation (excluding walk trips)

	1998	2003	2008	2018
No. of Trips (000/day)				
• Private	871.3	1,200.7	1,485.9	2,323.7
• Public	880.0	1,138.7	1,277.8	1,514.2
• Total	1,751.3	2,339.4	2,763.7	3,837.9
Modal Share (%)				
• Private	49.8	51.3	53.8	60.5
• Public	50.2	48.7	46.2	39.5
Average Trip Length (km)				
• Private	7.3	9.8	9.9	10.2
• Public	6.2	6.8	7.1	7.8
• Average	6.7	8.3	8.6	9.3
Average Travel Speed (km/h)	26.2	16.5	14.2	10.6
Average Volume/Capacity Ratio	0.59	1.11	1.38	2.20

Figure 7.2.1 Forecasted Traffic Flow on Existing Road Network



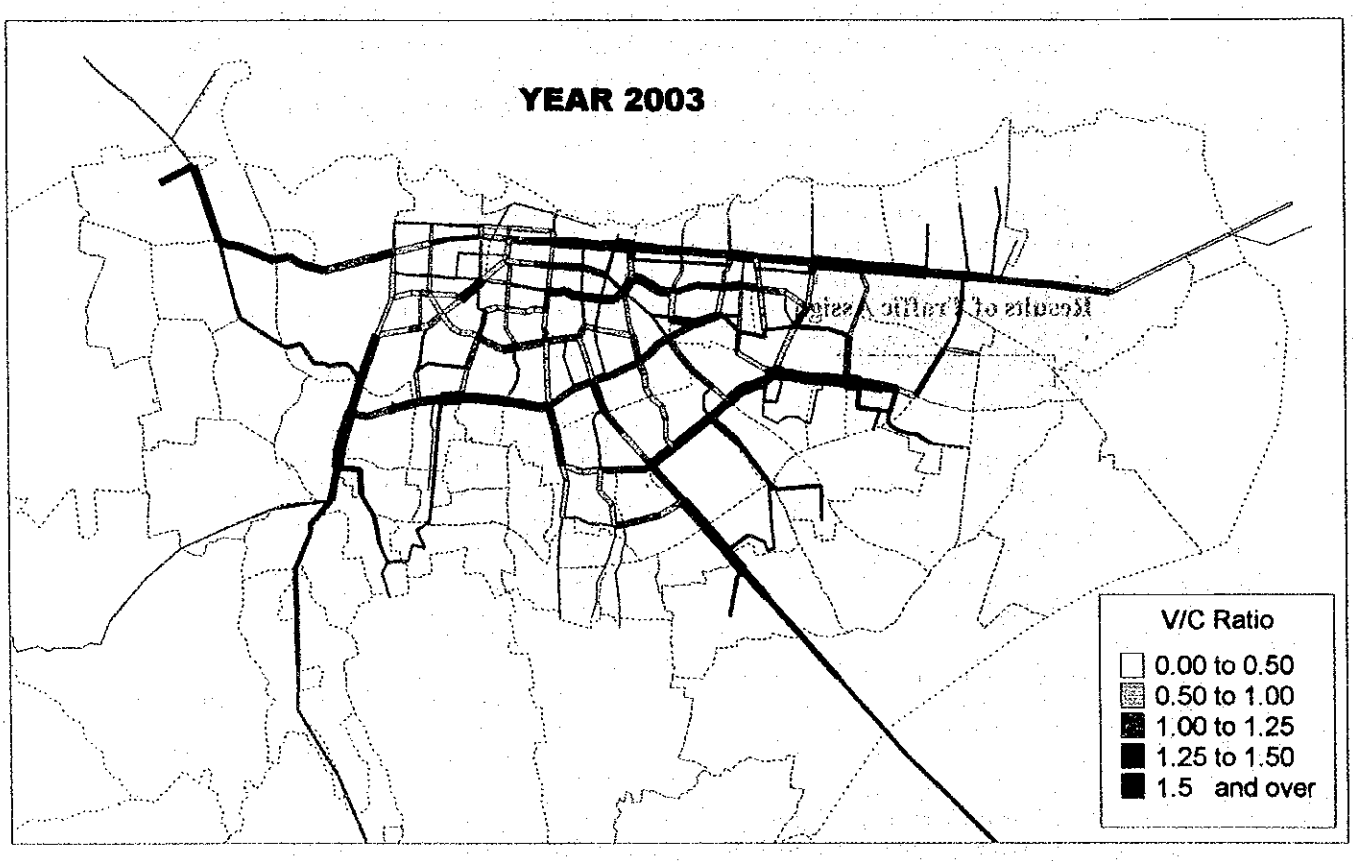
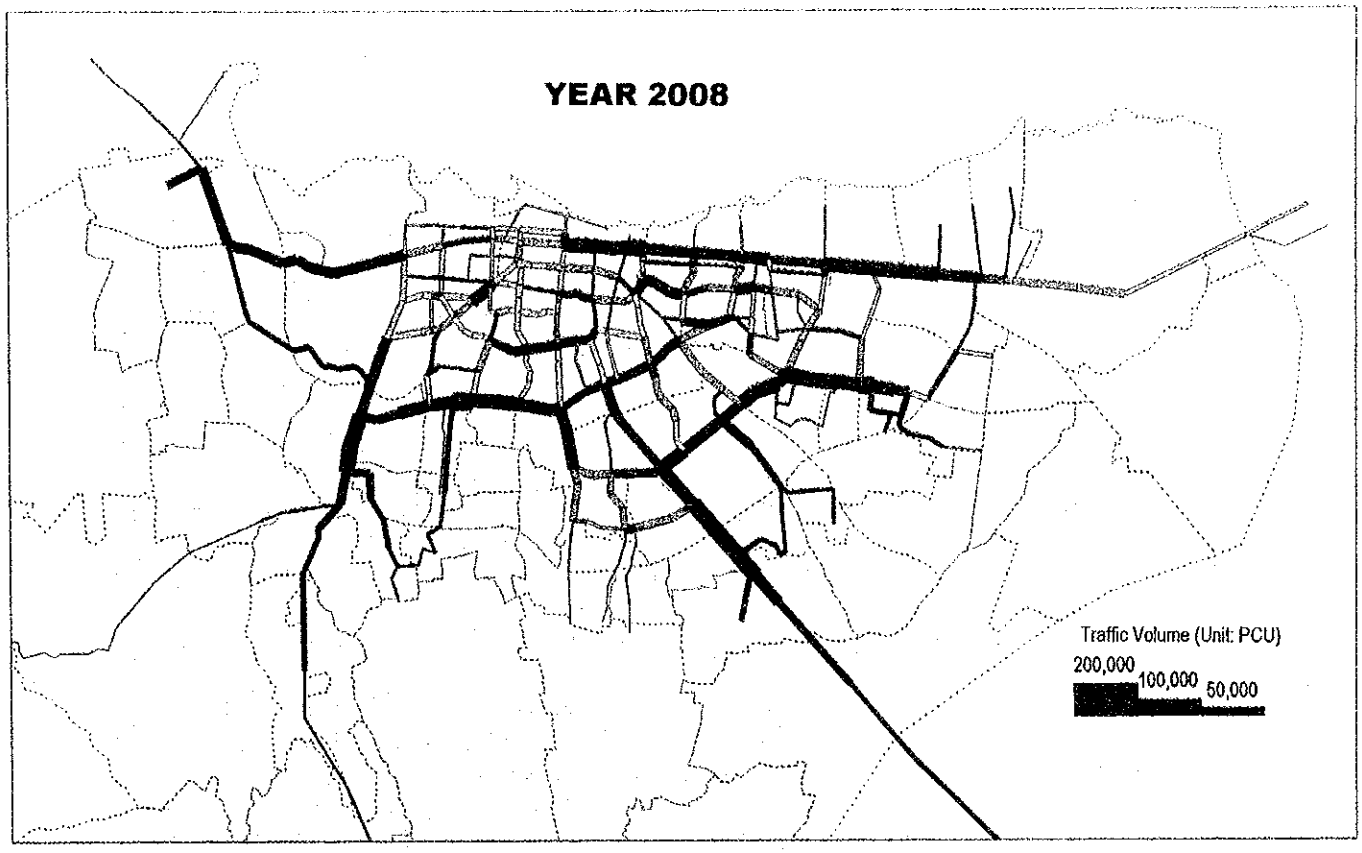
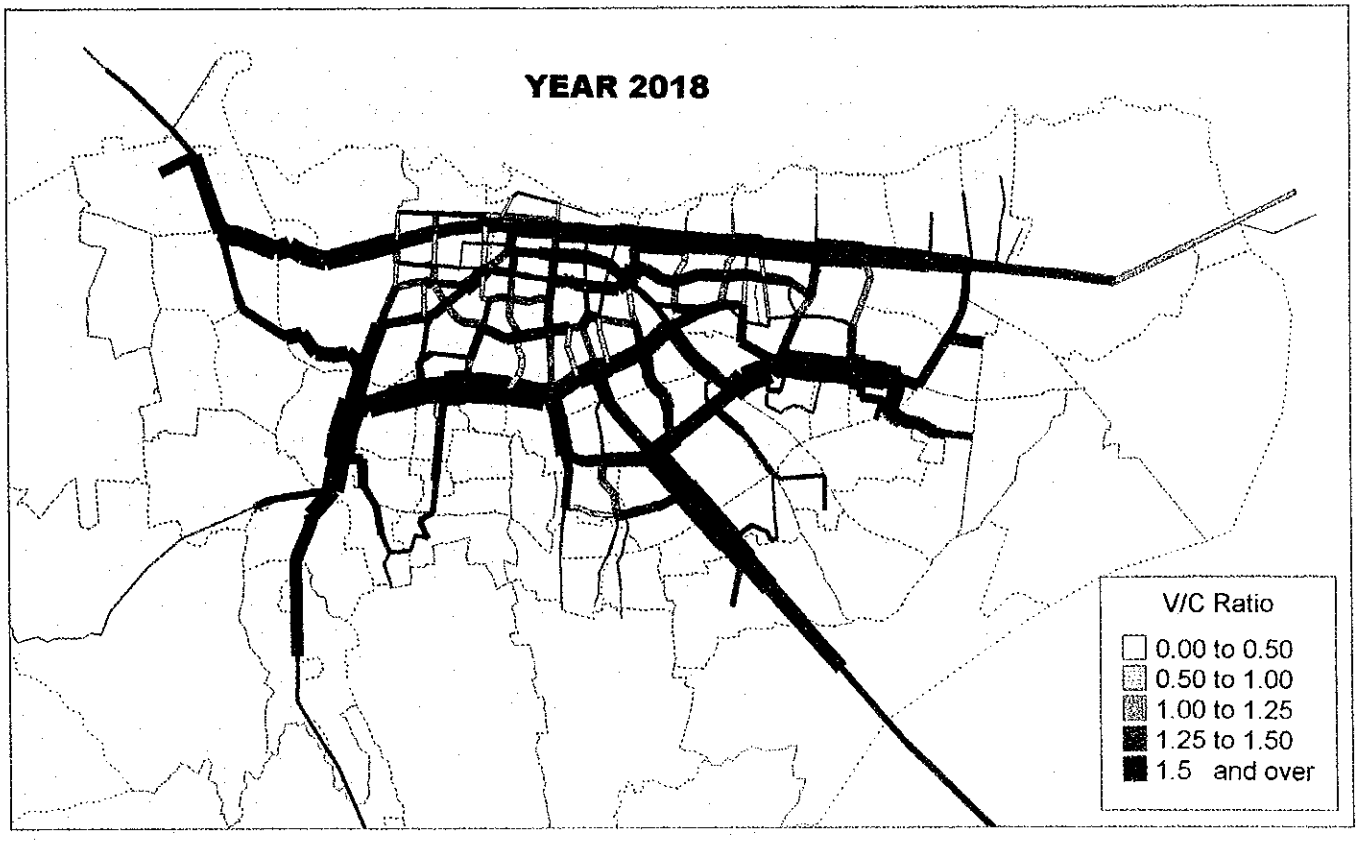


Figure 7.2.1 (Cont'd)





7.2.3 Desirable Future Road Network and Hierarchy

1) Guidelines

A. Compliance with the Land Use Plan

- Outside the area identified for future urbanization, new roads are not proposed except for a few interurban arteries.
- In the Short-Term Plan, the focus is put on the completion of bottleneck sections and missing links in the existing road network. In the Medium-Term and Long-Term Plan, the development of new roads is confined in the planned urban areas.

B. Clearly Defined Functional Hierarchy

- In the existing road development plan of ALMA, too much emphasis is placed on the Class 2 roads (Primary Distributor). Suitable hierarchy of roads should be pursued by redefining the function of roads as shown in Figure 7.2.3.
- The density of road network is planned in the light of trip generation/attraction.
- The type of intersection is unified based on the classes of intersecting roads (refer to Section 7.4.2). Class 1 roads (Travesía) do not intersect with Class 4 roads (Secondary Collector) and Class 5 roads (Local Road).
- The Plan Regulador de Managua defines the typical cross-section of roads by class. In this Master Plan, this standard is maintained as much as possible as shown in Figure 7.2.2.

C. Segregation of Interurban Traffic

- Interurban traffic, particularly those running through Managua, is segregated as much as possible from the city traffic. Class 1 road (Travesía) which passes along the boundary of planned urbanization is constructed basically for this purpose. This is an access-controlled high-standard road, and the possibility to construct this road as a tollway is discussed.

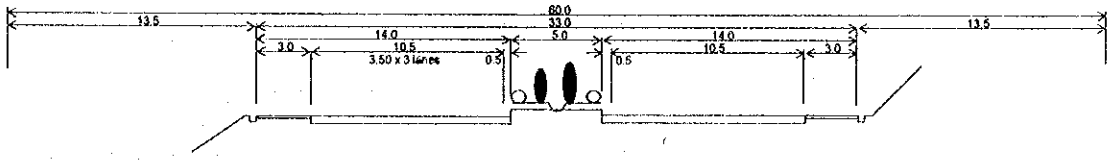
D. Earthquake-Proof Road Network

- In order to secure alternative route from one place to the other, the road network is planned as a grid pattern, not as radial-circumferential pattern that fits to the mono-centric urban structure. However, this is realized by changing the interpretation of the existing plan as much as possible.

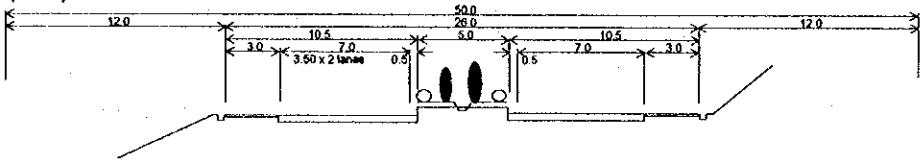
Figure 7.2.2 Typical Road Cross Section Plan by Road Classification

1. Travesia

a) 6 Lanes (w=60m)

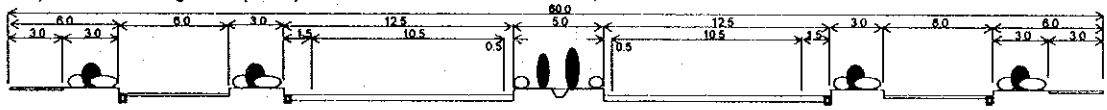


b) 4 Lanes (w=50m)

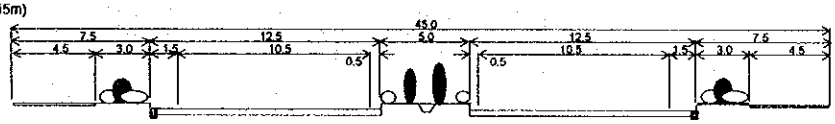


2. Primary Distributor

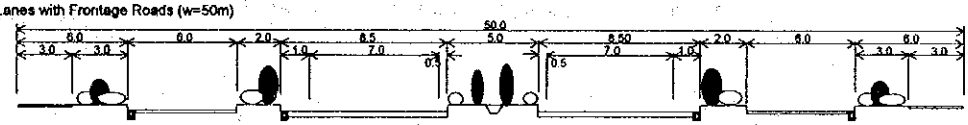
a) 6 Lanes with Frontage Roads (w=60m)



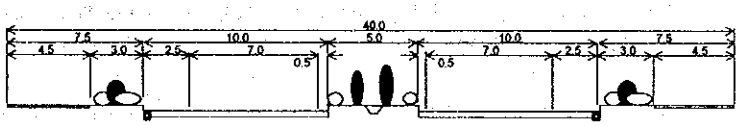
b) 6 Lanes (w=45m)



c) 4 Lanes with Frontage Roads (w=50m)

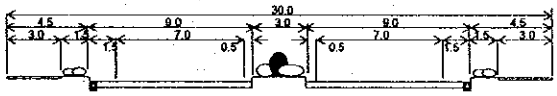


d) 4 Lanes (w=40m)



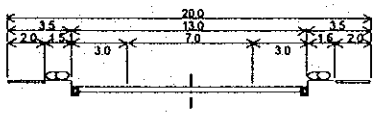
3. Primary Collector

a) 4 Lanes (w=30m)

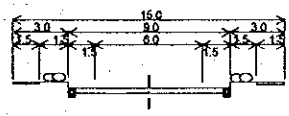


4. Secondary Collector

a) 2 Lanes (Commercial Area) (w=20m)



b) 2 Lanes (Residential Area) (w=15m)



2) Planning

A. Entire Network

- Figure 7.2.3 presents the Road Network Master Plan for Managua. Figure 7.2.4 shows the distribution of number of lanes of the Master Plan Network. The total length of the road network accounts for 449.3 km of which 225.9 km assumes new construction. Out of 225.9 km of new construction, 178.5 km (79.0%) were taken from the existing road development plan of ALMA, and the remaining 47.4 km (21.0%) have been newly proposed in this Study, as shown in Table 7.2.2.

Table 7.2.2
New Roads Proposed in This Study in Comparison with Existing Plan of ALMA

Class	ALMA		This Study	
	km	%	km	%
1	14.2	8.0	34.1	15.1
2	46.6	26.1	39.7	17.6
3	65.7	36.8	63.4	28.1
4	45.1	25.3	73.9	32.7
5	6.9	3.9	14.8	6.6
Total	178.5	100.0	225.9	100.0

Note: New Roads only

- Figure 7.2.5 shows the proposed new road construction projects while Figure 7.2.6 indicates the existing road sections of 101.3 km which need to be widened.

B. Phasing

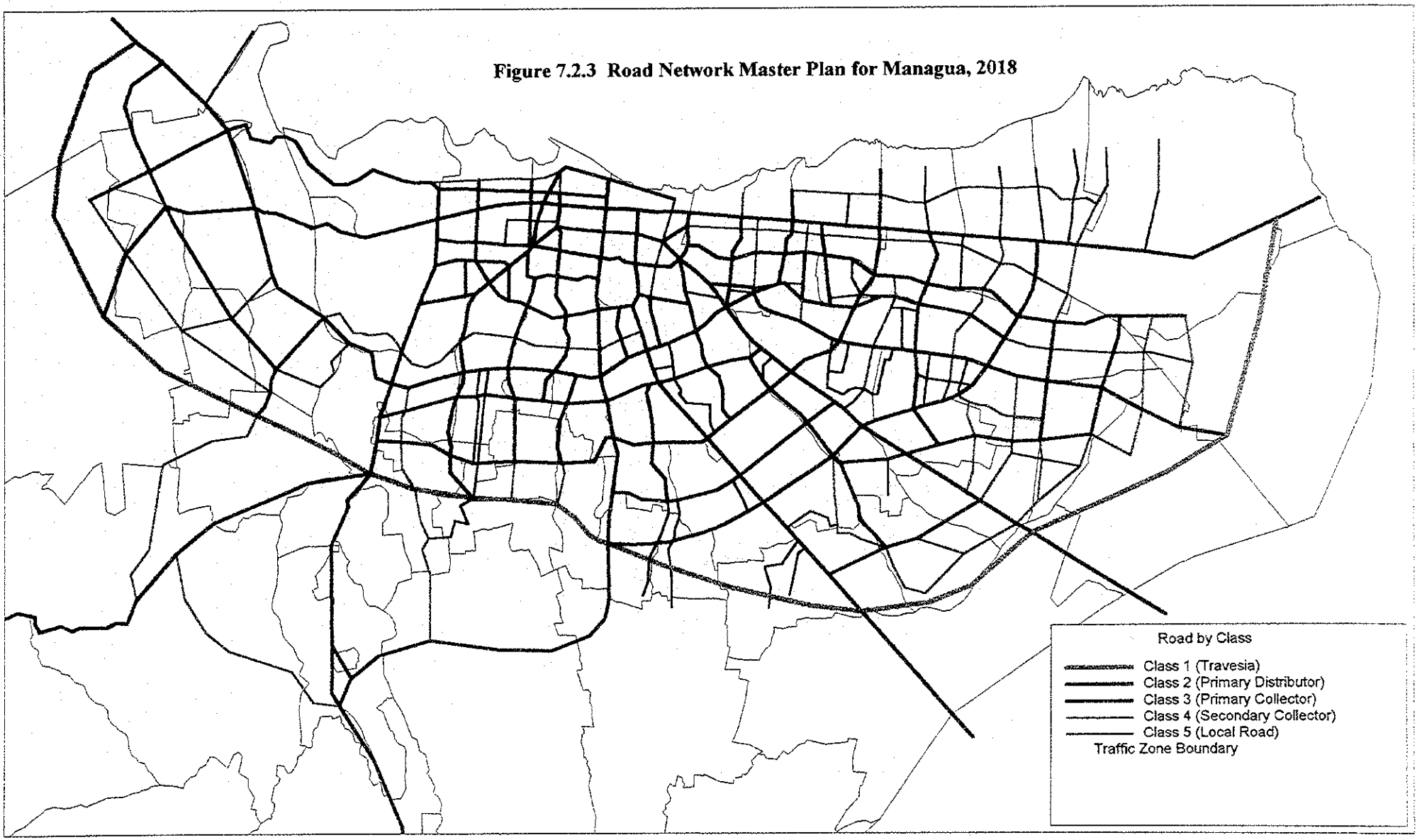
- Figure 7.2.7 shows the phasing of new road construction and widening of existing road sections.

- New road construction is shared by short, medium and long-term for 18.9 km, 52.4 km and 154.6 km, respectively, as shown in Table 7.2.3. In the case of widening, the allocation is 31.5 km, 41.9 km and 27.9 km, respectively as shown in Table 7.2.4.

Table 7.2.3
Phasing of New Road Construction

	Class	1	2	3	4	5	Total
Existing Roads	km	**0.0**	**121.4**	**55.1**	**19.3**	**27.6**	**223.4**
	%	0.0	54.3	24.7	8.6	12.4	100.0
Short Term	km	**0.0**	**16.1**	**2.8**	**0.0**	**0.0**	**18.9**
	%	0.0	85.2	14.8	0.0	0.0	100.0
Medium Term	km	**9.4**	**2.7**	**19.7**	**19.9**	**0.7**	**52.4**
	%	17.9	5.2	37.6	38.0	1.3	100.0
Long Term	km	**24.8**	**20.9**	**40.8**	**54.0**	**14.1**	**154.6**
	%	16.0	13.5	26.4	34.9	9.1	100.0
New Road Total	km	**34.2**	**39.7**	**63.3**	**73.9**	**14.8**	**225.9**
	%	15.1	17.6	28.0	32.7	6.6	100.0
Grand Total	km	**34.2**	**161.1**	**118.4**	**93.2**	**42.4**	**449.3**
	%	7.6	35.9	26.4	20.7	9.4	100.0

Figure 7.2.3 Road Network Master Plan for Managua, 2018



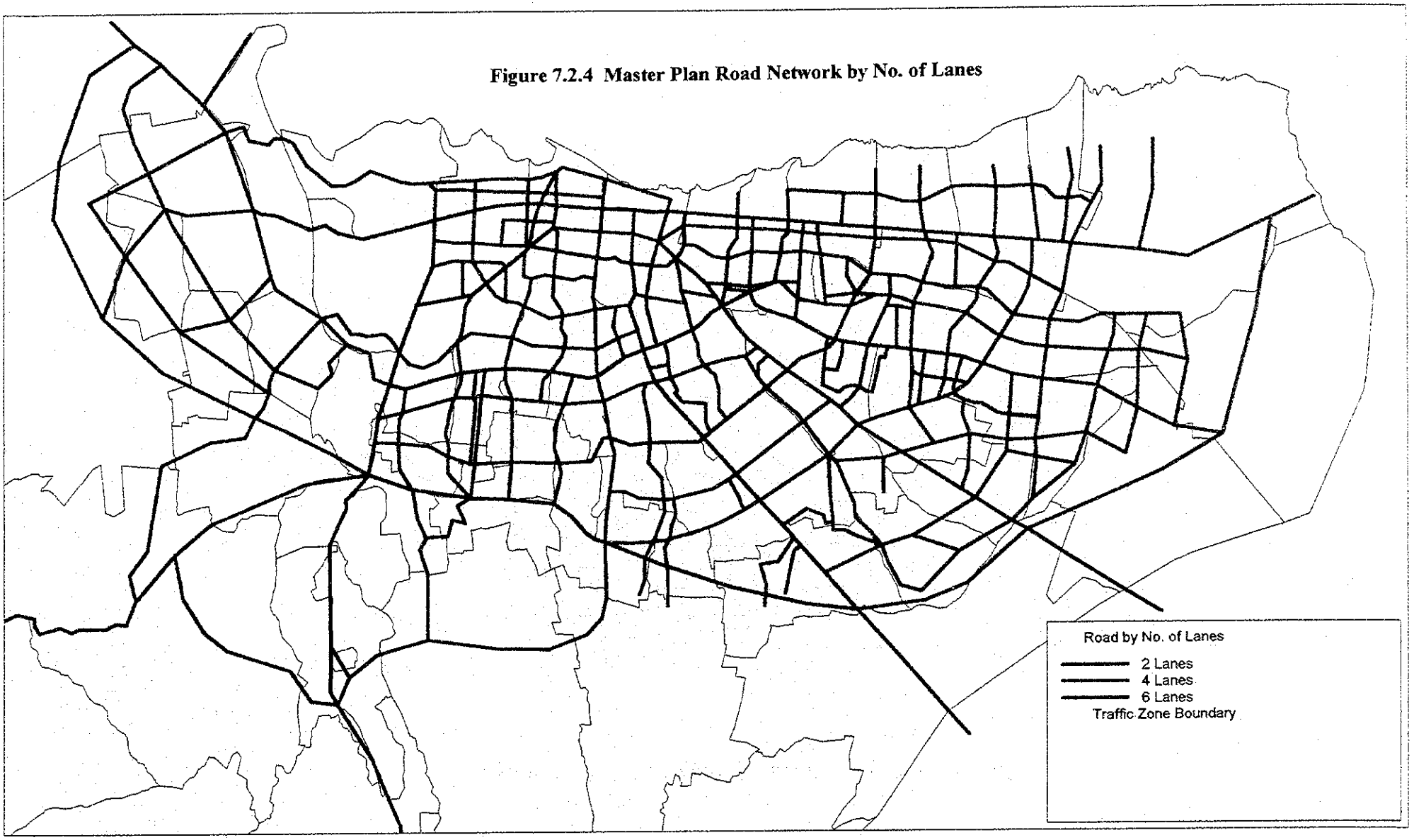
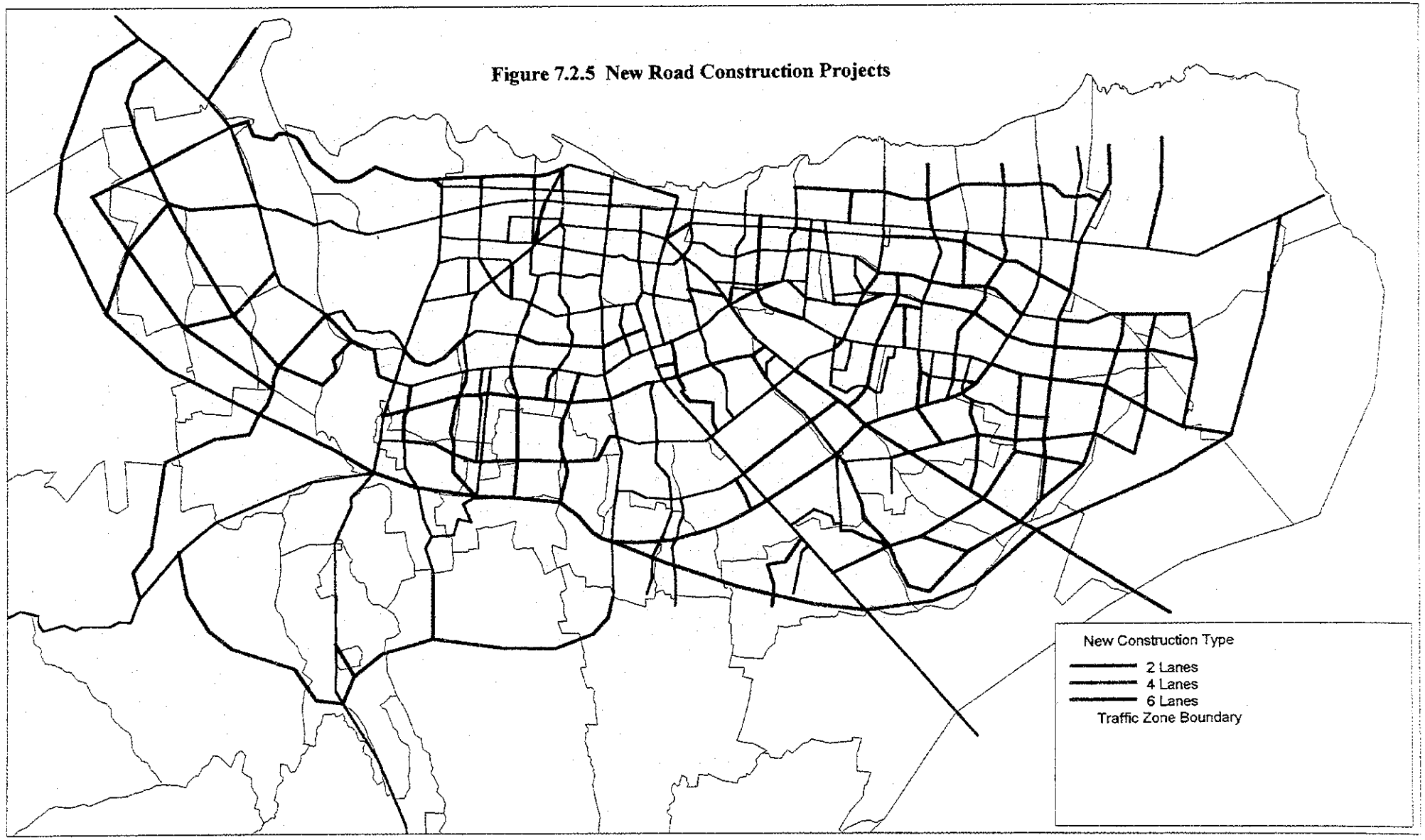


Figure 7.2.4 Master Plan Road Network by No. of Lanes

Figure 7.2.5 New Road Construction Projects



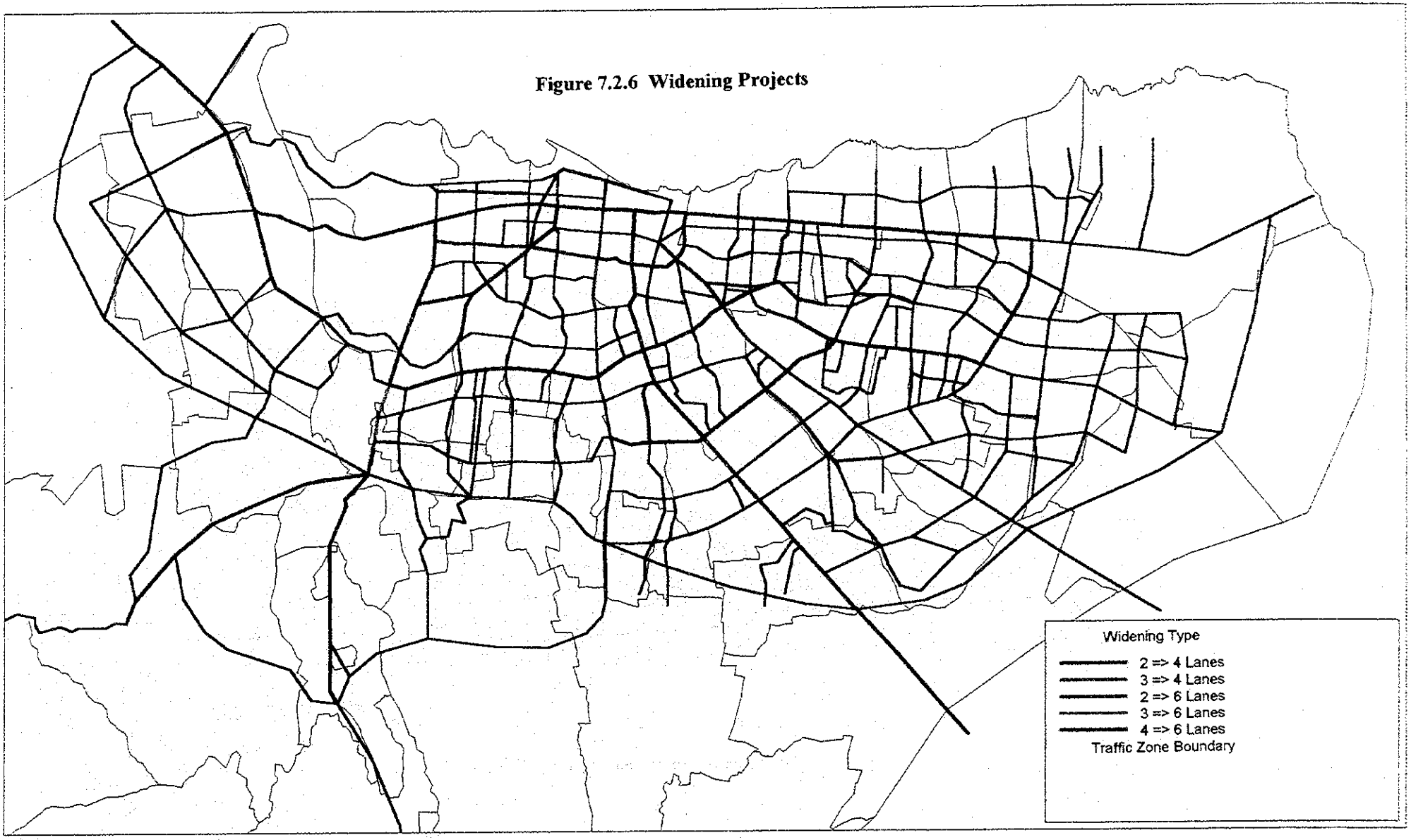


Figure 7.2.6 Widening Projects

Figure 7.2.7 Phasing of Road Development

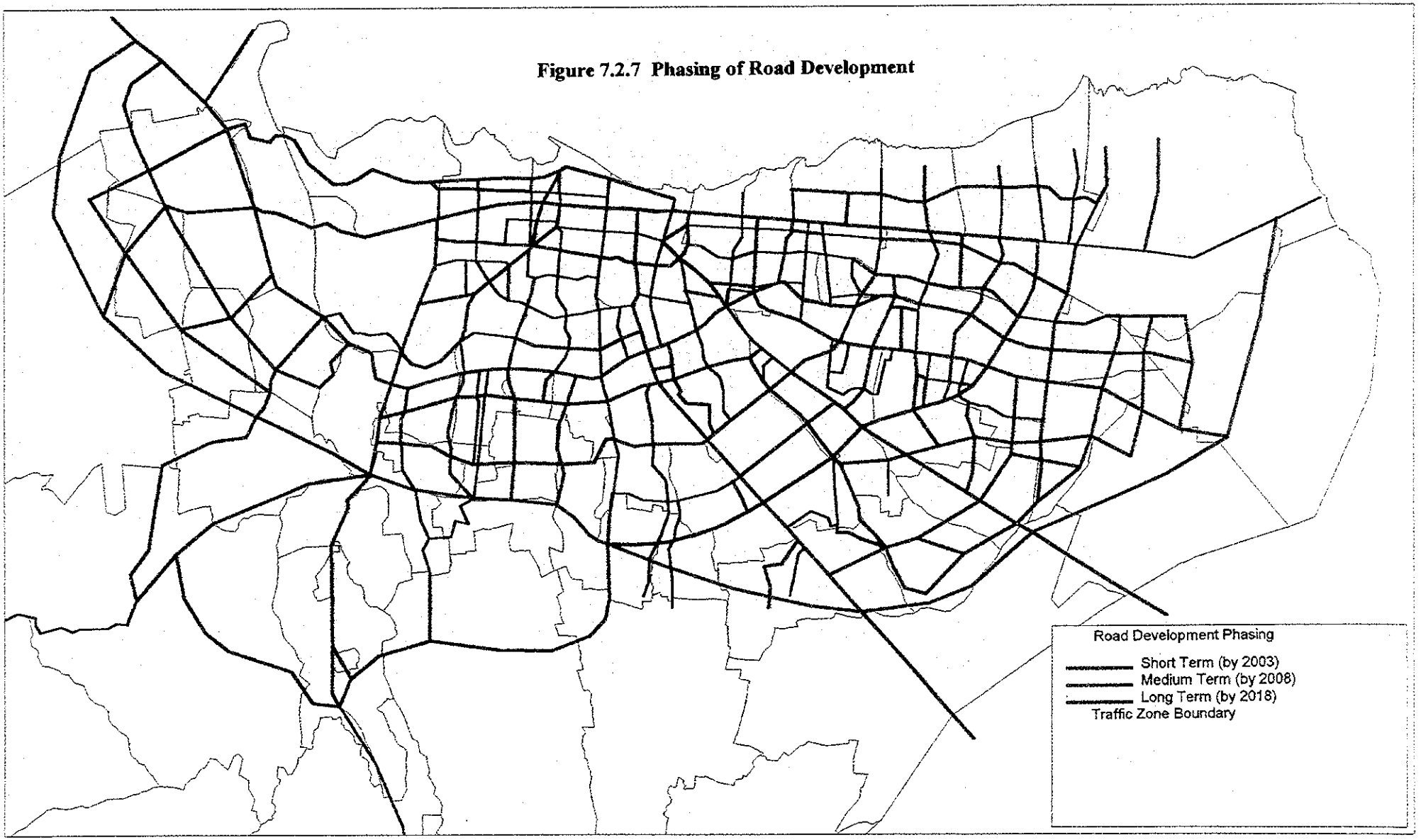


Table 7.2.4
Phasing of Widening of Existing Road Sections

Class		2					3	Total
No. of Lanes		2=>4	3=>4	2=>6	3=>6	4=>6	2=>4	
Short Term	km	**2.0**	**0.0**	**6.4**	**0.0**	**16.4**	**6.7**	**31.5**
	%	6.3	0.0	20.3	0.0	52.1	21.3	100.0
Medium Term	km	**8.0**	**1.0**	**5.2**	**1.2**	**23.8**	**2.7**	**41.9**
	%	19.1	2.4	12.4	2.9	56.8	6.4	100.0
Long Term	km	**17.5**	**0.0**	**0.0**	**0.0**	**3.6**	**6.8**	**27.9**
	%	62.7	0.0	0.0	0.0	12.9	24.4	100.0
New Road Total	km	**27.5**	**1.0**	**11.6**	**1.2**	**43.8**	**16.2**	**101.3**
	%	27.1	1.0	11.5	1.2	43.2	16.0	100.0

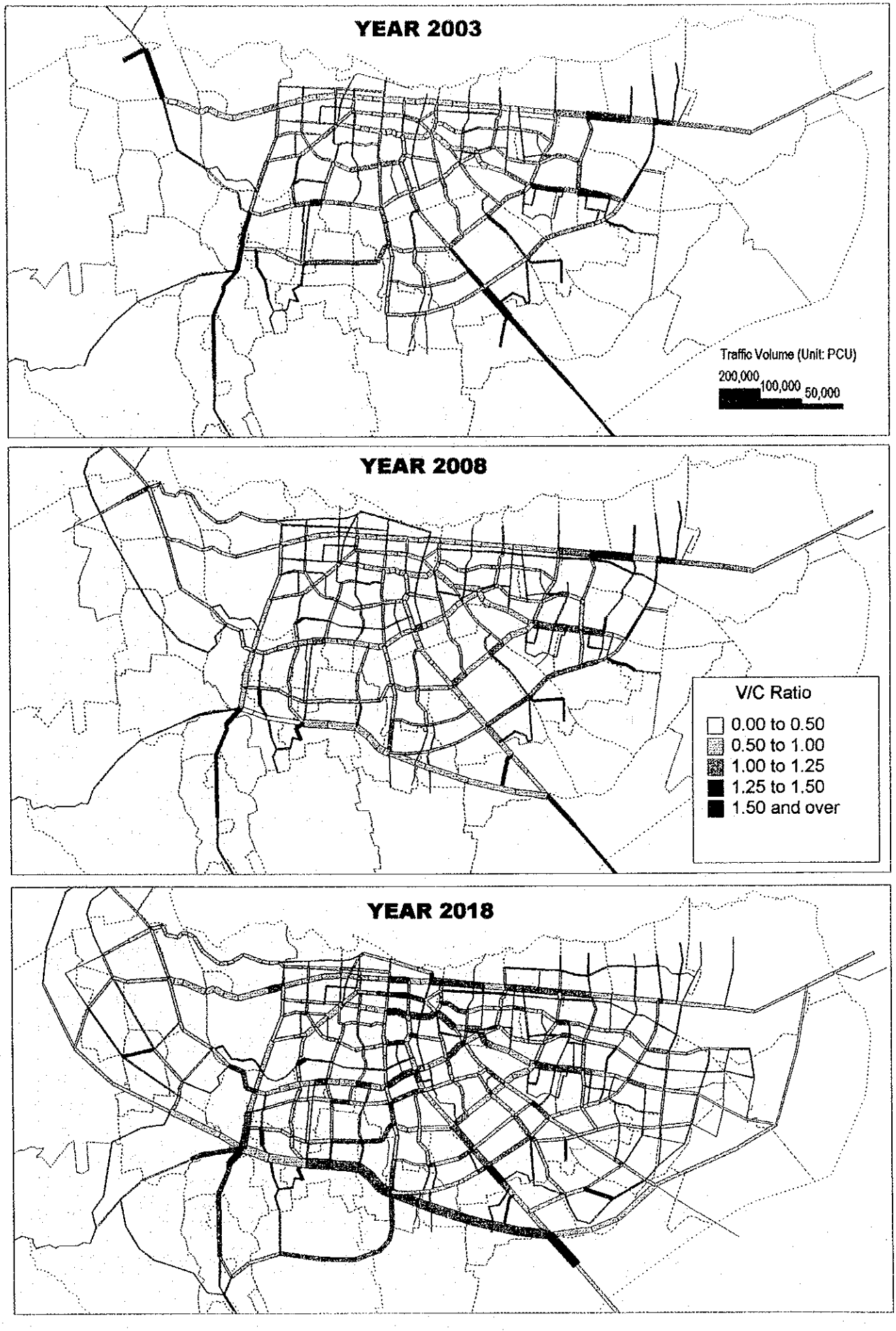
- Figure 7.2.8 illustrates the forecasted traffic flow for the years 2003,2008 and 2018 (also see Table 7.2.5). The traffic situation will be largely improved compared to the Do-Nothing situation (see Figure 7.2.1 and Table 7.2.1). The travel speed will be maintained at the current level, and the average volume/capacity ratio will be suppressed below 0.8, if the proposed projects are implemented.

- Nevertheless, traffic congestion will be still serious on some major corridors. This situation should be improved by upgrading the levels of service of public transportation and by controlling private vehicles as proposed later in this Chapter.

Table 7.2.5
Results of Traffic Assignment for Proposed Road Network

	2003	2008	2018
No. of Trips (000/day)			
• Private	1,200.7	1,485.9	2,323.7
• Public	1,138.7	1,277.8	1,514.2
• Total	2,339.4	2,763.7	3,837.9
Modal Share (%)			
• Private	51.3	53.8	60.5
• Public	48.7	46.2	39.5
Average Trip Length (km)			
• Private	9.2	9.2	9.7
• Public	6.4	6.6	7.3
• Average	7.9	8.0	8.8
Average Travel Speed (km/h)	21.2	25.0	24.6
Average Volume/Capacity Ratio	0.81	0.71	0.76

Figure 7.2.8 Traffic Flow Forecasted on Master Plan Road Network



C. Cost

- Table 7.2.6 shows the estimated cost for new road construction and widening.
- In the short-term, the cost is US$27.6 million for constructing 18.9 km of new roads. In the medium and long-term, the cost is US$55.7 million for 52.4 km and US$134.5 million for 154.6 km, respectively. The average construction cost per km decreases in the later stage reflecting the expansion of urban area to the suburbs where development cost is low.
- The cost of widening is US$33.2 million, 40.9 million and 22.3 million for short, medium and long-term, respectively.
- For the maintenance of existing and new roads, the annual cost will be about US$1.2 million in 1998, 1.5 million in 2003, 2.0 million in 2008 and 3.0 million in 2018, as shown in Table 7.2.7.

Table 7.2.6
Cost Estimate for Road Development

Project Type	No. of Lanes	Road Class	Frontage Road	Length (km)				Cost (000 US$)			
				Short	Medium	Long	Total	Short	Medium	Long	Total
New Construction	2	4	x	0.0	20.6	68.0	88.6	0	13,071	34,253	47,324
	4	1	x	0.0	0.0	24.8	24.8	0	0	31,743	31,743
	4	2	x	14.9	2.7	21.0	38.6	20,367	3,750	25,988	50,105
	4	3	x	2.8	19.6	40.8	63.2	5,171	22,446	42,534	70,151
	6	1	x	0.0	9.5	0.0	9.5	0	16,422	0	16,422
	6	2	x	1.2	0.0	0.0	1.2	2,072	0	0	2,072
	New Construction Total			18.9	52.4	154.6	225.9	27,610	55,689	134,518	217,817
Widening	2,3=>4	2	x	2.0	9.0	17.6	28.6	2,021	7,542	13,943	23,506
	2,3=>4	3	x	6.6	2.7	6.8	16.1	4,636	1,845	5,075	11,556
	2,3=>6	2	x	6.3	6.3	0.0	12.6	8,187	6,057	0	14,244
	4=>6	2	o	2.5	5.2	0.0	7.7	3,815	6,950	0	10,765
	4=>6	2	x	13.9	18.6	3.6	36.1	14,569	18,516	3,272	36,357
	Widening Total			31.3	41.8	28.0	101.1	33,228	40,910	22,290	96,428
Total				50.2	94.2	182.6	327.0	60,838	96,599	156,808	314,245

Table 7.2.7
Annual Road Maintenance Cost

Road Class	No. of Lanes	ROW (m)	Road Length (km)				Cost (000 US$/year)			
			1998	2003	2008	2018	1998	2003	2008	2018
1	4	50.0	0.0	0.0	0.0	24.8	0.0	0.0	0.0	180.7
	6	60.0	0.0	0.0	9.4	9.4	0.0	0.0	97.1	97.1
2	2	27.0	56.7	48.3	35.1	17.6	234.7	199.9	145.3	72.8
	3	27.0	2.2	2.2	0.0	0.0	12.4	12.4	0.0	0.0
	4	40.0	62.5	63.0	51.0	85.8	450.6	454.2	367.7	618.6
	6	45.0	0.0	24.0	54.1	57.7	0.0	245.3	552.9	589.7
3	2	27.0	16.3	9.6	6.9	0.0	67.5	39.7	28.6	0.0
	4	30.0	38.8	48.3	70.7	118.5	276.8	344.6	504.4	845.4
4	2	20.0	19.3	19.3	39.3	93.3	78.9	78.9	160.6	381.2
5	2	14.0	27.6	27.6	28.3	42.4	111.5	111.5	114.3	171.3
Total			223.4	242.3	294.8	449.5	1,232.3	1,486.5	1,970.9	2,956.9

D. Toll Road

- The Study proposes to convert the Class 1 road (Travesía) into a toll road. This road traverses the periphery of the urban arc of Managua, and confines urbanization inside the planned urban area using its access-controlled features (limited intersection, grade separation, fences, etc.).

- To forecast the traffic volume as well as toll revenue, a series of traffic assignments were conducted. The basic assumptions on the time value are shown in Table 7.2.8.

Table 7.2.8
Estimate of Time Value at 1998 Prices

	Car Owning Vivienda (Private Car)	Non Car Owning Vivienda (Bus)
Average Income/Vivienda 1998 (C$/month)	3,740	1,335
Average Vivienda Size (persons/vivienda)[1)]	5.43	5.43
Average Income/Person 1998 (C$/month)[1)]	689	246
Average Working Hours (hours/month)	160	160
Time Value/Person 1998 (C$/hour)	4.31	1.54
Time Value/Person 2003 (C$/hour)[2)]	4.96	1.77
Time Value/Person 2008 (C$/hour)[2)]	5.69	2.03
Time Value/Person 2018 (C$/hour)[2)]	7.97	2.85
Time Value/PCU 1998 (C$/hour)[3)]	8.46	22.73
Time Value/PCU 2003 (C$/hour)[3)]	9.74	26.13
Time Value/PCU 2008 (C$/hour)[3)]	11.17	29.96
Time Value/PCU 2018 (C$/hour)[3)]	15.65	42.07

Note: 1) Five years old or above.
2) In proportion to per-capita GDP.
3) 1.963 persons/PCU for private car and 14.76 persons/PCU for bus.

- Table 7.2.9 Summarizes the result of traffic assignments conducted for various levels of tolls both in 2008 and 2018. In 2008, however, the demand is quite sensitive against the toll level and the expected revenue is insignificant.

Table 7.2.9
Patronage Traffic and Revenue of Travesia by Toll Rate

Toll Rate (C$/PCU)	2008				2018			
	Patronage (1000 PCUs/day)			Total Revenue	Patronage (1000 PCUs/day)			Total Revenue
	Private	Public	Total	(Million C$/Yr)	Private	Public	Total	(Million C$/Yr)
0	100.2	5.2	105.4	0.0	144.8	11.2	156.0	0.0
2	39.7	1.7	41.4	25.7	134.2	10.1	144.3	89.5
4	16.5	0.6	17.1	21.2	111.3	5.7	117.0	145.1
6	7.7	0.3	8.0	14.9	88.8	4.4	93.2	173.4
8	3.7	0.2	3.9	9.7	71.4	3.6	75.0	186.0
10	1.7	0.1	1.8	5.6	56.8	3.0	59.8	185.4
12	1.0	0.0	1.0	3.7	47.2	2.6	49.8	185.3
14	-	-	-	-	40.4	2.4	42.8	185.8
16	-	-	-	-	33.7	2.1	35.8	177.6
18	-	-	-	-	28.8	2.0	30.8	171.9
20	-	-	-	-	24.9	1.8	26.7	165.5

- Figure 7.2.9 shows the traffic flow forecasted on the Master Plan Network with the proposed toll road (toll rate: C$10/PCU). Table 7.2.10 summarizes the result of these traffic assignments in comparison with the cases without tolls. Due to the traffic volume tolled off from Travesia, several roads become more congested, and the network performance in terms of average travel speed and average trip length is slightly affected.

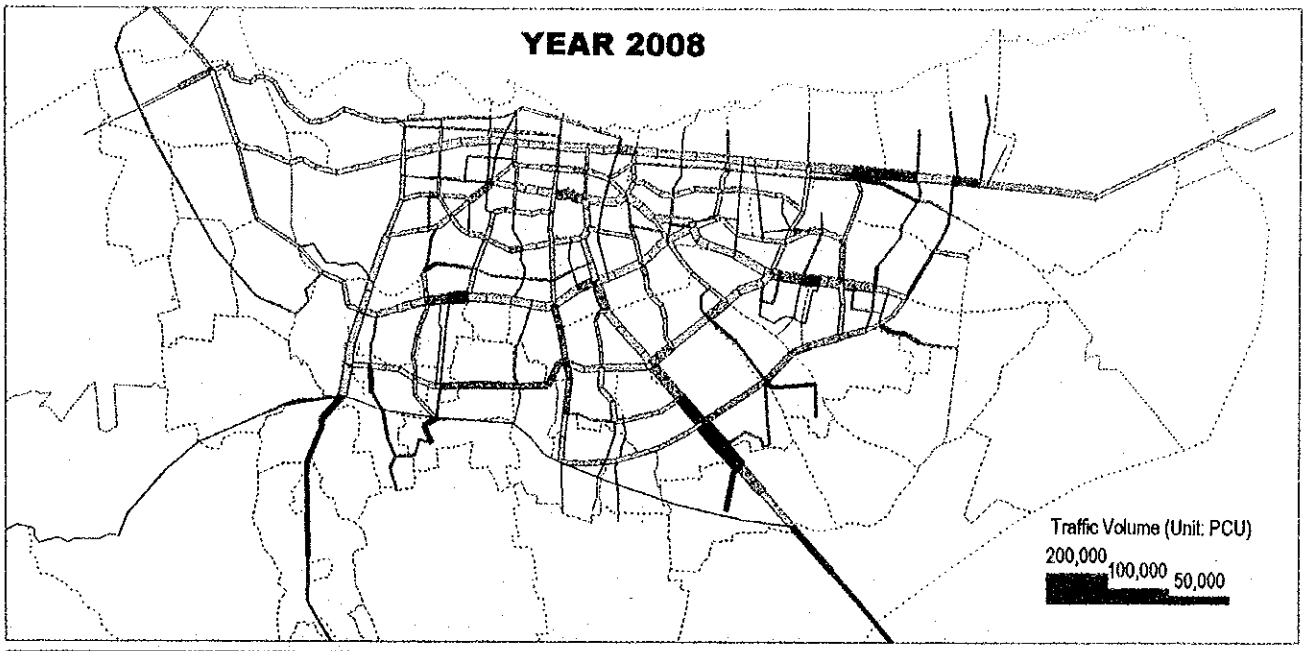
Table 7.2.10
Comparison of Network Performance, Without and With Tolls (C$10/PCU)

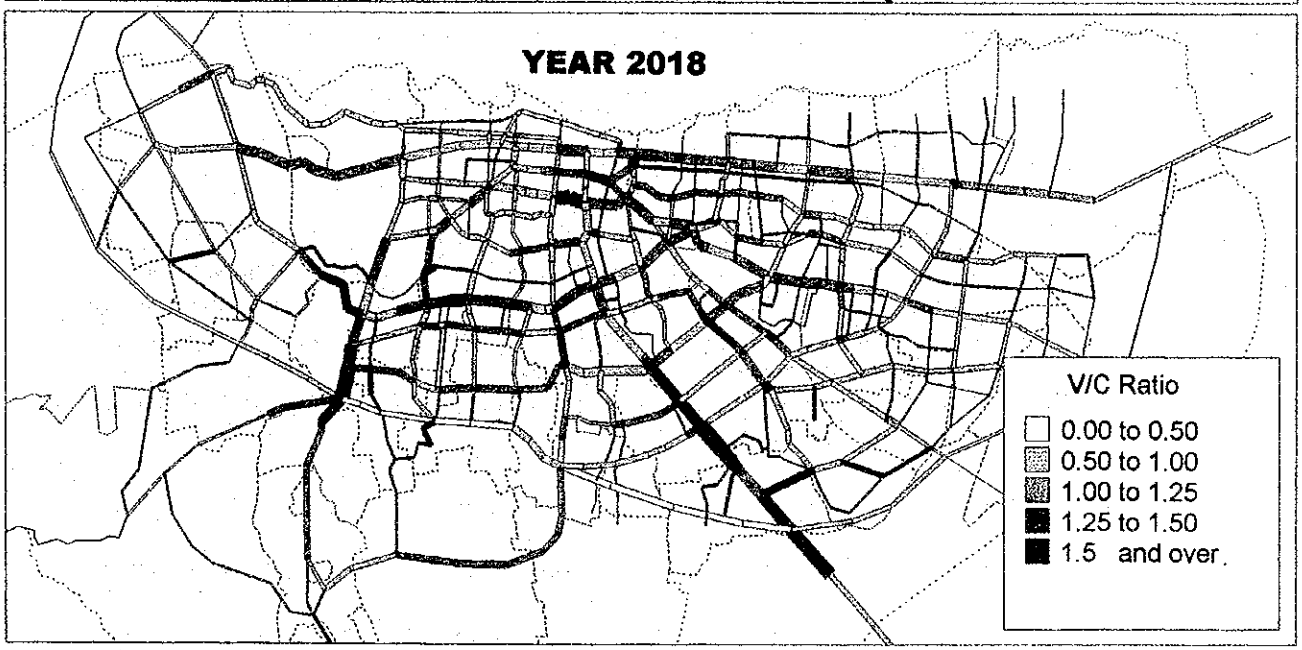
	2008		2018	
	Without	With	Without	With
Average Travel Speed (Km/h)	25.0	22.7	24.6	22.2
Average Volume/Capacity (km)	0.71	0.72	0.76	0.74
Average Trip Length (km)				
• Private	9.2	9.3	9.7	10.1
• Public	6.6	8.6	7.3	7.5
• Average	8.0	9.0	8.8	9.1

- In conclusion, it is recommended to convert Travesia into toll road in the long-term. In the medium-term, toll road seems to be immature. Considering the construction cost of about US$48 million (US$16 million in medium-term and US$32 million in long term, excluding toll facilities) and the estimated revenue of about US$18-19 million per year in 2018, the private sector can be invited for the implementation of this toll road project. Figure 7.2.10 shows the forecasted traffic flow on Travesia in 2018 without and with tolls.

Figure 7.2.10 Forecasted Traffic Flow on Travesia with and without Toll, 2018 (C$10 / Trip)

Figure 7.2.9 Traffic Flow Forecasted on Master Plan Network (with Toll Road)





Note: Toll level was assumed at C$ 10/PCU.

7.3 Public Transportation

7.3.1 General

The current urbanization will lead Managua to an auto-based city due to its expansion of low-rise housing areas along newly developed roads towards suburbs without strong control of the Government. A widespread auto-based city, which requires a huge investment on road development, is an energy-consumptive, expensive and environmentally poor city where public transportation can hardly be applied.

The basic policy of the Master Plan in relation to public transportation is, in one word, the creation of transit-based city. This policy is realized by a combination of varied measures that can be categorized into a) improvement of public transportation service, and b) discouragement of car use. The latter will be discussed in Section 7.4 of this Report, then this section focuses in the former.

The outline of the proposed actions is as follows:

I. Immediate Actions

- Take countermeasures to prevent robberies which occur frequently in the bus.
- Designate Public Transportation Corridors where bus exclusive lanes will be introduced.
- Introduce feeder bus system and reroute existing bus routes.

II. Short-Term Actions

- Designate a Public Transportation Corridor and segregate physically the bus exclusive lanes along Carretera Norte. Bus priority signals need to be installed.
- Introduce new public transportation services such as express bus, premium bus with enhanced service (e.g. air-conditioning) and feeder collective taxi. Reroute existing bus routes and adjust fare structure.
- Construct a city bus terminal in relation to Public Transportation Corridor and interurban bus services.

III. Medium-Term Actions

- Designate Public Transportation Corridor along Pista Juan Pablo II and Sabana Grande.
- Improve Public Transportation Corridors by constructing grade separated pedestrian bridges at bus stations.
- Reroute existing bus routes to rationalize the hierarchy of public transportation services land reset fares.
- Construct two city bus terminals.

IV. Long-Term Actions

- Improve Public Transportation Corridors by complete grade separation at major intersections and by introducing new large-capacity units, if necessary.
- Reroute existing bus routes according to the change in demand distribution and adjust fares if necessary.
- Construct three city bus terminals.

7.3.2 Development of Public Transportation Corridor

1) Concept of Public Transportation Corridor

Public Transportation Corridor is one of the most important projects in the Master Plan. The concept is a step-by-step action for promoting public transportation usage towards creation of a transit-based city and introduction of guideway transit in the future.

The concept is schematically illustrated in Figure 7.3.1–7.3.3 for short-term, medium-term and long-term, respectively. After selecting the Public Transportation Corridors, bus exclusive lanes, supported by widening of carriageway and bus priority signals, are first designated. Then, the bus exclusive lanes are physically upgraded little by little by grade separation of stations and bus lanes in medium to long-term. The final target of this project is the completion of a network of segregated busways.

Table 7.3.1 shows major busways and guided bus systems in the world. Some of them have a transportation capacity comparable to modern LRTs. Considering the lower cost of implementation, the busway system may better be promoted more in developing countries if existing road space is available. At present, the most successful busway system is seen in Curitiba, Brazil. In Curitiba, an extensive system of reserved busways and bus lanes has been implemented by the city authority under an integrated land use/transport policy favoring public transportation dating from 1974. Introduced between 1974 and 1981, the Integrated Transport Network expanded the length of express bus exclusive lanes, and patronage rose from 25,000 per day to 997,000 per day by 1993. Rapid growth of patronage was addressed by the Ligeirinho (very fast) system introduced in two corridors in 1991, and later extended. These routes are served by high-capacity luxury buses running on limited-stop schedules, providing an additional level of service and comfort within the existing network. They serve 'tube stations', which are stylish cylindrical glass shelters with a ticket machine at the single turnstile access and same-level entry to the buses from two side turnstiles. Stations have since been upgraded to allow the bi-articulated buses to open three or more doors at once, so reducing dwell times from 23 to 19 sec. The buses have no steps; instead extending platforms reach out to bridge the gap with the station platform. Loading is about four times faster than at conventional stops. In a further step to reduce overcrowding, 1992 saw introduction of bi-articulated buses to raise capacity from 160 to 270 passengers. The cost of typical busway in Curitiba is reportedly US$0.2 million per km. It should be noted that the Curitiba system is self-financing without any subsidy from their government.

The Public Transportation Corridor is proposed in Managua taking into account the examples of busway in the world, particularly that of Curitiba.

Table 7.3.1
Major Busways and Guided Bus Systems in the World

CITY	COUNTRY	TYPE OF OPERATION	LENGTH (KM)	REMARKS
Adelaide	Australia	Guided Bus	12	Guidewheels equipped. Dual mode operation.
Curitiba	Brazil	Busway	56	Extensive bus network. High-capacity buses. Tube stations.
Nagoya	Japan	Exclusive Bus Lane	81	Bus priority signals. Guided busway constructed partially.
Ottawa	Canada	Busway	2	Grade-separated. Extension proposed.
Porto Alegre	Brazil	Busway	5	
Port of Spain	Trinidad	Busway		
Sao Paulo	Brazil	Busway	183	High-capacity buses.

Figure 7.3.1 Public Transportation Corridor Development, Phase I (Short-Term)

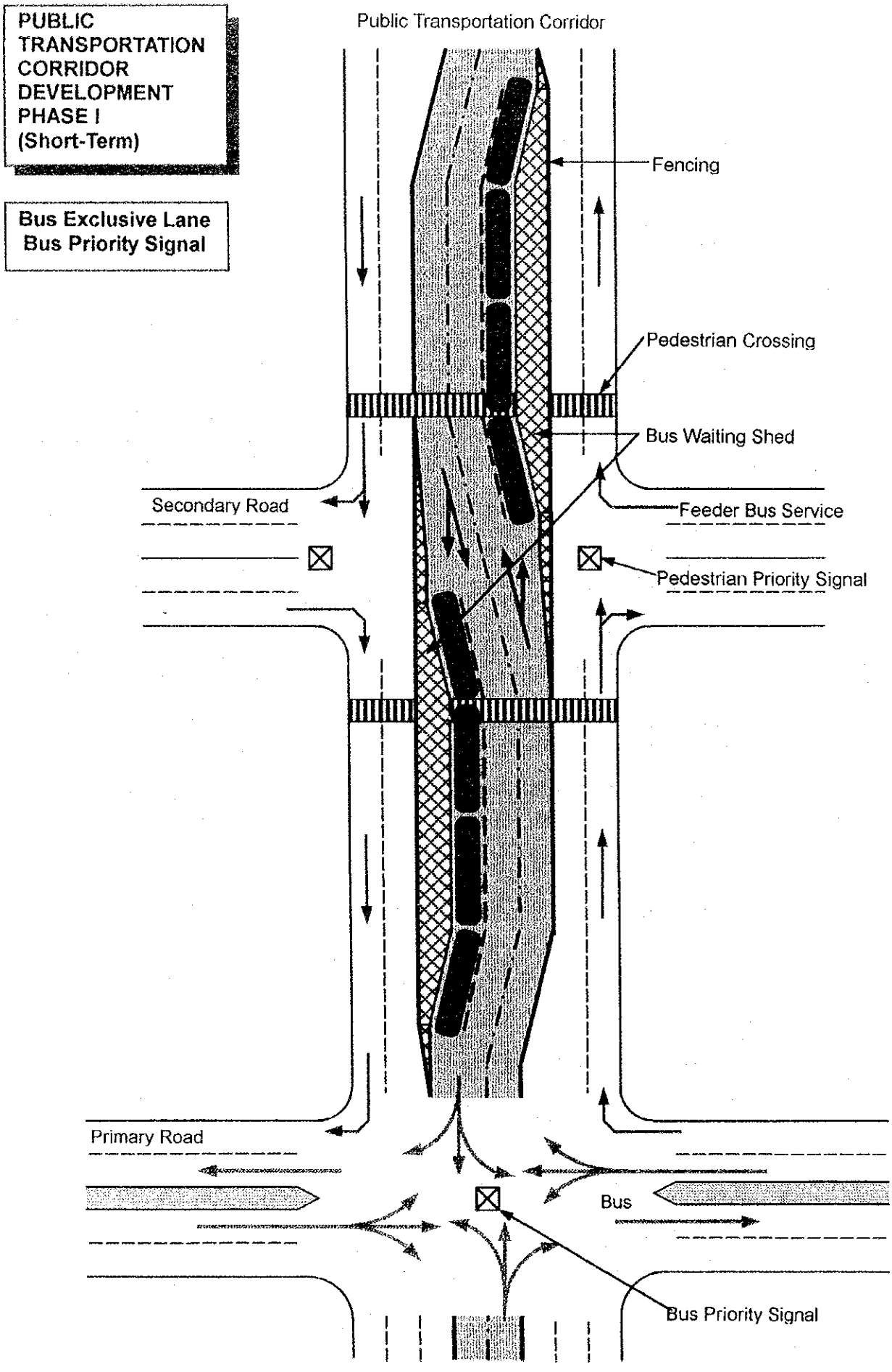


Figure 7.3.2 Public Transportation Corridor Development, Phase II (Medium-Term)

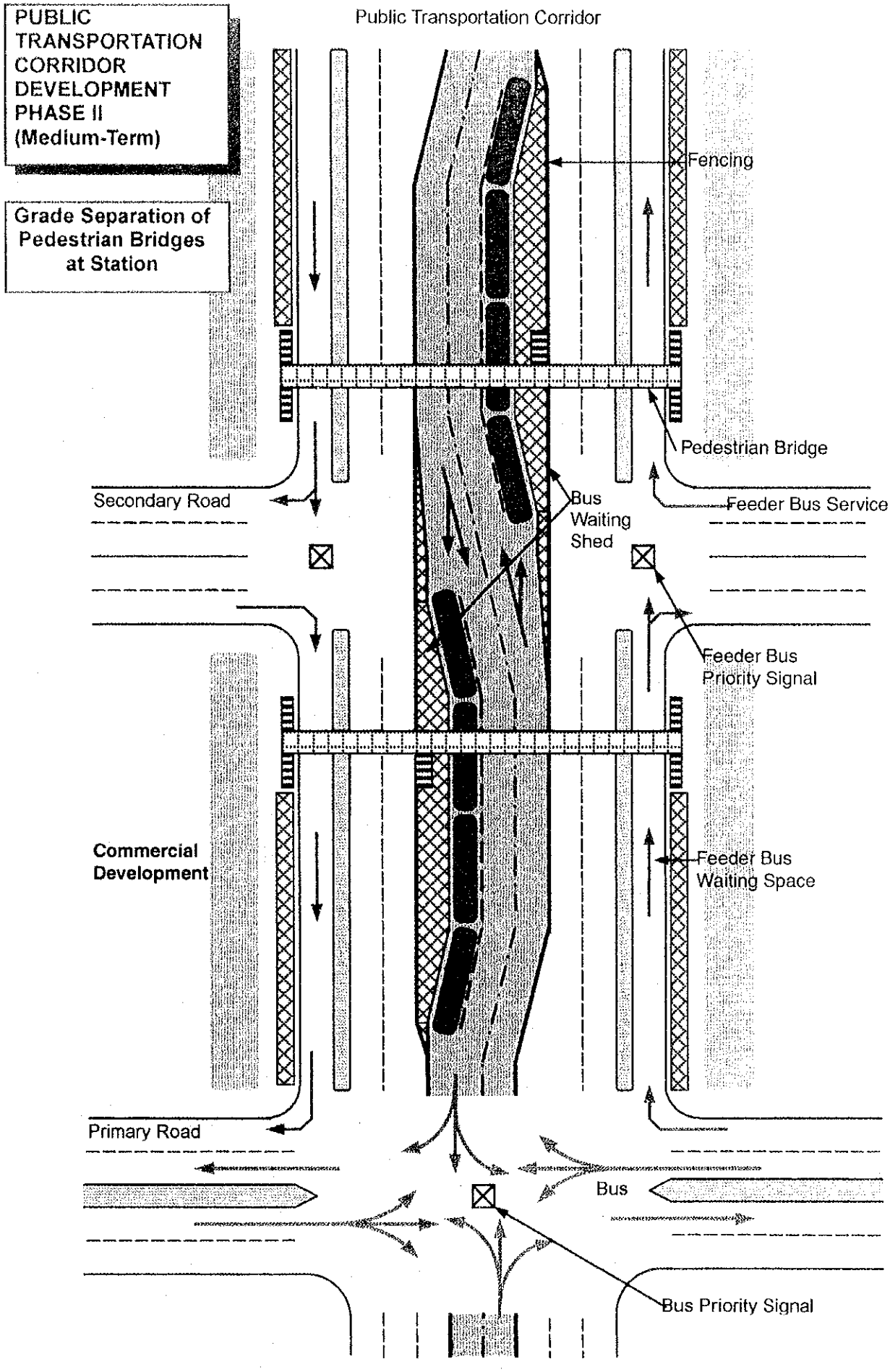
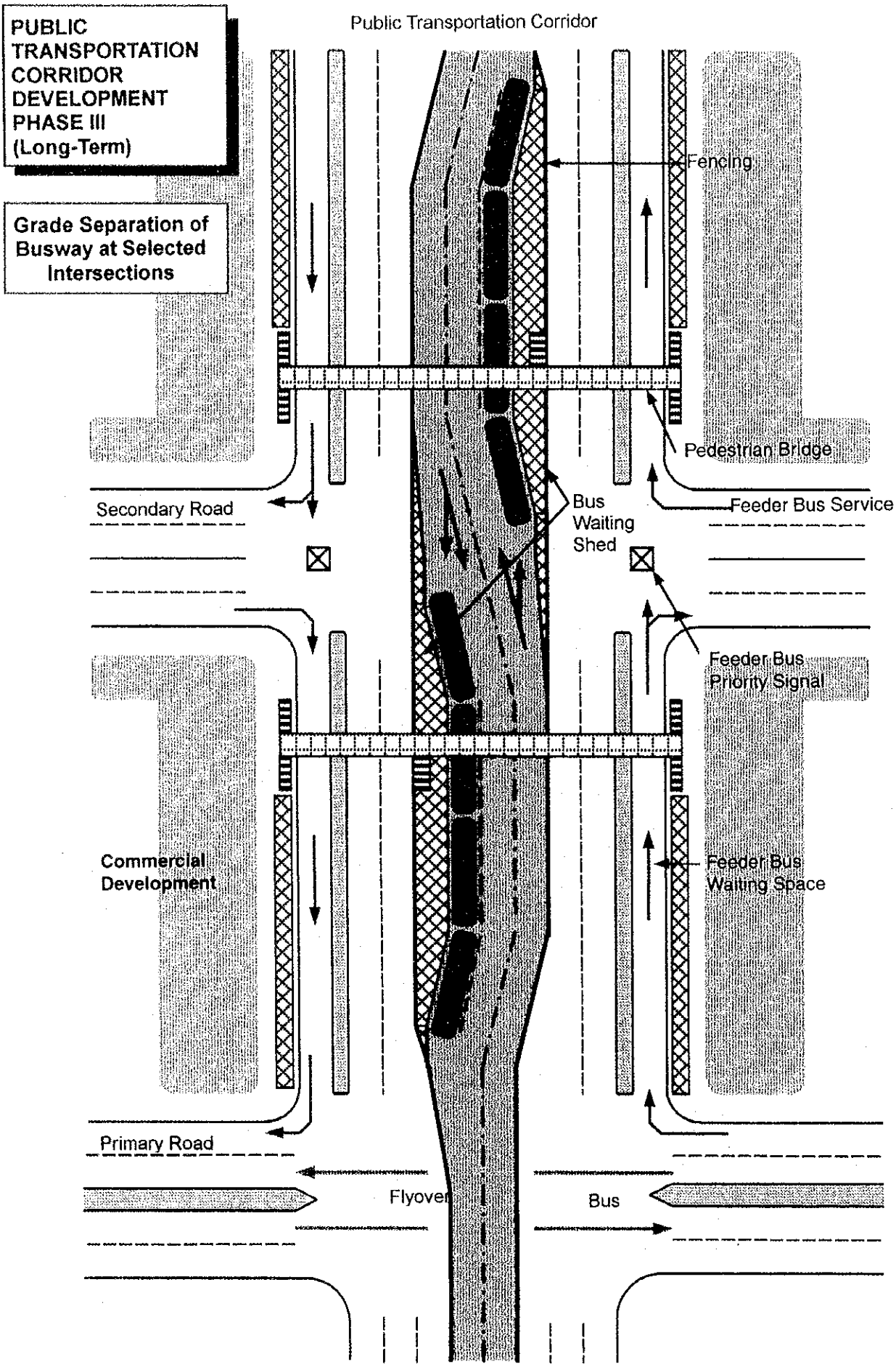


Figure 7.3.3 Public Transportation Corridor Development, Phase III (Long-Term)



2) Planning

A. Operational Aspects

- The proposed busway accommodates all buses excluding feeder bus (refer to the next section). Some bus routes will use the Public Transportation Corridor for the entire stretch of the routes, but most other routes will use it only partially. In order to secure safety, the Public Transportation Corridor should be separated physically by fence and median.

- The practical capacity of busway will be about 12,000 passengers/hour/direction assuming a headway of 15 seconds and an occupancy of 50 per bus. This is not sufficient to cope with the future traffic demand and needs to be upgraded by:

  1. Shortening the service headway.
  2. Increasing the capacity of bus units.

  The former requires a sophisticated methodology of headway control as well as specially designated bus units (e.g. multi-door). The latter also needs large-capacity bus units. However, these technologies are all existing and have been already tested (e.g. in Curitiba). It is recommended to shift gradually the bus units plying the Public Transportation Corridor to large-capacity units to cope with the increasing demand of bus passengers.

- In order to keep the travel speed high in the Corridor, the control of service headway is most important. The following actions are recommended:

  1. Control on the total number of bus units by route allowed to run on the Corridor.
  2. Control of bus movements at the intersecting points of the Corridor with other roads by bus priority signal. Manual control and guidance may be needed in the initial stage.
  3. Construction of bus arrival/departure space at stations as long as possible.
  4. Construction of bus waiting space en route to accommodate stranded buses and to adjust the running schedule.

B. Proposed Actions

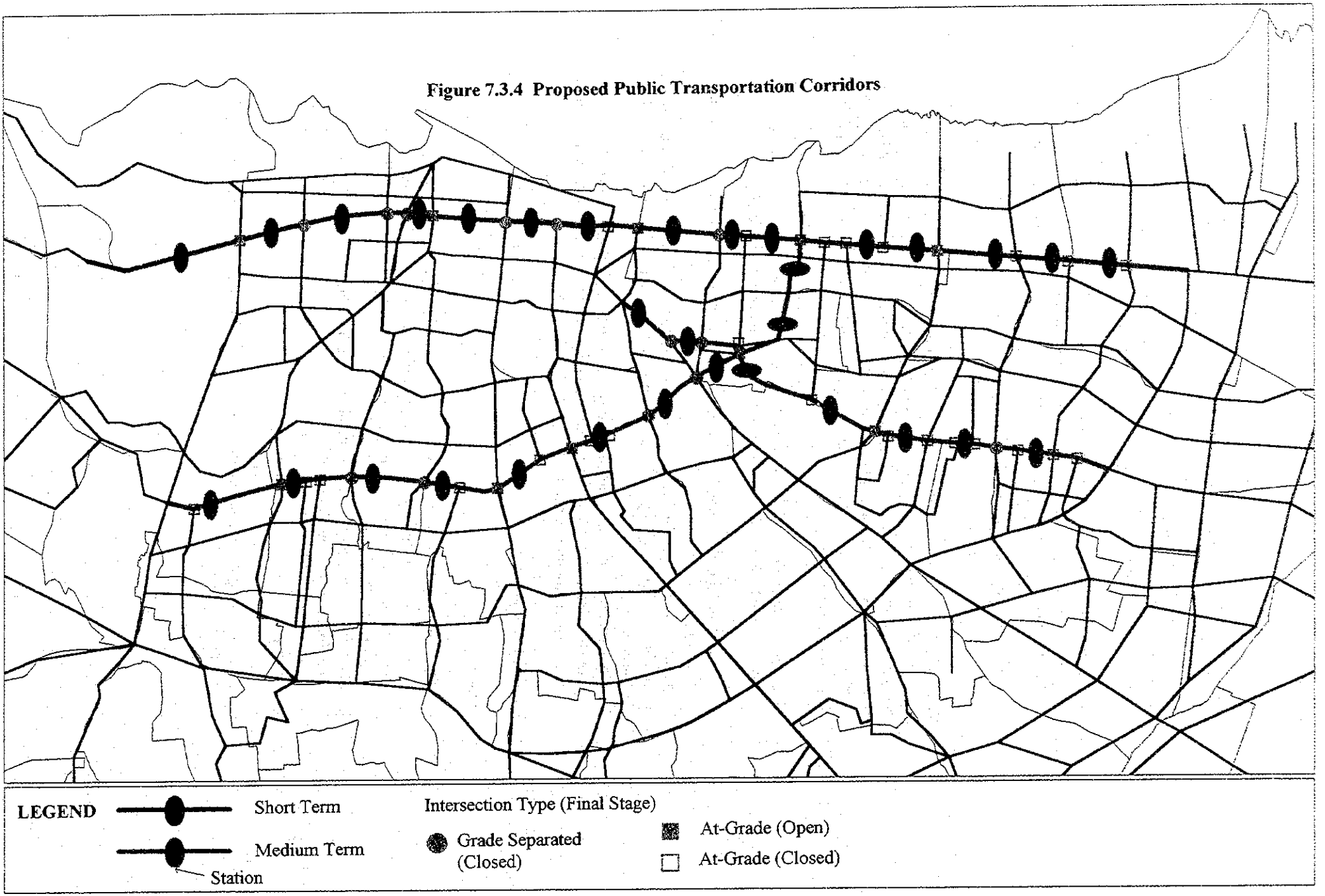
- Immediate

  1. To conduct a Feasibility Study on the Public Transportation Corridor in the context of improving entire public transportation system in Managua.
  2. Designate officially Public Transportation Corridors and conduct public relation activities to the citizen.
  3. Start discussions on social, technical and institutional aspects with the citizen including existing bus operators.

- Short-Term

  1. Construct a Public Transportation Corridor on Carretera Norte (refer to Figure 7.3.4).

Figure 7.3.4 Proposed Public Transportation Corridors



This includes the designation of 2 lanes (out of 6 lanes) exclusively for the Corridor, widening of central medians, fencing and necessary signs and markings. Typical cross-section of the Corridor will be Type A for the wide ROW section of Dupla Norte while Type B will be applied for the remaining section (Figure 7.3.5).

2. Construct 15 stations. The location of stations should be studied carefully in the proposed Feasibility Study. Figure 7.3.4 shows approximate location of stations identified with an average interval of about 800m. The construction of stations includes:

   - Waiting shed.
   - Pedestrian crossing.
   - Pedestrian priority signals.
   - Bus arrival/departure space.
   - Architectonic plans and its elevations.

   Since pedestrian crossings will be elevated in the medium-term, the waiting sheds should be constructed considering the future upgrading.

3. Convert existing signals at intersections to bus priority signals.

- Medium-Term

1. Construct Public Transportation Corridors additionally on Pista Juan Pablo II and Pista Sabana Grande (see Figure 7.3.4). The typical cross-section of the Corridor will be Type A for Pista Juan Pablo II between Carretera Sur and Metrocentro while Type B will be applied for the rest (Figure 7.3.5). The intersection of Public Transportation Corridors is open with each other as shown typically in Figure 7.3.6.

2. Elevate pedestrian crossings of the existing 15 stations and construct 17 new stations (with elevated pedestrian bridge) for the newly designated Public transportation Corridors.

- Long-Term

1. Grade separation of the Corridor at 13 intersections with the Primary Distributors (class 2 roads) and Primary Collectors (Class 3 roads) by constructing fly-over or underpass.

C. Effect of Public transportation Corridor

- In order to quantitatively test the influence of Public Transportation Corridor, traffic assignment was conducted.

- Prior to the traffic assignment, OD tables were re-estimated by applying the modal split model based on the following process modified from the original one (as explained in 7.2.2).

   - Firstly, the OD pairs of which minimum path passes the Public Transportation Corridor for more than 50% of its entire stretch were identified.
   - Then for the extracted OD pairs, the modal split model was applied assuming a higher travel speed of bus at 30 km/h (originally 20 km/h) for public mode.

Figure 7.3.5 Typical Cross Section of Public Transportation Corridor

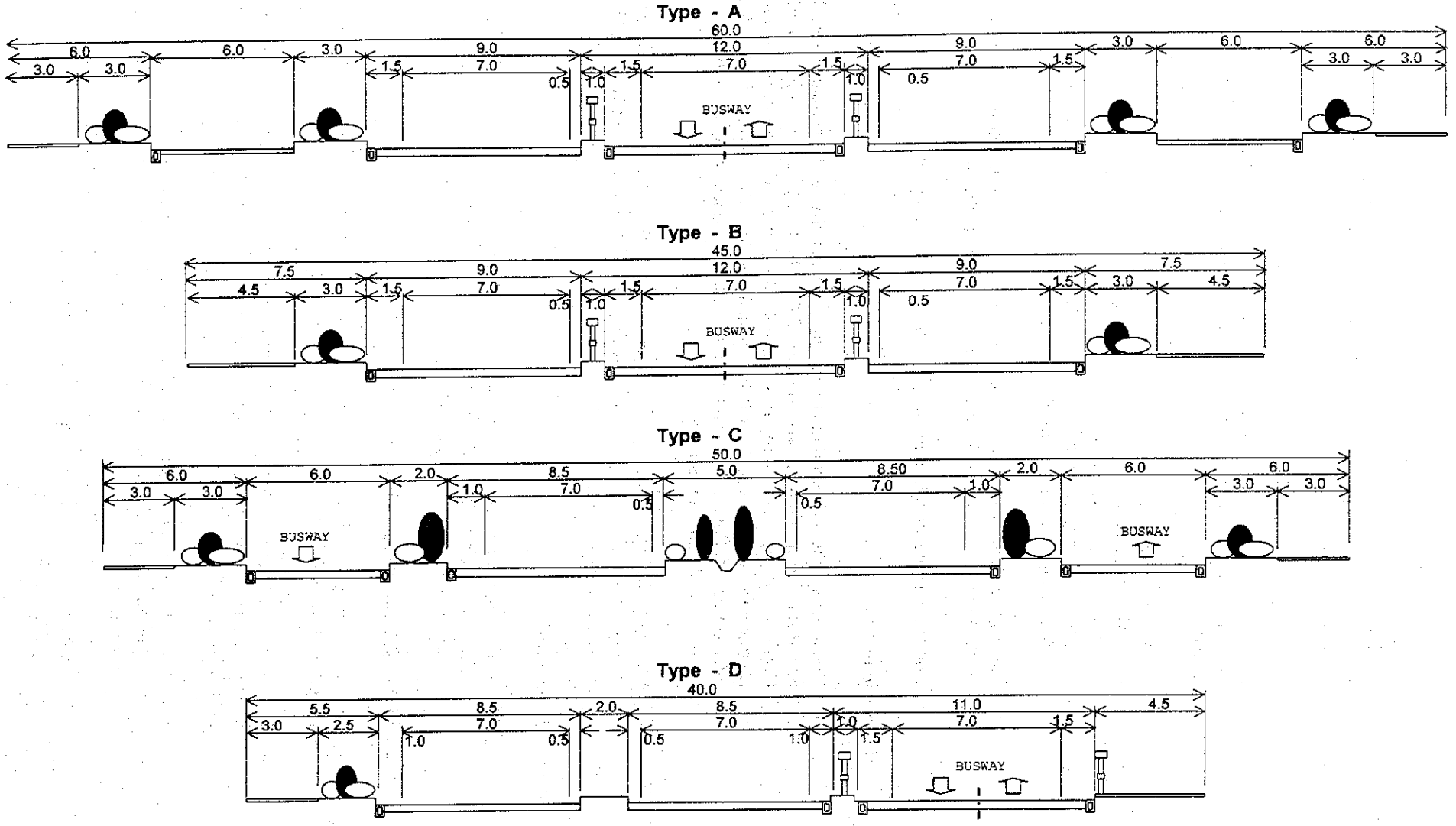
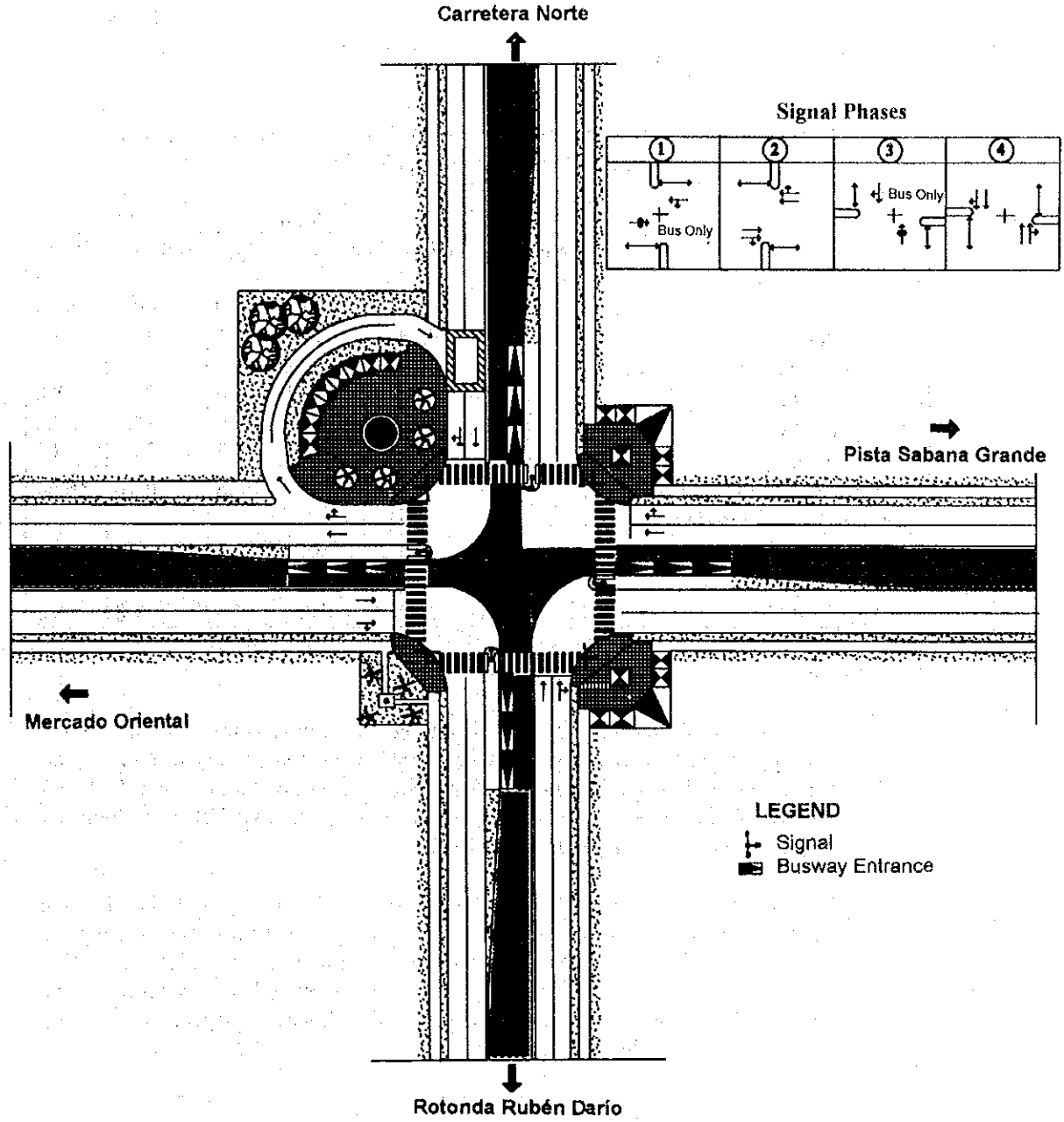


Figure 7.3.6 Layout of Intersection Pista Juan Pablo II and Pista Sabana Grande



- Figure 7.3.7 presents forecasted traffic flows on the proposed Public Transportation Corridors in 2003, 2008 and 2018. It is observed that the Corridors are extensively and efficiently utilized by buses. Table 7.3.2 summarizing the network performance also endorses the efficiency of Public Transportation Corridors. Although the effect is not remarkable in the short-term (2003), it will grow as time elapses from the medium-term (2008) to the long term (2018). In 2018, the share of public transportation is larger by 6% than the "Without" case, and the network performance in terms of travel speed and volume/capacity ratio is largely improved.

Table 7.3.2
Comparison of Network Performance, Without and With Proposed Public Transportation Corridor

	2003		2008		2018	
	Without	With	Without	With	Without	With
Modal Share (%)						
• Private	51.3	49.7	53.8	51.9	60.5	54.5
• Public	48.7	50.3	46.2	48.1	39.5	45.5
Average Travel Speed (km/h)						
• Private	21.2	21.0	25.1	25.0	24.6	28.0
• Public	21.2	21.2	24.5	27.9	24.3	30.4
• Average	21.2	21.0	25.0	25.2	24.6	28.2
Average Volume/Capacity Ratio	0.81	0.81	0.71	0.68	0.76	0.64
Average Trip Length (km)						
• Private	9.2	9.1	9.2	9.0	9.7	9.0
• Public	6.4	5.4	6.6	6.0	7.3	7.1
• Average	7.9	7.3	8.0	7.6	8.8	8.1

D. Project Cost

- Table 7.3.3 shows the facility development requirements for the Public Transportation Corridor, and Table 7.3.4 the estimated project cost. The total cost is about US$30 million for 29.7 km, which is equivalent to about US$1.03 million per km. Compared to LRT, which requires at least US$10 million per km, the busway is considered cost-efficient.

- Nevertheless, the cost of the proposed project is a large burden for the Nicaragua's Government. If a charge can be collected from buses entering the Corridor, it will be of great help to the Government. As traffic congestion worsens in the future, the charging rate could be raised in proportion to the benefit of bus operators and passengers. The financial aspects are further studied in detail in the next chapter.

Table 7.3.3
Facility Development Requirement for Public Transportation Corridor

	Short-Term	Medium-Term	Long-Term	Total
1. Route length (km)	13.7	16.0	0.0	29.7
2. No. of Stations	15	17	0	32
3. No. of Intersections				
- Grade Separated	0	0	13	13
- At-Grade (Open)	0	10	0	10
- At-Grade (Closed)	0	24	0	24

Figure 7.3.7 Forecasted Traffic Flow on Proposed Public Transportation Corridor

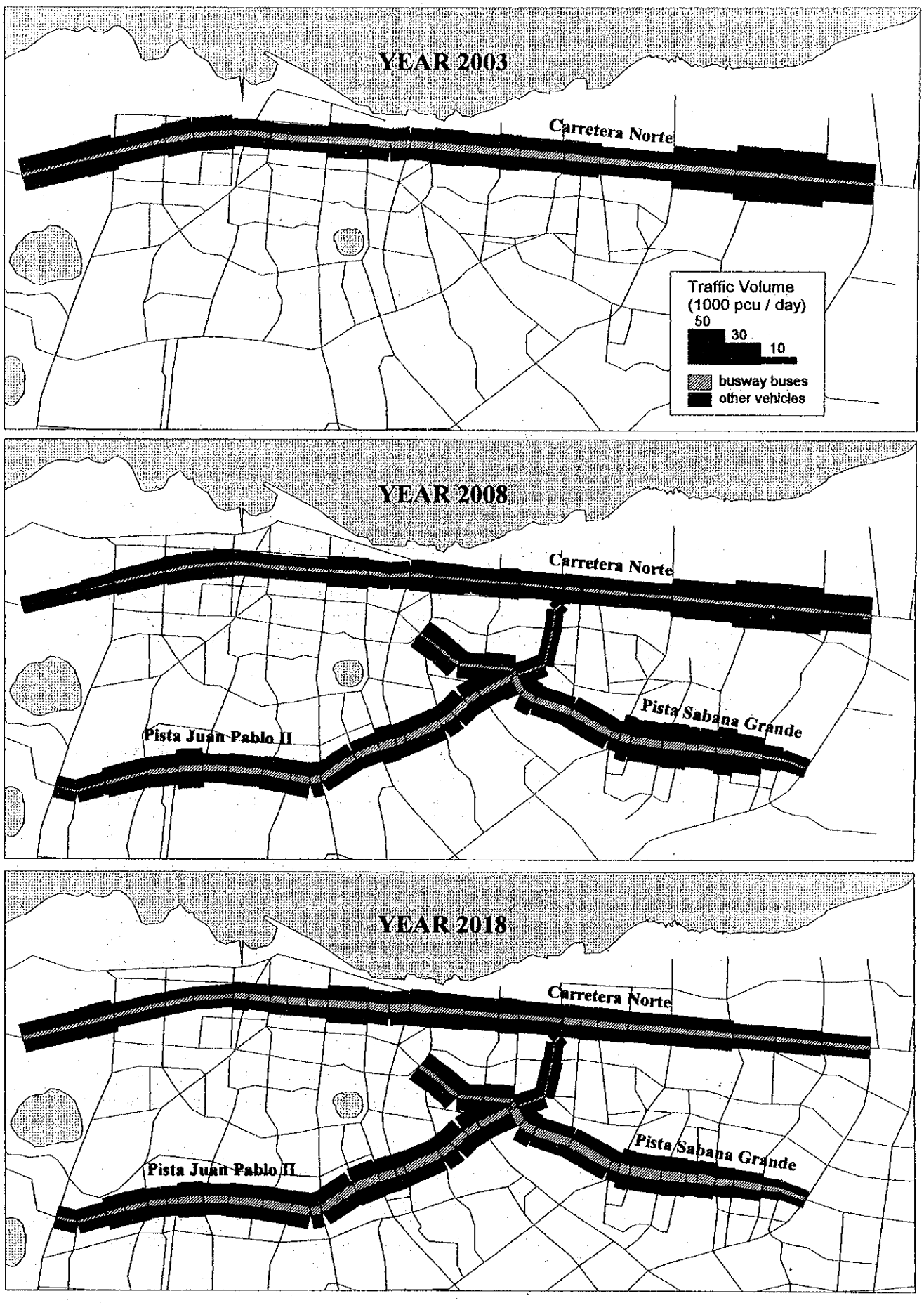


Table 7.3.4
Estimated Project Cost for Public Transportation Corridor

(US$)

Development Item	Unit Cost	Short-Term	Medium-Term	Long-Term	Total
1.Corridor	384,750	5,271,075	6,156,000	0	11,427,075
2.Station (At-Grade)	31,875	478,125	0	0	478,125
3.Station (Elevated)	120,000	0	3,840,000	0	3,840,000
4.Pedestrian Bridge	31,500	0	1,008,000	0	1,008,000
5.Grade Separation of Intersections	1,056,000	0	0	13,728,000	13,728,000 0
TOTAL COST	-	5,749,200	11,004,000	13,728,000	30,481,200

7.3.3 Diversification and Upgrading of Public Transportation Services

1) Guidelines

A. Security Improvement

- In Managua, bus is not considered to be a safe transportation. The danger is twofold:

  1. Robbery

     According to the Survey on Commuters' Perception and Use of Public Transportation (Encuesta de Percepción Comunitaria y Uso del Servicio del Transporte Urbano Colectivo) conducted in 1996 by MTI, ALMA and National Police, 23% of bus users answered that they have encountered a robbery in the bus during the year. This is an incredibly high rate enough to discourage people to use the bus service.

  2. Traffic Accident

     Although the rate of traffic accident of bus does not differ much from that of private cars, this fact itself is surprising because the bus drivers are supposed to be trained as professional drivers who are responsible for safe operation of bus service.

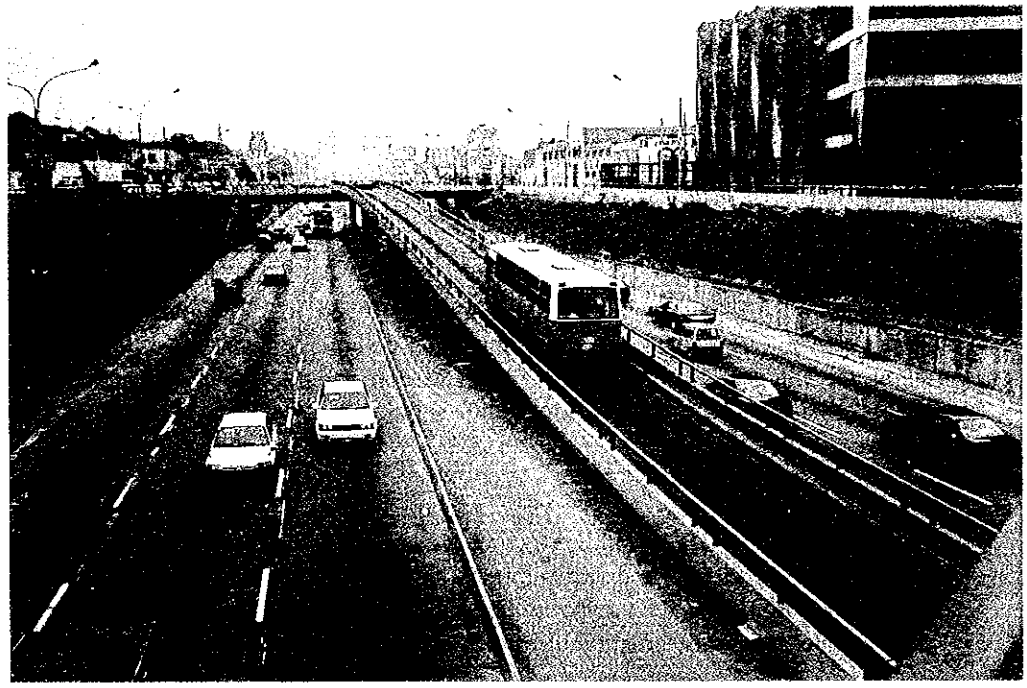
- This security issue needs to be solved urgently, and people's confidence must be recovered as soon as possible. In the 1996 survey mentioned above, a great majority (88%) of bus passengers expressed their insatisfaction regarding the security (the second insatisfaction was riding comfort at 38%). The relatively large share of taxi in person-trips in Managua at nearly 8% of motorized trips could be attributed to this reason.

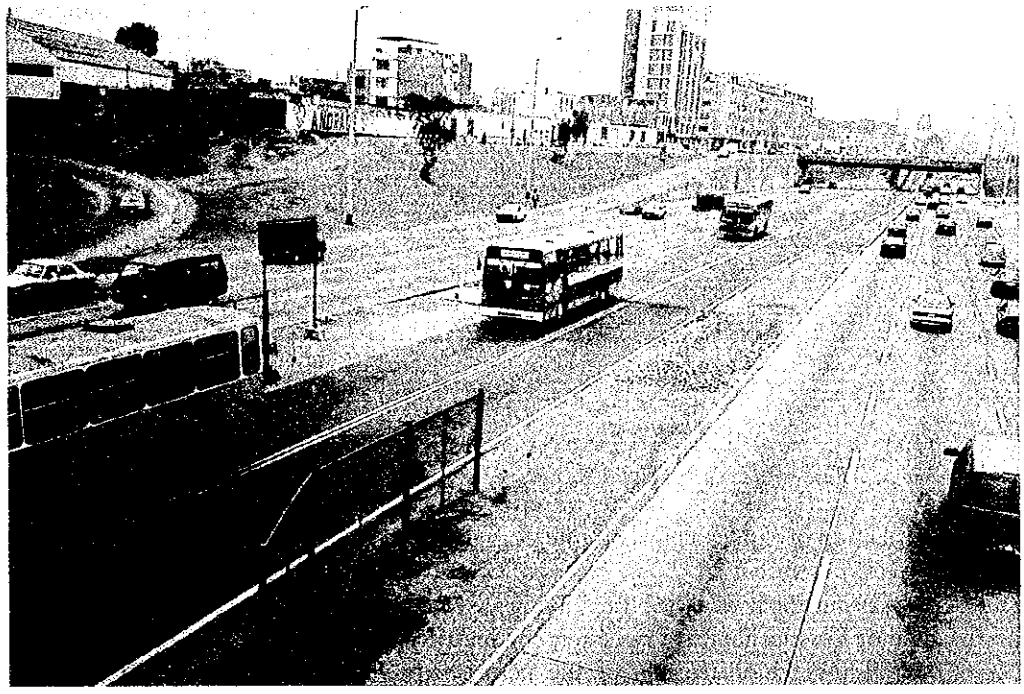
B. Rationalization of Existing Bus Routes

- There are 39 city bus routes in Managua. Their route length varies between 10 and 26 km with the average at about 18 km. However, the current route structure needs rationalization due to the following reasons:

  1. The average crow-fly distance between terminals of all the bus routes is 10 km. As compared to the average route length, it is about 45% shorter. This means that most of bus routes are extremely winding making large detours. Actually, the longer becomes the route length, the larger is the difference from the crow-fly distance (up to 3 times).

Figure 7.3.8 Exclusive Busway in Lima, Peru





2. Based on the results of interview surveys with bus operators conducted in this Study, the following figures could be obtained:

Average occupancy	36.2 passengers/bus
Average No. of passengers	741.8 passengers/day/bus
Average vehicle-kms	190 km/day/bus
Average passenger-kms	6,878 km/day/bus

Using the figures above, the average trip length of city bus passengers can be calculated at 9.3 km. However, this is considerably large compared to the city size and the average trip length obtained by the Person-Trip Survey (6.6 km including interurban passengers).

- The facts above suggests that passengers are forced to ride on the bus for unnecessarily long distance, causing huge losses both for passengers and bus operators. The current fare system of C$1.40 flat per ride may be responsible for this situation. Location of bus terminals should also be reviewed.

C. Introduction of Feeder Service

- According to the 1996 public transportation survey aforementioned, bus passengers walk to bus stops to ride on a bus 88 to 343m with an average at 228m. Although this seems to be reasonable, the problem is the walking condition in the current situation of Managua.

- Table 7.3.5 shows the variation of bus load factor by size of bus. It is clear that smaller buses are preferred to larger buses. Although further investigation is needed, there seems to exist a large possibility to start feeder services with smaller vehicles.

Table 7.3.5
Bus Average Load Factor by Vehicle Size

Seating Capacity	Number of Samples	Total No. of Passengers on Board	Ave. No. of Passengers on Board	Load Factor
- 19	253	5,526	21.8	1.37
20 – 29	1,038	22,748	21.9	1.10
30 – 39	1,853	72,722	39.2	1.01
40 – 49	2,534	95,078	37.5	0.81
50 – 59	254	8,595	33.8	0.63
60 - ...	1,010	45,645	45.2	0.75
Total	6,942	250,314	36.1	0.87

Source: Bus Occupancy Survey, 1998

D. Diversification of Public Transportation Service

- At present, most of city buses plying in Managua are not well maintained in spite of the mechanical inspection conducted periodically by MTI. This is also one of the major reasons of the poor security mentioned above. Reckless driving of bus drivers further aggravates the riding comfort as well as security for passengers.

- Actually, this situation is common to many developing countries. There is usually observed a vicious circle of low income of people, suppressed bus fare, low profitability of bus operators and worsening condition of bus units. In Managua, however, the situation seems to be considerably different. Judging from the financial vehicle operating cost (VOC) of bus (about C$600/day/unit) and average fare revenue (about C$1,000/day/unit), the bus industry is profitable as a whole. Presumably, the situation differs largely by route and by operator (based on the route statistics, the average bus-km per day per unit ranges 40 to 425).

- In order to rectify this situation as well as to upgrade the levels of service of public transportation, it is advisable to diversify the means of public transportation to give opportunities to select services to be provided both to existing operators and users. This should be, of course, conducted in conjunction with other measures proposed here. The possible diversification include:

    1. Premium bus (air-condition, all seater, etc.).
    2. Express bus.
    3. Feeder bus.
    4. Feeder collective taxi.

E. Direction of Rerouting of Buses

- Figure 7.3.9 presents the distribution of public transportation passengers in the year 1998, 2003, 2008 and 2018. In the future, the demand will grow largely, and at the same time the distribution will expand remarkably to the newly urbanized areas. The number of bus units should increase from 1998 to 2018 more than two (2) times, if the current operational characteristics is maintained in the future.

- Thus, the rerouting of buses needed in the future is basically an increase of bus routes and bus units coupled with the rationalization of existing bus routes. The existing bus operators are the beneficiaries of the rerouting, though sound competition basis must be maintained.

- Taking into account the future change of demand distribution, the desirable directions of bus rerouting will be as follows:

    1. Immediate

        - Rationalize the long-winding existing bus routes by increasing the routes connecting origin and destination more directly. The introduction of feeder bus service must be taken into account.

    2. Short-Term

        - Use efficiently the newly constructed road sections such as Pista Rural de Circunvalación.

        - Use positively the Public Transportation Corridor proposed on Carretera Norte.

    3. Medium-Term

        - Use extensively the Public Transportation Corridor proposed on Pista Juan Pablo II and Pista Sabana Grande.

        - Introduce new routes on newly constructed or widened road sections.

    4. Long-Term

        - Further introduce new routes of varied services using newly constructed roads including Travesia.

Figure 7.3.9 Future Public Transportation Demand

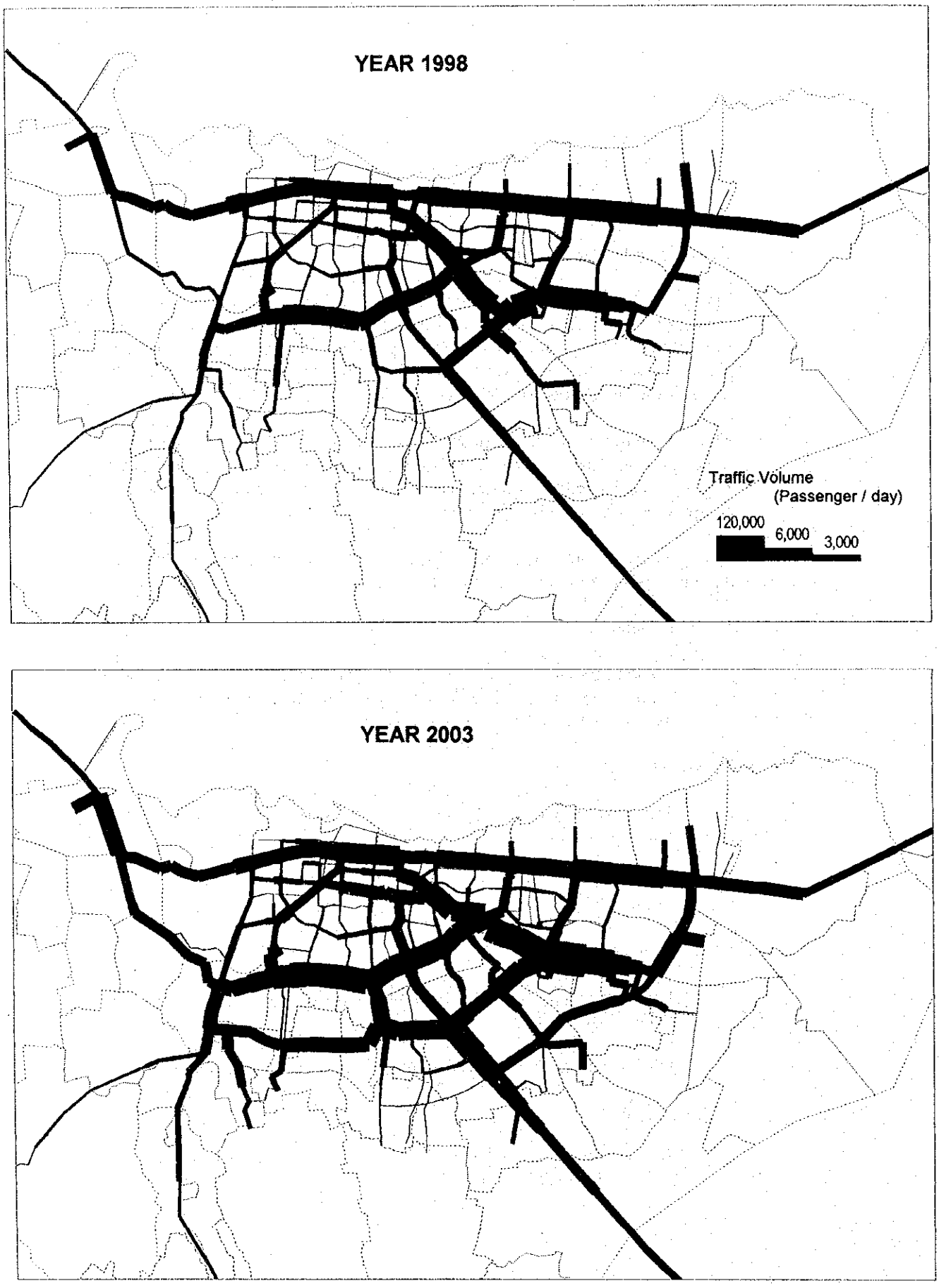
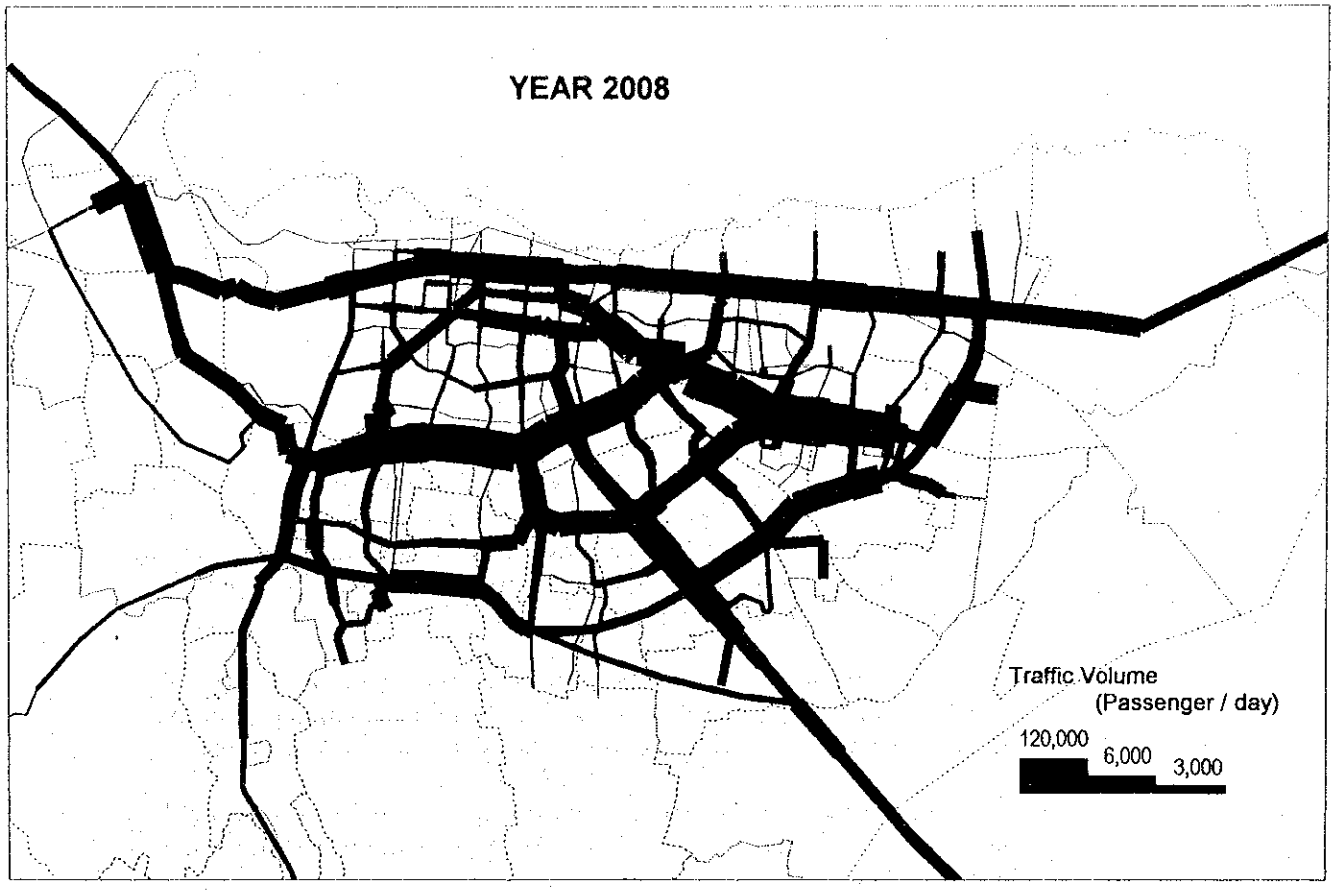
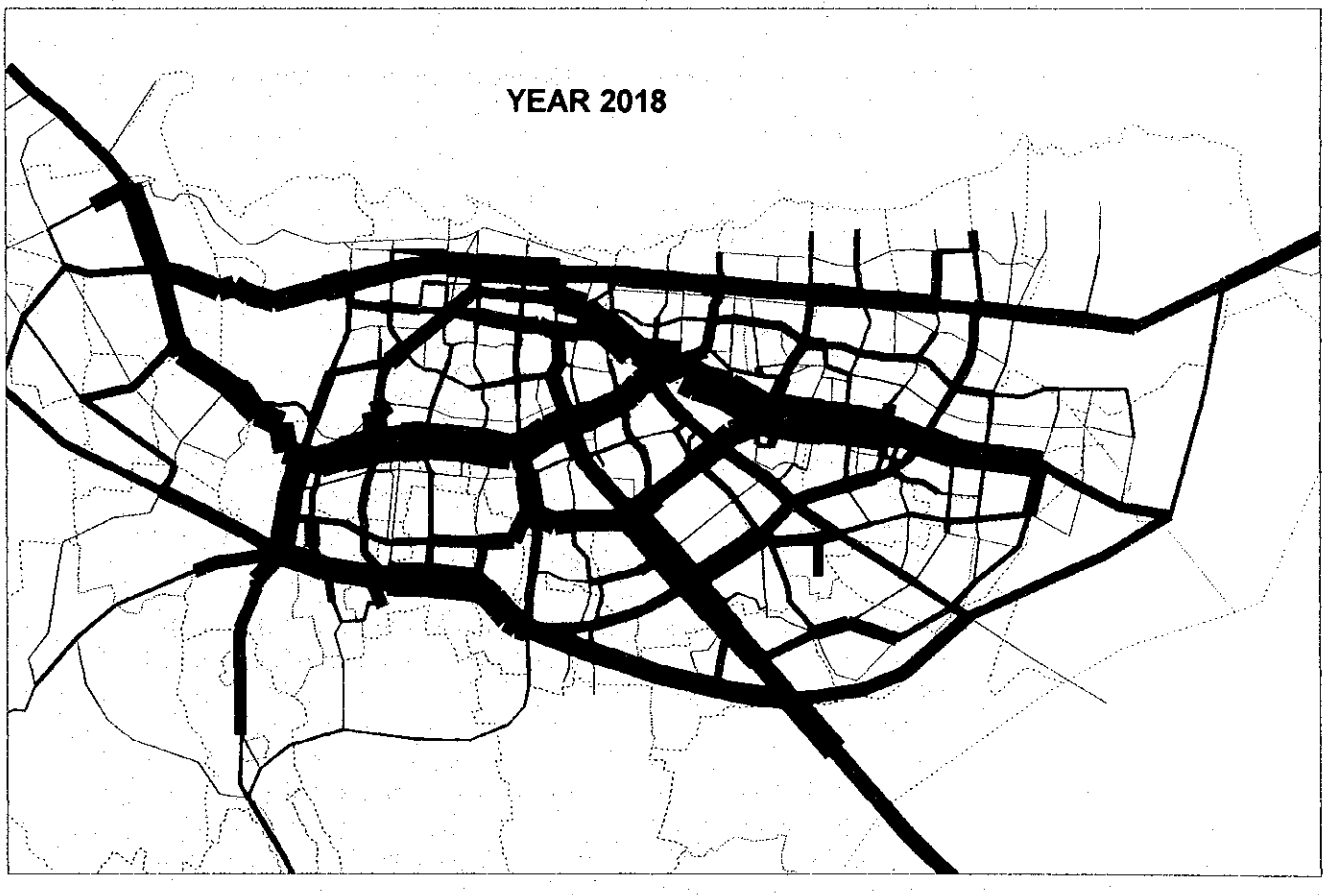


Figure 7.3.9 Future Public Transportation Demand (Cont'd)





2) Planning

A. Enhancement of Security

- Enhancement of security is an immediate action required essentially to promote the ridership of public transportation to create an efficient transit-based city.

- At present, the responsibility for the crimes in the bus is with the National Police while MTI is in charge of controlling bus operations. In order to improve the security of bus against crimes and traffic accidents, close coordination between both agencies is indispensable. However, both agencies could not have taken effective countermeasures so far due mainly to the lack of financial resources.

- The following is proposed:

  1. Against the crimes in buses, a two-man team of security guards, armed but not wearing uniforms, ride on a bus selected randomly for inspection. At first, about 400 security guards (200 teams) would have to be employed. This is equivalent to about 5 teams/route. The total cost will be the order of US$400 thousand per year, which corresponds to about 1% of the fare revenue of Managua's bus industry.

  2. To reduce the number of traffic accidents, well-conditioned bus units should be used. This is basically a matter of control and enforcement. MTI should strengthen its capacity for inspection of bus units and operation.

  3. The cost necessary for the actions proposed above should be shouldered by bus users finally. This will need a revision of the current fare structure as discussed later.

B. Public Transportation System

- Table 7.3.6 proposes the future public transportation system in Managua.

  1. Immediate Action

     a) Rerouting of existing bus routes should be conducted in order to rationalize the current long-winding route structure.

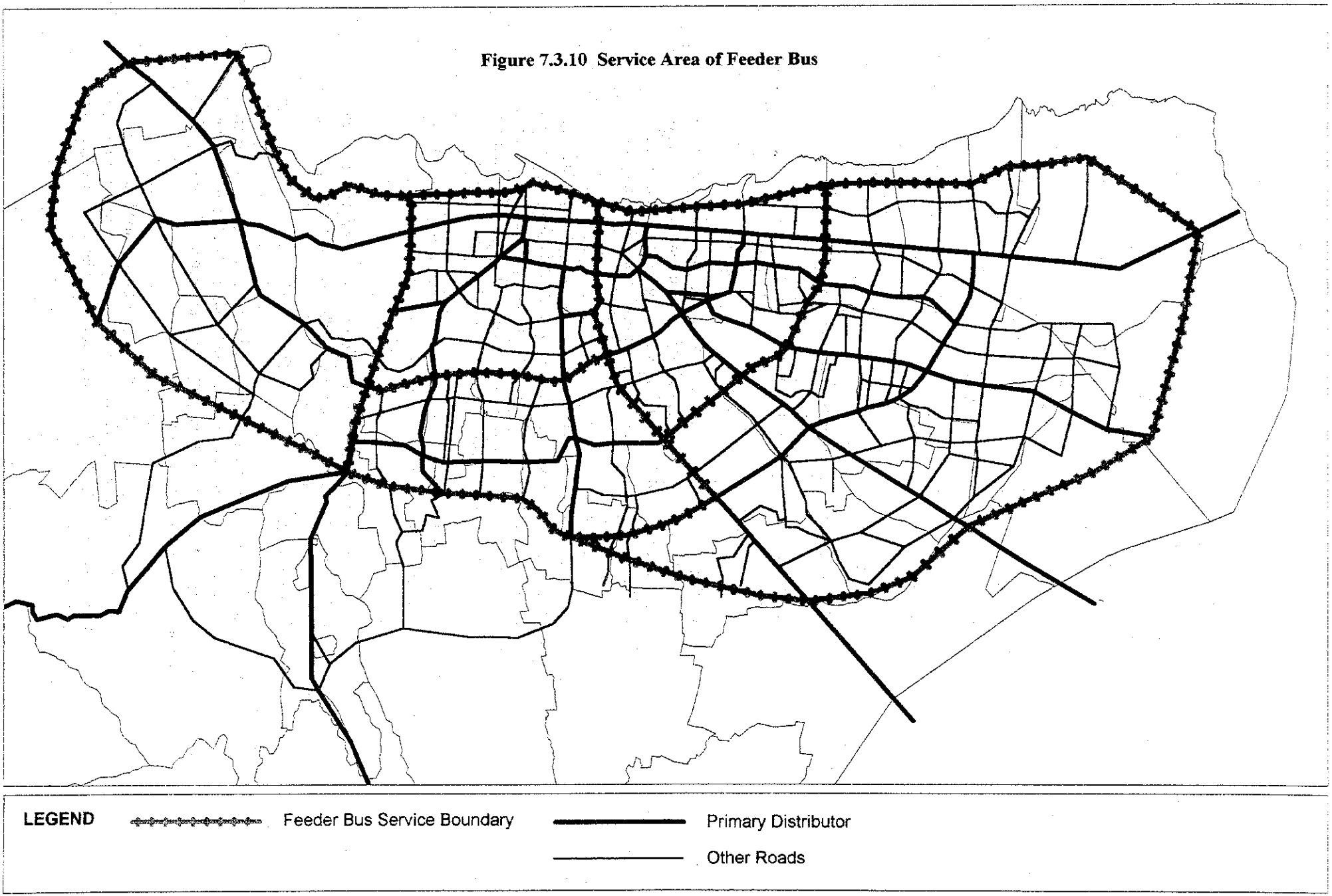
     b) In relation to the above, a new public transportation service "Feeder Bus" should be introduced. Initially, the old bus units used at present can be applied for this service, but in a few years, smaller units of a seating capacity of about 20 will replace the old units.

     c) The fare structure of the ordinary bus service should be amended from C$1.40 flat to distance related fare (e.g. C$0.50 plus C$0.40 per km). This will help rationalize the bus route structure, and, moreover, will have an effect to control the urbanization to the suburbs.

     d) The fare structure of the feeder bus service should be flat at, for instance, C$1.00. The area of this feeder service is determined tentatively as presented in Figure 7.3.10 with the following considerations:

        - Service area is segregated basically by urban axes where varied activities are to be concentrated.
        - Competition with ordinary bus route, particularly those that pass Public Transportation Corridor, is avoided.

Figure 7.3.10 Service Area of Feeder Bus



c) In the rerouting of ordinary bus routes and the introduction of new feeder bus routes, a bidding process may be adopted. MTI will invite proposals from all existing bus operators and newcomers on the intended route, service frequency, headway, operating hours, number of units, type and model year of units, maintenance facility and security measures taken. Prior to this bidding, MTI should announce the requirements such as fare, available terminals and minimum specifications on the service level. Based on the proposals, some (not only one) operators will be selected for a specific service area (a group of similar routes for ordinary bus and an area for feeder bus).

The subsequent inspection and enforcement by MTI shall be conducted based on the operators' proposals and the following negotiations between MTI and operators, if any.

f) For the proposed Public Transportation Corridors, only ordinary buses are allowed to enter at this stage.

2. Short Term Action

a) The following new public transportation service is introduced:

- Premium bus (air-conditioned, all-seater)
- Express bus
- Collective taxi

b) New routes for premium bus and express bus are determined in the same bidding process as mentioned earlier. Their fare levels, however, should be deregulated to a certain extent (e.g. with an upper limit). Minor rerouting may be necessary for ordinary buses depending on the new route proposals.

c) The service area for collective taxi is not limited since its main objective is a point-to-point transportation to flexibly meet the demand of small groups. Its fare will be determined by zone (e.g. the area determined for feeder bus), and each passenger will pay the fixed fare (e.g. C$1.50 per zone) depending on the number of zones traveled.

d) For ordinary taxis, the provision of taximeter is made obligatory. In this process, illegal taxi operation rampant at present should be controlled strictly.

e) For the designated Public Transportation Corridor, ordinary bus and newly introduced premium bus and express bus are allowed to pass.

3. Medium-Term Action

a) A comprehensive rerouting of existing bus services should be conducted in order to further rationalize Managua's public transportation system and to solve the problems inherent to the commencement of new services.

b) The levels of service of ordinary bus should be upgraded in terms of riding comfort such as air-conditioning. To support this upgrading, ordinary bus is gradually phased out from the Public Transportation Corridors.

4. Long-Term Action

a) According to the urbanization, route and fare structure of public transportation modes should be reviewed and improved. It is most important to continuously monitor the operation of public transportation and to flexibly change the rules and regulations in a timely manner, if necessary.

Table 7.3.6
Proposed Public Transportation System

Action	Premium Bus	Express Bus	Ordinary Bus	Feeder Bus	Collective Taxi	Taxi
Immediate Action						
- Operation	-	-	Existing	New	-	Existing
- Rerouting	-	-	0	-	-	-
- Fare Resetting	-	-	Distance	Flat	-	Negotiation
- PTC	-	-	0	-	-	-
Short-Term						
- Operation	New	New	Existing	Existing	New	Existing
- Rerouting	-	-	0	0	-	-
- Fare Resetting	Distance	Distanc e	Distance	Flat	Zone	Meter
- PTC	0	0	0	-	-	-
Medium-Term						
- Operation	Existing	Existing	Existing	Existing	Existing	Existing
- Rerouting	0	0	0	0	-	-
- Fare Resetting	Distance	Distanc e	Distance	Flat	Zone	Meter
- PTC	0	0	-	-	-	-
Long-Term						
- Operation	Existing	Existing	Existing	Existing	Existing	Existing
- Rerouting	0	0	0	0	-	-
- Fare Resetting	Distance	Distanc e	Distance	Flat	Zone	Meter
- PTC	0	0	-	-	-	-

Note: 1) PTC: Public Transportation Corridor

7.3.4 Improvement of Public Transportation Terminals

1) Guidelines

A. Improvement of Passengers' Convenience and Comfort

- At present, there are 45 bus terminals in Managua. Out of 45 terminals, 4 are interurban, 3 are both interurban and urban, and the remaining 38 are urban. Out of the 38 urban terminals, 11 are merely turning circuits using the existing roads and the remaining 27 are merely vacant lots or roadside space without passenger facilities.

- According to the bus passenger interview survey conducted by this Study, 40% passengers pointed out as No.1 problem of bus terminal "dirtiness" and 36% "poor outside access". It is important to improve urban bus terminals in terms of location and passenger facility.

B. Enhancement of Bus Operators' Efficiency

- As discussed in the previous section, the current bus route structure is unusual. This may be partially due to the scattered location of bus terminals where each bus operator (cooperative) could find an available land.

- As urbanization proceeds, it will become difficult for bus operators to find or maintain a land area suitable for bus terminal. Moreover, on-road bus terminals which accounts for 24 at present should be removed in the near future.

- If integrated bus terminals are constructed in proper location, most bus operators will be benefited.

C. Rationalization of Public Transportation Industry

- When bus transportation service is reorganized as proposed in the preceding section, Government should take the initiative to construct new bus terminals as a part of its responsibility.

- The Government is also benefited by easier monitoring and control on bus operation.

- Fortunately, there is an existing public organization called COMMEMA (Corporación Municipal de Mercados de Managua), which operates bus terminals (mainly interurban) in addition to public markets. It is ideal if COMMEMA could expand its activity to cover urban bus terminals in coordination with MTI.

2) Planning

A. Location of Public Bus Terminal

- Most of urban bus terminals are merely an end of a route at present. If all the route ends are to be integrated into a limited number of public terminals, this regulation will not only cause an intolerable inconvenience for bus passengers but require a huge public investment for the construction of terminals. Therefore, it is not recommended to accommodate all bus route ends on both sides (origin and destination) in public bus terminals to be constructed.

- At present, there are 7 interurban bus terminals in Managua of which 5 are located in or adjacent to the markets operated publicly by COMMEMA. Although urban buses also use 3 of these terminals, their role is minimal due to the small space allocated to them. Thus, while interurban bus terminals are relatively well organized supported by the public sector, interconnection between interurban and urban bus services is not sufficiently provided.

- Based on the discussions above, the following is proposed:

  1. Construct 6 public bus terminals, one each for each service area of feeder bus (see Figure 7.3.10). The proposed location is shown in Figure 7.3.11.

     A. Mercado Oriental.
     B. Mercado San Judas.
     C. Mercado Virgen de Candelaria.
     D. Villa Flor.
     E. Sabana Grande.
     F. Ciudad Satélite Asososca.

     The former three (3) terminals will be constructed in parallel to the redevelopment and expansion of the existing markets.

  2. The proposed public bus terminals will accommodate all bus services; i.e. interurban (ordinary and express) and urban (ordinary, express, premium and feeder). The size of public bus terminal is supposed to be about 1 ha on the average (30 berths and 30 parking spaces).

  3. Existing interurban bus terminals should be used to the maximum extent. However, the terminals currently operated by COMMEMA should be improved or expanded in order to accommodate various types of bus services.

  4. Each bus operator should pay the terminal charge to the terminal operator (possibly COMMEMA) depending on the facility they use and the number of departures. The terminal charge, however, should be set at a low level (particularly for urban buses), because the market itself will be benefited by the concentration of bus passengers.

B. Phasing of Public Bus Terminal Construction

- Short-Term: Mercado Oriental.

  This is needed urgently. Mercado Oriental is the largest source of trip generation and attraction at present. A large number of buses are concentrating in this area, and the turning circuits scattered in the vast area of this market are one of the major reasons of the traffic mess in the area. Presumably, 2 or 3 separate public bus terminals will be required in this area. This, however, depends on the design of market redevelopment.

- Medium-Term: Mercado San Judas and Mercado Virgen de Candelaria.

  These two terminals are both in or around the existing markets. Bus terminals and markets are usually dependent with each other. When the markets are renovated and expanded, which is considered inevitable as population increases, the proposed public bus terminals would preferably be taken into account by COMMEMA.

- Long-Term: Villa Flor, Sabana Grande and Ciudad Satélite Asososca.

  These three terminals should be constructed in accordance with future urbanization and development of markets.

C. Construction Cost of Bus Terminals

- Using the unit cost of US$0.75 million/ha which was estimated based on the cost of the newly constructed interurban bus terminal in Mercado Mayoreo (see Appendix 7), the cost of the proposed public bus terminals was estimated as follows:

Short-Term	Mercado Oriental (1 ha x 2)		US$1.50 million
Medium-Term	Mercado San Judas (1 ha)		0.75
	Mercado Virgen de Candelaria (1 ha)		0.75
	Sub-Total		1.50
Long-Term	Villa Flor	(1 ha)	0.75
	Sabana Grande	(1 ha)	0.75
	Ciudad Satélite Asososca	(1 ha)	0.75
	Sub-Total		2.25
	Total		US$5.25 million

The estimated cost above does not include land acquisition. If it is included, the cost for medium-term will rise by about US$0.2 million and for long-term by about US$0.15 million. It is recommended for the Government to acquire land while it is cheap.

- The construction of public bus terminal seems to be self-financing judging from the following hypothetical calculation:

Cost of Construction (1 ha.)	US$0.75 million
Revenue from terminal charge	US$0.23 million/ year
Assuming C$5/departure (average)	
No. of berths	30
No. of departures/berth/day	50
No. of operating days/year	310

Note: Terminal charge for departure of interurban bus is C$25-30 at present (Mercado Mayoreo, bound for Matagalpa)

Figure 7.3.11 Proposed Location of Public Bus Terminal