

COMPREHENSIVE
TRANSPORTATION PLAN
IN THE MUNICIPALITY OF
MANAGUA
IN THE REPUBLIC OF
NICARAGUA

Final Report
Executive Summary

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March 1999

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PREFACE

In response to a request from the Government of the Republic of Nicaragua, the Government of Japan decided to conduct a master plan study on the Comprehensive Transportation Plan in the Municipality of Managua and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Takashi Shoyama of ALMEC Corporation and consist of ALMEC Corporation and Yachiyo Engineering Co. Ltd. to Nicaragua, two times between January 1998 and December 1998.

The team held discussions with the officials concerned of the Government of Nicaragua and conducted field surveys in the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Nicaragua for their close cooperation extended to the study team.

March 1999



Kimio Fujita

President

Japan International Cooperation Agency

March 1999

Mr. Kimio Fujita
President
Japan International Cooperation Agency

Letter of Transmittal

Dear Sir,

We are pleased to formally submit herewith the final report of "The Comprehensive Transportation Plan in the Municipality of Managua in the Republic of Nicaragua".

This report compiles the results of the study which was undertaken both in Nicaragua and Japan, from January 1998 to February 1999 by the study team, organized jointly by ALMEC Corporation & Yachiyo Engineering Co. Ltd.

We owed a lot to many people for the accomplishment of this report. First, we would like to express our deep appreciation and sincere gratitude to all those who extended their kind assistance and cooperation to the study team, in particular, the Municipality of Managua, Ministry of Transport and Infrastructure and other government agencies of Nicaragua.

We also acknowledge the officials of your agency, the JICA Advisory Committee and the Embassy of Japan in Nicaragua.

We wish the report would contribute to Managua's transportation development in the future.

Very truly yours,



Takashi Shoyama
Team Leader,
The Study Team for
Comprehensive Transportation
Plan in the Municipality of
Managua in the Republic of
Nicaragua

EXECUTIVE SUMMARY

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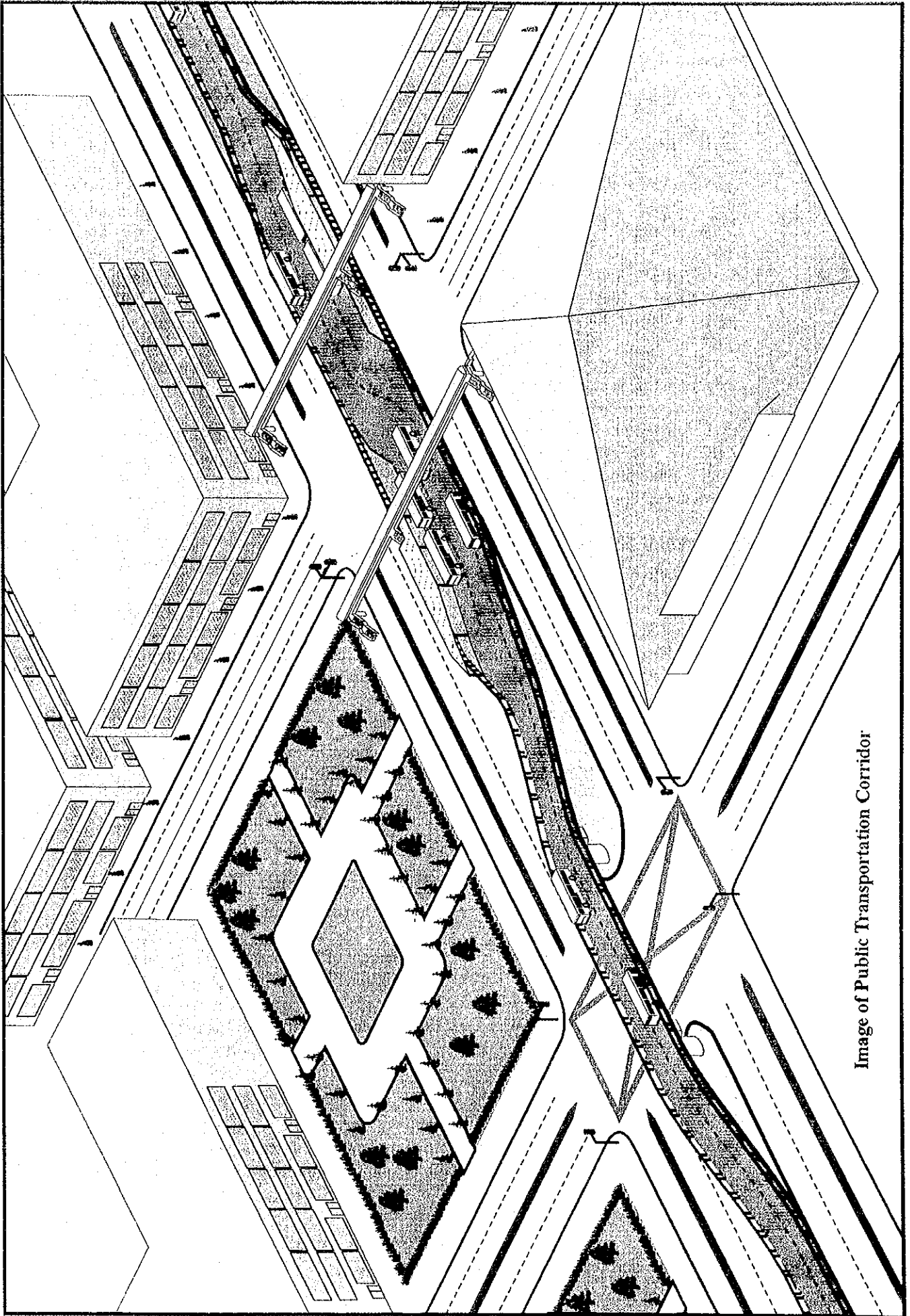


Image of Public Transportation Corridor

1. INTRODUCTION

Background of the Study

- A devastating earthquake hit and destroyed the Municipality of Managua (hereafter referred to as Managua) in 1972. Since then, disorderly urbanization of low rise buildings went on towards the suburbs and the damaged city center was left untouched. Furthermore, a civil war occurred in 1979 between the Sandinista government and the Contras supported by the US government and it continued until the cease-fire in 1990. During this period, Nicaragua's economy was strangled and its negative growth continued till 1993. Nicaragua's social and economic restoration has started only a few years ago.
- Under these circumstances, various urban transportation problems have been actualized in Managua. Due to the insufficiency of existing plans and schemes, the government of Nicaragua requested the Japanese government to conduct a master plan study to improve the transportation network in Managua. The Japanese government, in response to this request, dispatched a preparatory study team to Nicaragua in September 1997 and the scope of work for the study has been signed by both governments.
- Accordingly, Japan International Cooperation Agency (hereinafter referred as "JICA"), the official agency responsible for the implementation of technical cooperation programs of the Government of Japan, has undertaken the Study in close cooperation with the authorities in Nicaragua.

Objectives of the Study

- The objectives of the Study are as follows:
 - 1) To formulate a master plan on comprehensive urban transportation system including road and public transportation network (Target Year 2018).
 - 2) To transfer technology in relation to data processing and planning to the counterpart staff of Nicaragua during the course of the Study.

Study Schedule

The Study commenced in January 1998 and ended in February 1999 with a total duration of 14 months. The Study is divided into the following stages:

Stage I (January-March, 1998)	<ul style="list-style-type: none">• Data collection through surveys• Submission of Progress Report
Stage II (May-July, 1998)	<ul style="list-style-type: none">• Basic concept and directions of Master Plan• Submission of Interim Report
Stage III (August-December, 1998)	<ul style="list-style-type: none">• Refinement of Master Plan and Recommendations• Submission of Draft Final Report
Stage IV (January-February, 1999)	<ul style="list-style-type: none">• Refinement of Draft Final Report• Submission of Final Report

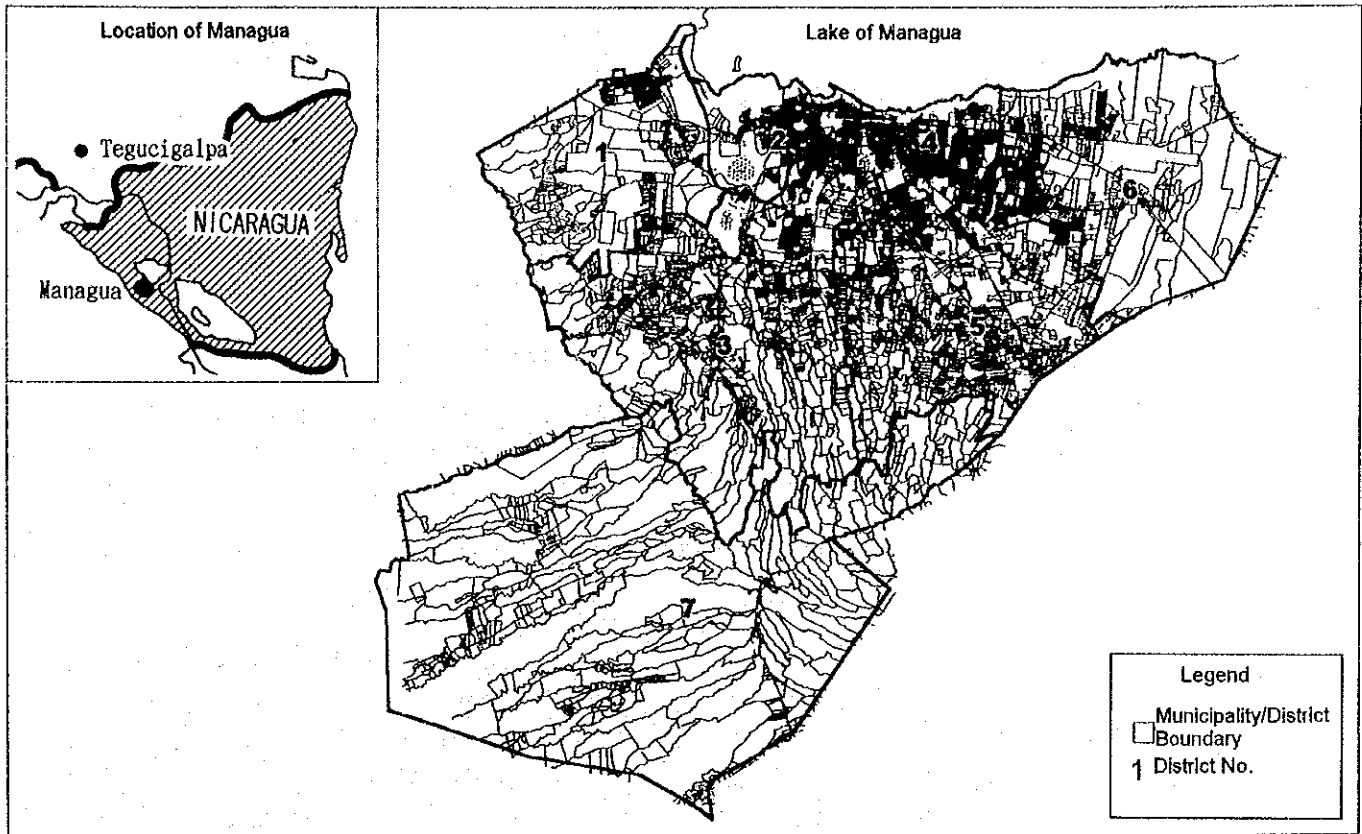
Study Organization

JICA assigned the JICA advisory Committee and the JICA Study Team for the study on the Japanese side. The municipal government of Managua established the Consultative Committee, the Coordination Committee and the Counterpart Team on the Nicaraguan side.

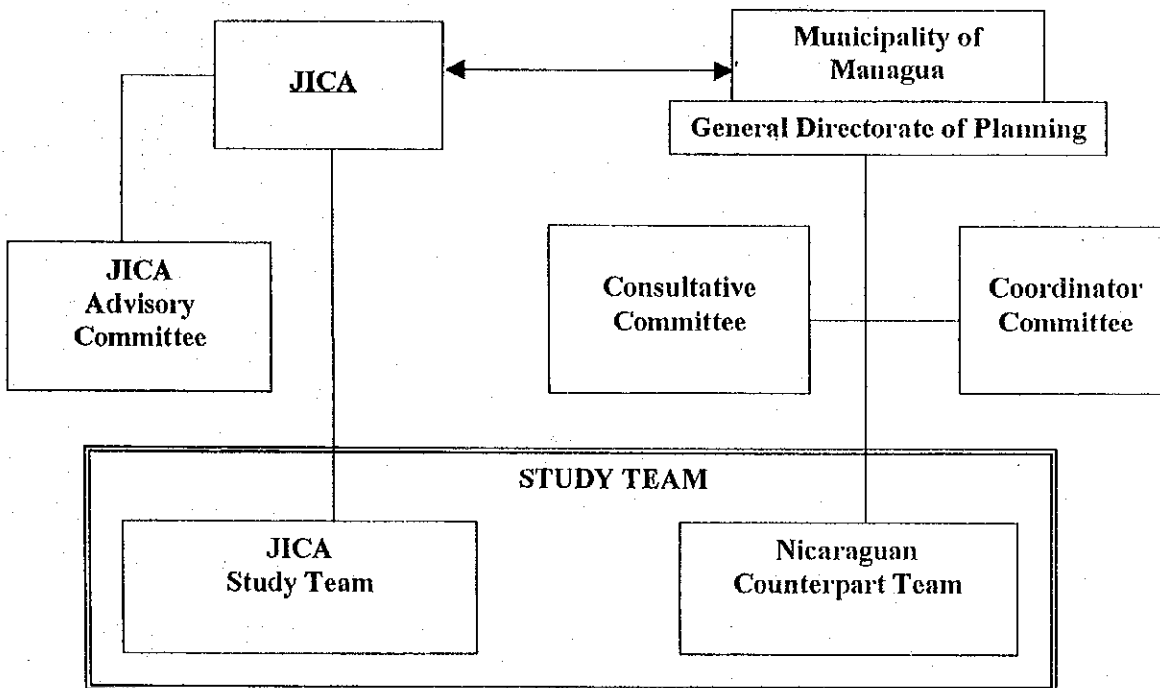
Study Area

The study area is the entire municipality of Managua.

Study Area



Study Organization



2. PRESENT URBAN TRANSPORTATION SITUATION IN MANAGUA

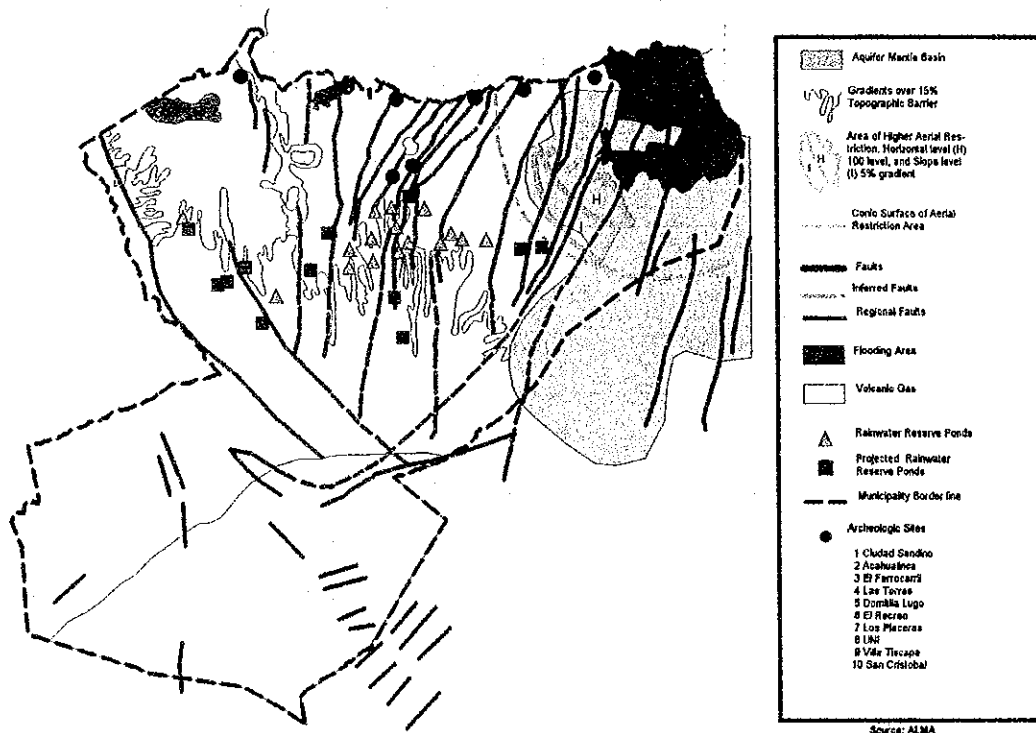
2.1 Natural Condition and Land Use

- Managua, with an area of about 3,465 square kilometers, is the capital of Nicaragua. It is located along the southern shore of the Managua Lake and its urbanized area is approximately 250 square kilometers.

Earthquake

- Managua City was hit and destroyed by two major earthquakes in March 1931 and December 1972. Earthquake is a very critical issue in this region and has negative impact on social and natural environment, and of the City development. Most of the earthquakes in Nicaragua have been observed around the Pacific Lowlands Area. In Managua, a number of active and inferred faults are found.
- Judging from the situation, the conditions of Managua for development are not ideal. Particularly in relation to earthquake, some preventive measures should be considered in land use and city planning in the future.

Physical Constraint Factors in Managua



2.2 Socio-Economic Profile of Managua

Population and Employment

- The population of Managua in 1998 is estimated at 1.2 million, 24.2% of the national total. The number of viviendas (houses) is 192 thousand and the average number of persons per vivienda is 6.25.
- Out of the total labor force of 454 thousand, employed are 357 thousand (78.8%) and unemployed 96 thousand (21.2%). Of the total employed persons, 349 thousand (97.6%) have a workplace in Managua and its compositions are, primary sector 1.2%, secondary sector 21.0% and tertiary sector 77.8%.

Average Vivienda Income and Car Ownership

- Average vivienda income of Managua's residents is C\$2,470 per month. Average car ownership for Managua is about 20% in terms of number of viviendas. On average, one car is owned by 43 population.
- Car ownership has a strong relationship with income level. Car ownership increases as income grows. For the viviendas with an income of C\$4,000 per month or more, it seems to be natural to own a car.

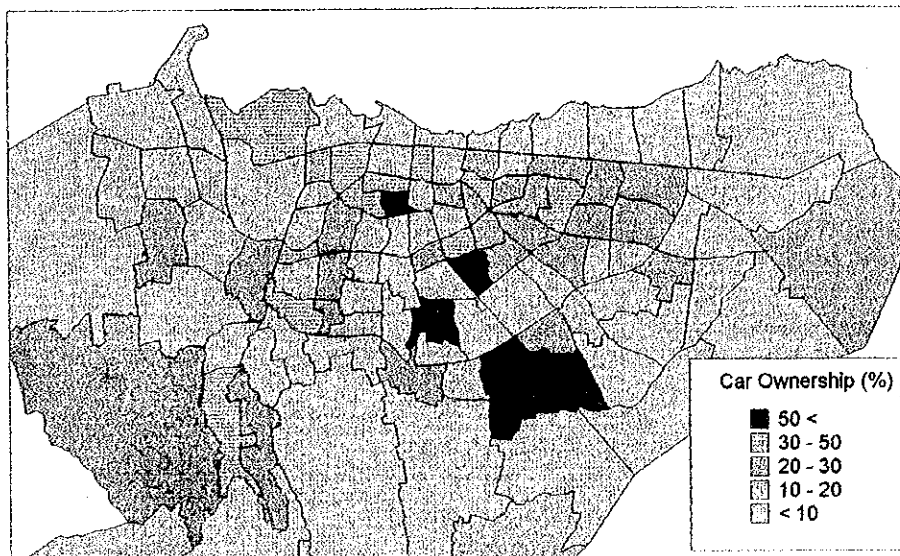
Socio-Economic Profile of Managua, 1998

Indicators	Managua	
Population: 000	1,200	
No. of Viviendas: 000	192	
Average Vivienda Size	6.25	
Employment: 000 (%)	349.3	(100.0)
Primary	4.1	(1.2)
Secondary	73.5	(21.0)
Tertiary	271.7	(77.8)
No. of Students/Pupils: 000	413.3	
Average Income/Viviendas: C\$/month	2,470	
Car Ownership		
Car Owning Vivienda: %	19.9	
No. of Registered Vehicles (incl. motorcycle): 000	51.5	
Ownership Rate: No./000 pop.	43	

Source: Person-trip survey (1998) and various official statistics

Note: Employment and school attendance are at workplace and school place, respectively.

Car Ownership of Managua by Zone, 1998



2.3 Transportation Demand

Number of Trips

- In 1998, the total number of trips generated in a weekday in Managua was about 2.5 million of which 95.8% were made by residents in Managua and the remaining 4.2% by non-residents. About 2.3 million trips or 94% were those that move inside Managua, while 160 thousand trips or 6% move crossing the boundary of Managua. Although the share is low, those inter-city trips have a considerable influence on the traffic situation of Managua because all of them are motorized without any walk trips.

Trip Generation and Attraction

- Trip generation (excluding "To Home" trips) is large in the south-eastern part of the urbanized area of Managua. Ciudad Sandino and some other densely populated zones also have a large generation. Regarding the trip attraction (excluding "To Home" trips), more than 100 thousand trips are attracted to Mercado Oriental.

Distribution of Traffic Demand

- "To Work" trips concentrate in the existing commercial area of central Managua including Mercado Oriental and Mercado Roberto Huembes. The zone of Mercado Oriental attracts the largest number of "To Work" trips at 42,400 per day. "To School" trips generally have a short travel distance because most of primary and secondary school pupils go to school within the residing zone. Attraction of this trip is large in the zones where large universities exist. In some urban zones, "To School" trips to the adjacent zones are remarkable.

Modal Share

- In Managua, private mode shares 36.5% and public mode 35.1%. The remaining 28.4% is by non-motorized modes such as walk and bicycle. Of the private mode, car shares nearly 80%, and bus is actually the only choice of the public mode. Namely, the modal choice in Managua is simple, i.e. car or bus.

Number of Person Trips by Mode of Transportation (Managua's Residents), 1998

Mode	No. of Trips (000)	% to Mode	% to Total
Private Mode	858.7	100.0	36.5
Passenger Car	679.6	79.1	28.9
Truck	12.0	1.4	0.5
Taxi	131.8	15.4	5.6
Motorcycle	35.3	4.1	1.5
Public Mode	826.6	100.0	35.1
Bus	806.0	97.5	34.2
Micro Bus	16.1	2.0	0.7
Passenger Truck	4.5	0.5	0.2
Other Modes	667.9	100.0	28.4
Walking	638.3	95.6	27.1
Bicycle	25.7	3.8	1.1
Others	3.9	0.6	0.2
Total	2,353.3	-	100.0

Source: Person Trip Survey, 1998

Note: 1/ "Truck" includes "Heavy Truck" and "Trailer".

2/ "Taxi" is classified as private mode.

3/ "Passenger Truck" and "Micro Bus" are institutionally city buses.

2.4 Roads and Road Traffic

Road Network

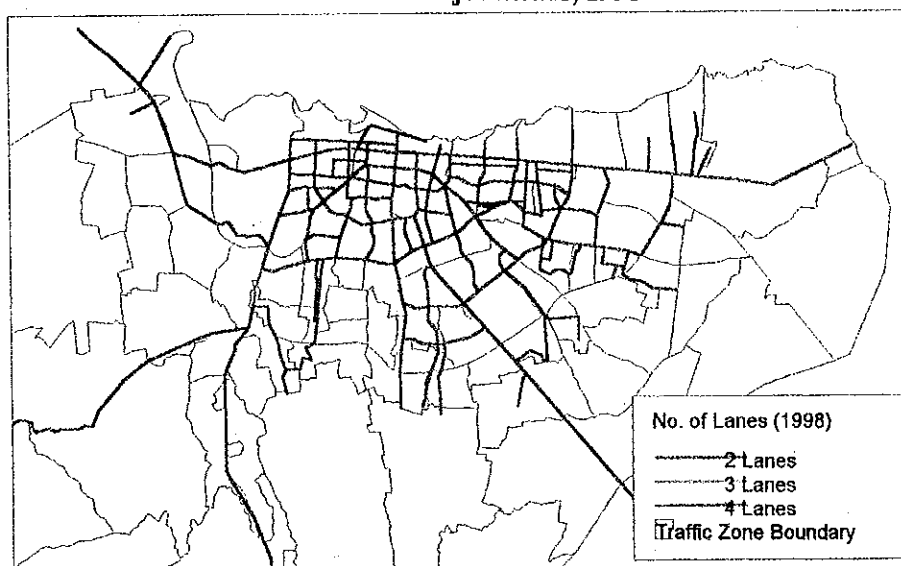
- The total road length in Managua is estimated at approximately 1,100 km at present. It is composed of 4-lane and 2-lane roads. Most of major arteries are of 4 lanes in urban area but there are still many 2-lane road sections that should constitute the basic network.

Road Length by Class, 1998

Road Class	Length: km	% to Sub-Total	% to Total
Travesia	4.52	3.0	0.4
Primary Distributor	93.29	61.8	8.4
Primary Collector	34.70	23.0	3.2
Secondary Collector	18.35	12.2	1.6
Sub-Total	150.86	100.0	13.6
Local Road	957.86	-	86.4
Total	1108.72	-	100.0

Source: Alma

No. of Lanes of Major Roads, 1998



Road Traffic

- The most heavily trafficked road section is Pista Pedro Joaquín Chamorro with a traffic volume of about 55 thousand vehicles per day. Pista Juan Pablo II, Ave. Ruben Darío and Pista Portezuelo also show a large traffic volume of about 30 to 45 thousand vehicles. In a few sections, volume/capacity ratio exceeds 1.0.

Traffic Volume on Major Roads, 1998 (24 hours)



2.5 Public Transportation System

Bus

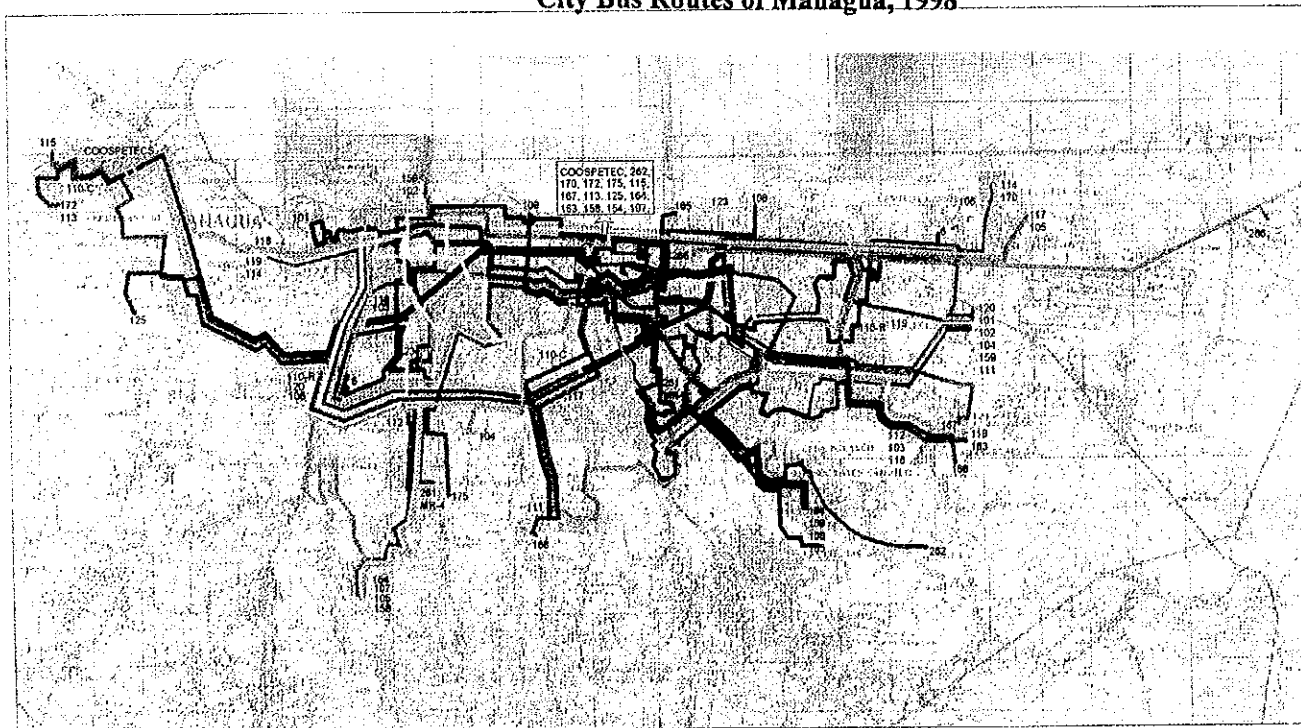
- Bus is the only mode of public transportation in Managua. There are 39 city bus routes, at present. Most of the major arteries of Managua are serviced by city bus. The interurban arteries such as Carretera a Masaya, which are not serviced by city bus, are covered by inter-city bus services. Generally, the service network of city buses is dense in the urbanized areas, while the newly developing outer areas have a poor access to bus service. The average length of bus route is about 18 km, ranging from 10 km to 26 km.
- Scheduled speeds of buses are ranging from 17 to 23 km/h. The service hours vary by route but typically from 5:00 am to 22:00 pm. Average occupancy and load factor are 36.2 passengers per bus and 87%, respectively.

City Bus Operational Characteristics, 1998

Number of Operating Units	930 units (85.6% to the total of 1,087)
Average Seating Capacity	46 passengers/veh. (ranging from 17 to 64)
Average Operating Days	6.6 days/week
Scheduled Speed	17-23 km/h
Service Hours	Varies by route but typically from 5:00 am to 10:00 pm.
Headway	1-15 min. (some routes have a fixed headway)
Occupancy (Load Factor)	36.2 passengers/bus (87%)

Source: MTI and JICA Study Team

City Bus Routes of Managua, 1998



Taxi

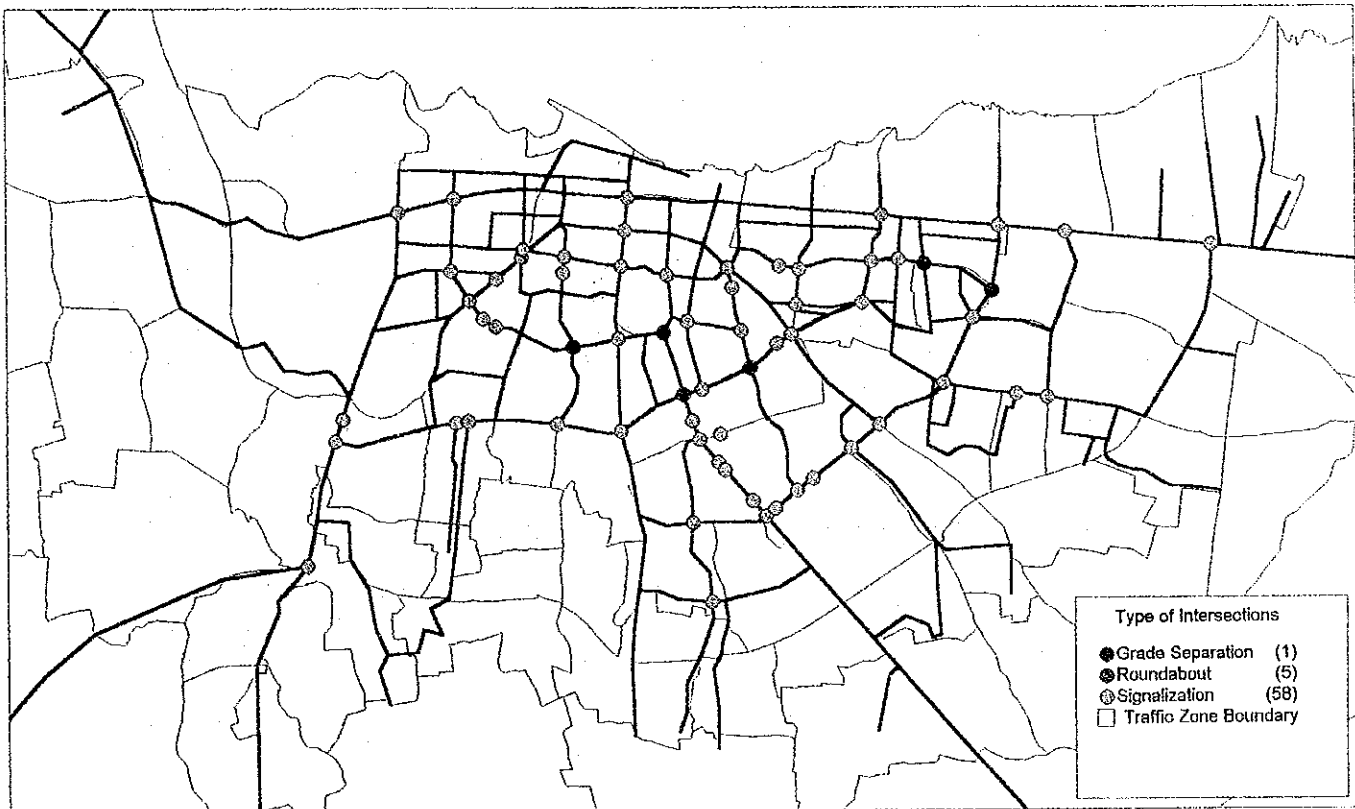
- Taxi is available and useful in Managua. According to the result of taxi survey, about 76% of taxi vehicles is owned by driver. On average, one taxi makes 32 paid trips running 274 km a day. Gross daily income is around C\$300 and the net income is around C\$120 a day after various expenditures. The drivers usually work six days a week for 10 hours a day.

2.6 Traffic Management and Traffic Safety

Traffic Management

- In Managua, there are approximately 180 intersections on the existing arterial network, including primary distributors, primary and secondary collectors. Out of 180 intersections, only one intersection is provided with an underpass structure, five intersections are roundabouts and 58 intersections are signalized. Others are operated with “Stop” signs on minor traffic flow directions.
- The present signal operation in Managua applies the pre-timed control system. It is a conventional system not sufficient to control heavy traffic demand on the major roads.
- According to the signal and traffic sign survey of the Study, most of the signals are well maintained but insufficient signal phasing plan was observed at some intersections.

Control Type of Major Intersections in Managua, 1998



Traffic Safety

- During last five years from 1993 to 1997, a total of more than 30 thousand traffic accidents have occurred in Managua. Managua has the highest share at nearly 70% of the national total. In 1997, the number of deaths accounted for 134.
- In the urban area of Nicaragua, the major causes of traffic accidents occurred in 1997 are specifically “incorrect turns” (28%), “failure to keep enough distance”(15%), “failure to stop” (12%) and “intercepting right-of-way” (11%).

Number of Traffic Accidents in Managua

Year	1993	1994	1995	1996	1997	93-97
Managua	5,903	6,312	6,283	5,818	6,897	31,215
% to total Nicaragua	73.2	71.6	69.8	66.2	66.2	69.2

Source: National Police

3. URBAN TRANSPORTATION POLICIES

3.1 Overview of Managua's Urban Transportation

- 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. 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 road 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.
- 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.
- 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 the current severe constraints in Government budget. Within these constraints, the plan could maximize the benefits of the people.

3.2 Urban Transportation Strategies

Policy Goals of Managua

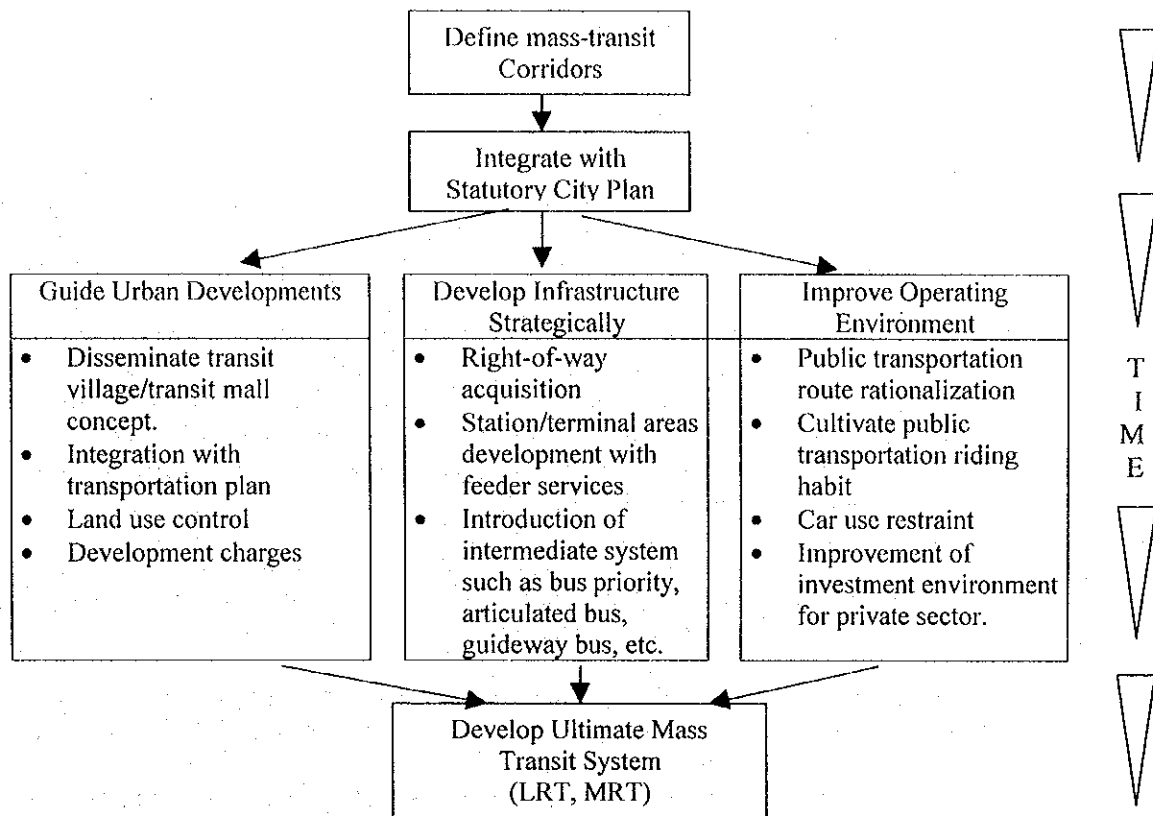
- Understanding that transportation is only a component of urban systems and their interactions are always significant, the sustainability of urban transportation can be ensured only when transportation development contributes to the sustainability of the City as a whole. Therefore, at first, policy goals of urban development for Managua 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. 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 should be ready to tackle the situation.
 - 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.

Transportation Strategies

- In line with the policy goals determined above, the following broad strategies have been identified for the transportation of Managua:
 - 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 still has a good chance to achieve the envisioned goal. 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.

Approach to Promoting Public Transportation-Based City



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 countries. 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.

c) 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.

4. FUTURE TRANSPORTATION DEMAND

4.1 Socio-Economic Framework

- The population of Managua as of 1998 is estimated at 1.20 million which shares 24.2% of the national total. Assuming that this share is maintained at the same level, future population of Managua is projected. 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.
- Managua's GRDP can be estimated by multiplying labor productivity with employment by sector. 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. Future projection was made, in consistency with the national economy, on the following assumptions:
 - 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.
- As economy grows, economically active population will grow as well as the demand for labor force. In the Study, the current unemployment rate of 21.2% was projected to decline continuously to 6.1% in 2018.
- 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. By 2018, the number of students/pupils in Managua including those from outside will increase by more than 90%.
- Future income per vivienda was estimated in proportion to GRDP per capita. Future car ownership which has a strong correlation with the income level will grow from 20% in 1998 to 41% in 2018.

Future Socio-Economic Framework of Managua

	1998	2003	2008	2018	Growth Rate (% p.a.)		
					98-03	03-08	08-18
Population (000)	1,200	1,384	1,574	1,964	2.9	2.6	2.2
No. of Viviendas (000)	192	221	252	314	2.9	2.6	2.2
GRDP (US\$ million)	745	977	1,287	2,250	5.6	5.7	5.7
GRDP per Capita (US\$)	620	710	820	1,150	2.7	2.9	3.4
Economically Active Population (000)	454	547	645	864	3.8	3.4	3.0
Unemployment Rate (%)	21.2	19.4	15.9	6.1	-	-	-
No. of Students/Pupils (000)	413	501	594	800	3.9	3.5	3.0
Car Ownership (%)	19.9	23.9	27.5	40.5	-	-	-
Average Vivienda Income (C\$/month, 1998 price)	2,470	2,840	3,260	4,570	2.8	2.8	3.4

4.2 Future Traffic Demand

Forecast Methodology

- Prior to forecast traffic demand in the future, a set of models were developed based on the results of the 1998 Person-Trip Survey. They are the four-step conventional models, i.e. Trip Generation/Attraction Model (including Trip Production Model), Trip Distribution Model, Modal Split Model and Traffic Assignment Model.

Alternative Urban Development Scenarios

- As the city size becomes compact, the efficiency of urban activities becomes high, while the cost of urban redevelopment and vulnerability against earthquake will be remarkable. On the other hand, if urbanization expands without control, the cost of developing urban infrastructure will be enormous, while existing built-up area can be left untouched. In this Study, the following three (3) scenarios with different urban areas and population density were compared in terms of transportation network performance using the models developed for this purpose:

Scenario I Mono-Polar High-Density Development which assumes a compact city with the present CBD and a large-scale redevelopment in the existing built-up area.

Scenario II Extended Low-Density Development which is actually the extension of current urbanization with scattered functional distribution.

Scenario III Corridor Controlled Development which assumes a planned urbanization with determined urban axes and urban redevelopment in critical areas.

- Based on the results of application of the demand forecast models, Scenario I is the most effective and efficient in terms of network performance. However, this scenario assumes a very high population density in the long-term and requires urban redevelopment of about 4,000 ha. Scenario 2 shows a poor performance and requires an investment on transportation infrastructure 66% higher than Scenario I.
- Considering the network performance, required cost and reality, Scenario 3 was selected as the most realistic and desirable direction to be pursued in the long-term. In the short to medium-term, however, the concept of Scenario I was taken into account due to its excellent network performance.

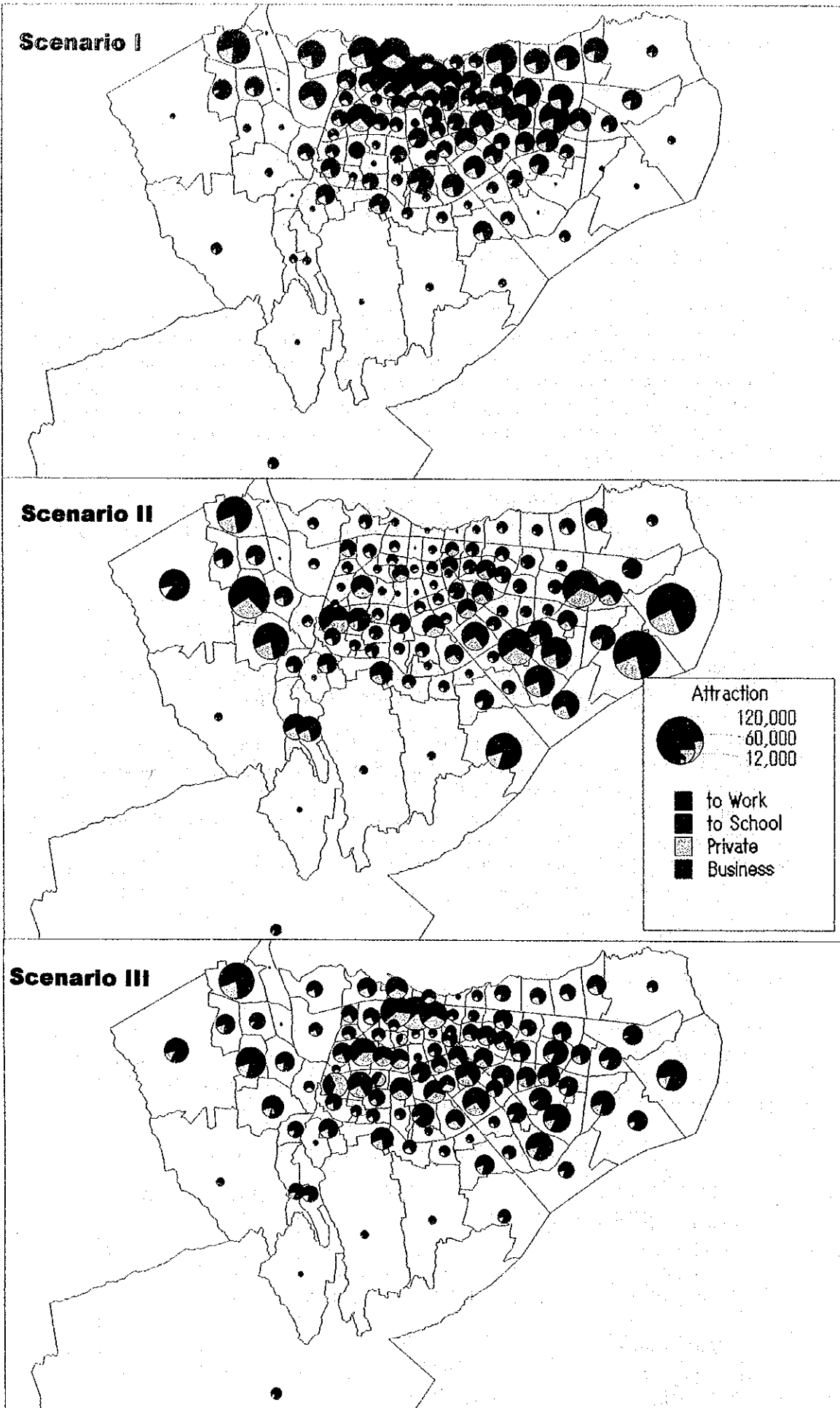
Future Traffic Demand

- For the selected urban development scenario, future traffic demand was projected. Total number of trips will increase from 1998 by 34% in 2003, by 58% in 2008 and by 119% in 2018. 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%.

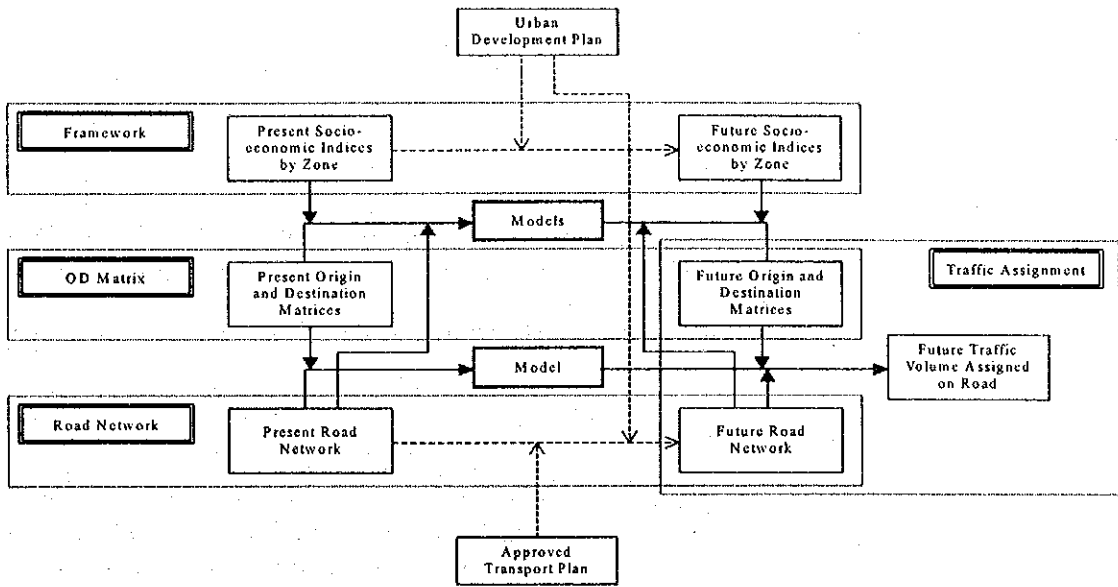
Future Traffic Demand (excluding Walk Trips)

	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

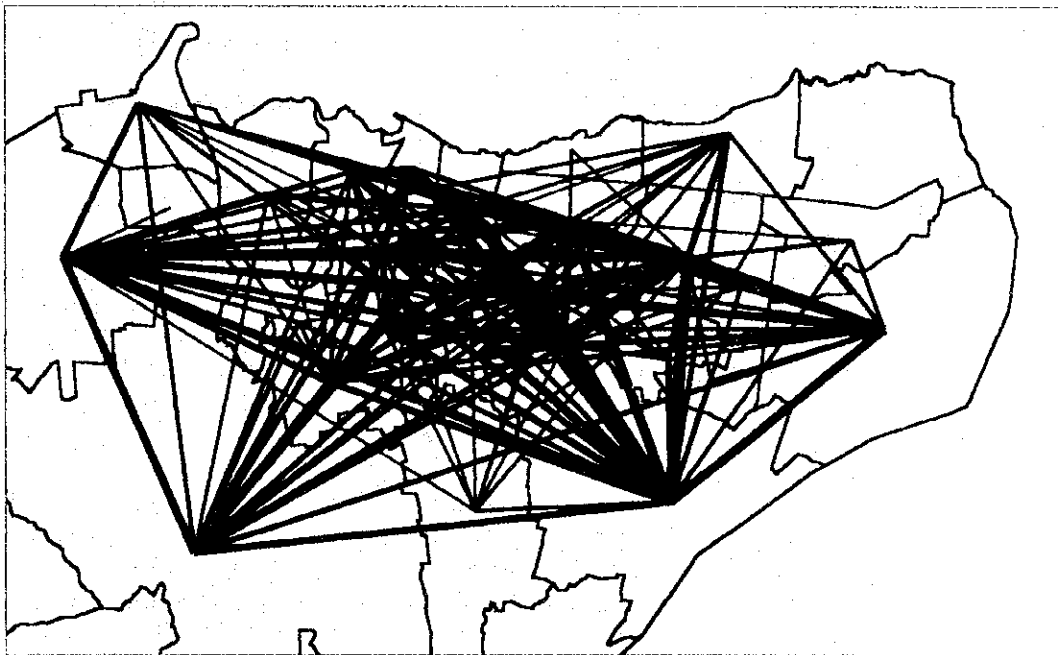
Trip Attraction by Development Scenario, 2018



Outline of Traffic Demand Forecast



Forecasted Trip Distribution, 2018



5. MASTER PLAN

5.1 Land Use

Development Concept

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)

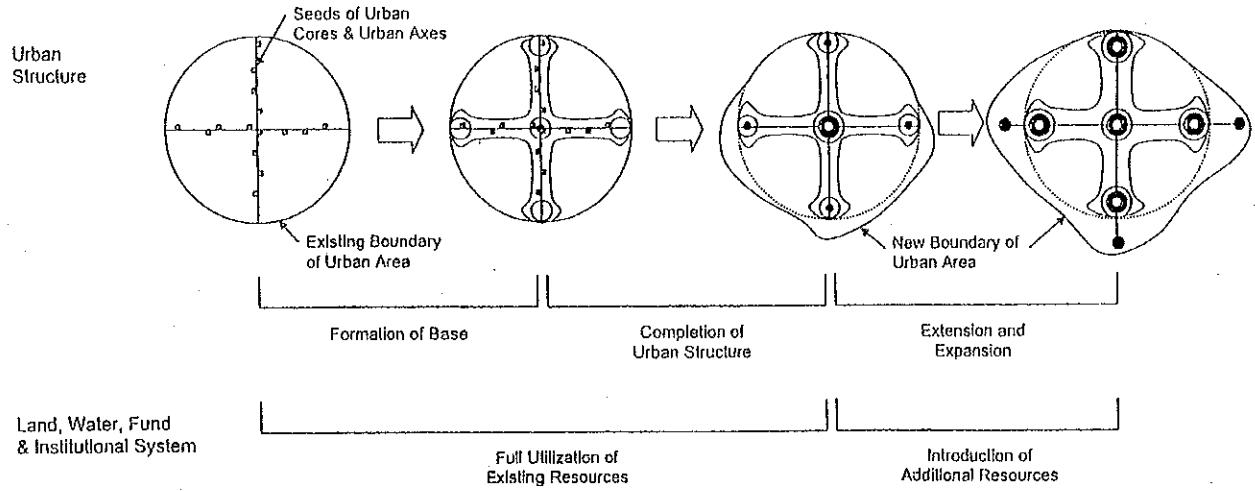
- Urbanization will be expanded considerably. It must be controlled in the defined urban areas, and roads should not be developed outside the urban area with a few exceptions that were necessarily proposed to avoid anticipated traffic congestion of the urban road network.
- Urban axes should be extended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

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.
- 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, land use must be strictly controlled to prohibit disorderly urban sprawl.
- Regarding the proposed expansion of Managua International Airport, the Study recommends to conduct an in-depth study to compare the pros and cons of various possible alternatives for airport development.

Managua's Development Strategies

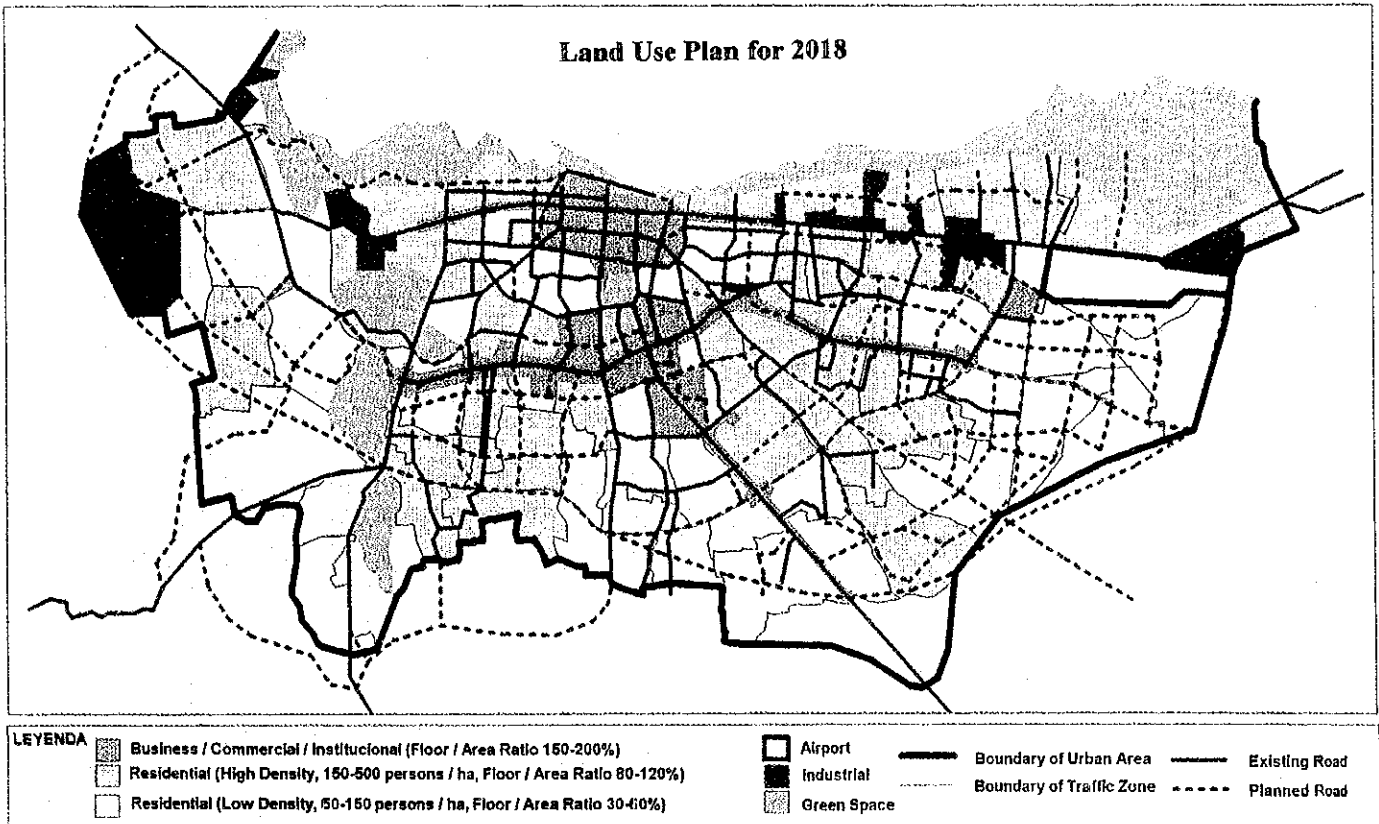
Year	1998	2003	2008	2018
Population	1.2 M	1.4 M	1.6 M	2.0 M



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)
I. Urban Area	12,358	1,116,575	90.4	12,358	1,285,900	104.1	15,536	1,493,780	96.1	19,447	1,902,800	97.8
I.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		
I.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
II. 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.



5.2 Road Network

Planning Guidelines

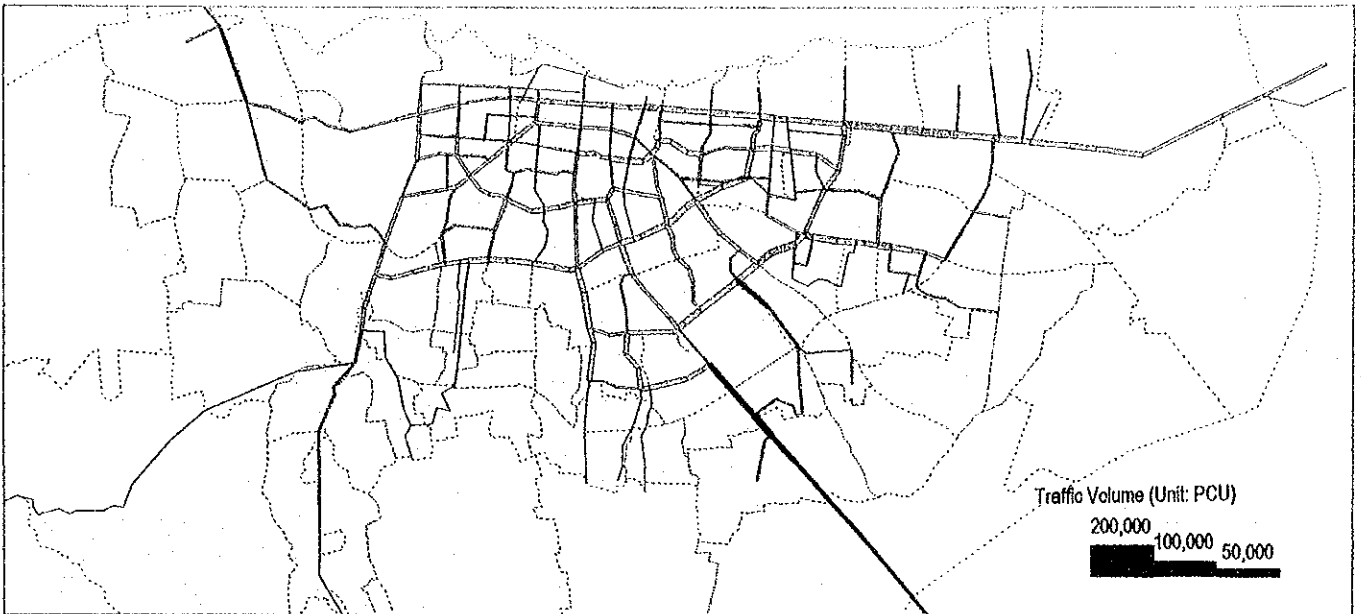
- The road network of Managua will soon be congested due to the increase of number of vehicles as a result of economic growth and population increase. Hence, the development of new roads as well as the improvement and maintenance of existing roads becomes essential for the future of Managua.
- However, 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 following guidelines have been identified for the Master Plan of road network:
 - Compliance with the land use plan.
 - Clearly defined functional hierarchy.
 - Segregation of interurban traffic
 - Construction of disaster-proof road network

Master Plan Network

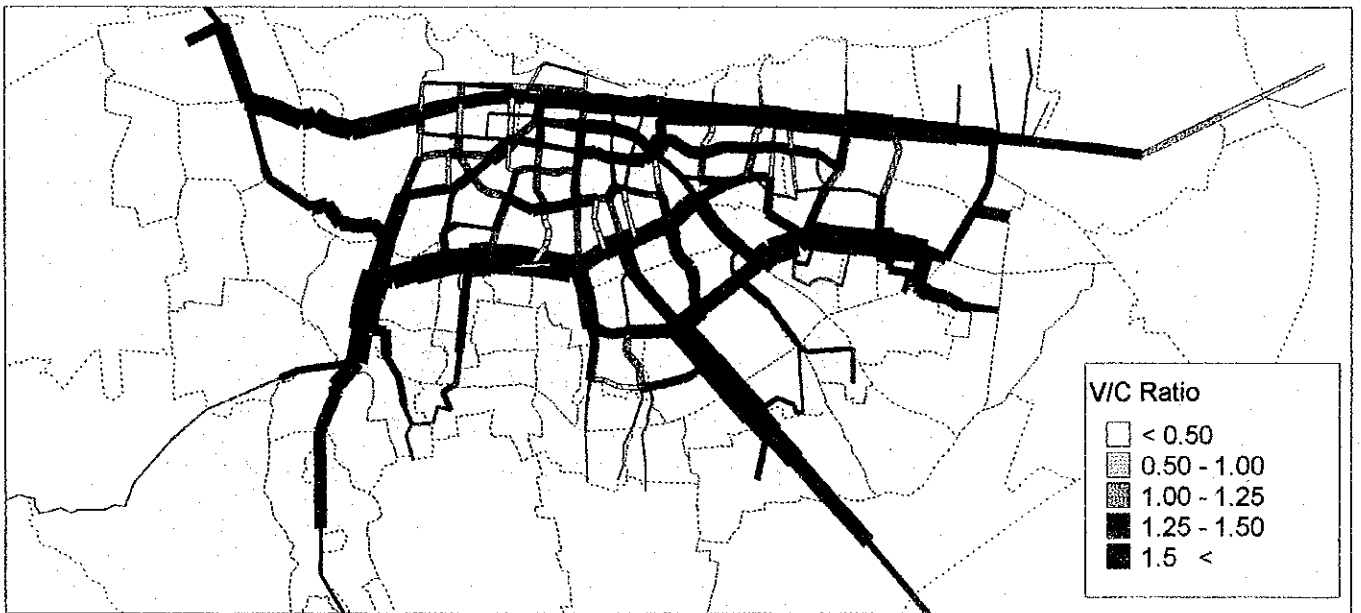
Proposed Projects and Estimated Cost

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

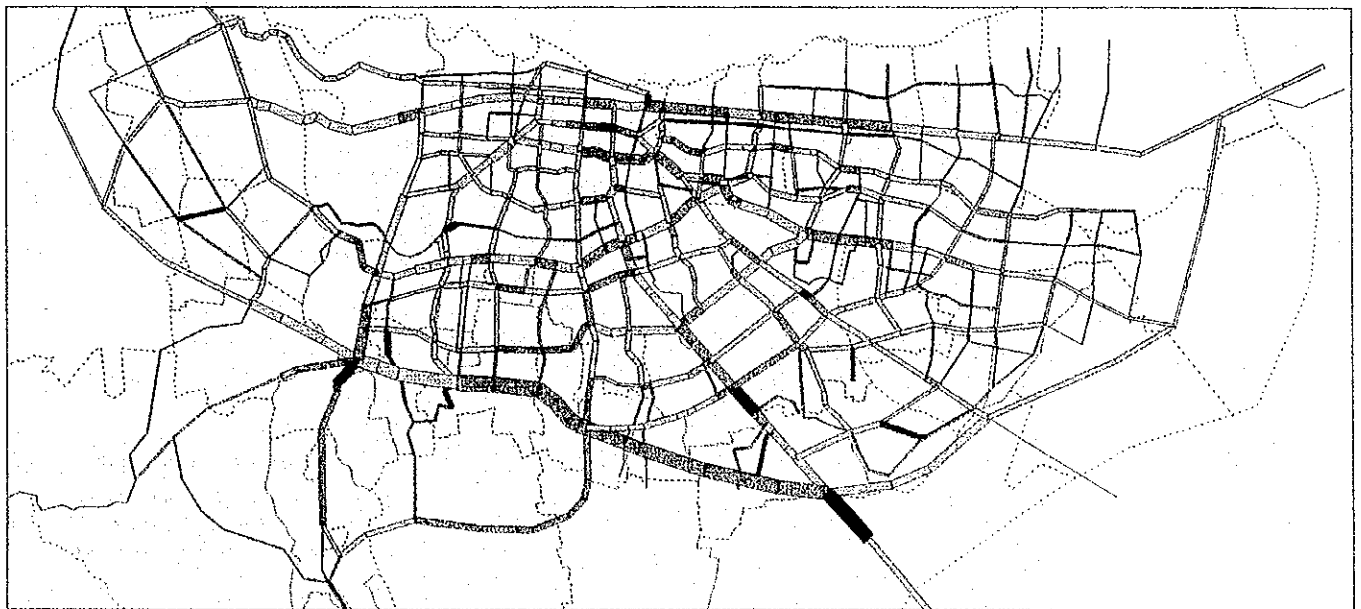
1998 Traffic Flow on Existing Road Network



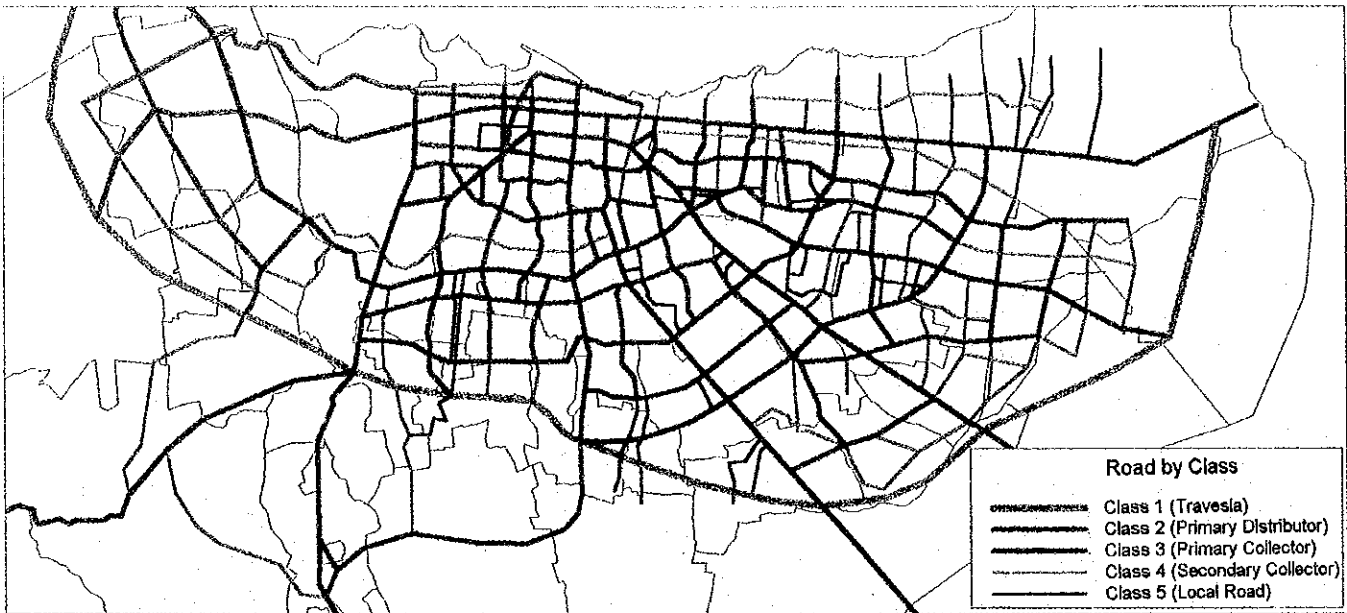
2018 Forecasted Traffic Flow on Existing Road Network



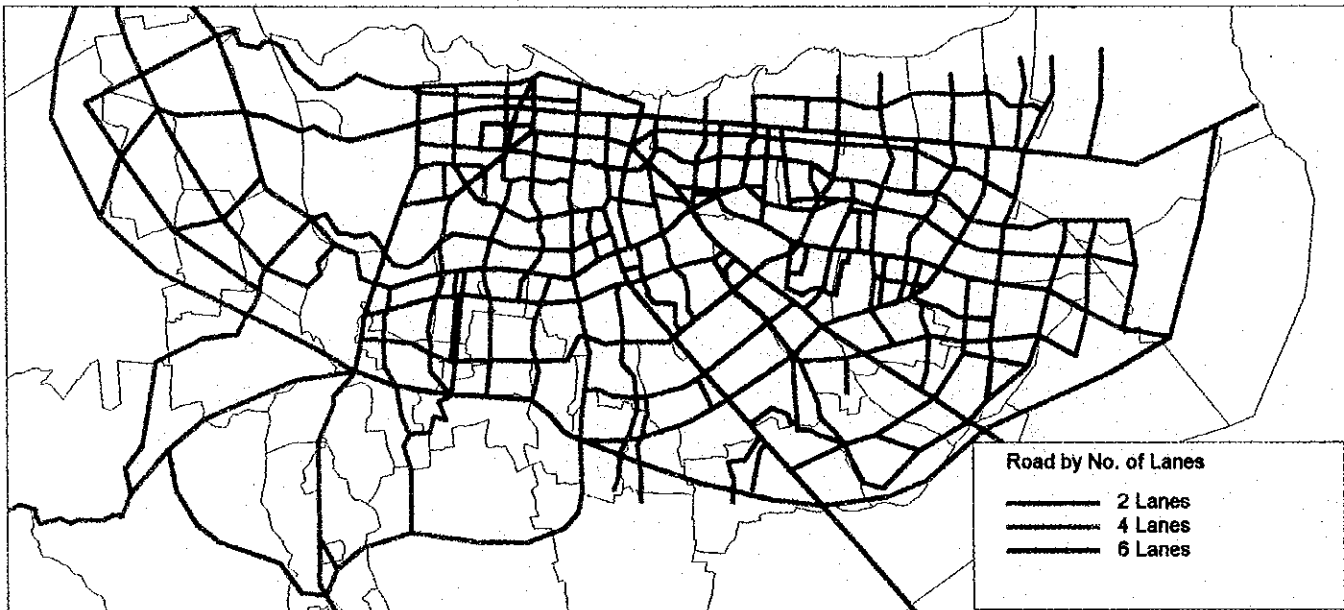
2018 Forecasted Traffic Flow on Master Plan Road Network



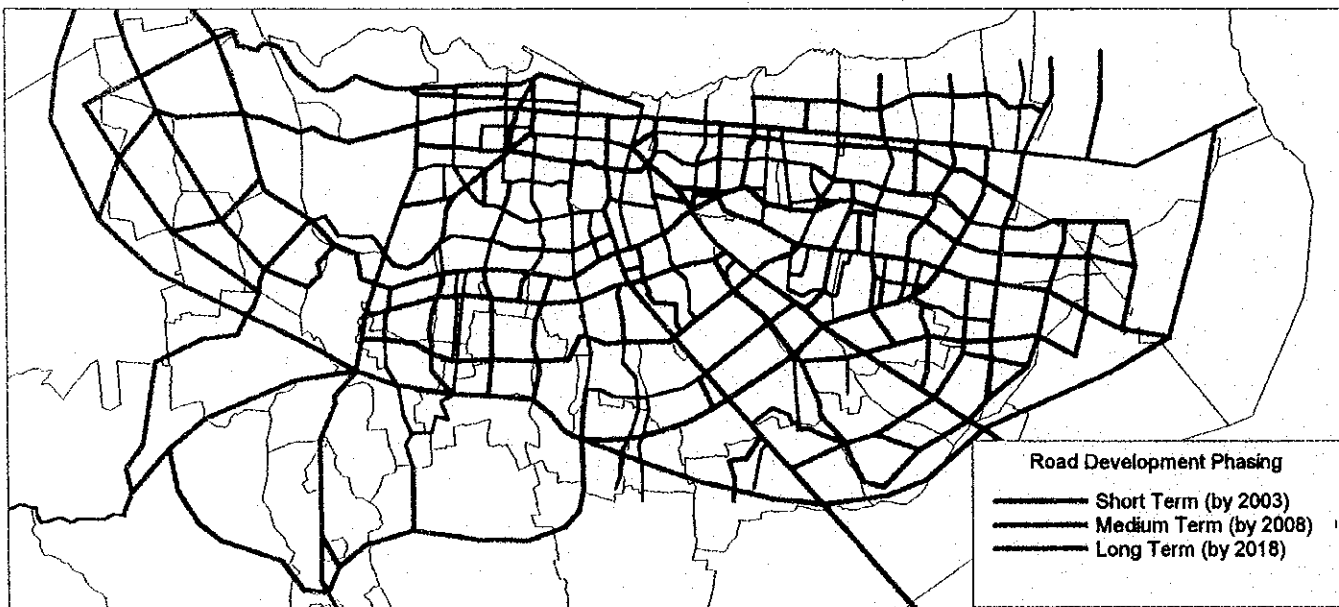
Functional Hierarchy of Master Plan Road Network



No. of Lanes of Master Plan Road Network



Phasing of Road Development Projects



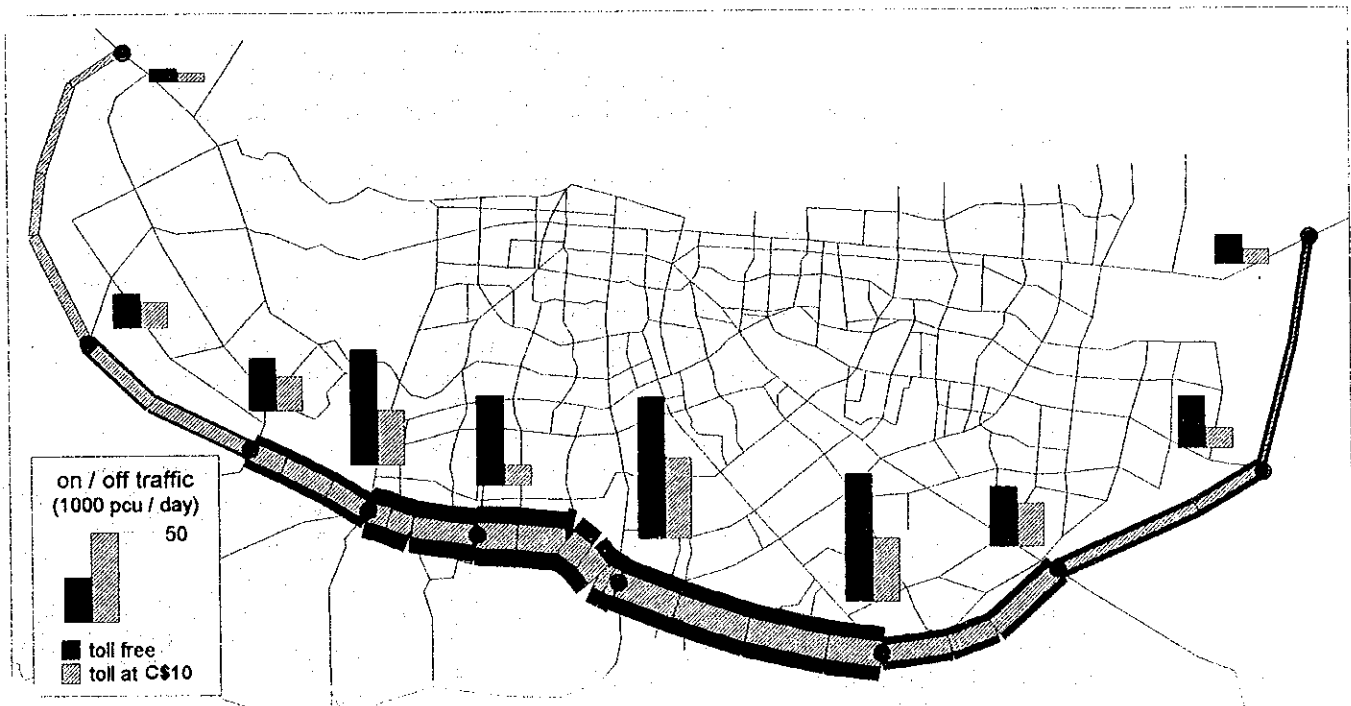
Characteristics of Master Plan Network

	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	9.2	9.2	9.7
• Public	6.2	6.4	6.6	7.3
• Average	6.7	7.9	8.0	8.8
Average Travel Speed (km/h)	26.2	21.2	25.0	24.6
Average Volume/Capacity Ratio	0.59	0.81	0.71	0.76

Toll Road

- In this Study, it is recommended to convert Travesia into a toll road in the medium to long-term. In the medium-term, toll road seems to be immature at higher toll rates. 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.
- This road aims to confine urbanization inside the planned urban area using its access-controlled features (limited intersection, grade separation, fence, etc.). This, however, requires strong enforcement.

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



5.3 Public Transportation

Public Transportation Corridor

- Public Transportation Corridor aims to construct busways which 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.
- Public Transportation Corridor is proposed on Carretera Norte (Short-Term) and Pista Juan Pablo II/Sabana Grande (Medium-Term) where demand for public transportation is large. This project will bring about a huge economic benefit because the modal share of public transportation is forecasted to increase by 1.6%, 1.9% and 6.0% for Short, Medium and Long-Term, respectively.

Diversification and Upgrading of Public Transportation Services

- In Managua, bus is not considered to be a safe transportation. Danger comes from the extremely high rate of robbery in the bus and traffic accidents. This security issue needs to be solved urgently, and people's confidence must be recovered as soon as possible. This is the key issue to start the movement towards the public transportation-oriented city. Random inspection of running buses by armed security guards and stricter inspection of bus units by MTI are proposed.
- Bus services should be diversified by introducing new services such as feeder bus, premium bus and express bus. Introduction of collective taxi and modernization of existing taxi are also proposed. It is most important for public transportation system to efficiently meet the diversifying demand.
- In order to rationalize bus operation and to solve the problems inherent to the commencement of new services, rerouting and fare adjustment should be done in a timely manner. Introduction of distance-related fare system is recommended except for feeder bus.

Improvement of Public Transportation Terminals

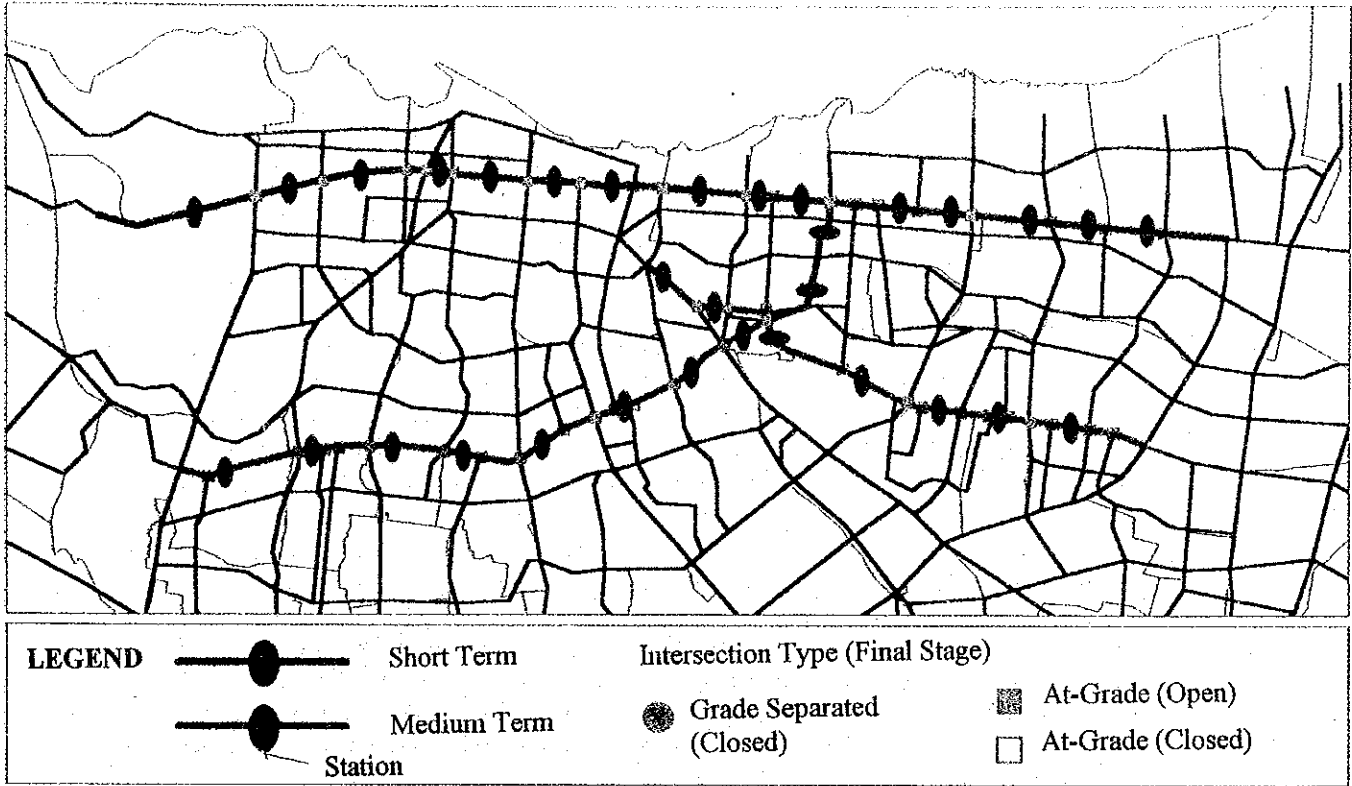
- At present, there are 7 interurban bus terminals in Managua of which 5 are located in or adjacent to the markets operated publicly by COMMEMA. Although urban buses also use 3 of these terminals, their role is minimal due to the small space allocated to them.
- Construction of six (6) public bus terminals is proposed in conjunction with the development or renovation of public markets, one each for the feeder bus service area.
- 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.

Proposed Projects and Estimated Cost

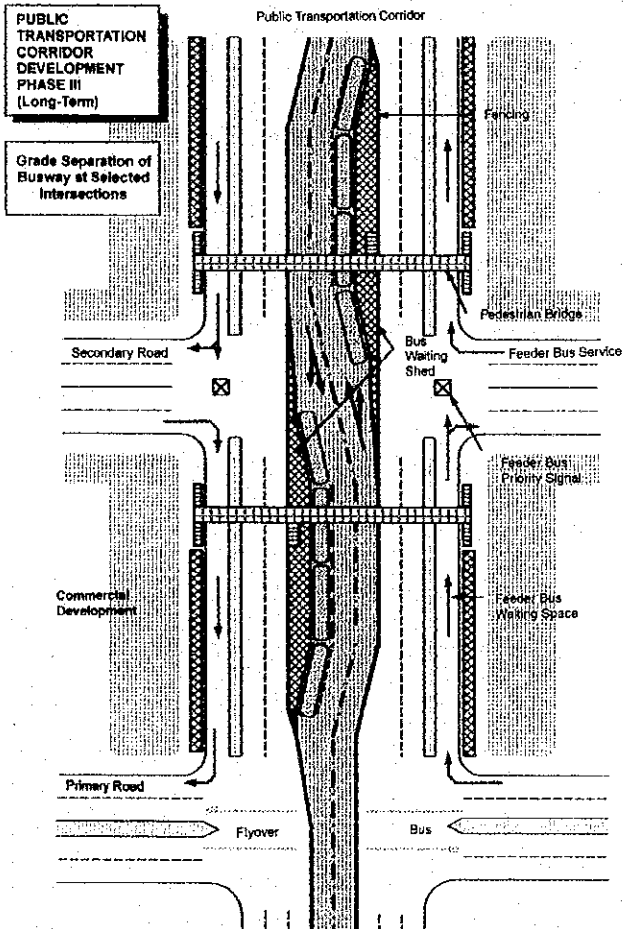
(US\$000)

Project	Immediate	Short-Term	Medium-Term	Long-Term	Total
• Public Transportation Corridor					
- Carretera Norte	-	5,749	2,273	6,336	14,358
- Pista Juan Pablo II/Sabana Grande	-	-	8,731	7,392	16,123
• Diversification/Upgrading of Public Transportation Service					
- Security Enhancement	400	1,600	2,000	4,000	8,000
- Rerouting, Fare Setting, New Services	-	-	-	-	-
• Public Bus Terminals (6)	-	1,500	1,700	2,400	5,600
Total	400	8,849	14,704	20,128	44,081

Proposed Public Transportation Corridors



Public Transportation Corridor Development



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	Distance	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	Distance	Distance	Flat	Zone	Meter
- PTC	0	0	-	-	-	-
Long-Term						
- Operation	Existing	Existing	Existing	Existing	Existing	Existing
- Rerouting	0	0	0	0	-	-
- Fare Resetting	Distance	Distance	Distance	Flat	Zone	Meter
- PTC	0	0	-	-	-	-

Note: PTC: Public Transportation Corridor

5.4 Traffic Management

Intersection Improvement

- The existing 58 signalized intersections which are pre-timed and have not been adjusted to the increasing traffic should be improved immediately considering the small cost and large economic benefit. A total of 259 intersections should be signalized by 2018. Although this includes 58 existing signals, all the signals should be modernized (e.g. actuated or semi-actuated). 4 road sections that have a series of traffic signals in a short distance are proposed to have a coordinated control of the signals.
- 10 intersections should be grade-separated in relation to the proposed Travesia. In addition, 6 intersections of Primary Distributors where traffic volume will exceed its capacity should be grade separated. This does not include the grade separation of busway. In addition to the existing 5 roundabouts, new 5 roundabout are proposed on Carretera Norte and Pista Sabana Grande in relation to the proposed Public Transportation Corridor.

Development of Space for Pedestrians and Bicycles

- In order to improve walking condition, 3 pedestrian crossings with signal installation are proposed in identified critical sections as an immediate action. A bicycle road of about 40 km and a pedestrian path of about 5 km are proposed as a long-term action to connect vista points, lakes, major cultural and recreational zones and universities.

Transportation Demand Management

- Designation of Public Transportation Priority Area is proposed to restrict the movements of private vehicles around public markets, and On-Road Parking Banned Area is proposed in relation to the Public Transportation Corridors. Increase of Fuel Consumption Tax and Car Import Duty is recommended to restrict car use and ownership as well as to raise funds to invest on the transportation infrastructure.

Designation of Truck Routes

- In order to avoid the serious damage on road pavement caused by overloaded trucks, the Study proposes to restrict the routes of trucks by recommending (Short-term) and designating (Medium and Long-Term) the truck roads mainly on Travesia and a few Primary Distributors.

Proposed Projects and Estimated Cost

(US\$000)

	Immediate	Short-Term	Medium-Term	Long-Term	Total
• Intersection Improvement					
- Improvement of Existing Signals	58	-	-	-	58
- Signalization and Coordinated Control	-	9,357	3,997	7,380	20,734
- Grade Separation	-	6,263	18,819	19,217	44,299
- Roundabout Construction	-	2,200	1,150	1,700	5,050
• Development of Pedestrian/Bicycle Space					
- Pedestrian Crossing	150	-	-	-	150
- Bicycle Road and Pedestrian Path	-	-	-	10,000	10,000
• Transportation Demand Management (TDM)					
- Public Transportation Priority Area	-	200	1,400	600	2,200
- On-Road Parking Banned Area	-	-	-	-	-
- Increase of Fuel Consumption Tax	-	-	-	-	-
- Increase of Car Import Duty	-	-	-	-	-
• Designation of Truck Routes	-	-	-	-	-
Total	208	18,020	25,366	38,897	82,491

Note: The cost of Public Transportation Priority Area is for installing traffic signals and signs

Desirable Type of Intersection

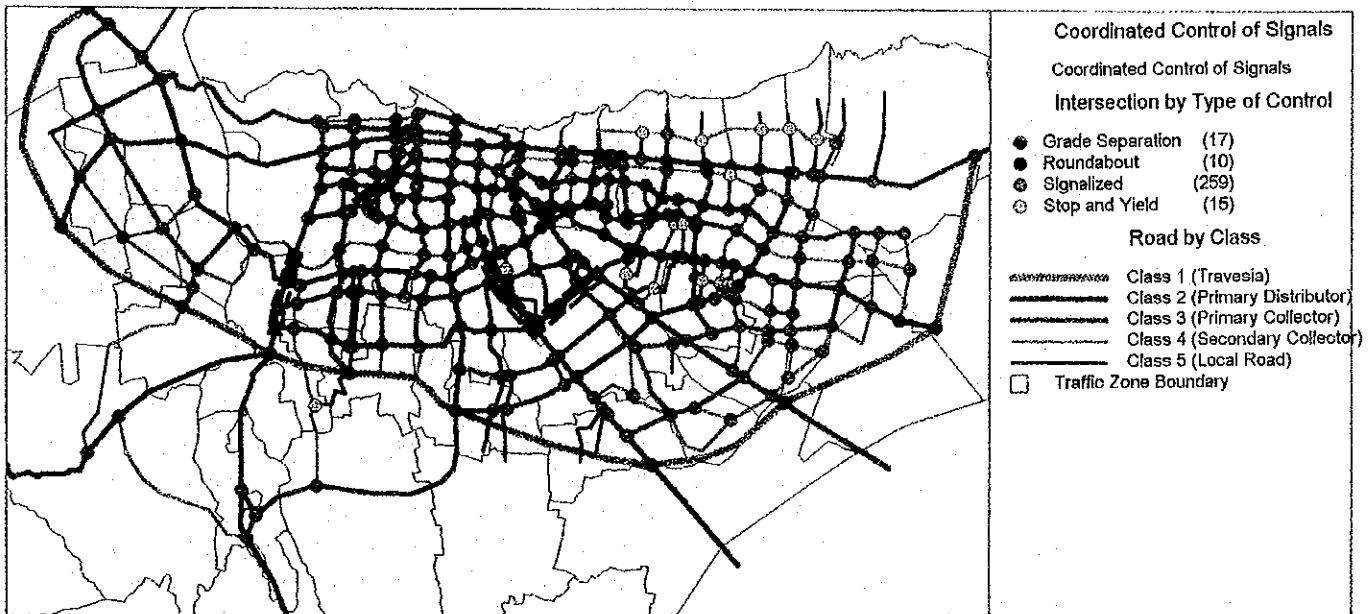
Road Hierarchy	Travesía	Primary Distributor	Primary Collector	Secondary Connector	Local Road
Travesía	IC	GS	GS	NA	NA
Primary Distributor	--	SI (GS/RA)	SI (RA)	SI	SI
Primary Collector	--	--	SI	SI	SI
Secondary Collector	--	--	--	SI	AG
Local Road (calle)	--	--	--	--	AG

Note:

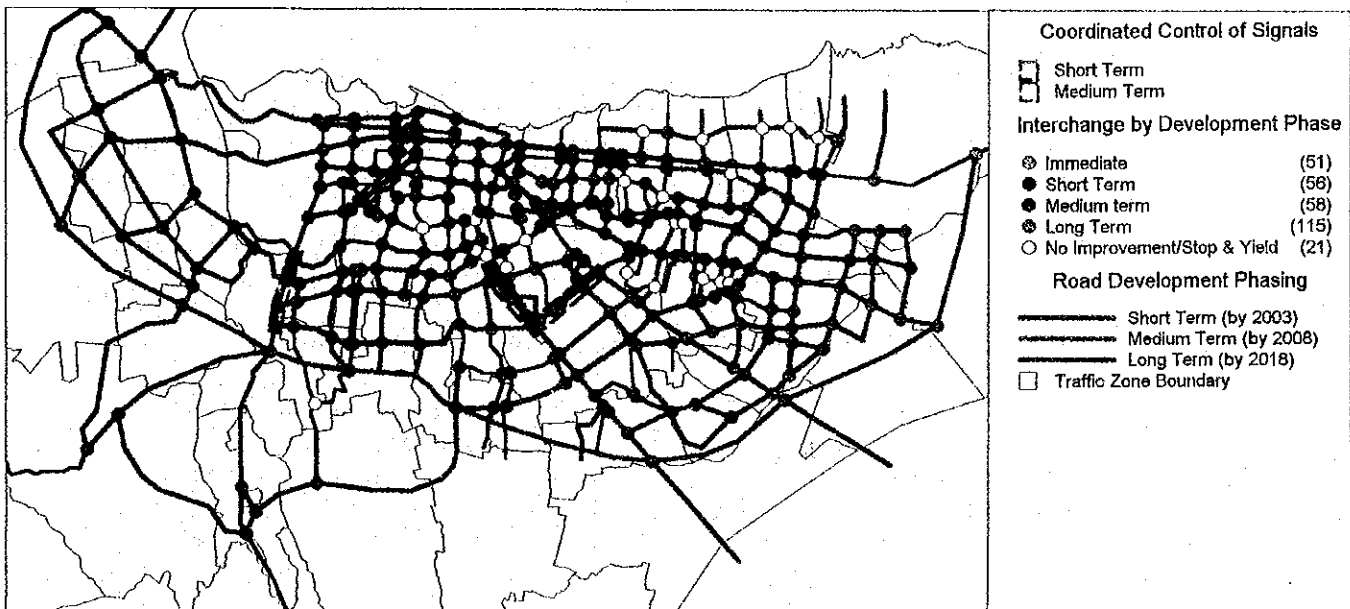
IC = Interchange
SI = Signalization
AG = At Grade

GS = Grade Separation
RA = Roundabout
NA = No Access

Master Plan of Intersection Improvement and Development



Phasing of Intersection Improvement and Development



6. PROJECT EVALUATION

6.1 Economic Evaluation

Entire Master Plan

- Proposed Master Plan was evaluated as a whole by comparing with the “Do-Nothing” case assuming all the component projects are implemented according to the proposed implementation program. Traffic assignment was done for each case year by year from 1998 to 2018.
- Overall economic IRR was calculated at 97%. This extraordinary rate can be attributed to the imaginary “Do-Nothing Case” and the nature of IRR which does not assume continuously increasing benefit and cost streams.
- Nevertheless, the benefit/cost ratio (BCR) and the net present value (NPV) are also very high at 8.3 and US\$975 million, respectively. The Master Plan was proven to be highly economically feasible.

Road Development Projects

- At first, all the proposed road project packages were evaluated as a whole in a similar manner to the Master Plan. However, the cost included only those of road development projects. Due to the same reasons as the Master Plan, the calculated economic IRR is extremely high at almost 100%. BCR and NPV were calculated at 10.8 and US\$910 million, respectively.
- Economic analysis was conducted also by project package. The resultant IRR ranges between 19% and 80%, i.e. all the proposed projects were proven economically feasible. The highest IRR is expected for Pista Alternativa Masaya. Generally, the IRR is relatively high for the projects proposed in the south-east of Managua and relatively low in the central area. In addition, Travesia has the largest NPV.

Travesia Toll Road Project

- When no toll is assumed for Travesia, the IRR was 58%. However, if toll is raised, it goes down little by little, and reaches 23% at a toll rate of US\$1.0 and 12% at a toll rate of US\$2.0, due to the effect of tolls to distort the distribution of traffic.
- Although the economic viability has been proven at moderate toll rates, careful investigation is needed to determine the toll prior to the implementation since financial viability is always attained on the sacrifice of economic desirability.

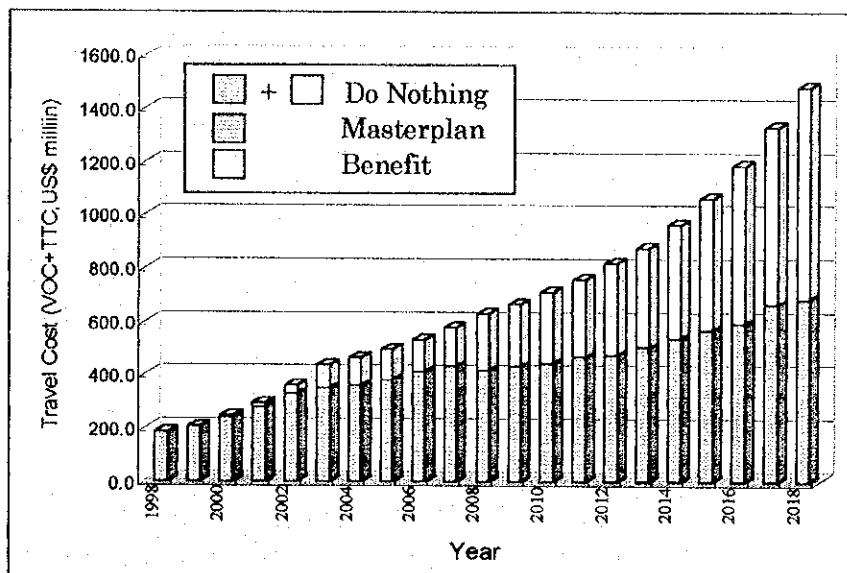
Public Transportation Corridor

- Two projects are proposed; one on Carretera Norte and the other on Pista Juan Pablo II/Sabana Grande. Those projects were evaluated individually first then as a whole.
- The economic return of these projects is huge. The IRR is extremely high due mainly to the expected modal shift from private to public. It is noted that these two projects will have a combined effect influenced with each other favorably.
- The EIRR of the Carretera Norte project which is proposed for the Short-Term decreases from 86% to 52% if road widening is taken into account.

Economic Evaluation of Public Transportation Corridor

	Carretera Norte	Pista J. Pablo II/ Sabana Grande	Both
Net Present Value (US\$ million)	53.4	40.0	118.6
Benefit/Cost Ratio	13.1	13.5	16.6
Internal Rate of Return (%)	86.2	66.1	88.9

Trend of Total Travel Cost and Economic Benefit



Economic Evaluation of Road Project Packages

No.	Project Package	Financial Cost (US\$ million)	Economic Cost (US\$ million)	Benefit in 2018 (US\$ million)	Evaluation Indicators		
					Net Present Value	IRR %	Benefit/Cost Ratio
1	Carretera Norte	20.6	17.1	28.5	33.5	34.4	4.4
2	Travesia	48.2	40.6	92.9	76.0	57.6	7.0
3	Pista Juan Pablo II	11.4	9.7	7.5	7.2	30.3	2.9
4	Carretera Sur	9.9	8.4	20.4	13.2	55.8	6.4
5	Pista Portezuelo	11.1	9.4	19.4	29.3	37.9	5.9
6	Pista Rural de Circunvalacion	13.6	11.6	19.5	45.0	52.4	6.6
7	Pista Sabana Grande	14.3	12.1	21.1	38.8	70.9	9.6
8	Ave. Ruben Dario-Carretera a Masaya	11.3	9.4	41.9	33.6	60.3	10.4
9	Carretera Nueva a Leon	8.3	6.7	12.0	11.3	42.8	5.0
10	Carretera Vieja a Leon	4.6	3.8	2.1	0.1	38.7	1.3
11	Pista Alterna a Masaya	10.8	9.0	21.1	3.0	79.8	3.5
12	Central Road Package (Short-Term)	12.7	11.5	5.9	6.1	19.7	1.9
13	Central Road Package (Medium-Term)	12.8	11.6	3.6	2.9	19.1	1.6
14	Central Road Package (Long-Term)	10.0	8.7	6.6	3.9	42.2	3.1
15	Western Road Package (Medium-Term)	15.3	12.8	24.8	25.6	46.2	5.7
16	Western Road Package (Long-Term)	10.4	8.6	8.1	2.9	47.3	3.2
17	Southern Road Package (Short-Term)	1.6	1.3	6.6	9.2	60.1	13.5
18	Southern Road Package (Medium-Term)	7.7	6.6	11.3	12.7	54.0	6.1
19	Southern Road Package (Long-Term)	17.4	14.7	39.4	17.3	78.9	7.1
20	Eastern Road Package (Short-Term)	2.4	2.0	4.8	7.9	48.0	7.7
21	Eastern Road Package (Medium-Term)	7.0	5.9	2.5	4.4	28.9	2.8
22	Eastern Road Package (Long-Term)	52.8	44.3	60.0	22.2	61.7	3.9

6.2 Financial Evaluation

Travesia Project (Toll Road)

- By conducting a series of traffic assignments, traffic volume as well as toll revenue was estimated for Travesia by changing the toll rate. It seems that the toll road is still immature in the Medium-Term, because the traffic demand is easily tolled off from Travesia at a very low charging rate. However, assuming a toll rate of US\$0.2 in 2006 (partial opening between Carretera Sur and Carretera a Masaya) and US\$1.0 in 2018 (full opening in 2014), and gradual increase of the toll in the intermediate years, the project was found financially feasible with a financial IRR of 16.5%.
- Due to the deficit in cash flow up to 2014, however, operation of the toll road solely by the private sector will be difficult. Some subsidy measures by the Government will be necessary.

Public Transportation Corridor

- Using the result of traffic assignments, financial analysis was conducted assuming a charge of C\$75/day/bus. This resulted in a financial IRR of 10.6%. However, if the charge can be raised to C\$100/day/bus, the project becomes highly feasible.

**Sensitivity of Financial IRR of Public Transportation
Corridor Project to Charging Rate**

Rate (C\$/day/unit)	Package 1 Carretera Norte	Package 2 Pista J. Pablo II/ Sabana Grande	Package 1 & 2 (%)
50	4.6	4.8	4.7
60	7.2	6.9	7.0
70	10.0	8.9	9.4
75*	11.3	9.9	10.6
80	12.7	10.9	11.9
90	15.5	12.9	14.3
100	18.3	14.8	16.8

*Recommended Rate

- Considering the huge economic benefit, higher charges are not recommended. The following arrangement will be necessary:
 1. Government finance for initial investment (Economic benefit is huge).
 2. Operation and repayment by a public or semi-public organization newly established.
 3. Operation by one organization for both Package 1 and 2 (Interaction of two packages is strong).

Public Transportation Terminal

- By an indicative financial analysis for a typical terminal, the financial feasibility was tested based on several assumptions both on cost and revenue.
- The project was proven highly feasible financially with a financial IRR of more than 20%. Even if the cost increases by 30% and the revenue decreases by 30%, the project is still financially feasible. The project is suitable for the private sector to take the initiative.

6.3 Initial Environmental Examination (IEE)

- The environmental items to be evaluated by IEE were selected to analyze and summarize the environmental issues, in consideration of the purpose of IEE and the characteristics of Managua.

Environmental Items

1. Social Environment	2. Natural Environment	3. Pollution
1.1 Resettlement	2.1 Topography and Geology	3.1 Air Pollution
1.2 Economic Activities	2.2 Soil Erosion	3.2 Water Pollution (surface & ground)
1.3 Traffic and Public Facilities	2.3 Ground Water	3.3 Soil Contamination
1.4 Split of Community	2.4 Hydrological Situation	3.4 Noise and Vibration
1.5 Cultural Heritage & Properties	2.5 Coastal Zone	3.5 Ground Subsidence
1.6 Water Rights and Rights of Common (Property of the land)	2.6 Fauna and Flora (Protected and Fragile Areas)	3.6 Offensive Odors
1.7 Public Health Condition	2.7 Meteorology	
1.8 Waste	2.8 Landscape	
1.9 Disaster (Risks)		

- IEE was conducted for the major projects proposed in the Master Plan, i.e. road development (new construction and widening), Public Transportation Corridor and Public Transportation Terminal.
- Based on the results of IEE, relocation/resettlement is the most critical issue to be studied by EIA for the proposed projects. Air pollution, noise and vibration foreseen by the increase of traffic due to project implementation also need a careful investigation. In relation to some public transportation terminals proposed in existing market areas, possible economic impact must be studied.

Summary of IEE Results

Projects	Road Network						Public Transportation Corridor			Public Transportation Terminal					
	Widening Sections			New Road Sections			Phase			Location					
	Short	Medium	Long	Short	Medium	Long	Short	Medium	Long	MO	MSJ	MVC	VF	SG	CSA
Resettlement	B	B	C	A	A	A	C	C	C	A	B	A	A	C	C
Economic Activities	D	D	D	C	C	C	C	C	C	B	B	B	C	C	C
Traffic and Public Facilities	D	D	D	C	C	C	C	C	C	C	C	C	C	D	D
Split of Communities	D	D	D	C	C	C	D	D	D	C	C	C	C	C	C
Cultural Property	D	D	D	C	C	C	D	D	D	D	D	D	D	D	D
Water Rights and Rights of Common	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Public Health Condition	D	D	D	D	D	D	D	D	D	C	C	C	C	C	C
Waste	D	D	D	D	D	D	C	C	C	C	C	C	C	C	C
Hazards (Risk)	D	D	C	C	C	C	C	D	D	D	D	D	D	D	D
Topography and Geology	D	C	D	C	C	C	C	C	C	D	D	D	D	D	D
Soil Erosion	C	C	C	C	D	C	D	D	D	D	D	D	D	D	D
Groundwater	C	C	C	C	C	C	D	D	D	D	D	D	D	D	D
Hydrological Situation	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Coastal Zone	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Fauna, Flora and Protected Area	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Meteorology	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Landscape	D	D	D	D	D	D	D	C	C	D	D	D	D	D	D
Air Pollution	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Water Pollution (Surface & Ground)	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Soil Contamination	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Noise and Vibration	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Land Subsidence	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Offensive Odor	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D

Note:

Short : 1999 - 2003	A : Serious impact is expected	MO : Mercado Oriental
Medium : 2004 - 2008	B : Some impact is expected	MSJ : Mercado San Judas
Long : 2009 - 2018	C : Extent of impact is unknown (Further study will be required)	MVC : Mercado Virgen de Candelaria
	D : No impact is expected	VF : Villa Flor
		SG : Sabana Grande
		CSA : Ciudad Satélite Asososca

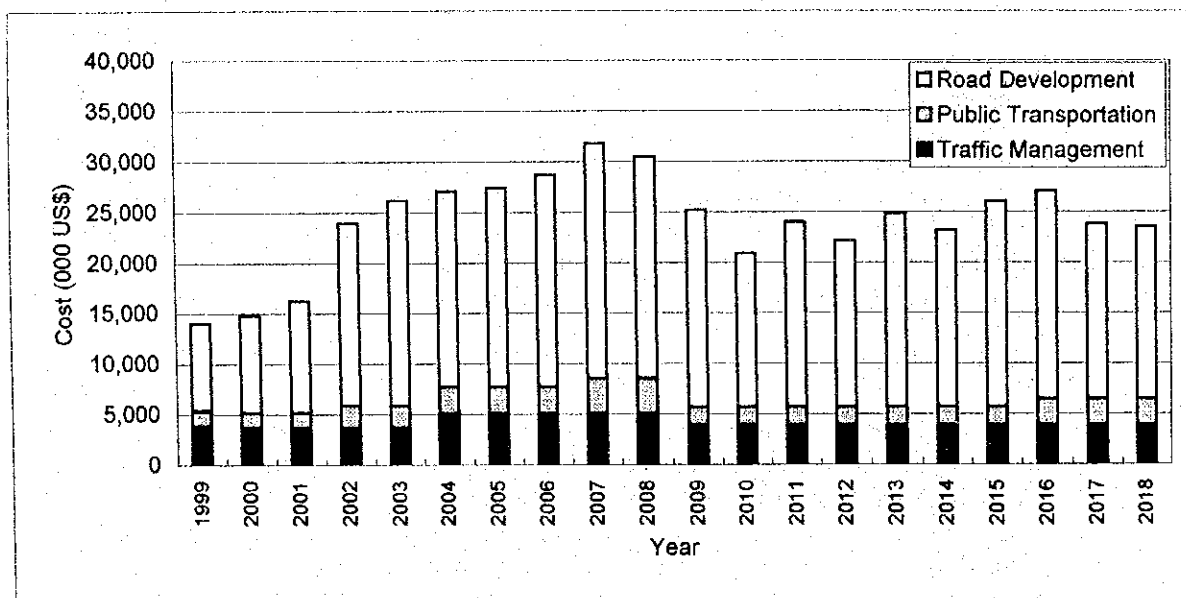
- It should be noted, however, that the proposed projects would have a large positive effect on the environment as a whole due to mitigation of traffic congestion, modal shift from private to public and rectified traffic movement.

7. TOWARDS IMPLEMENTATION

7.1 Investment Requirement

- The total cost of the Master Plan accounts for US\$481 million. The allocation is US\$95 million in the Short-Term, US\$145 million in the Medium-Term and US\$241 million in the Long-Term. Required average annual investment is the highest in the Medium-Term.

Summary Investment Program of All Projects in Master Plan



- However, there are some financially viable projects to be financed by the project revenue such as Travesia (toll road), Public Transportation Corridor and Public Bus Terminals (coupled with Public Transportation Priority Area). If the cost of these projects is excluded, the total investment of US\$481 million can be reduced to US\$395 million by about 18%.

Investment Requirements of Master Plan

(US\$ million)

	Short Term	Medium Term	Long Term	Total
Road Projects	67.7	105.4	181.6	354.8
Self-Financing Projects*	-	16.4	31.7	48.2
Sub-Total	67.7	89.0	149.9	306.6
Public Transportation Projects	9.2	14.7	20.1	44.1
Self-Financing Projects*	7.2	12.7	16.1	36.1
Sub-Total	2.0	2.0	4.0	8.0
Traffic Management Projects	18.2	25.4	38.9	82.5
Self-Financing Project*	0.2	1.4	0.6	2.2
Sub-Total	18.0	24.0	38.3	80.3
All Projects	95.2	145.5	240.6	481.4
Self-Financing Projects*	7.4	30.5	48.5	86.4
Total	87.8	115.0	192.2	394.9

Note: * Revenue Generating Projects

Summary Investment Program by Road Project Package and Planning Period

(US\$000)

	Package	Short Term	Medium Term	Long Term	Total
1	Carretera Norte	15,450	-	5,158	20,608
2	Travesia	-	16,421	31,743	48,164
3	Pista Juan Pablo II	-	11,440	-	11,440
4	Carretera Sur	-	6,169	3,762	9,931
5	Pista Portezuelo	6,692	4,456	-	11,148
6	Pista Rural de Circunvalacion	11,667	-	1,940	13,607
7	Pista Sabana Grande	5,079	3,379	5,863	14,321
8	Ave. Ruben Dario-Carretera a Masaya	2,867	6,078	2,400	11,345
9	Carretera Nueva a Leon	2,412	5,845	-	8,257
10	Carretera Vieja a Leon	-	-	4,575	4,575
11	Pista Alterna a Masaya	-	-	10,772	10,772
12	Central Road Package (Short-Term)	12,733	-	-	12,733
13	Central Road Package (Medium-Term)	-	12,778	-	12,778
14	Central Road Package (Long-Term)	-	-	10,026	10,026
15	Western Road Package (Medium-Term)	-	15,339	-	15,339
16	Western Road Package (Long-Term)	-	-	10,386	10,386
17	Southern Road Package (Short-Term)	1,551	-	-	1,551
18	Southern Road Package (Medium-Term)	-	7,731	-	7,731
19	Southern Road Package (Long-Term)	-	-	17,437	17,437
20	Eastern Road Package (Short-Term)	2,387	-	-	2,387
21	Eastern Road Package (Medium-Term)	-	6,960	-	6,960
22	Eastern Road Package (Long-Term)	-	-	52,752	52,752
23	Road Maintenance	6,906	8,833	24,804	40,542
	Total	67,744	105,429	181,618	354,790

Summary Investment Program by Public Transportation Project Package and Planning Period

(US\$000)

	Package	Immediate	Short Term	Medium Term	Long Term	Total
1.	Public Transportation Corridor: Carretera Norte	-	5,749	2,273	6,336	14,358
2.	Public Transportation Corridor: J. Pablo/ S. Grande	-	-	8,731	7,392	16,123
3.	Security Enhancement	400	1,600	2,000	4,000	8,000
4.	Rerouting	-	-	-	-	-
5.	Fare Adjustment	-	-	-	-	-
6.	Introduction of New Service	-	-	-	-	-
7.	Public Bus Terminal: Mercado Oriental	-	1,500	-	-	1,500
8.	Public Bus Terminal: Mercado San Judas	-	-	850	-	850
9.	Public Bus Terminal: Merc. Virgen de Candelaria	-	-	850	-	850
10.	Public Bus Terminal: Villa Flor	-	-	-	800	800
11.	Public Bus Terminal: Sabana Grande	-	-	-	800	800
12.	Public Bus Terminal: Ciudad Satélite Asososca	-	-	-	800	800
	Total	400	8,849	14,704	20,128	44,081

Summary Investment Program by Traffic Management Project Package and Planning Period

(US\$000)

	Package	Immediate	Short Term	Medium Term	Long Term	Total
1.	Improvement of Existing Signals	58	-	-	-	58
2.	Signalization and Coordinated Control (Short-Term)	-	9,357	-	-	9,357
3.	Signalization and Coordinated Control (Medium-Term)	-	-	3,997	-	3,997
4.	Signalization (Long-Term)	-	-	-	7,380	7,380
5.	Grade Separation (Short-Term)	-	6,263	-	-	6,263
6.	Grade Separation (Medium-Term)	-	-	18,819	-	18,819
7.	Grade Separation (Long-Term)	-	-	-	19,217	19,217
8.	Roundabout Const. (Short-Term)	-	2,200	-	-	2,200
9.	Roundabout Const. (Medium-Term)	-	-	1,150	-	1,150
10.	Roundabout Const. (Long-Term)	-	-	-	1,700	1,700
11.	Pedestrian Crossing	150	-	-	-	150
12.	Bicycle Road and Pedestrian Path	-	-	-	10,000	10,000
13.	Public Transportation Priority Area	-	200	1,400	600	2,200
14.	On-road Parking Banned Area	-	-	-	-	-
15.	Increase of Fuel Consumption Tax	-	-	-	-	-
16.	Increase of Vehicle Import Duty	-	-	-	-	-
17.	Designation of Truck Routes	-	-	-	-	-
	Total	208	18,020	25,366	38,897	82,491

7.1 Fund Sources

- Estimated amount of funds available for Managua's transportation sector has a very wide range of projection due to the following reasons:
 1. Aid from foreign countries is not reliable depending largely on the economic, social and political situation of both recipient and donor countries.
 2. Increase of tax needs social consensus and amendments of related laws and regulations. Although the Petroleum Consumption Tax is likely to be raised soon, the municipal Road User Tax and the national Import Tax for cars will require a lengthy discussion to be amended.
- Thus the budget envelope will be US\$53 to 143 million in the Short-Term, US\$77 to 248 million in the Medium-Term and US\$239 to 750 million in the Long-Term to invest on the transportation sector in Managua.

Possible Fund Sources for Managua's Transportation

(US\$ million)

	Short Term	Medium Term	Long Term	Total
Public (Existing Source)				
• Internal	36.6	48.2	147.8	232.6
• External (Grant)	(29.7)	(33.0)	(78.8)	(141.5)
• External (Loan)	(10.0)	(59.3)	(181.5)	(250.8)
Sub-Total	36.6~76.3	48.2 ~ 140.5	147.8 ~ 408.1	232.6 ~ 624.9
Proposed Tax Increase				
• Real Property Tax (ALMA)*	0.9	3.3	12.9	17.1
• Road User Tax (ALMA)	(2.1)	(4.5)	(15.6)	(22.2)
• Petroleum Consumption Tax (Nicaragua)**	15.7	25.0	78.0	118.7
• Car Import Tax (Nicaragua)**	(47.5)	(75.0)	(235.0)	(357.5)
Sub-Total	16.6 ~ 66.2	28.3 ~ 107.8	90.9 ~ 341.5	135.8 ~ 515.5
Total	53.2 ~ 142.5	76.5 ~ 248.3	238.7 ~ 749.6	368.4 ~ 1,140.4

Note: * Proposes timely amendment of cadastral values, not increase of tax rate.

** Assumes 25% allocation to Managua.

- In the Short-Term and Medium-Term, the investment requirements of the Master Plan are considerably larger than the lower limit of the budget envelope by US\$35 million and 39 million, respectively. This means that the proposed projects cannot be implemented unless a large amount of foreign aid (grant or loan) and/or new tax revenue are mobilized. There is a way to tap loans from foreign countries having the long-term revenue as a source of its repayment. However, this is also uncertain due to the current guideline set by IMF which is prohibitive for international funding organizations and bilateral sources to arrange new loans for the Government of Nicaragua, though this restriction is expected to be lifted in the near future.
- Therefore, it is strongly recommended for the Government of Nicaragua to secure a revenue enough to fund the proposed projects by increasing the rate of import duty for private cars. In parallel to this action, the arrangement to tap grant aid from external sources should be accelerated for immediate needs of funding.

8. CONCLUSION AND RECOMMENDATIONS

8.1 Conclusion

1. Urban transportation system in Managua is entirely road-based. While roads are relatively well provided in terms of right-of way (ROW), the network is configured without explicit functional hierarchy, and existence of missing links and lack of maintenance amplify inefficiency of the network. Construction of new roads is led by low-rise low-density urbanization which occurs inevitably under strong pressure of population increase and in the absence of strict control of the Government. Under these circumstances, Managua will become an energy-consuming, expensive and environmentally poor auto-based city if road is not developed in compliance with an elaborated land use plan.
2. At present, the magnitude and seriousness of traffic problems are not outstanding yet in Managua as are seen in many other large cities in the world. This is not only because of the smaller scale of Managua's economy but because of the relatively high level of infrastructure stock and well disciplined behavior of the citizen. Due, however, to the increasing population and growing economy, traffic congestion will soon be serious. Volume/capacity ratio of roads, which is 0.6 at present, is projected to reach 1.1, over the capacity, by the year 2003. Hence, it is imperative to construct new roads in a well planned manner. If no measure is taken, road network efficiency as well as people's discipline will be eroded causing irreparable damages in the society and economy.

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 demand management. In other words, traffic problem cannot be solved by supply-side measures alone, and demand-side measures should be taken into account.

3. Public transportation is much more efficient than private car in terms of travel cost and road space. Managua should adopt a policy towards the creation of public transportation-based city. However, the current levels of service of public transportation should be upgraded in many areas such as safety, comfort, accessibility and diversity. This is very much critical to curb the future modal shift of people from bus to private car as income increases. Introduction of busways and different types of public transportation services including feeder bus, premium bus (e.g. air conditioned, all-seater, etc.), express bus and collective taxi will contribute to the improvement of Managua's public transportation system coupled with other supportive measures such as rerouting, adjustment of fare structure and development of public bus terminals.

Current public transportation of the City has been operated entirely by the private sector which is not the cases in many other countries. 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.

4. At the current level of vehicular traffic, most of traffic congestions and safety problems at some critical sections can be solved or mitigated with low-cost traffic management measures. Usually traffic management measures produce a large economic benefit compared to its small cost. The role is also important in the future to improve traffic flow, to reduce traffic accidents and to enhance road users' comfort. 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 should 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 and taxes. However, direct pricing measures such as road pricing seem to be immature at present judging from the low time value of the citizen (i.e. distortion of traffic distribution could be unusually large). Presumably in the long-term, these measures should be looked into in relation to clearly determined target roads.
5. Safe and comfortable walking is the most fundamental component of urban transportation system. Sidewalk must be improved or constructed in conjunction with road improvement and construction works. Taking advantage of relatively ample road space, widely distributed open space including greenery and lakes in the City, pedestrian and bicycle paths should be provided to improve recreational and environmental conditions of Managua.
6. The severe natural conditions of Managua, particularly the possibility of earthquake, should be taken into account in planning land use and road network. Although it is impossible to prevent damages, the City must be ready to control the damage by establishing strong regulatory framework on the land use.
7. The proposed projects in the Master Plan will have no significant negative impact on environment except for possible relocation of housing settlements located in right-of-way of some of the proposed roads and in some sites of the proposed bus terminals. Air pollution, noise and vibration are also critical factors which need to be analyzed in relation to the proposed roads. However, the proposed projects as a whole will bring about positive impacts on the environment.
8. There is a sheer lack of public funds to finance the implementation of the proposed projects. Particularly in the Short and Medium-Term, the proposed projects cannot be implemented unless foreign aid (grant/loan) and/or new tax revenue is tapped sufficiently.

8.2 Recommendations

Land Use Plan

- Authorize and legalize the proposed land use plan (with density restrictions) after discussions with relevant agencies and amendment, if any (Immediate Action).
- Conduct an in-depth study to compare various possible alternatives in relation to the proposed expansion of Managua International Airport, coupled with land use planning.

Road Development

- Execute the proposed road projects according to the implementation program. All the proposed projects are economically feasible.
- Pay due attention in the design of proposed road projects to avoid conflict with the proposed Public Transportation Corridors. Improvement of sidewalk and drainage must be taken into account as well.
- Invite the private sector in constructing the proposed Travesía as a toll road (Medium-Term). This project has been proven financially viable. Prior to the negotiation with the private sector, Government should establish the rules and regulations for implementing privately financed infrastructure projects.
- Conduct routine and periodic road maintenance systematically.

Public Transportation

- Construct Public Transportation Corridors, one on Carretera Norte (Short-Term) and the other on Pista Juan Pablo II/Pista Sabana Grande (Medium-Term). Although these projects are economically and financially feasible, a full-scale feasibility study should be conducted for the former (Immediate Action). Government should take a strong initiative in this project considering the huge economic benefit.
- Employ about 400 security guards to randomly inspect running buses in order to prevent in-vehicle crimes. This is an urgent issue to recover people's confidence towards the policy goal of public transportation-oriented city (Immediate Action). In order to reduce the number of traffic accidents, MTI should strengthen its capacity for inspection of bus units and operation.
- Diversify public transportation services by introducing feeder bus (Immediate Action), premium bus (e.g air-conditioned, all-seater, etc.), express bus and collective taxi (Short-Term). For feeder bus, service area should be determined considering the location of urban axes and Public Transportation Corridors.
- Conduct rerouting of bus routes and amendment of fare structure in a timely manner in order to rationalize bus operation and to solve the problems inherent to the commencement of new services. Bus fare structure should be amended from the current flat rate to distance-related system (Immediate Action).
- Construct public bus terminals in conjunction with development or renovation of public markets in Mercado Oriental (Short-Term), Mercado San Judas, Mercado Virgen de Candelaria (Medium-Term), Villa Flor, Sabana Grande and Ciudad Satélite Asosoca (Long-Term). These projects seem to be financially viable at a relatively low terminal charge and would desirably be operated by COMMEMA.

Traffic Management

- Improve existing traffic signals by adjusting signal phases coupled with minor geometric improvement (Immediate Action).
- Execute intersection improvement projects according to the implementation program. This includes 259 signal installations coupled with coordinated traffic control on 4 sections, 16 grade separations and 5 roundabouts.
- Develop pedestrian crossings with signal installation to improve safety at 3 critical sections (Immediate Action).

- Develop a bicycle road of about 40 kms and a pedestrian path of about 5 km to connect the shoreline of Managua Lake, vista points, major cultural/recreational zones and universities (Long-Term).
- Designate Public Transportation Priority Area around public markets to improve traffic situation by restricting private cars. This should be done in conjunction with the development of public bus terminals.
- Designate On-Road Parking Banned Area in relation to the proposed Public Transportation Corridors for strict enforcement of parking control (Short-Term and Medium-Term).
- Increase the rate of Fuel Consumption Tax (Immediate Action) and Import Duty on cars (Short-Term) to discourage car use and ownership.
- Restrict truck routes by recommending (Short-Term) and designating (Long-Term) the truck roads in order to avoid the serious damage on road pavement caused by overloaded trucks.

Financing

- Establish an organization to construct and operate the proposed Public Transportation Corridors under strong initiative of the Government (Short-Term).
- Investigate the possibility for COMMEMA to construct and operate the proposed public bus terminals and Public Transportation Priority Areas (Short-Term).
- Take administrative steps to timely re-evaluate the cadastral value of real property to capture the indirect benefit of property owners due to road development (Immediate Action).
- Double the municipal Road User Tax (Rodamiento) for private cars (Short-Term).
- Start negotiation with the national Government regarding the allocation to Managua of the proposed Road Maintenance Fund (Fondo de Mantenimiento Vial) collected from Petroleum Consumption Tax (Immediate Action).
- Negotiate with the national Government regarding the possible increase of Import Duty for cars and its allocation to Managua (Immediate Action). This is important to finance the proposed projects in this Master Plan.
- Accelerate the arrangement to tap fund from international funding organizations and bilateral sources (Immediate Action).

Further Studies

- Conduct environmental impact assessment (EIA) for the identified road projects which need relocation of housing settlements.
- Conduct feasibility studies on the proposed major projects or project packages.

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| 5) Mr. Michimasa TAKAGI | : | Traffic Management |
| 6) Mr. Kagemasa NAKAKOJI | : | Transportation Survey |
| 7) Dr. Tetsuji MASUJIMA | : | Demand Forecast |
| 8) Mr. Tetsuo WAKUI | : | Economic/Financial Evaluation |
| 9) Mr. Kenji IGARASHI | : | Environmental Evaluation |
| 10) Dr. Shizuo IWATA | : | Transportation Policy |
| 11) Mr. Fumihiro HANDA | : | Data Processing |
| 12) Ms. Yasuko YAMADA | : | Coordinator |

Consultative Committee, Coordination Committee and Counterpart Team

Consultative Committee Members

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|------------------------------|---|--|
| Eng. René Quesada Prado | : | General Director of Planning and Coordinator of the Committee, ALMA. |
| Eng. Víctor Valdivia Hidalgo | : | Project Manager and Secretary of the Committee, ALMA. |
| Cap. -Eng. Gilberto Solís | : | National Police. |
| Dr. Sergio López | : | Ministry of Finances. |
| Dr Adolfo Evertsz | : | Secretariat of External Cooperation. |
| Eng. Rafael Urbina | : | Ministry of Transport and Infrastructure |
| Lic. Milton Medina | : | MARENA. |

Coordinator Committee Members

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|------------------------------|---|--|
| Eng. René Quesada Prado | : | General Director of Planning and Coordinator of the Committee, ALMA. |
| Eng. Víctor Valdivia Hidalgo | : | Project Manager and Secretary of the Committee, ALMA. |
| Eng. Jorge González Mosquera | : | General Director of Urban Development, ALMA. |
| Eng. Víctor Guerrero | : | General Director of Municipal Development, ALMA. |
| Eng. Mario Palacios | : | Representative from MTI. |

Counterpart Members

- | | | | |
|-------------------------|---|-------------------------|--------|
| Eng. Víctor Valdivia H. | : | Project Manager | ALMA |
| Eng. David Gaitán F. | : | Traffic and Transport | ALMA |
| Arch. Ligia Solorzano | : | City Planning | ALMA |
| Lic. Luisa M. Castellón | : | Environment | ALMA |
| Arch. Cony Mendoza | : | Urban Planning | ALMA |
| Arch. Gerald Pentzke | : | Urban Planning | ALMA |
| Lic. Humberto Araúz | : | Pre-Investment | M.T.I. |
| Eng. Yasser Mahmud G. | : | Public Transport | M.T.I. |
| Mr. Jardiel Quesada S. | : | Data Processing | ALMA |
| Mr. Rafael Bautista S. | : | Administrator Assistant | ALMA |
| Miss Karla Ramírez P. | : | Secretary | ALMA |
| Mr. Carlos Adán Genet | : | Driver | ALMA |
| Mrs. Celia Zavala | : | Janitor | ALMA |

JICA