4-1.4 Improvement of Bus Transport and Coordination with MRT

1) Basic Improvement Plan of Bus Transport

The target of improving bus transport in a long-term to try to improve transport services by means of establishing a public transport system to coordinate with MRT. The transport efficiency in the urban area as a whole can be heightened by enhancing reliance of the users upon buses as well as making the result thereof be related to restriction of the demand for private cars. Such being the case, consideration of bus transport is conducted concerning the following three points:

- Improvement of the suppliers' organizations or structures
- Increase in transport capacity
- Orderly arrangement of necessary facilities and improvement of institutional systems

a. Improvement of Suppliers' Organizations

The suppliers' organizations comprise basically minor enterprises and the supply of bus services can be secured by private efforts of them including such ones as owning only one bus. Indeed, it is a surprising matter that they have so far played a certain role of bus services under such a circumstance as this, but it is difficult for them to acquire ability to plan and carry out investment and improvement in a large-scale in advance so as to meet expansion of the urban area, increase in cars, augmentation of bus demand and all anticiapted in future. Re-organization, reinforcement, mutual cooperation, etc. of the suppliers' organizations would become necessary, from the above point of view.

In case of introducing MRT into the main traffic routes, re-organization of the bus routes coordinated with MRT is important and, in this case, it is necessary to reform the structures of their small manual industry into those of capable enterprise.

b. Increase in Transport Capacity

In order to ensure smooth bus operations and enhance the transport capacity of buses, the following measures are needed:

- Expansion of the measures for allowing buses to be operated preferentially.
- Improvement and re-organization of the bus network.
- Improvement of transport terminals, connecting points, etc.

b-1 Measures for Operating Buses Preferentially

It would become necessary to separate the traffic of buses from that of private cars by means of securing exclusive space for buses either in a large-scale or partially providing the bus lanes within the existing roads, etc.

These measures should be selected respectively depending on the volume of demand, width of roads, possibility of widening roads, shapes of the town area, etc.

b-2 Improvement and Re-organization of Bus Network

It is necessary to improve or re-organize the bus network for enhancing the transport capacity of buses so as to meet the demand effectively.

In case ot MRT having been constructed, the examples of re-organization of the bus network such as coordinated with MRT are as follows:

(1) To secure feeder service between MRT's suburbs stations and the residential areas as well as between MRT's CBD stations and CBD (Refer to Figure 4-1.8, 19).

(2) To secure service within the inter-areas out of the MRT's service area.

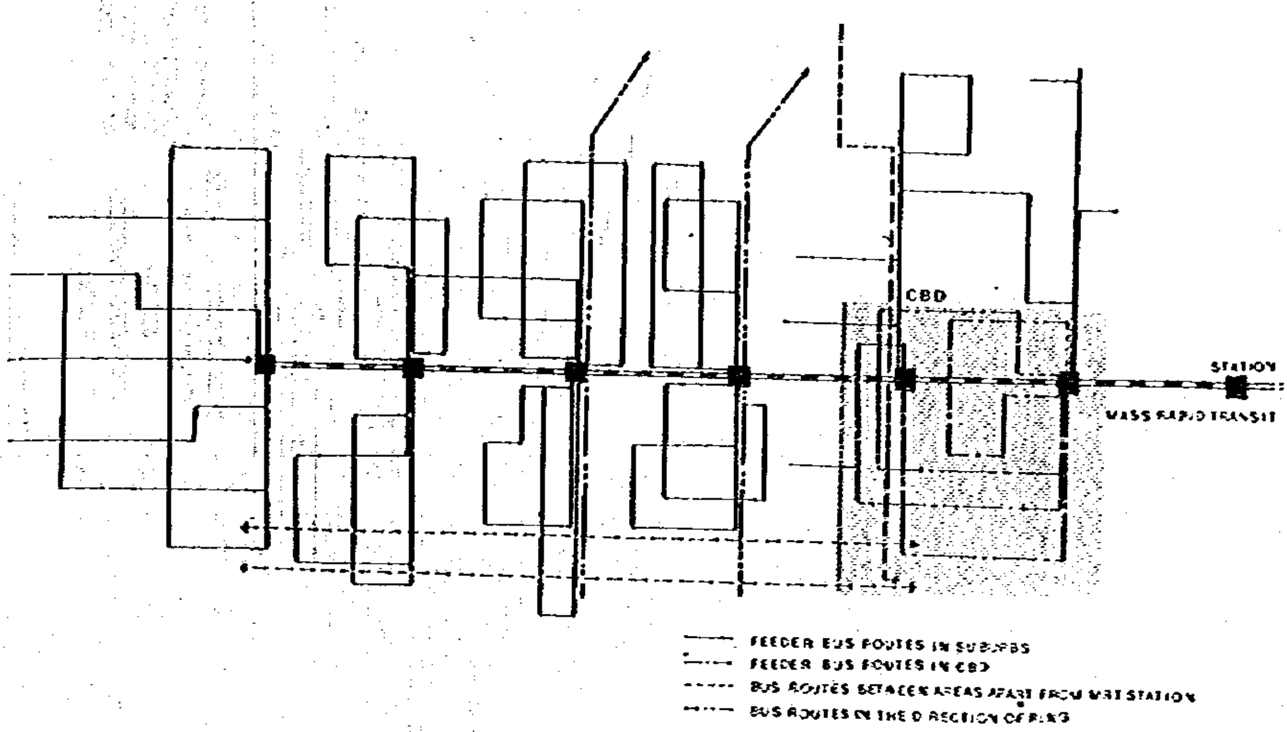
(3) To secure service for trips generating with low density along the loop-line direction.

In case of no MRT being introduced, the bus network should be re-organized according to the following measures:

(4) To introduce a trunk line bus system into MRT routes making other buses maintain such a functional separation as described in the above (1) - (3).

(5) To secure an exclusive bus lane along the MRT route and, in addition, combine it with the feeder service of (1).

Figure 4–1.18 BUS NETWORK PATTERN COORDINATED WITH MRT STATION



b-3 Improvement of Transport Terminals, Connecting Points, Etc.

In order to minimize inconvenience increased by transfer, the transport connecting points are should be provided with necessary facilities described later in 2).

Fig. 4-1.19 shows an example of connecting points after the completion of the MRT North-South route.

c) Orderly Arrangement of Necessary Facilities and Improvement of Institutional Systems

In order to push forward positively enhancement of the bus transport capacity and improvement of the suppliers' organizations, it would be necessary to aid these plans from the public administrative side not only for the sphere of the facilities but also for the sphere of software (the aspects of administrative organization, constitutional systems, etc.).

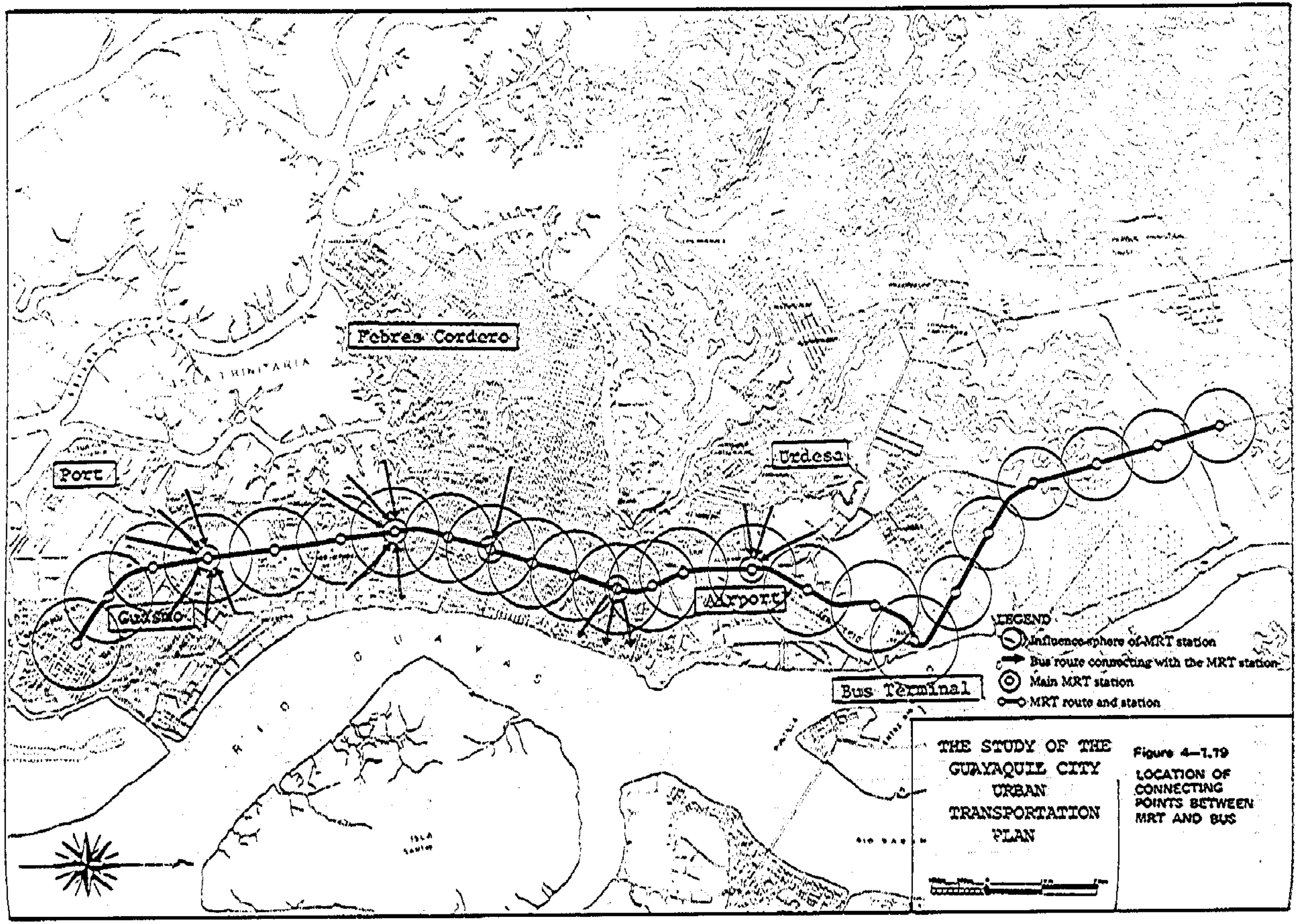


Figure 4—7.19 LOCATION OF CONNECTING POINTS BETWEEN MRT AND BUS

2) Coordination of Bus Routes with MRT Stations

It is indispensable service to be offered by public transport system to coordinate MRT with buses and other modes, and to make private vehicles' users divert themselves to a public system who are accustomed to "door to door" mobility.

In order to provide a better transfer function, transport terminals connecting MRT stations to bus routes, etc. are requested to be planned as below:

a. Terminals in Suburban Area

A few MRT stations in the suburban area should be provided with transfer function as a terminal, where bus routes, taxis, etc. are re-organized so as to coordinate with the stations. Enough parking area for a park and ride system is one of essential facilities to divert vehicles' users to MRT with ease and comfort.

A conceptual example of this terminal type is shown in Figure 4-1.20.

b. Terminals in Urban Area

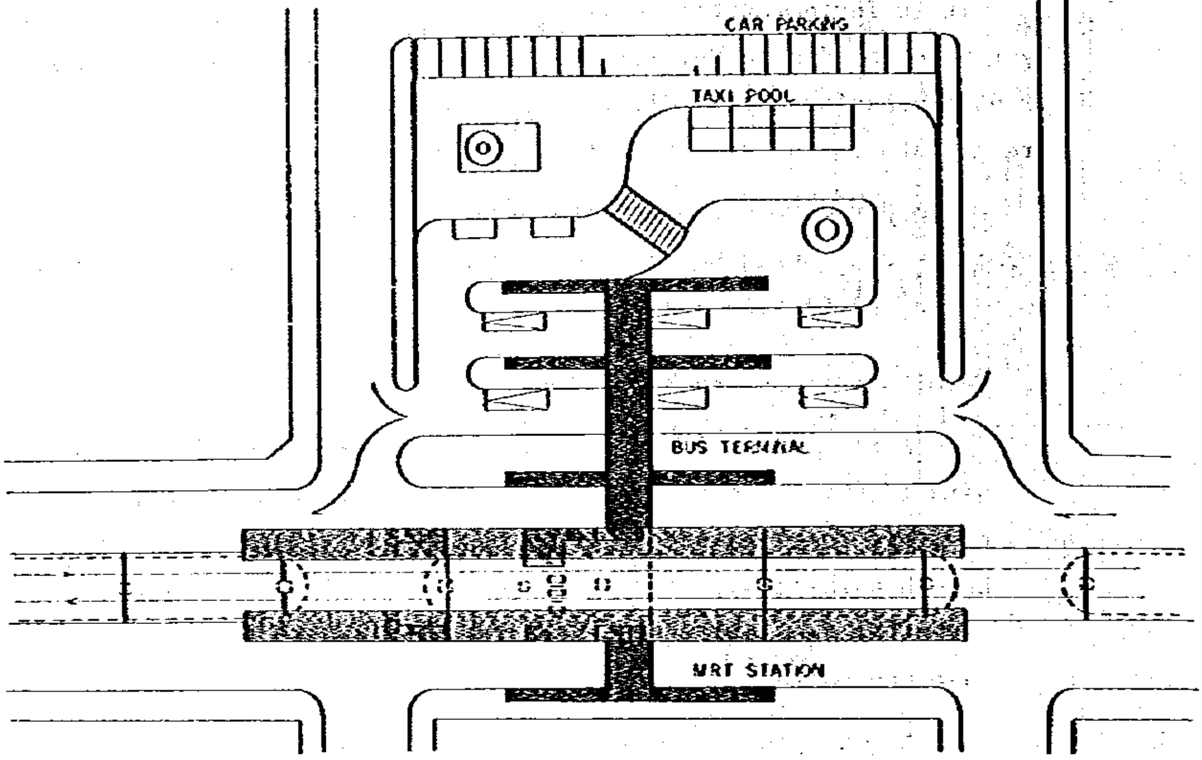
A few main MRT stations should be also prepared as terminals, where bus routes are re-organized to coordinate not only with MRT but also between them. At the same time, facilities for pedestrians should be provided so as to improve accessibility on foot since it is very difficult to get enough space for parking in the urban area.

A conceptual example of this type is shown in Figure 4-1.21.

c. Other Intermediate MRT Stations

There are not special facilities necessary for intermediate stations except above terminals, if bus bays and stops are provided.

Figure 4-1.20 EXAMPLE OF STATION PLAZA IN THE SUBURBAN AREA



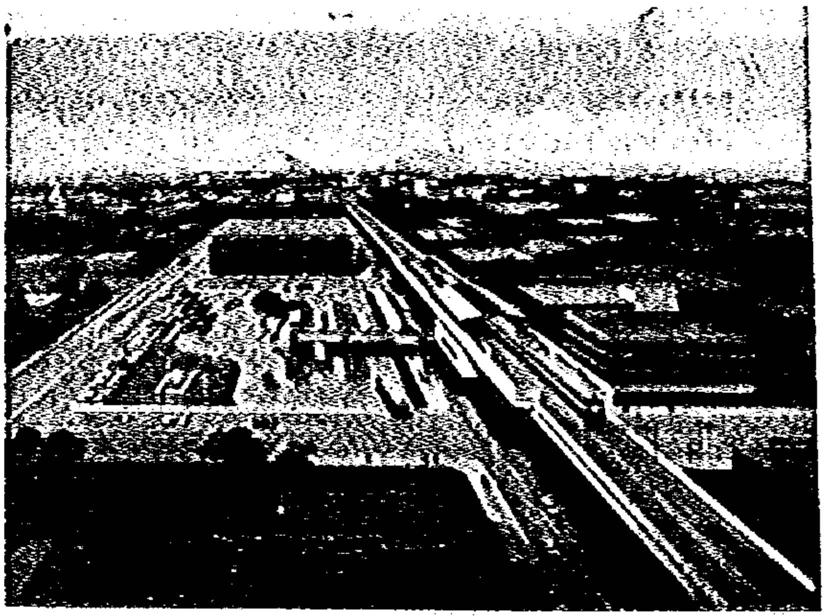
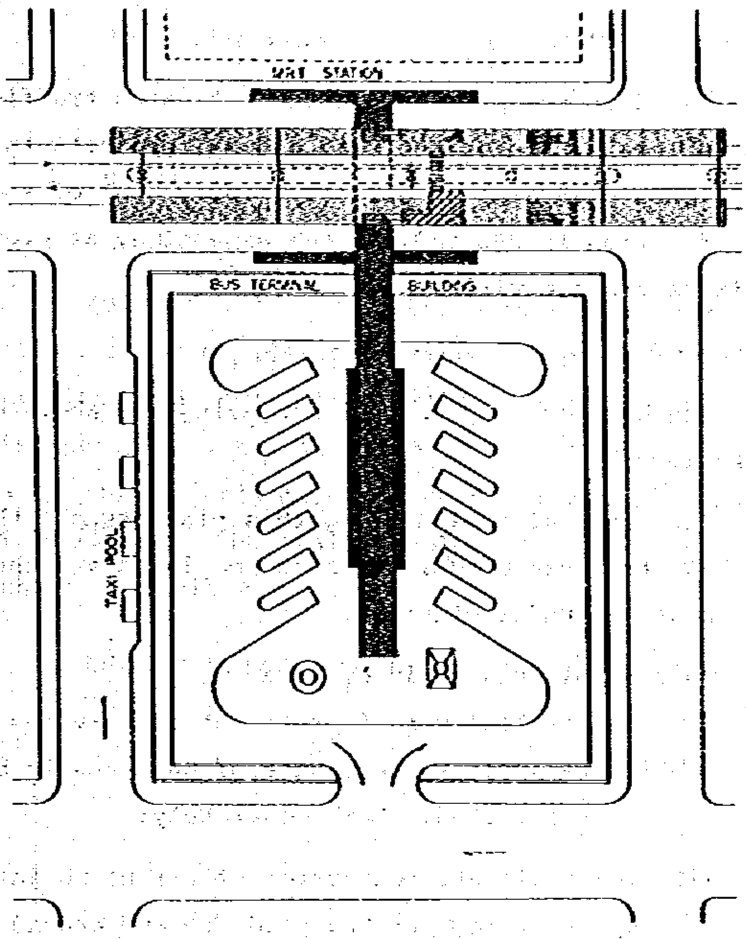
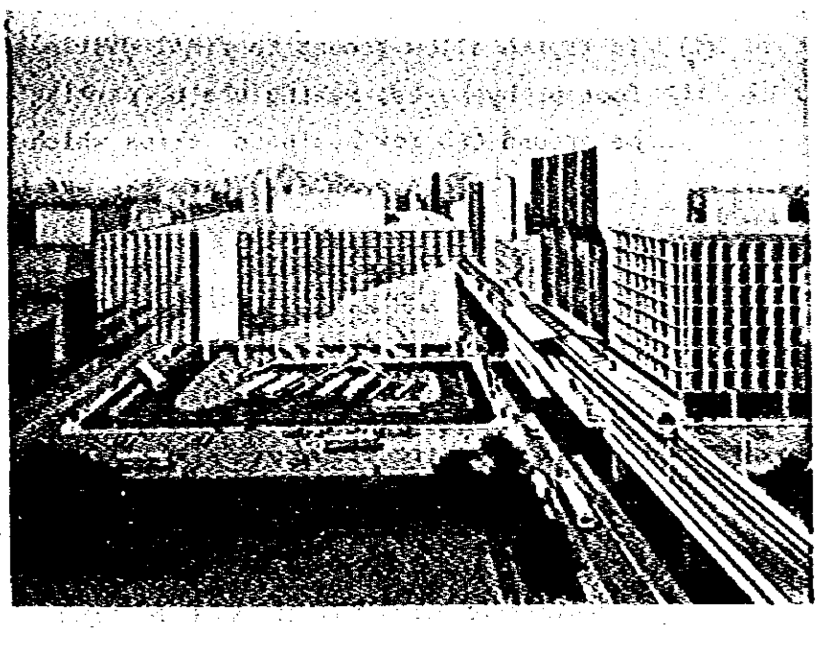


Figure 4-1.21 EXAMPLE OF STATION PLAZA IN THE CENTRAL AREA





3) Improvement of Public Transport System and Traffic Management in CBD (Central Business District ... Casco Central)

a. Purpose of Plan

Based on the premises of the estimated traffic demand and implementation of the road and MRT projects in the master plan, this plan aims at directly improvement of smooth transport function in CBD and, at the same time, at preserving desirous urban environment.

b. Course of Plan

The basic conception for achieving the above purpose is as follows:

The stage of implementing this plan assumes that the North-South route of MRT has been completed and the East-West route is under planning.

b-1 To control driving-in by cars

In parallel with improvement of services by the public transport systems, use of cars should be more or less restricted. More concretely:

(1) To accelerate conversion of car users into MRT users by providing parking yards in and around the suburban MRT stations, etc. for those users who are not always in need to use cars.

(2) To try to allow access to final destinations on foot or by buses, making use of parking yards in or around CBD for business trips which are difficult to be converted from cars into the MRT but are neither necessary nor urbent.

(3) However, for those trips which necessiate to use cars up to final destinations, it should be made possible to use roads smoothly.

b-2 Improvement of public transport systems

(1) Complementary systems by buses should be established so as to improve mutual access between MRT stations and CBD.

(2) Orderly arrangement of space for pedestrians so as to allow access on foot as much as possible. Space for pedestrians should be separated from car driving lanes and the mode of such space should be realized so as to make pedestrians prefer walking to driving cars.

c. Anticipated traffic volume

The urban development pattern in this master plan makes it a basic conception to evolve from the present one point concentration type toward the northern area forming a belt zone. It is inevitable, however, that the existing CBD should also grow up and not only have higher density but also extend outward in future. The traffic volume anticipated in future is as shown in Table 4-1.14.

Table 4-1.14 TRAFFIC VOLUME IN A-1 ZONE

(Unit: 1000 trips)

Year	Total	Car			Bus		
		Car	Taxi	Total	Urban bus	Inter-zone bus	Total
1982	1786	775	360	1136	565	85	650
2000	2769	993	598	1591	1128	50	1178
Growth rate	1.55	1.28	1.66	1.40	2.00	0.56	1.81

The above traffic volume is estimated on the premise that a parking restriction policy is put into practice in the A-1 zone.

The number of passengers getting on and off at each station in CBD of the North-South route of MRT is shown in Fig. 4-1.22.

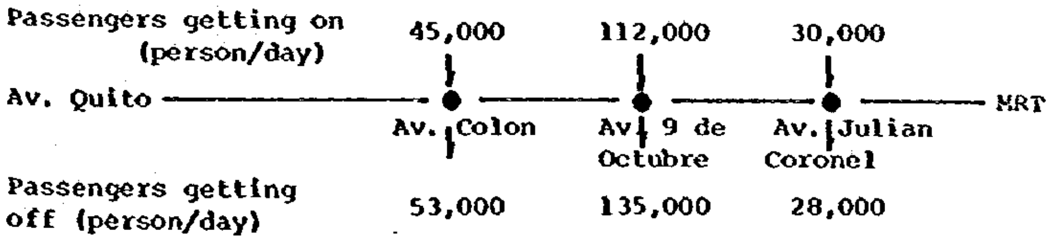


Figure 4-1.22 NUMBER OF PASSENGERS

d. Improvement Measures

d-1 Road projects

In order to eliminate through traffic in CBD and try to disperse flowing-in traffic, orderly arrangement of a CBD ring line should be implemented.

The CBD ring line is formed up with the following roads:

(1) East side: Maleoon Simon Bolivar

The existing Malecon is used as a road in the zone and a trunk road along the Rio Guayas is newly constructed. (The existing park is moved from the new road to the river side.)

(2) West side: Av. Quito and Av. Machala

(3) South side: Av. Olmedo and Calle Colon

Orderly arranged as a trunk road

(4) North side: Calle Julian Coronel is orderly arranged as a trunk road.

Av. Quito, Av. Machala and Calle Julian Coronel are connected by under-pass, etc.

Av. Boyaca, Calle Junin, Aguirre, etc. are orderly arranged as local distributors. It is conceivable that the traffic load on Av. 9 de Octubre and Calle Pichincha is considerably lessened by orderly arrangement of this ring line.

The disposing method of the traffic flow is shown in Fig. 4-1.23.

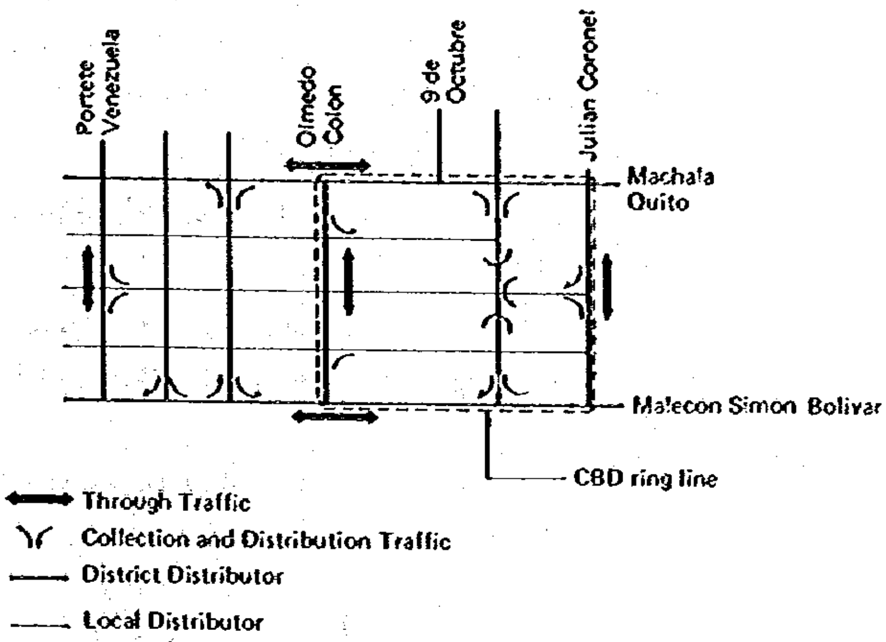


Figure 4-1.23 SCHEMATIC PLAN OF TRAFFIC FLOW

d-2 Pedestrians' road projects

For the purpose of leading MRT users smoothly toward CBD, accelerating "Park and Walk", etc., pedestrians' roads will be orderly arranged shown in Fig. 4-1.26.

9 de Octubre: The width of the sidewalk is widened by decreasing the car lanes to 2 lanes. The section from the MRT station up to the river side park of Malecon is converted into a continuous sidewalk park.

Pichincha : The number of pedestrians has been most so far in this road as it is now. This road is converted into a sidewalk park by decreasing 1 car lane among the lanes concentrated to the business facilities as well as existing in the parking zone, and by widening the width of the sidewalk.

Besides this, the width of the sidewalks of Boyaca, 10 de Agosto, etc. is widened by removing the green belt of the separator. Since the number of car lanes is not decreased, orderly arrangement of the sidewalks is feasible without lowering the traffic volume.

d-3 Traffic jointing point projects

Traffic jointing points are orderly arranged at the MRT stations in CBD.

By allowing buses and taxis to drive into traffic squares, transfer of the transport means by passengers is made easier.

Fig. 4-1.24 conceptionally shows the idea of Items d-2 and d-3.

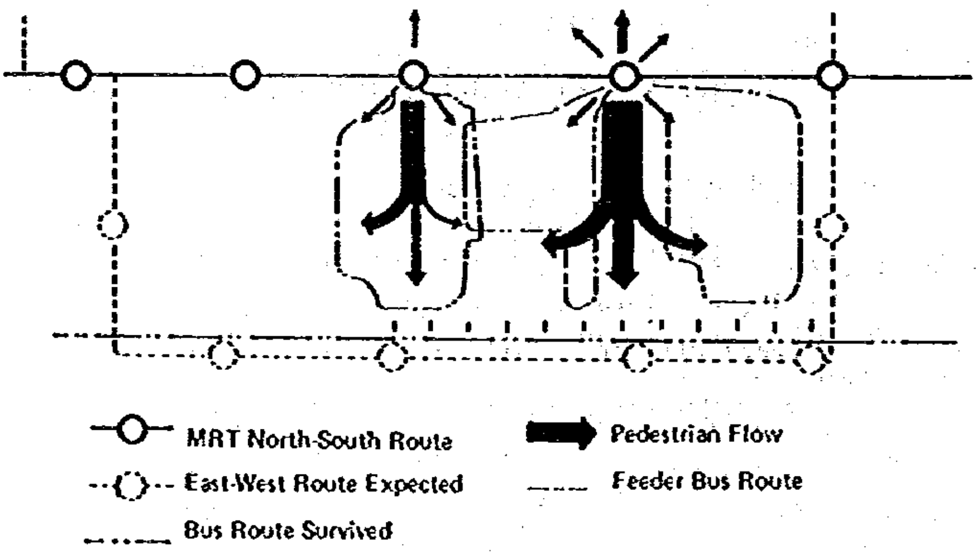


Figure 4-1.24 SCHEMATIC PLAN OF PUBLIC TRANSPORT PASSENGERS FLOW

d-4 Parking yard projects

Although it is difficult to satisfy the demand of parking in CBD, generation of the demand 1.4 times as large as the present one is anticipated on the premise that a parking restriction policy will be put into practice. Therefore, in order to meet this demand, orderly arrangement of public parking yards in the underground of Parque Centerario, etc. connecting pedestrians' roads is implemented together with accelerating installation of parking yards in the individual building.

In order to make up for the shortage of parking facilities in CBD, a large-scaled fringe parking is orderly arranged near the above ring line, and "Park and Walk" as well as "Park and Bus ride" are accelerated.

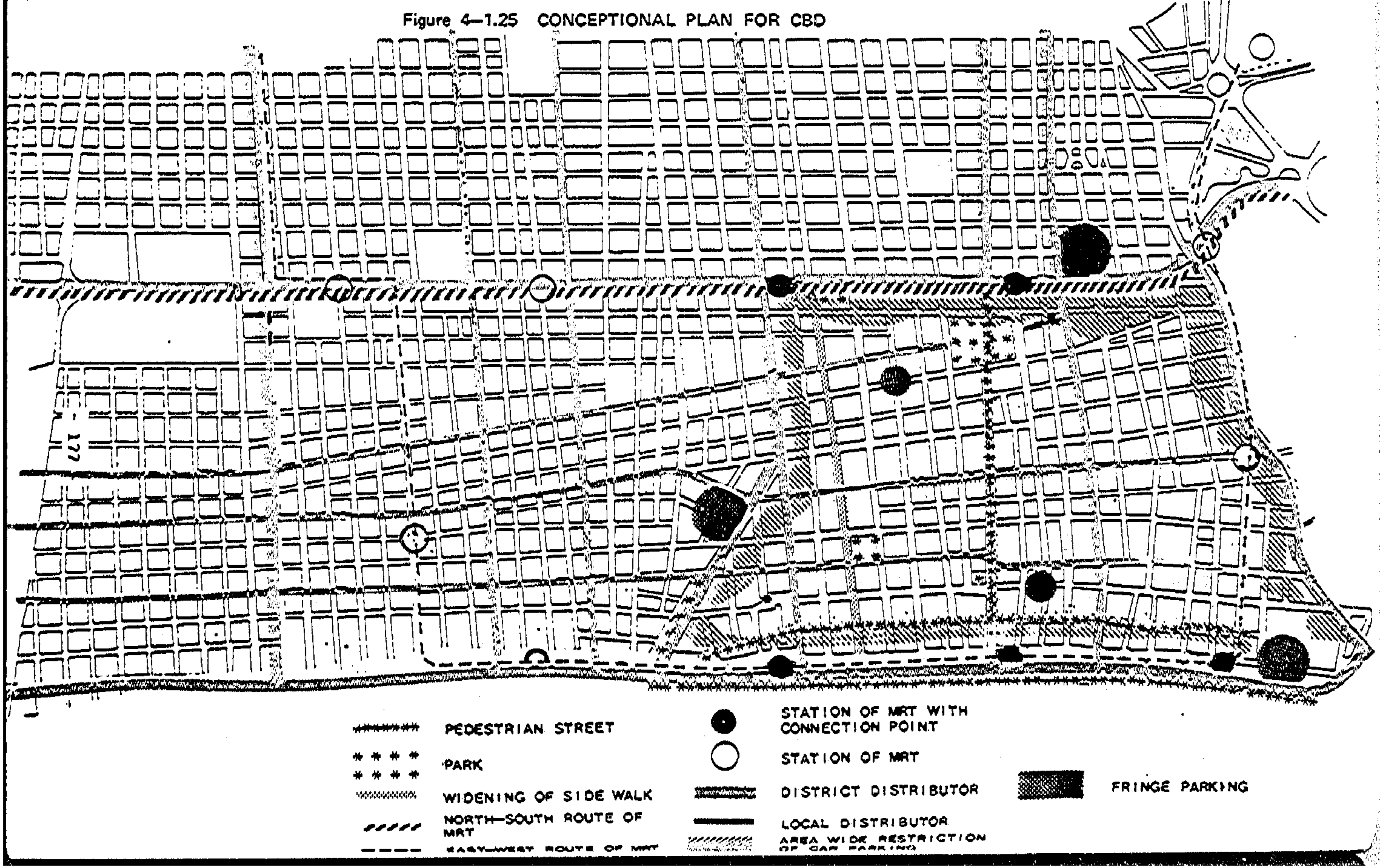
e. Conceptional Figure

Fig. 4-1.25 expresses the abovementioned plan and Fig. 4-1.26 shows an example of the image of pedestrians' roads.

4-1.5 Summary for Long-Term Transportation Plan

Taking into account of afore-mentioned matters, the planning target and policy etc. of Long-term transportation plan is summalized as seen in Figure 4-1.27. In the later chapter, its evaluation and implementation program are carried out.

Figure 4—1.25 CONCEPTIONAL PLAN FOR CBD



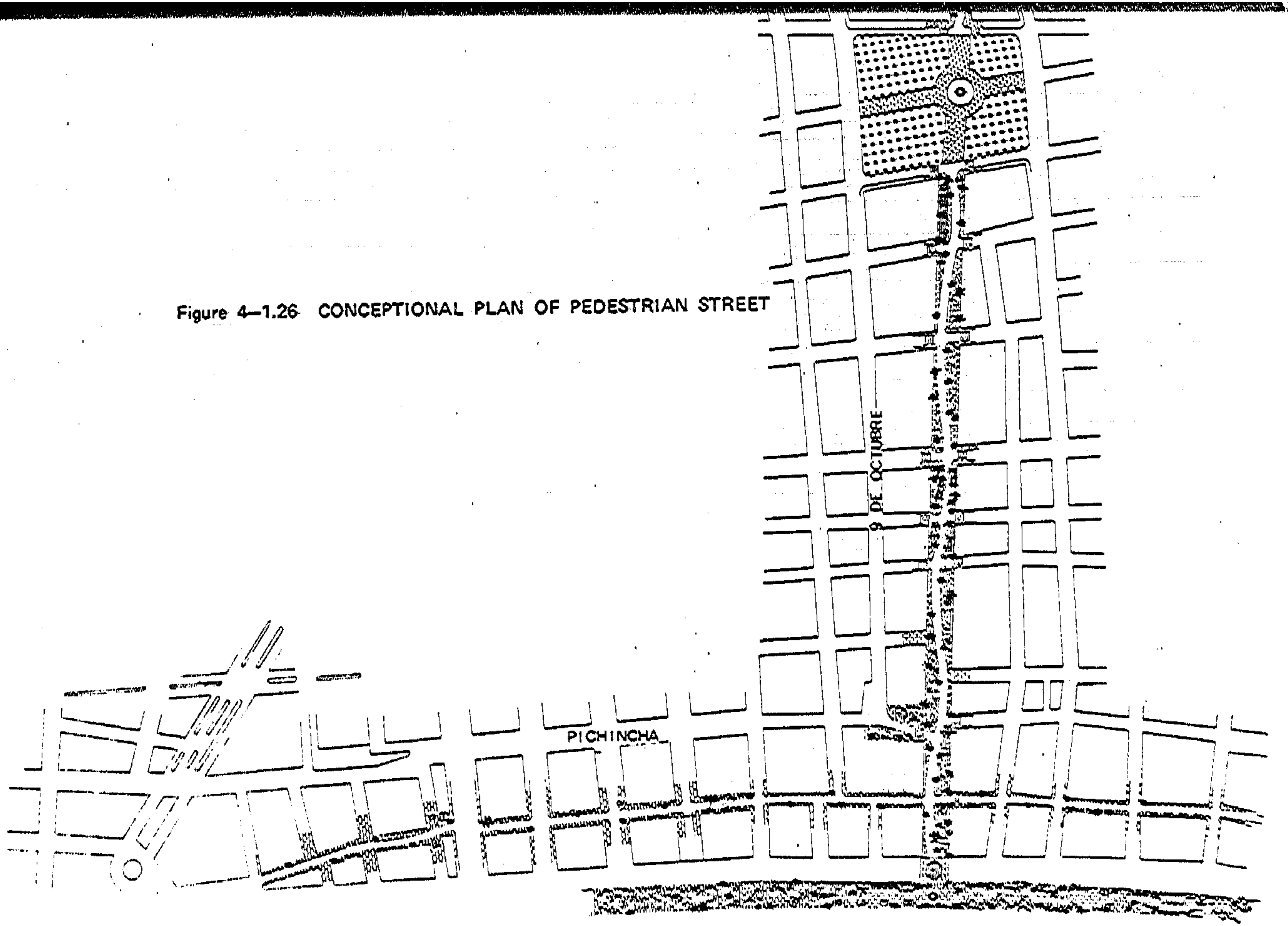
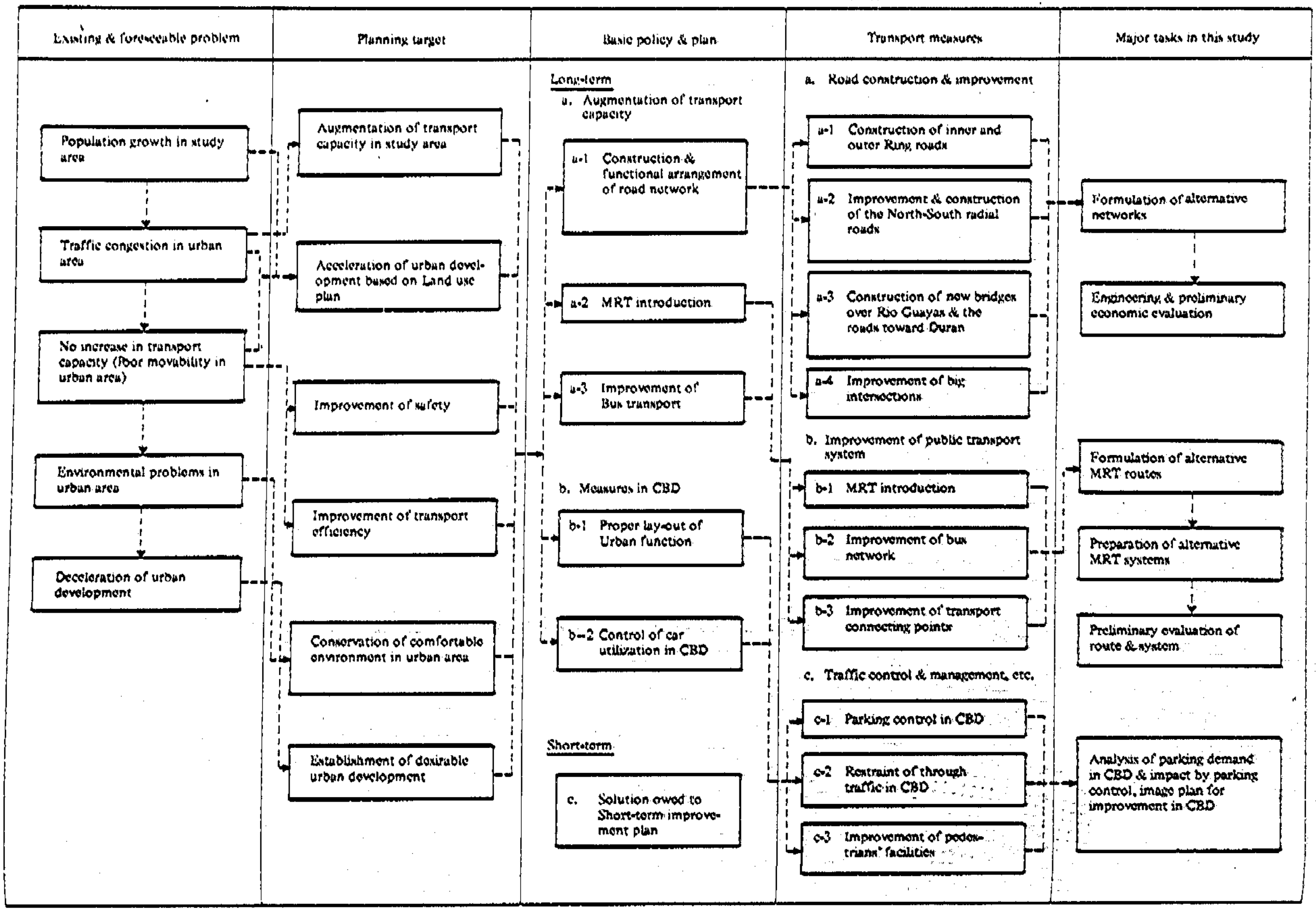


Figure 4–1.26 CONCEPTIONAL PLAN OF PEDESTRIAN STREET

Figure 4–1.27 SCHEMATIC DIAGRAM OF LONG-TERM TRANSPORTATION PLAN



4-2 TRAFFIC FORECAST FOR LONG TERM TRANSPORT PLAN

4-2.1 Outline

The traffic forecast for the long term transport plan, which was established in the previous section, is carried out in this section. As its outline flow is shown in Figure 4-2.1, estimation of the MRT passengers volume and the traffic assignment to the road network of the long-term transport plan are made, based on the basic traffic volume estimated in the Chapter 3.

4-2.2 Estimation of Total Traffic Volume

The traffic demand by mode was estimated, using the same procedure mentioned in 3-2 as followings;

1) Parking control option

Based on the analysis of present parking demand behaviour, certain amount of the vehicle trip volume, which is generated or attracted in CBD (zone A-1), are diverted to the public transport demand.

2) With MRT option

The trip modal split with MRT was carried out, applying the trip modal split model to the network including MRT route.

The estimation result is shown in Table 4-2.1. Compared with the basic case result, the vehicle trip share (car + taxi) decreases 1% in the "parking control case" and 1% more in the "with MRT case".

Table 4-2.1 TOTAL TRAFFIC VOLUME IN 2000

Unit: Trips/day

Case	Car trip	Taxi trip	Public transport trip	Car + taxi trip share
Basic case	1,996,800	906,300	2,076,500	0.58
Parking control	1,917,000	906,300	2,156,300	0.57
With MRT	1,863,900	906,300	2,209,400	0.56

4-2.3 MRT Passengers Estimation

1) Outline

Following assumptions are premises to estimate the number of passengers on MRT.

(1) MRT passenger volume is extracted from the total volume of public transport demand (mainly bus passenger demand at the present).

(2) It depends on the generalized cost for each mode, which is measured by time cost plus transport fare, whether a user decides to choose MRT or not.

(3) Public transport demand is broken down into three groups in accordance with their access method to MRT stations, i.e., walk, other means. And the particular diversion curve is applied to them respectively.

(4) The inter city bus passengers who use the Bus Terminal are considered to be a part of the diverted demand to MRT.

2) Estimation Procedure

General flow is shown in Figure 4-2.2. As seen in this figure, first step of MRT passengers estimation is to break down the public transport demand into 3 divertible O-D tables, and the diversion curve is applied respectively in the second step. The diverted traffic volume is aggregated between the MRT Stations in the final step.

a. Diversion curve

As mentioned before, both traffic time cost and transport fare are taken into account to make the diversion curve. The diversion curve is formulated by combining the average time value distribution and the time difference between each mode, bus and MRT, and their transport fare. Ten sucres are assumed as MRT transport fare for one time riding. The distribution of passenger's time cost is made from the trip production survey result. Figure 4-2.3 shows the diversion curve concept.

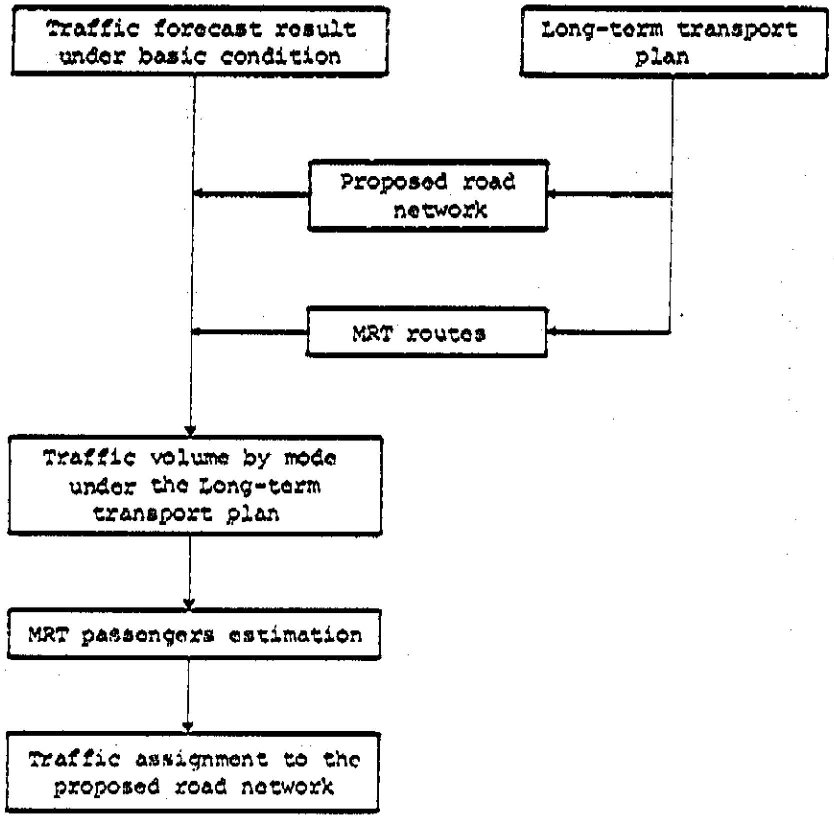
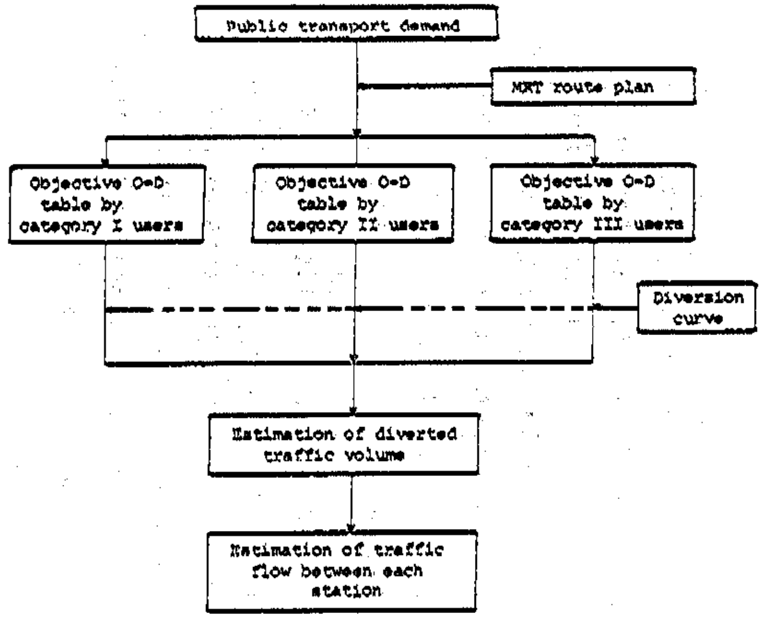


Figure 4—2.1 FORECASTING FLOW FOR LONG-TERM TRANSPORTATION PLAN



User classification (category)

Trip origin \ Trip destination	Stations' zone	Outside zone
Stations' zone	I	II
Outside zone	II	III

Figure 4—2.2 GENERAL FLOW OF MRT PASSENGERS ESTIMATION

b. Bus route consideration

Conventional bus service could be a strong competitor against MRT if its route characteristics is similar to that of MRT. However, it is still uncertain now whether the bus route is re-organized relating to the MRT introduction. Therefore, the present bus routes exist as a rival in estimating MRT passengers.

3) Passenger Volume Estimation Result

Total passengers was estimated 1,172,000. Figure 4-2.4 shows the number of passengers who get on MRT at each station. High volume of passengers is expected at the junction of MRT routes. This is because many transfer passengers are included. And it indicates the necessity to provide the transfer facility at such stations. The numbers of passengers for the other stations are between 1,000 and 86,000.

Figure 4-2.3 DIVERSION CURVE CONCEPT

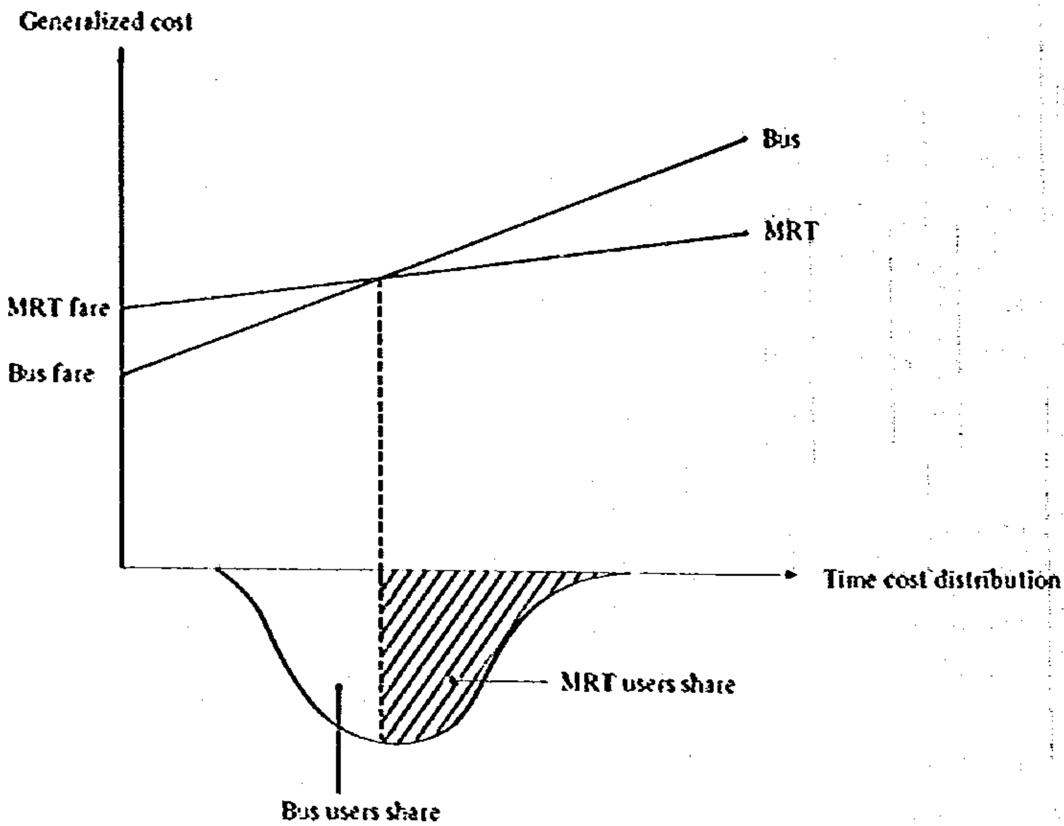


Figure 4-2.5 shows the path flow volume. In general the maximum path flow is seen at the northern section near CBD and it amounts to about 280,000 passengers a day.

4-2.4 Traffic Assignment to Proposed Road Network

The traffic assignment was carried out in the same method as being used in the chapter 3. Its result is shown in Figure 4-2.6. According to it the link volume of main traffic line, i.e., Av. Quito, Av. Machala, 9 de Octubre and Av. Portete, decreases to considerable extent and the road condition is effectively improved, compared with "basic case".

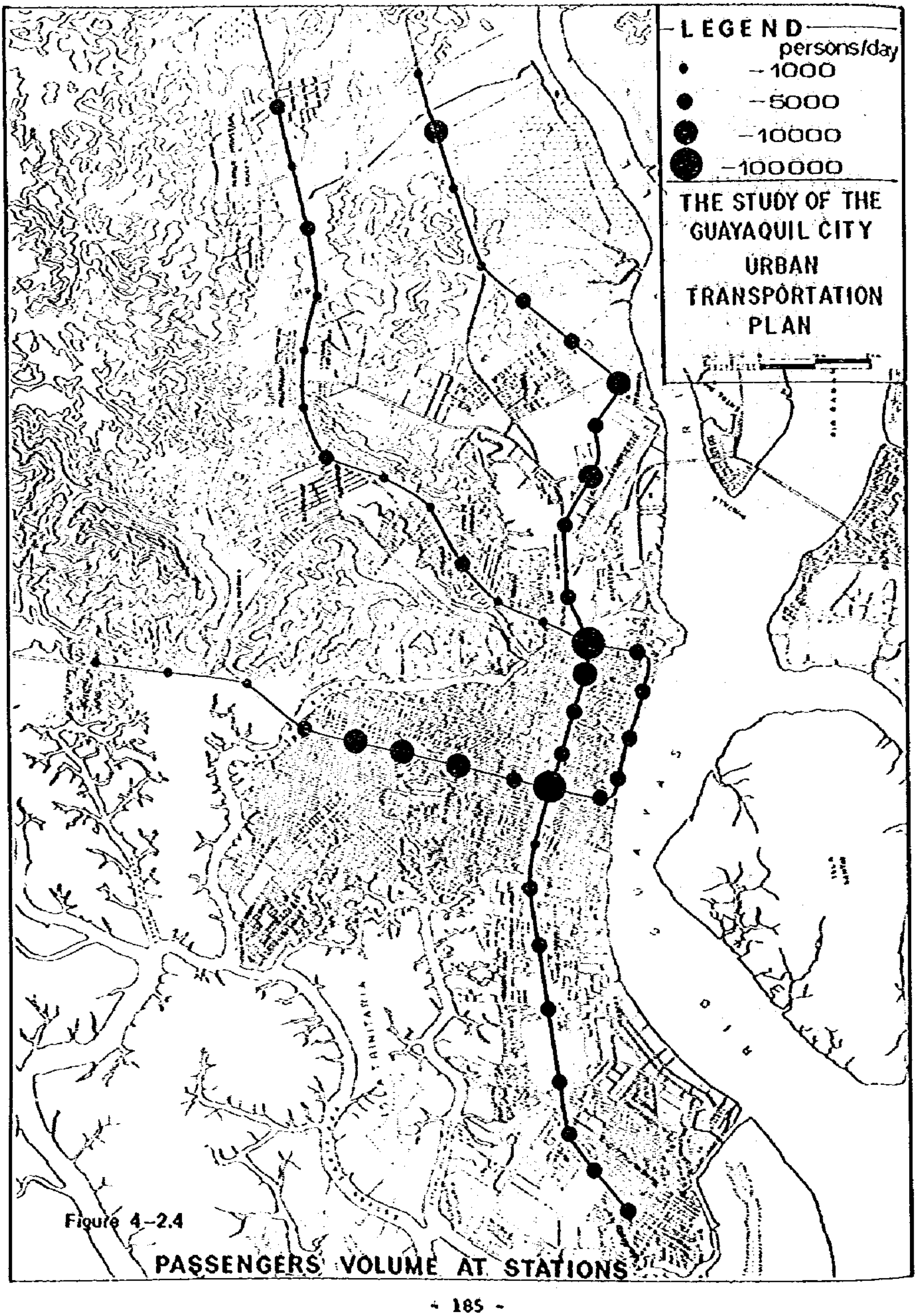


Figure 4-2.4

PASSENGERS VOLUME AT STATIONS

CHAPTER 5.

EVALUATION OF LONG-TERM TRANSPORTATION PLAN

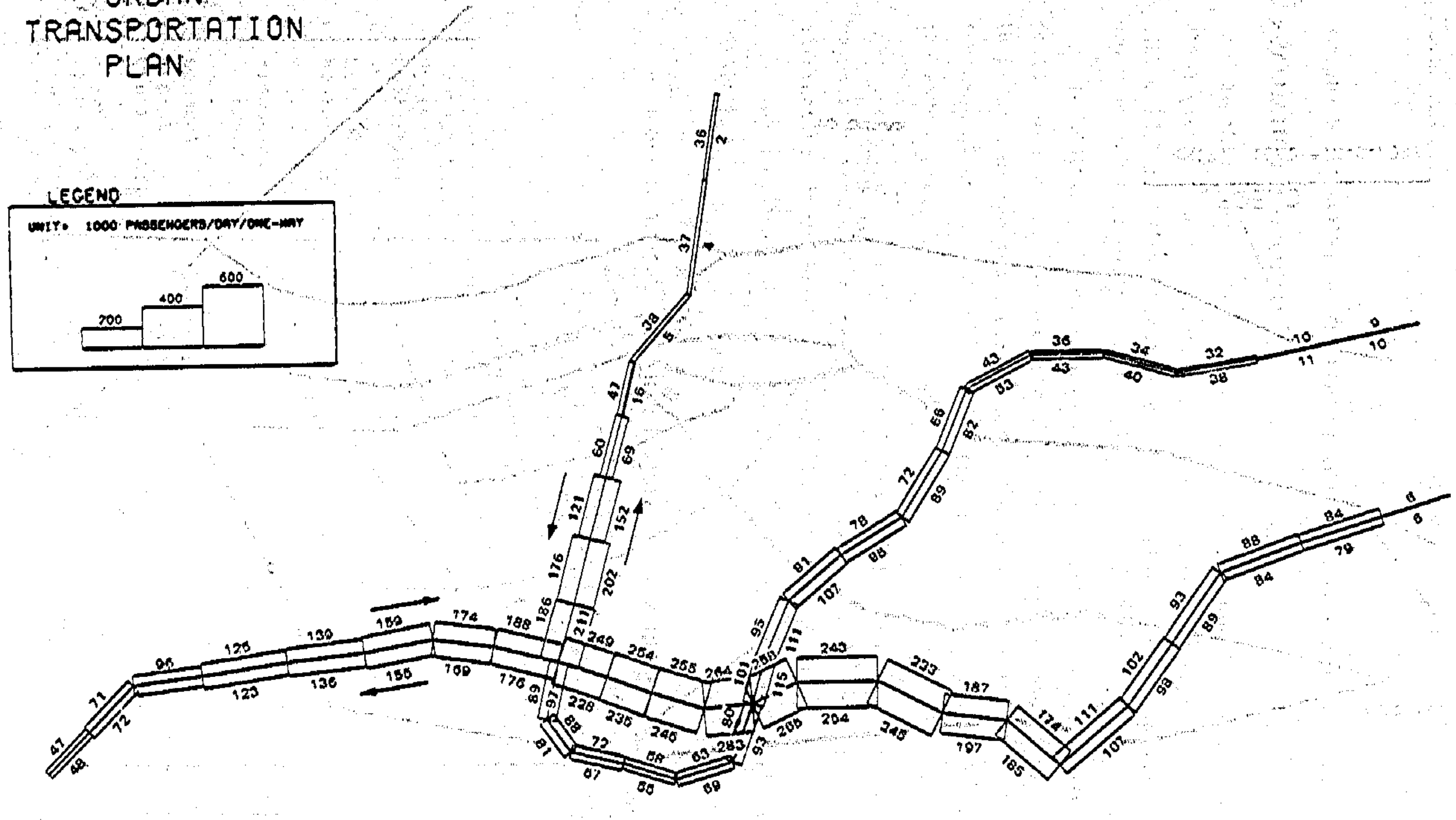
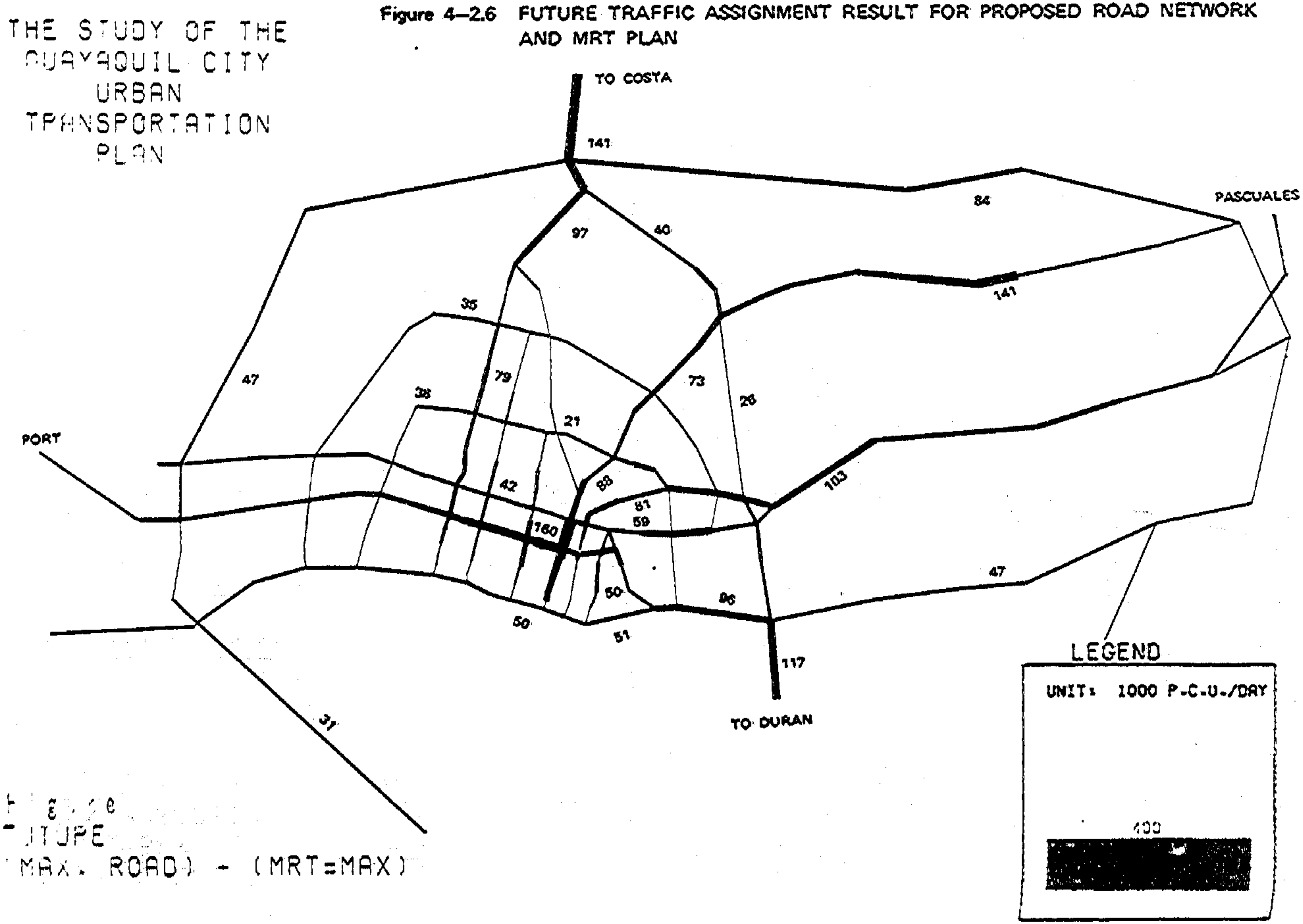


Figure 4—2.5 LINK VOLUMES ON MRT NETWORK

Figure 4–2.6 FUTURE TRAFFIC ASSIGNMENT RESULT FOR PROPOSED ROAD NETWORK AND MRT PLAN



Chapter 5 EVALUATION OF LONG-TERM TRANSPORTATION PLAN

5-1 EVALUATION PROCEDURE

In this Chapter, the long-term transportation plan (the master plan) prepared in the previous Chapter is evaluated from the three main aspects: engineering effects to the future traffic demand, economic and financial feasibility, and social impacts.

In addition, the project priority is considered on the main projects which are proposed in the long-term transportation plan, and in process of the above evaluation, effectiveness of the mid-term implementation in 1990 of the long-term plan is also examined from the same aspects.

The method of evaluating alternatives is based on the relative comparison that consists of the comparative analysis among several alternatives including "do nothing case".

These evaluations are carried out according to the following diagram.

Figure 5-1.1 EVALUATION PROCEDURE DIAGRAM

	Long-term Plan in 2000		Mid-term Execution in 1990 of Long-term Plan
	Road Alternative Network	MRT Network	
Transportation System Evaluation	O	O	O
Economic Evaluation	O	O	O
Financial Analysis	—	O	O
General Impact Consideration	O	O	—
Project Priority Consideration	O	O	—

5-2 GENERAL DIAGNOSES ON TRAFFIC IN FUTURE

5-2.1 Consideration on Road Traffic

1) Results of Traffic Assignment to Road Network

The proposed road network in the master plan consists of the combination of three ring and several diagonal roads as a skeleton.

Figure 5-2.1 and 5-2.2 show the congestion degree in each section of the both network: the basic case without any action and the proposed network of long-term transportation plan, based on the traffic assignment to each network respectively. Comparing both figures, the effectiveness of the proposed network is very clear, for example, on the trunk road northward from CBD where the congestion rate with more than 2.0 in the basic case decreased remarkably in the proposed network.

Note. Congestion rate in the Figure 5-2.1 and 2 is calculated by the following expression:

$$\text{Congestion rate} = \frac{\text{Projected traffic volume/day, both ways}}{\text{Practical design capacity/day, both ways}}$$

Congestion rate interpretations:

Less than 1.0 : assures normal running conditions

1.0 ∿ 1.2 : disturbs normal running conditions but cars can still move at low speed

1.2 ∿ 2.0 : means very low speed

More than 2.0 : means almost impossible to move

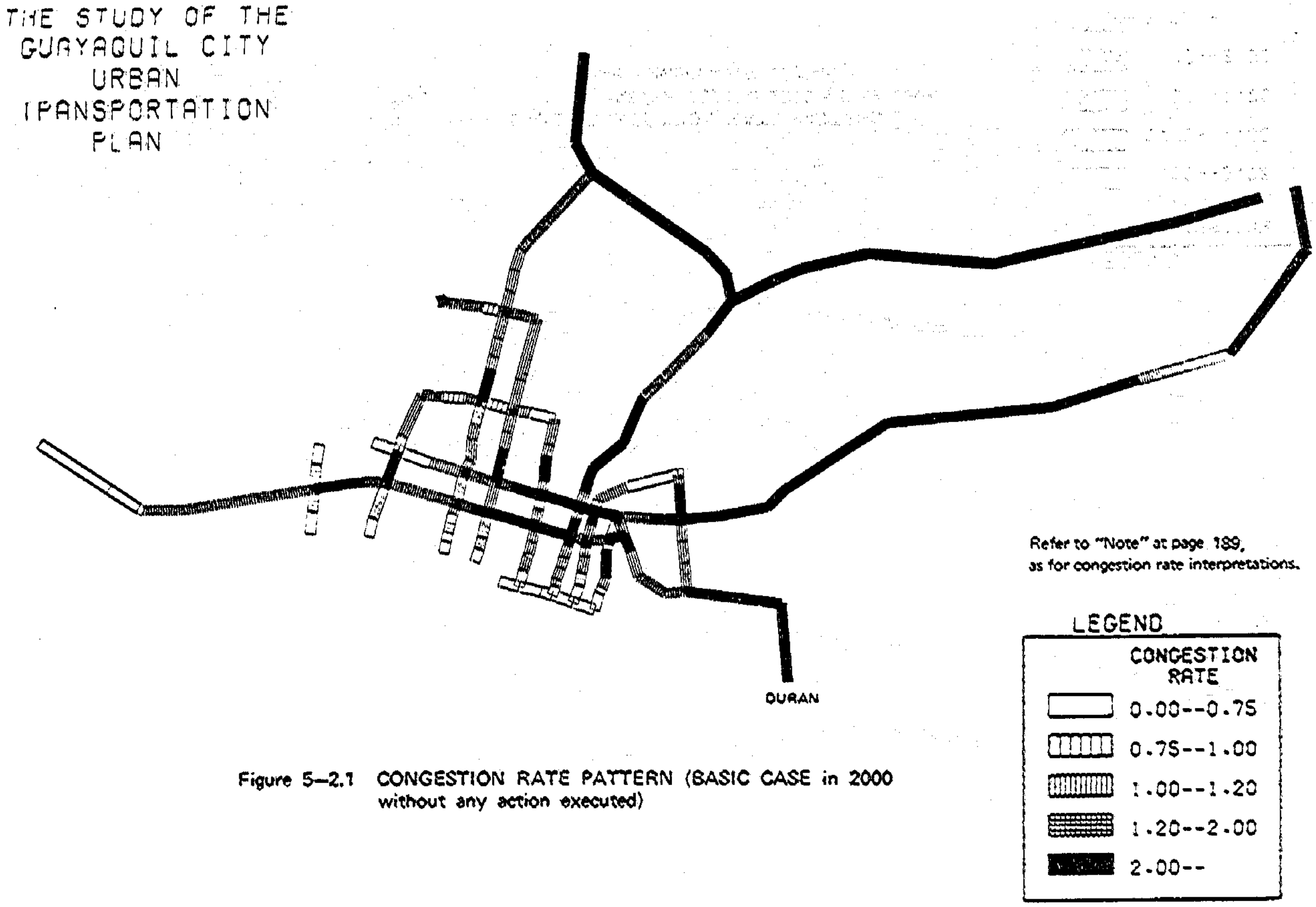


Figure 5—2.1 CONGESTION RATE PATTERN (BASIC CASE in 2000 without any action executed)

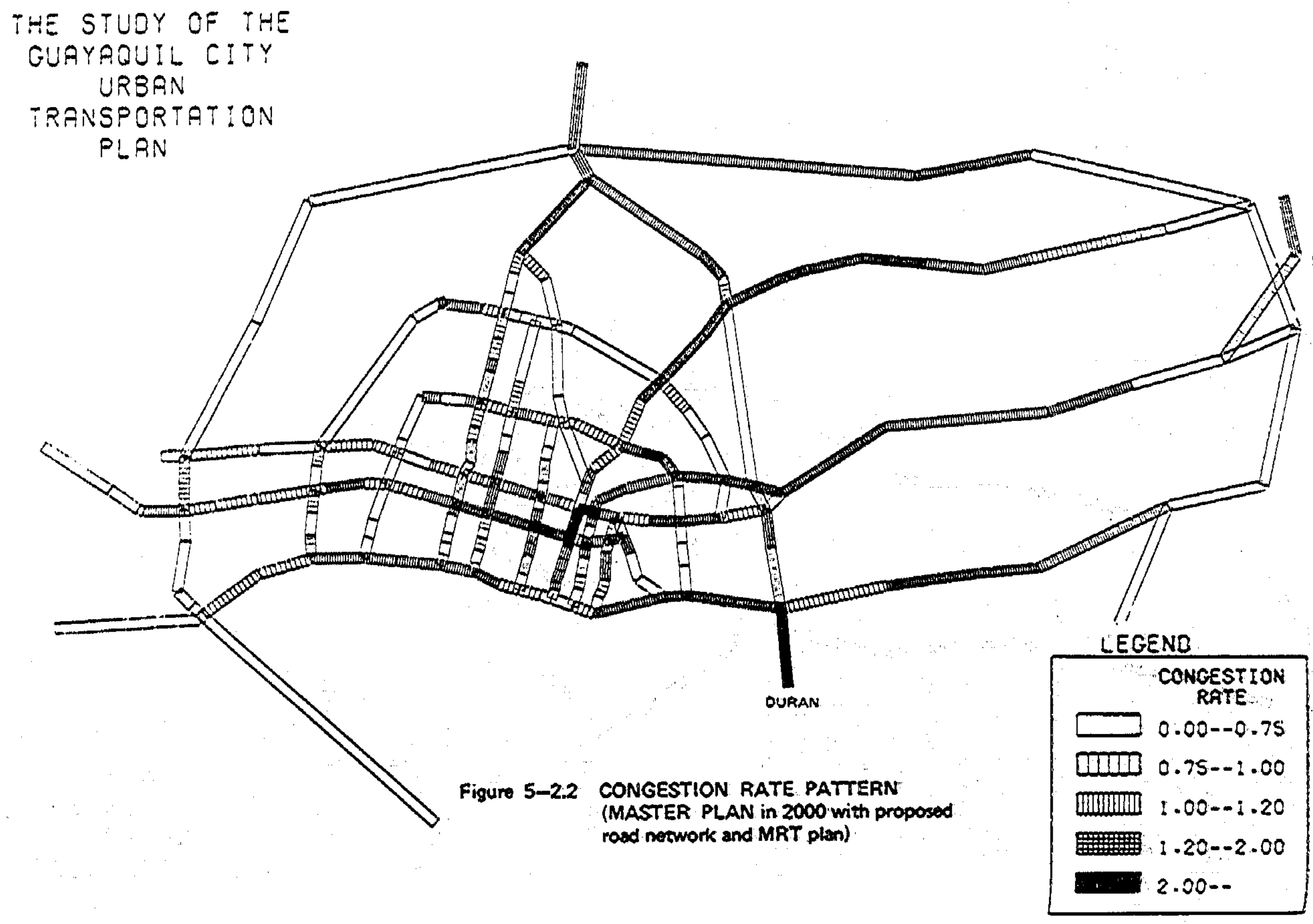


Figure 5–2.2 CONGESTION RATE PATTERN
(MASTER PLAN in 2000 with proposed road network and MRT plan)

Principal results of the assignment to the proposed network are given as under:

a. The traffic volume crossing the screen line A (see Figure 5-2.3), which is projected to be 556,000 car trips a day in 2000, will be transported effectively by the four new roads and increase of the lanes on the existing ones in the proposed network.

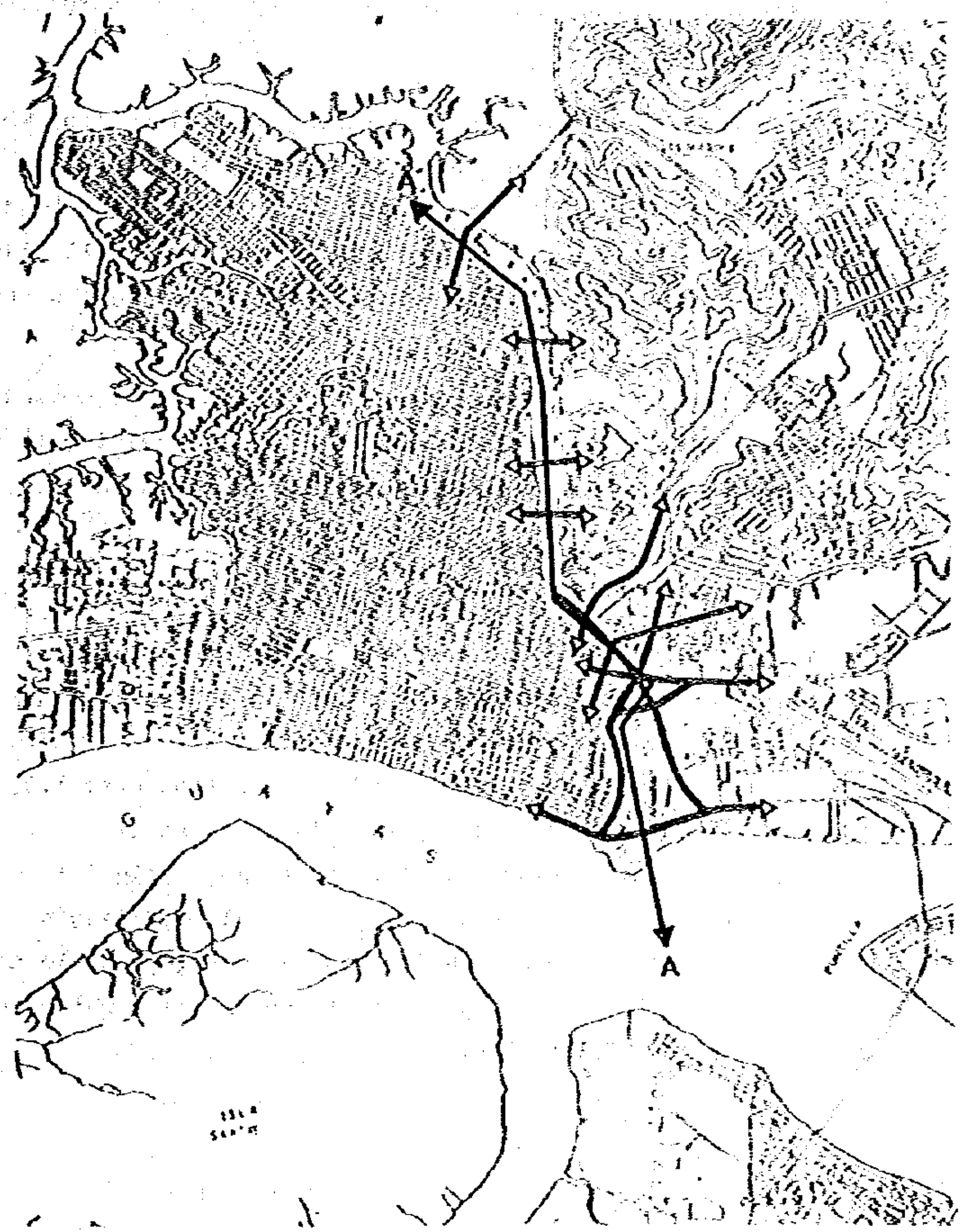


Figure 5-2.3 LOCATION MAP OF SCREEN LINE A

b. The total traffic volume crossing Rio Guayas is projected to reach 170,000 car trips a day, of which 65% tends to concentrate to Puente de la Unidad Nacional. It is recommended that some of its volume should be distributed to two new bridges in the north or south by special policy like raising of the toll on the existing bridge, since this policy contributes to not only the alleviation of the congestion both in Durán and CBD, but also promotion of the development in the northern area which is targetted in this master plan.

c. The traffic volume along the north-south direction, which is the basic axis in the existing urban structure, is projected getting bigger toward 2000. Three ring roads, two of which are allocated in the urban area, will play an important role in distributing and bypassing the traffic along the axis.

Judging from the above points and so on, the proposed road network in the master plan proves to be very promising to cope effectively with the foreseeable traffic problems in 2000.

2) Congestion Degree on Roads

Figure 5-2.4 shows the distribution of traffic congestion in 2000 in the basic case and in the master plan. The curve in the Figure combines the points in shares of section length corresponding to each congestion level to the whole road length. Total road length under congestion rate 1.0, which allows to run without any trouble in a practical mean, is 40% of the whole network in the basic case while 80% in the master plan. On the contrary, the total road length beyond congestion rate 2.0, which mean almost impossible to run, is 30% of the whole network in the basic case while less than 10% in the master plan.

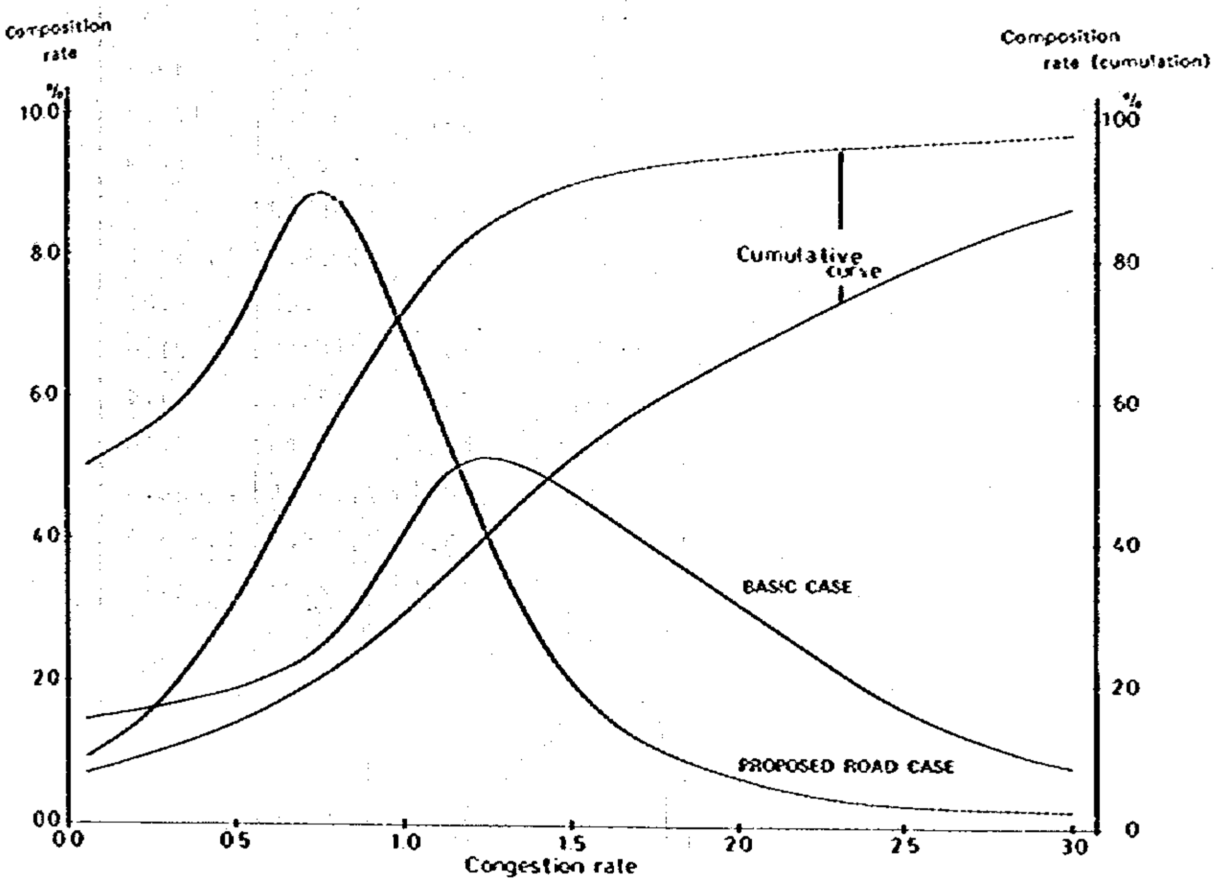


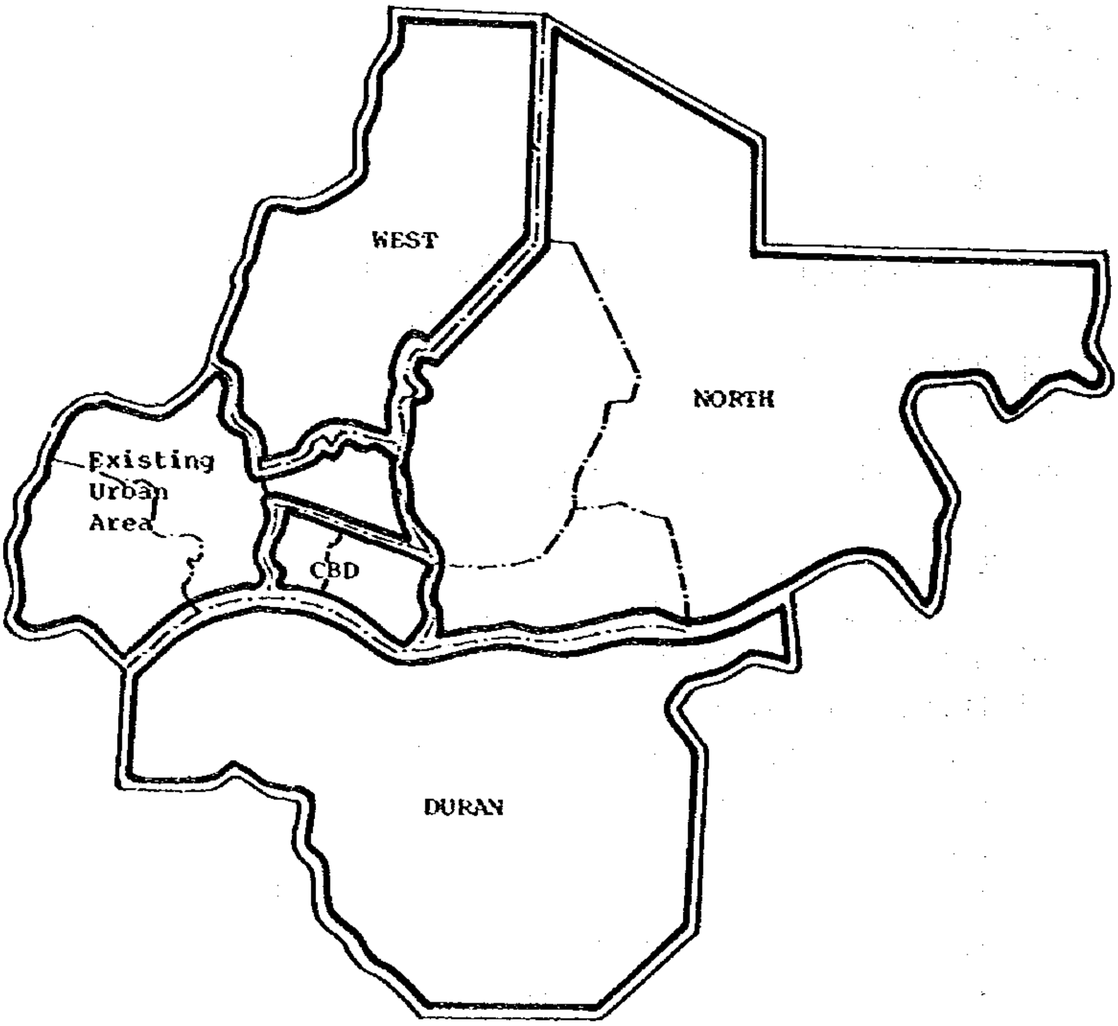
Figure 5-2.4 DISTRIBUTION OF CONGESTION RATE

3) Traffic Demand and Road Supply in Each Zone

Table 5-2.1 compares the increments of traffic volume and road supply both in length and transport capacity in 5 zones shown under the Table. The average increments in the whole Study Area are about 2 times of the present in trips and 3.5 times in car·kilometers, however, increases of the trip generation and car·kilometers are predominant in the west, east area and Durán, while rather low in the existing urbanized area including CBD. Opposing to the traffic increase, the proposed network makes the road supply both in length and capacity in proportion to the increments in each zone. The road supply level itself does not amount to the increments of traffic, but the balance between the demand and supply in each zone is kept in rather good conditions in general.

Table 5-2.1 COMPARISON OF ROAD NETWORK DENSITY

AREA		CBD	Existing Urban Area	WEST	NORTH	DURAN
TRIP GENERATION (Car) (x 1000 Trips)	1982	792.4	260.0	33.3	354.6	30.7
	2000	1,089.6	470.0	247.2	918.9	177.7
	2000/1982	1.38	1.81	7.42	2.59	5.79
VEHICLE KILOMETER (x 1000 Vehicles·kilometers)	1982	1,385.2	569.6	135.0	1,367.8	159.7
	2000	1,878.6	1,801.2	861.9	6,019.1	1,533.2
	2000/1982	1.36	3.17	6.38	4.40	9.60
TOTAL LINK LENGTH PROVIDED (km)	1982	45.9	39.0	17.5	59.0	21.6
	2000	51.3	62.6	28.3	134.7	57.4
	2000/1982	1.12	1.61	1.62	2.28	2.66
TOTAL ROAD CAPACITY (x 1000 Vehicles·kilometers)	1982	1,696.8	1,422.8	560.4	2,790.5	628.0
	2000	1,914.4	2,469.8	1,089.6	6,398.5	2,383.2
	2000/1982	1.13	1.74	1.94	2.29	3.79



From the above viewpoint, it is concluded that the road network proposed will be able to meet the needs of the demand and changes in future.

4) Efficiency of Road Usage

Table 5-2.2 summarizes traffic indicators on running conditions in both the basic case and the master plan. The total car·running hours in the Study Area increase steeply in 2000 consequently upon more than three times of the existing car·kilometers. The total car·running hours on the basic case is forecast to amount to about 6 times of the existing ones, while those on the master plan will be confined to 3.4 times which is almost same increase rate as shown in running kilometers. Such a condition is assumed to be resulted from considarable decrease of the running speed on the basic case, and on the contrary, about a half of total running hours for the same demand is saved on the proposed network and considerable time benefits are also produced. Likewise, the proposed network will asure the existing level of running speed in 2000 in general, and produce about 700 million sucres a day of running cost savings in comparison with the basic case.

Based on these indicators, the road usage in the master plan is concluded to be very efficient.

Table 5-2.2 COMPARISON OF TRAFFIC INDICATORS

	In 1982	In 2000	
		Basic Case	Master Plan
Vehicle-kilometers (x 1000 Veh·kms)	3,617.9	13,127.4	12,176.1
Vehicle-Hours (x 1000 Veh·Hours)	140.2	805.8	473.2
Travel Speed (kms/hr)	25.8	16.3	25.7
Estimated Running Cost (x 1000 Sucres)	10,562.1	43,418.5	36,029.7

NOTE) Excluding the data for the external part of zone 9.

5-2.2 Evaluation of MRT Introduction

This master plan premises the introduction of MRT. The preliminary evaluation of the whole plan composed of the road network and MRT routes in economic aspect is examined by benefit/cost analysis later on. This part examines the necessity and effectiveness of MRT itself, separately from the road network, by checking possibility of the substitute by bus transport for MRT.

The following method is applied for the verification:

(1) The screen line A (see Figure 5-2.3) is used for the examination.

(2) Influences on the road traffic in case that all the MRT demand on North-South route which crosses the line A could divert to buses, are examined. The number of substitute buses for MRT is calculated on the assumption as under:

Bus capacity	40 passengers/bus
Average riding rate	125% of capacity
Number of passengers	50/bus

Table 5-2.3 shows the results of the examinaiton. Based on the above assumptions, about 20,500 bus operation a day is necessary on this screen. In case without MRT and bus exclusive lanes, such numerous bus fleets, however, make not only bus operation but also other vehicles' running difficult and thus transport efficiency will drop steeply. The road traffic congestion rate except for bus transport would rise further to 1.41 at average congestion rate even if bus exclusive lanes were provided on each road in order to avoid the above mentioned situation and maintain smooth bus operation.

Judging from the foreseeable confusion in the above, there is scarcely possibility to substitute by bus transport, and the introduction of MRT is an indispensable condition to meet the transport demand in 2,000.

Table 5-2.3 POSSIBILITY OF BUS SUBSTITUTION FOR MRT

	With MRT	Without MRT
		With Bus Exclusive Lanes **
Car + Taxi (Veh./day)	550,427	550,427
Bus (Veh./day)	5,117	Running on the exclusive lane
Road Traffic Volume Total (Veh./day)	555,544	550,427
Capacity for road traffic (Veh./day) *	500,000	390,000
Average Congestion RAte	1.11	1.41
MRT Link Volume (Persons/day)	772,000	0

Note: * Screen A consists of 11 road sections or 50 lanes.

** 11 lanes of total lanes are necessary for bus exclusive lanes.

b. Effectiveness of MRT introduction

Introduction of MRT brings about reduction of transport hours and produces benefits derived from time saving. If we calculate the total time saving of MRT passengers by the number of MRT passengers x saved time (time required by bus - MRT), then it amounts to 236,400 hours a day, corresponding to 12 minutes saving/passenger.

In addition, since MRT is operated on a exclusive track way independent of other transport modes it assures the scheduled operation and improvement of transport services to the users, and will be able to recover the trust to the public transport system and also to improve road traffic condition.

5-2.3 Mid-term Evaluation of Long-term Transportation Plan in 1990

Implementation of the long-term transportation plan at mid-term stage is also evaluated based on the forecast result in 1990.

The traffic volume in 1990 is estimated by ammending the traffic volume in 2000, taking into account of the socio economic framework in 1990. For the purpose of it the trip modal ratio was interpolated between the present modal split ratio and future one.

The traffic network is composed of road links and MRT links which will be constructed at that stage (1990), reffering to the implementation program that is discussed later, and is shown in Figure 5-2.5.

According to the traffic assignment result to the road network, as a whole the traffic congestion rate seems to settle down between that of 2000 and present as seen in Figure 5-2.6.

It is considered that the traffic condition in 1990 is kept rather better than in 2000 because of the sufficient transport capacity for its demand.

According to the areal distribution of congestion rate shown in Figure 5-2.7, the critical sections of roads with more than 2.0 of the traffic congestion rate are limited to very few parts and most of the major roads do not suffer from difficulty.

As mentioned above, since no fundamental problems can be found through the examination in the mid-term stage in 1990 of the master plan, it is considered that the interium stage meet its demand adequately as a whole.

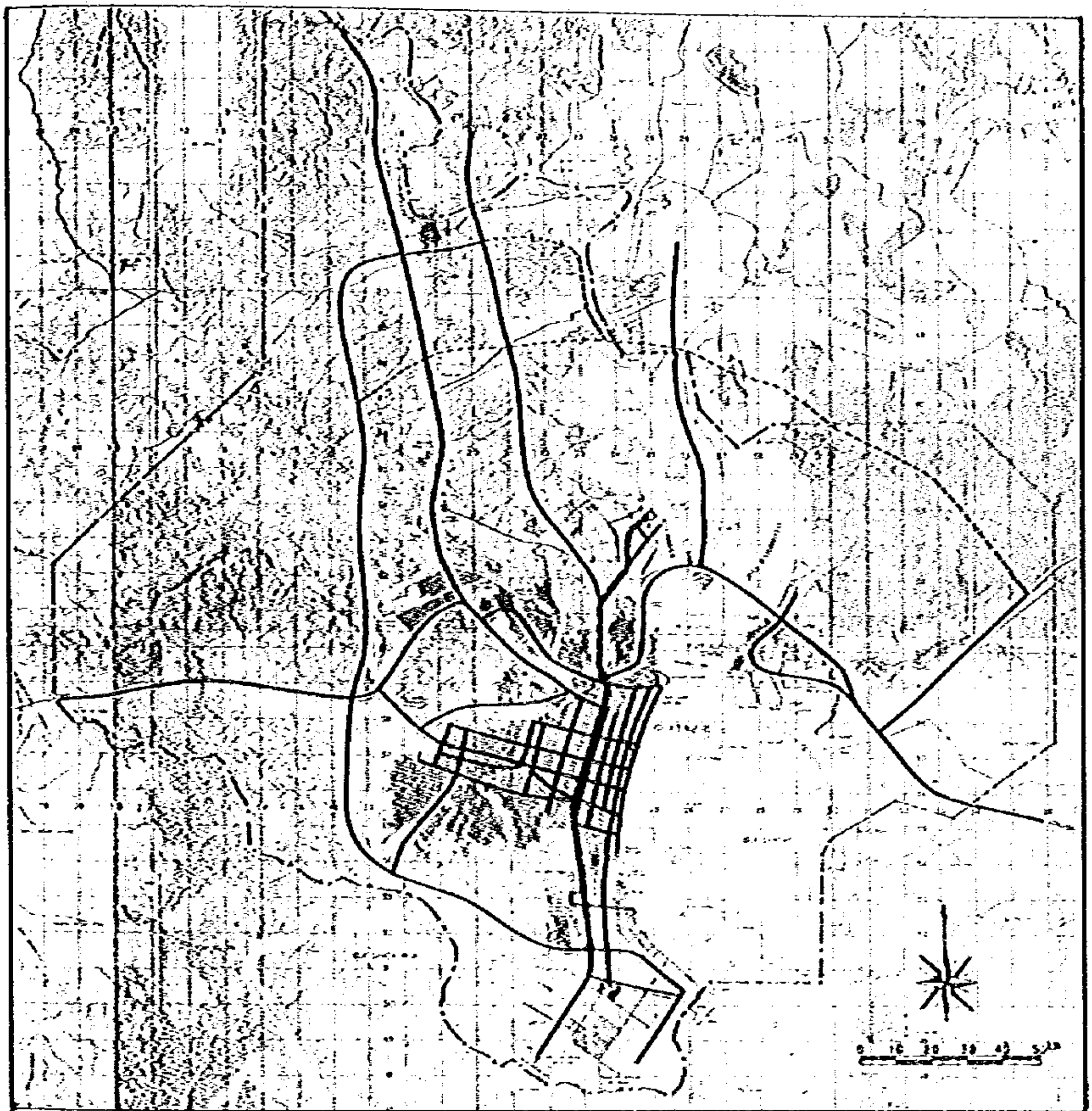


Figure 5-2.5 NETWORK IN 1990 FOR MID TERM EVALUATION

——— Existing road
- - - - Construction
▬▬▬ MRT route

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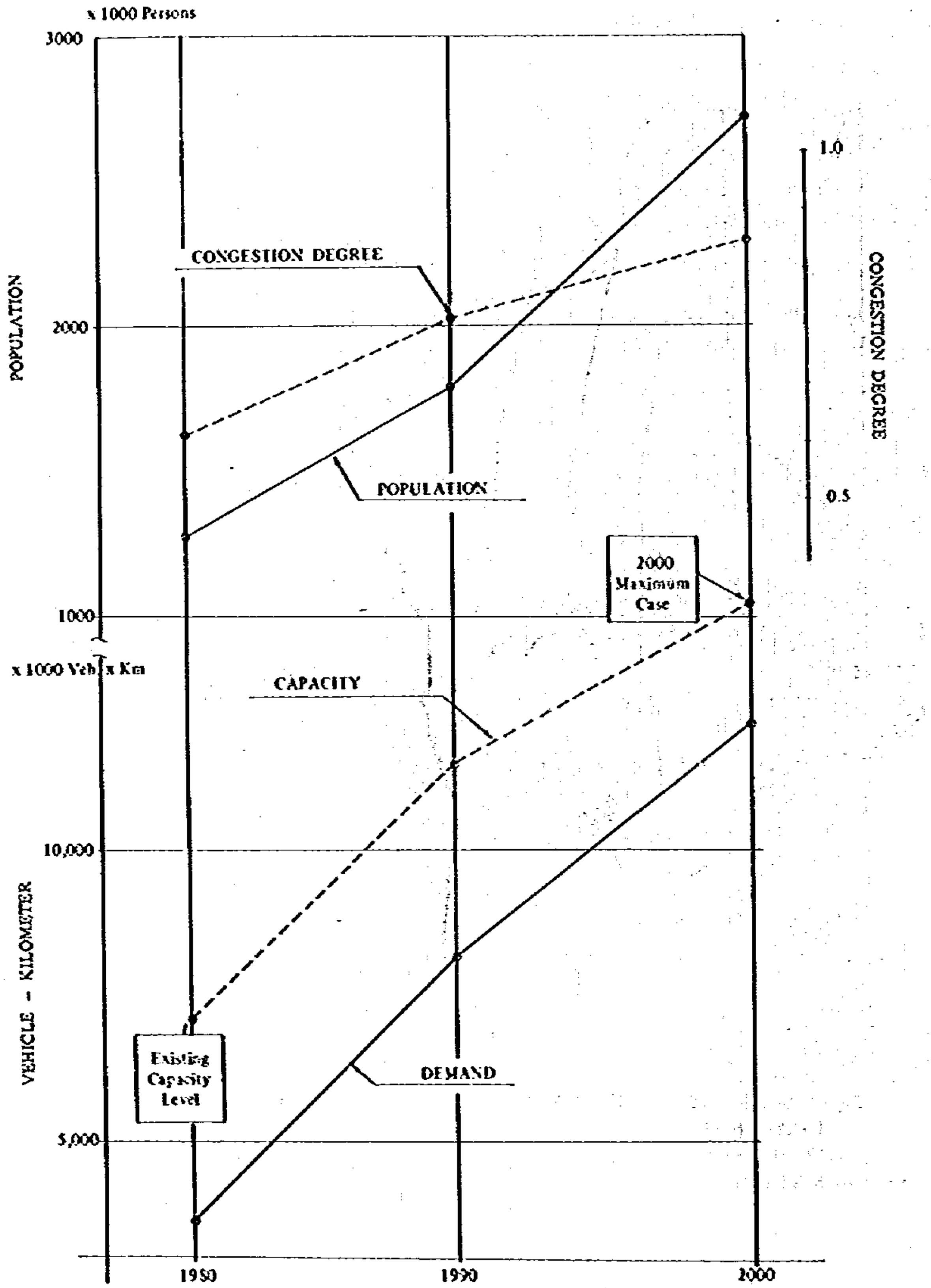


Figure 5-2.6 TRAFFIC CONDITION IN 1990

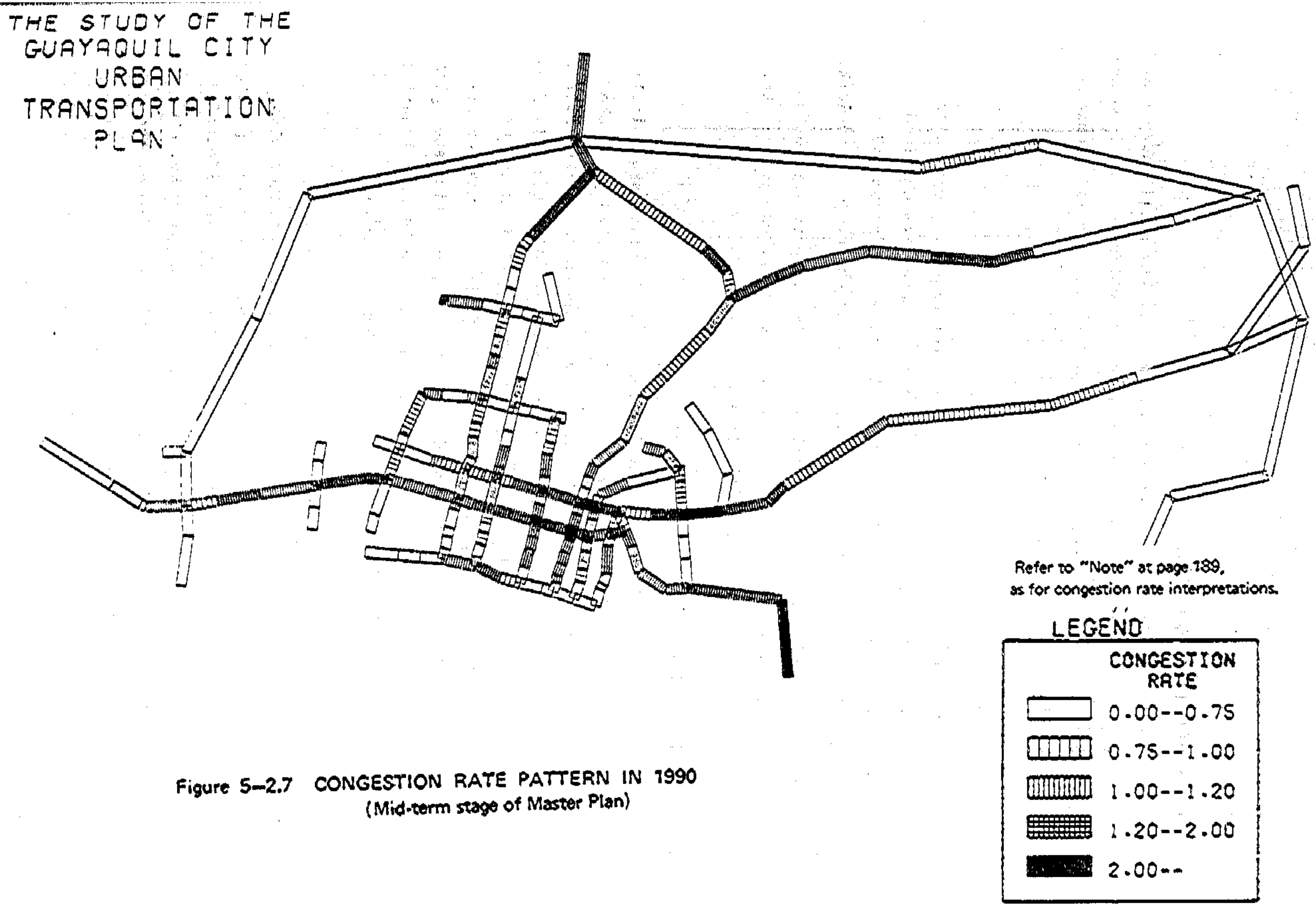


Figure 5–2.7 CONGESTION RATE PATTERN IN 1990
(Mid-term stage of Master Plan)

5-3 COST BENEFIT EVALUATION

The purpose of this section is to evaluate the preliminary feasibility in economic aspect of the master plan which was examined and proved to be very promising on solving foreseeable traffic problems both in 1990 and the target year 2000.

5-3.1 Evaluation Procedure

In this economic evaluation, costs for executing each case shown in Table 5-3.1 are estimated, and then benefits obtained from each case are calculated as the difference in travel cost between the basic case without any action and the proposed network.

In calculating the abovementioned costs, opportunity costs are used, but the transfer accounts such as taxes, subsidies, etc. are excluded from the cost calculation.

1) Indicators of Economic Analysis

In the following analysis, costs and benefits are calculated by simplified methods, not for the period throughout the project life but for each single year. As an annualized factor of the capital cost, 12 percent per annum is used and this factor is the present opportunity cost of capital in Guayaquil obtained through discussion with the officials of the commercial banks. It is conceivable that if the proposed master plan produces positive net benefits, the difference between benefits and costs, the plan shall be feasible economically.

2) Cases Tested

Main objective is to evaluate the proposed master plan, consisting of the road network and MRT routes plan in a package deal. A few cases, however, are tested for problem identification, examination of policy options, or a basic case, etc. shown in Table 5-3.1. Mid-term examination in 1990 of the master plan is also tested.

Table 5-3.1 CASES TESTED

A. For master plan

Cases	Policy options		Road network premised		Proposed master plan	
	Without parking control	With parking control	Existing network	On-going project roads	Proposed road network	Proposed MRT routes plan
Test-1	●		●			
Test-2 (Basic case)		●		●		
Master Plan		●			●	●

B. For mid-term examination in 1990 of master plan

Cases	Policy options		Road network premised	Proposed mid-term executing plan
	Without parking control	With parking control	Existing road network	A part of on-going, proposed road & MRT
Test-1 Do nothing (Basic case)	●		●	
Case-1 Mid-term stage *		●	●	●

* : Examination of the mid-term stage of the master plan

3) Measurements of Benefits

a. Characteristics of Benefits in This Study

It is generally defined that the benefits generating from road network and MRT plan should be equal to the difference between socio-economical costs in case of implementing these transport plans and the same costs without implementing the same ones, and these benefits should be brought to the consumers, producers and societies. The most direct and measurable benefits accruing to the consumers are shortening travel time and saving travel costs. It would be also possible that the consumers can enjoy the benefits through lowered fares and improved service quality. On the one hand, if a transport plan should need more resources than another transport plan does for producing these benefits, it means that the former produces disbenefits or cost.

In addition to the abovementioned benefits brought to the consumers or producers, there are such impacts on communities as decrease in traffic accidents, development in the influencial area where these plans are implemented, expansion of marketing spheres, etc. However, these impacts are handled separately in overall evaluation as qualitative matters. In the followings, the benefits limited to the consumers and producers are calculated respectively.

b. Categories of Benefits

The benefits generating from executing each case and the receivers of the benefits are as follows:

b-1 In Case of Only Road Network Being Improved

In this case, not only those who directly utilize the improved or newly constructed roads (consumers and bus operators), but also those who make use of the existing roads account for the benefit receivers. The former obtain the benefits produced from directly making use of the improved or newly constructed roads, while the latter obtain the benefits from the running condition of cars on the existing roads being alleviated.

b-2 In Case of Road Network and MRT Being Constructed

(1) Benefits by Diverted Traffic

The benefits of the diverted traffic to MRT are produced from reduction of travel time, and saving of running cost such as fuel, tyre, maintenance cost and depreciation, etc. which might be consumed in case of without MRT.

(2) Benefits by Non-diverted Traffic

The benefits of the non-diverted traffic to MRT are also produced from reduction of travel time and saving of running cost since the transport conditions are improved through decrease of traffic diverted to MRT.

c. Measurements of Benefits

The benefits are calculated with the following expressions:

c-1 Time Benefits

$$TB = \sum_{ij} (P^1ij \times t^1ij - P^2ij \times t^2ij) \times V$$

TB	;	Time benefits
P^1ij	;	Traffic volume from zone i to j in basic case
t^1ij	;	Travel time from zone i to j in basic case
P^2ij	;	Traffic volume from zone i to j in alternative plan
t^2ij	;	Travel time from zone i to j in alternative plan
V	;	Houry time value

c-2 Running Cost Savings

$$RB = \sum_{ij} (P^1ij \times L^1ij - P^2ij \times L^2ij) \times Rc_1$$

$$+ \sum_{ij} (P^1ij \times t^1ij - P^2ij \times t^2ij) \times Rc_2$$

RB	;	Running cost savings
L^1ij	;	Running distance in km between zone i and j in basic case
L^2ij	;	Running distance in km between zone i and j in alternative plan
Rc_1	;	Running cost per km
Rc_2	;	Running cost per hour

The above calculation is carried out simultaneously when O-D tables between zones of cars and public transport passengers (buses and MRT) are assigned to road networks and MRT routes, respectively.

5-3.2 Estimate of Traffic Cost

Traffic costs in this Study consist of two kinds of costs; operating costs of vehicles and time cost related to the time value of private car drivers (including fellow passengers) and public transport passengers (buses and MRT).

1) Operating Costs of Vehicles

Vehicle operating costs are composed mainly of running and fixed costs. Running costs are directly related to the use of vehicles and fixed costs are related to the ownership and are independent of the degree of vehicle usage.

Running costs are divided into the following:

a. Fuel costs
b. Oil costs
c. Tyre costs
d. Maintenance and repair costs
e. Depreciation costs

Fixed costs are divided into the following:

a. Crew costs
b. Time-related depreciation
c. Interest
d. Administration and overhead

In calculating the above costs, the following average values of the sampling data by each vehicle type obtained from C.T.G. were used. The prices are those in September 1982.

a. Running Costs (Kilometer-related costs)

a-1 Fuel cost
The fuel cost is calculated based on fuel consumption per kilometer, the running speed and fuel price per litre.

a-2 Oil cost
The oil cost is calculated on the basis of oil consumption per kilometer and oil price.

a-3 Tyre cost
The tyre cost is calculated based on the tyre life span, annual running kilometer and set prices of tyres.

a-4 Maintenance and repair cost
The maintenance and repair costs are divided into the cost of labor hours and the cost of spare parts.

a-5 Depreciation cost

In this Study, 50% of depreciation cost is apportioned to running costs caused by abrasion and damage in the running period, while the rest 50% is apportioned to fixed costs in a sense of decrease in the value of vehicles. The salvage value of 15% is applied to all types of vehicles.

b. Fixed Costs

b-1 Crew cost

The crew costs are calculated separately for taxi, bus, and truck drivers, cargo loading and unloading laborers for trucks.

b-2 Time-related depreciation

The time-related depreciation is given by the remains of the running distance-related depreciation. Then the depreciation cost per hour is calculated by the estimated vehicle life and annual running hours.

b-3 Interest

Since the opportunity cost of capital is estimated at 12 percent per annum, the annual interest amount payable is assumed to be 12 percent on one half of the total investment over the life year.

b-4 Administration and overhead for business vehicles

Since the data concerning these costs are not clarified, it is assumed that these costs should become 20 percent of the total sum of fuel cost, oil cost, tyre cost, maintenance and repair costs, depreciation and interest.

c. Traffic Costs Estimated

The results of calculation based on the above assumption are as shown in Table 5-3.2 and 5-3.3 In addition, the relationship between operating costs and speed is shown in Figure 5-3.1.

Table 5-3.2 GENERAL CHARACTERISTICS OF ECONOMIC COSTS BY VEHICLE TYPE

in 1982 prices

Vehicle type	Private Vehicles		Passenger Vehicles			Commercial Vehicles	
	Motorcycle	Car	Taxi	Mini-bus	Bus	Light Truck less than 2 tons	Truck more than 2 tons
1. Average size	100 cc	Family car with 1,600 cc	1,600 cc	20 passengers	40 passengers	1 ton-truck	4 ton-truck
2. Power unit	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline
3. Vehicle cost excluding tax (1,000 sucres)	48	300	250	620	1,300	230	880
4. Assumed life years for paved road	7	9	7	10	10	10	9
5. Annual running distance (km), in urban area for bus	22,400	23,000	61,000	55,000	55,000	35,000	92,000
6. Annual running time (hours)	2,800	2,500	4,400	3,900	3,900	3,100	3,400
7. Fuel cost less tax (s./liter)	9.3 s./lit. for Gasoline (4.0 s./lit. for Diesel)						
8. Oil cost less tax (s./liter)	120 s./lit.						
9. Fuel consumption (lit./km)	0.037	0.12	0.13	0.19	0.33	0.14	0.27
10. Oil consumption (lit./km)	0.004	0.0012	0.0014	0.0018	0.0025	0.0014	0.0030
11. Fuel cost (s./km), (7 x 9)	0.34	1.12	1.21	1.77	3.07	1.30	2.51
12. Oil cost (s./km), (8 x 10)	0.05	0.14	0.17	0.22	0.30	0.17	0.36
13. Tires set price less tax (s.)	1,700	5,200	5,200	9,600	24,000	6,800	24,000
14. Tire life time for paved road (month)	30	22	9	12	12	18	9
15. Tire cost (s./km)	0.03	0.12	0.11	0.17	0.44	0.13	0.35
16. Labor hours for maintenance (hour/year)	25	43	105	180	250	55	370
17. Labor cost for maintenance (s./year), 64 s./h	1,600	2,752	6,720	11,520	16,000	3,520	23,680
18. Maintenance & spare parts cost (s./year)	1,200	9,000	25,000	38,000	51,000	13,500	71,500
19. Maintenance cost (s./km), (17+18)/5	0.13	0.51	0.52	0.99	1.34	0.49	1.04
20. Crew wages & others (s./month)	-	-	12,000	18,000	25,000	12,000	30,000
21. Crew wages & others cost (s./h)	-	-	32.73	55.38	76.92	32.73	105.88
22. Depreciation	Depreciated on a straight-line basis over assumed life year except salvage value						
23. Salvage value	15% of vehicle cost						
24. Annual interest	Annual amount of interest payable is assumed to be half of (interest rate 12% x vehicle cost) over life year						
25. Annual depreciation (s./year)	5,800	28,300	30,400	52,700	110,500	19,600	83,100
26. Annual interest (s./year)	2,880	18,000	15,000	37,200	78,000	13,800	52,800
27. Kilometerage-related depreciation (s./km), 50% of 25	0.13	0.62	0.25	0.48	1.00	0.28	0.45
28. Time-related depreciation (s./hour)	1.04	5.66	3.45	6.76	14.17	3.16	12.22
29. Interest cost (s./hour)	1.03	7.20	3.41	9.54	20.00	4.45	15.53
30. Administration & overhead							
a. annual cost (s./year)	-	-	33,000	40,800	75,100	21,600	87,900
b. hourly cost (s./hour)	-	-	7.50	10.46	19.26	6.97	25.85

Sources: No. 3 – 6, 9, 10, 13, 14, 16, 18 obtained from the sampling data in C.T.G.

Note: As for the power unit, some buses and trucks are equipped with diesel, but gasoline was applied to all vehicles since its spread is still very in a small portion.

Table 5-3.3 VEHICLE OPERATING COST

(Sucres in 1982 prices)

Vehicle type	Private Vehicles		Passenger Vehicles			Commercial Vehicles	
	Motorcycle	Car	Taxi	Mini-bus	Bus	Light Truck less than 2 tons	Truck more than 2 tons
Kilometer related cost (s./km)	0.68	2.51	2.26	3.63	6.15	2.37	4.71
Fuel	0.34	1.12	1.21	1.77	3.07	1.30	2.51
Oil	0.05	0.14	0.17	0.22	0.30	0.17	0.36
Tire	0.03	0.12	0.11	0.17	0.44	0.13	0.35
Maintenance	0.13	0.51	0.52	0.99	1.34	0.49	1.04
Depreciation	0.13	0.62	0.25	0.48	1.00	0.28	0.45
Non-Kilometer related Cost (s./h)	2.07	16.46	47.09	82.14	130.35	47.31	159.48
Crew	-	-	32.73	55.38	76.92	32.73	105.88
Depreciation	1.04	5.66	3.45	6.76	14.17	3.16	12.22
Interest	1.03	7.20	3.41	9.54	20.00	4.45	15.53
Overhead	-	-	7.50	10.46	19.26	6.97	25.85

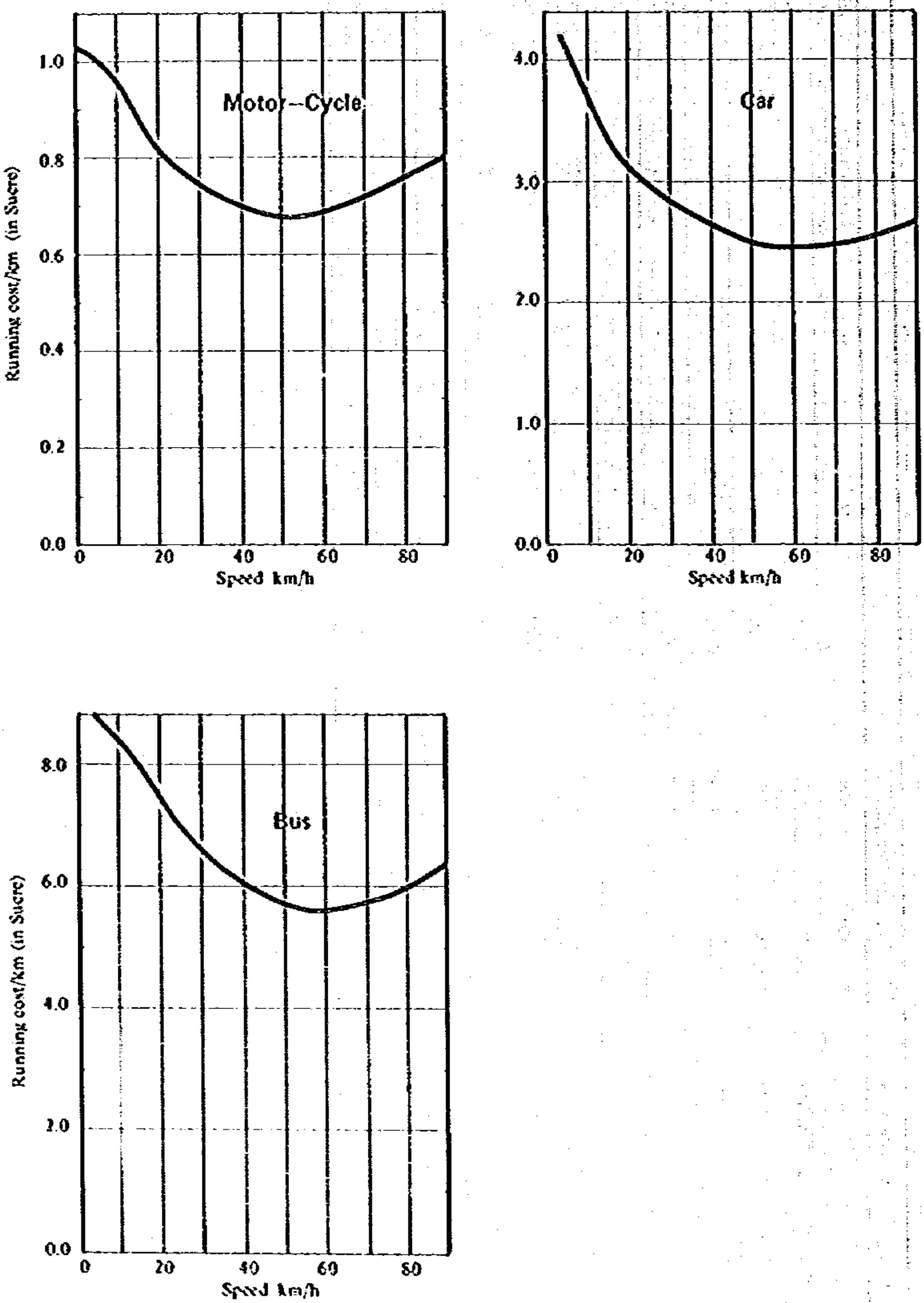


Figure 5-3.1 RELATION BETWEEN RUNNING SPEED AND OPERATING COSTS (Sucres in 1982 prices)

2) Value of Time

In selecting transport modes, there is a close relationship between travel time and travel costs for trip makers. On the one hand, in converting the value of time savings into a monetary value, it is a quite significant variable for calculating the benefits of each case to evaluate how much the value of a time is.

In this Study, trips on employers' business are valued at the full value of both kinds of average wages paid to car owners and non-car owners, trips on "to and from work" are valued at 50% of the above respectively, while all other trips at non-value regardless of trip purposes or modes as under.

Value of time by trip purpose

1.	Business trip	100% of hourly wages
2.	To and from work	50% of hourly wages
3.	To and from school	Non value
4.	Others	Non value

Average wages are derived from dividing the family income by family size, EAP (Economically Active Population) rate and monthly working hours, using the data in Table 3-2.10. Hourly wages are thus estimated to be 102 sucres for car owners and 56 sucres for non-car owners in 1982 prices, being applied to each vehicle type as given in Table 5-3.4.

Table 5-3.4 HOURLY TIME VALUE

Time value by trip purpose — Sucres/hour, person in 1982 prices

Trip purpose	Car owners	Non-owners	Trip purpose rate in 2000
Business	102 Sucres	56 Sucres	26.8%
To and from work	51	28	29.6
To and from school	non	non	11.2
Others	non	non	32.4
Weighted average	42.4	23.3	100.0

(To be continued next page)

Houry time value by vehicle type

	Average Occupancy	Sucres/hour	Note
Car	1.8 person/car	61/car	42.4 for driver + 0.8 x 23.3 for fellow passenger
Taxis	1.4	33/car	1.4 x 23.3 for passenger
Buses		23/passenger	

5-3.3 Cost Estimates of Cases Tested

Table 5-3.5 summarises the cost estimates in 1982 prices of the proposed master plan and other cases tested. Detailed cost estimates are already described in 4-1.2 and 4-1.3.

Table 5-3.5 COST ESTIMATES OF CASES TESTED

(1) Cost by each project

Million sucres in 1982 prices

Project \ Year	2000	1990	Remarks
Road network			
On-going project roads	6,990	3,940	This cost was estimated for reference since On-going projects are not evaluated.
Proposed network	20,900	6,730	Additional cost to the On-going projects
Sub total	27,890	10,670	
MRT routes plan			
A. Urban railway	28,250	8,120	These systems are alternative.
B. LRT	29,520	7,910	
C. Monorail	38,930	9,190	
D. Rubber tyre railway	43,410	10,210	
E. Subway	62,760	25,330	

Note: MRT-A: Urban railway
-B: LRT (Light rail transit)
-C: Monorail
-D: Rubber tyre type railway
-E: Subway

1 US Dollar = 50 sucres (average in 1982)

(2) Total project cost by cases

Million sucres in 1982 prices

Cases			On-going project road	Proposed master plan: Proposed road net-work	Proposed master plan: MRT routes plan	Total
For master plan (2000)	Basic case		(6,990)	-	-	(6,990)
	Master plan	MRT-A	(6,990)	20,900	28,250	49,150
		-B	(6,990)	20,900	29,520	50,420
		-C	(6,990)	20,900	38,930	59,830
		-D	(6,990)	20,900	43,410	64,310
		-E	(6,990)	20,900	62,760	83,660
For mid-stage of master plan (1990)	Basic case		-	-	-	-
	Middle term executing plan	MRT-A	3,940	6,730	8,120	18,790
		-B	3,940	6,730	7,910	18,580
		-C	3,940	6,730	9,190	19,860
		-D	3,940	6,730	10,210	20,880
		-E	3,940	6,730	25,330	36,000

Note: Figures in ( ) are excluded in total cost since On-going project roads are premised to be executed before the Master plan.

5-3.4 Benefit Estimates of Cases Tested

Based on the measurements of benefits described in 5-3.1, the results of the estimates are shown in Table 5-3.6.

Table 5-3.6 ANNUAL BENEFITS OF CASES TESTED

(1982 prices)

	Mid-term examination in 1990	Master plan in 2000	
		Basic case	Master plan
1. Daily vehicle kilometer (1,000 km)	8,172	14,990	14,393
2. Daily vehicle hours (1,000 hrs)	319.4	641.3	501.8
3. Vehicle operating cost saving (1,000 sucres/day)	5,460	13,174	24,533
4. Time saving for vehicle users (1,000 sucres/day)	4,478	8,631	16,630
5. Time saving for MRT passengers (1,000 sucres/day)	1,511	-	5,288
6. Total benefit (3∿5) (1,000 sucres/day)	11,449	21,805	46,451
7. Benefit increment (1,000 sucres/day)	11,449	-	24,646
8. Annual benefit increment (Million sucres/year)	4,179	-	8,996

Note: Benefit in 1990 corresponds to the benefit increment since it shows the remainder in its basic case.

5-3.5 Consideration on Results of Economic Examination

The economic indicators based on the results of benefit and cost estimation are as shown in Table 5-3.7.

Since the proposed master plan comprises the road network plan and MRT plan, and there are 5 alternatives as to the MRT systems, evaluation varies depending on which one of these 5 systems is adopted. However, the benefit of any alternative plan combined with one of the 4 systems except E: Subway is over its cost, and particularly, most advantageous in case of A: Urban railway being adopted.

Table 5-3.7 ECONOMIC INDICATORS

(1) Master plan in 2000

Million sucres in 1982 prices

		Total cost for execution (1)	Annualized cost at 12% (2)	Benefit in 2000 (3)	Net benefit in 2000 (3)-(2)	Simplified B/C ratio (3)/(2)	Ranking
Master plan	MRT-A	49,150	5,898	8,996	3,098	1.53	A
	-B	50,420	6,050	8,996	2,946	1.49	A
	-C	59,830	7,180	8,996	1,816	1.25	B
	-D	64,310	7,717	8,996	1,279	1.17	B
	-E	83,660	10,039	8,996	-1,043	0.90	C

(2) Mid-term examination in 1990 of master plan

		Total cost for execution (1)	Annualized cost at 12% (2)	Benefit in 1990 (3)	Net benefit in 1990 (3)-(2)	Simplified B/C ratio (3)/(2)	Ranking
Mid-term examination	MRT-A	18,790	2,255	4,179	1,924	1.85	A
	-B	18,580	2,230	4,179	1,949	1.87	A
	-C	19,860	2,383	4,179	1,796	1.75	B
	-D	20,880	2,506	4,179	1,673	1.67	B
	-E	36,000	4,320	4,179	-141	0.96	C

Although it is generally difficult to expect much benefit over its cost from a development plan necessary for a lot of investment in advance such as transportation projects, indicators in Table 5-3.7 show the better results and suggest economic feasibility of the proposed master plan.

As to the MRT systems, 2 systems with steel tyres (A: Urban railway and B: LRT), 2 systems with rubber tyres (C: Monorail and D: Rubber tyre type railway) and 1 subway (E) have been compared. As a result, it has been found that there is almost no difference between A and B, but C and D become lower than A and B with the same sequence and E is lowest and economically difficult to be executed. Accordingly, the feasible systems would be limited to A,B,C or D. Although the difference in indicators among these 4 systems is respectively slight in terms of the master plan, this small difference could sometimes affect to a great extent on fare and income in operating the project in regard with the financial analysis of the MRT project. It would be recommendable, therefore, to select A: Urban railway which is most favorable among these alternatives.

5-3.6 Sensitivity Analysis

However detailed estimate may be applied, uncertainty cannot entirely be removed off from project evaluation and, therefore, it is important to make sure to what extent the error of the estimated values affects on the final results obtained by accumulating these estimated values.

The parameters to affect the economic evaluation indicators finally become benefit amount and project cost and, since the degree of increase or decrease of these benefit and cost is directly related to the increase and decrease of the indicators, the change in the former can be clearly seen by the change in the latter. (For example, 10% increase in cost lowers the indicator value by 10%) Consideration will be made hereunder, therefore, as to the case of the change in population which is basis of the traffic forecast.

The future population in the Study Area was derived from the second alternative (recommended by CAD) among 3 alternative projections by CAD, but the third alternative in which the decrease in the estimated fertility is assumed to go on at a rate twice as high as that of the second plan was examined hereunder.

The population allocated to each zone in the third alternative was assumed to be same as that in the second alternative up to 1990, and the increment during 1990 - 2000 in the second was assumed to decrease in the third. The results of comparison of these 2 plans are shown in Table 5-3.8.

From the above table, the decrease rate of population is 7.15%, indicating that this causes decrease both in benefits and simplified B/C ratio by 9.36% respectively. In other words, the increase or decrease of 1% in the estimated population causes to increase or decrease these indicators by 1.31% (the net benefits decrease by 26.5% since the costs of both cases are same). However, even for the decrease of the population in the third as shown in the above, this proposed master plan is still economically feasible and, even when the change in the other premises overlaps upon the abovementioned assumption, it would be possible to consider that there should be the room more or less.

Table 5-3.8 RESULT OF SENSITIVITY TESTING (2000)

(1) General dimensions in the Study Area

	Master plan (1)	Test case (2)	(2)/(1) Rate (%)
Population (person)	2,726,000 (CAD Hypothesis-II)	2,531,000 (CAD Hypothesis-III)	-7.15
Traffic volume			
Vehicles (car)	2,590,200	2,404,900	-7.15
Bus, MRT (person)	2,209,500	2,051,500	-7.15
Total	4,799,500	4,456,400	-7.15

(2) Sensitivity analysis

	Master plan		Test case		D/C, D/B Rate (%)
	A. Basic case	B Master plan	C. Basic case	D. Master plan	
(1) Vehicle kilometer (10^3 Km/day)	14,990	14,393	13,600	13,024	- 9.51
(2) Vehicle hour (10^3 hrs/day)	662.8	501.8	583.7	438.5	-12.6
(3) Average speed (Km/h)	22.6	28.7	23.3	29.7	+ 3.48
(4) Vehicle operating cost saving (10^3 sucres/day)	-	11,359	-	10,214	-10.1
(5) Time saving for vehicle users (10^3 sucres/day)	-	7,999	-	7,216	- 9.79
(6) Time saving for MRT passengers (")	-	5,288	-	4,910	- 7.15
(7) Total benefit (10^6 sucres/day)	-	24,646	-	22,340	- 9.36
(8) Annual benefit (10^6 sucres/year)	-	8,936	-	8,154	- 9.36
(9) Total project cost (10^6 sucres)	-	49,150	-	49,150	-
10) Annualized project cost (10^6 sucres)	-	5,818	-	5,898	-
11) Annual net benefit (8)-(10) (10^6 sucres)	-	3,068	-	2,256	-26.5
12) Simplified B/C ratio (8)/(10)	-	1.53	-	1.38	- 9.36

Note: 1). Basic case executes On-going project roads only.
2). The cost of the Master plan is calculated by Urban railway.

5-4 FINANCIAL ANALYSIS OF MRT PROJECTS

The purpose of this section is to evaluate the preliminary financial aspect of the MRT projects examined economically in the former section 5-3.

5-4.1 Analysis Procedure

A detailed evaluation of the financial feasibility of the project would require sufficient investigation and analysis of the capital investment flow throughout the project life, annual operating cost, fare, financing conditions, etc. However, the financial analysis proceeded hereinafter is limited to the rough examination at the master plan stage and the following simplified procedure will be applied for the analysis.

1) Indicators of Financial Analysis

In the following analysis, under the assumed fare level, a financial indicator (which accounts for an approximate interest rate required for making a project financially feasible) is examined. The following expression is used as an indicator of the analysis.

$$(R) = \frac{\text{Annual operation profit (P)}}{\text{Total investment (I)}}$$

(R) = Financial indicator

(P) = Annual operating revenue (A) - Annual operating cost (C)

a. Total investment (I)

Total investment for this project (refer to 5-3.3)

b. Annual operating revenue (R)

Fare revenue and other income equivalent to 3% of the former are expected.

c. Annual operating cost (c)

(c) is composed of costs for track maintenance, electric facilities maintenance, rolling stock maintenance, conducting transportation, power supply, general administration. Interest and depriciation are excluded since calculation of the (R) is aimed in this analysis.

2) Cases Tested

The Whole MRT routes proposed in the master plan and the mid-term executing route in 1990 are tested.

Transport Demand	Master plan	:	Whole projects (51 km), Demand in 2000
	Mid-term examination of master plan	:	First stage (North-South route 13.5 km), Demand in 1990
Fare	Case 1	:	6 sucres/one riding
	Case 2	:	10 sucres/one riding

The above fares are twice of the existing bus fares of the standard bus (Colectivo) and the mini bus (Buseta), which are 3 and 5 sucres respectively in January 1983, and the uniform fare system is applied.

5-4.2 Operating Structure

Since the ratio of the personnel cost is comparatively large among the operating costs of the MRT, operating structure should be considered as an important factor for calculating the annual operating cost.

1) Organization for Operation

Standardized and simplified organization required for the MRT operation is shown in Figure 5-4.1.

2) Required Number of Staffs

Required number of staffs was estimated based on examples of urban railway enterprises in various countries of the world and Japan. The result is shown in Table 5-4.1.

5-4.3 Annual Operating Revenue and Cost

1) Annual Operating Revenue (A)

(A) is calculated by the following expression.

(A) = (number of passengers per day) x 365 days x (fare per one riding) x 1.03

The result is shown in Table 5-4.2.

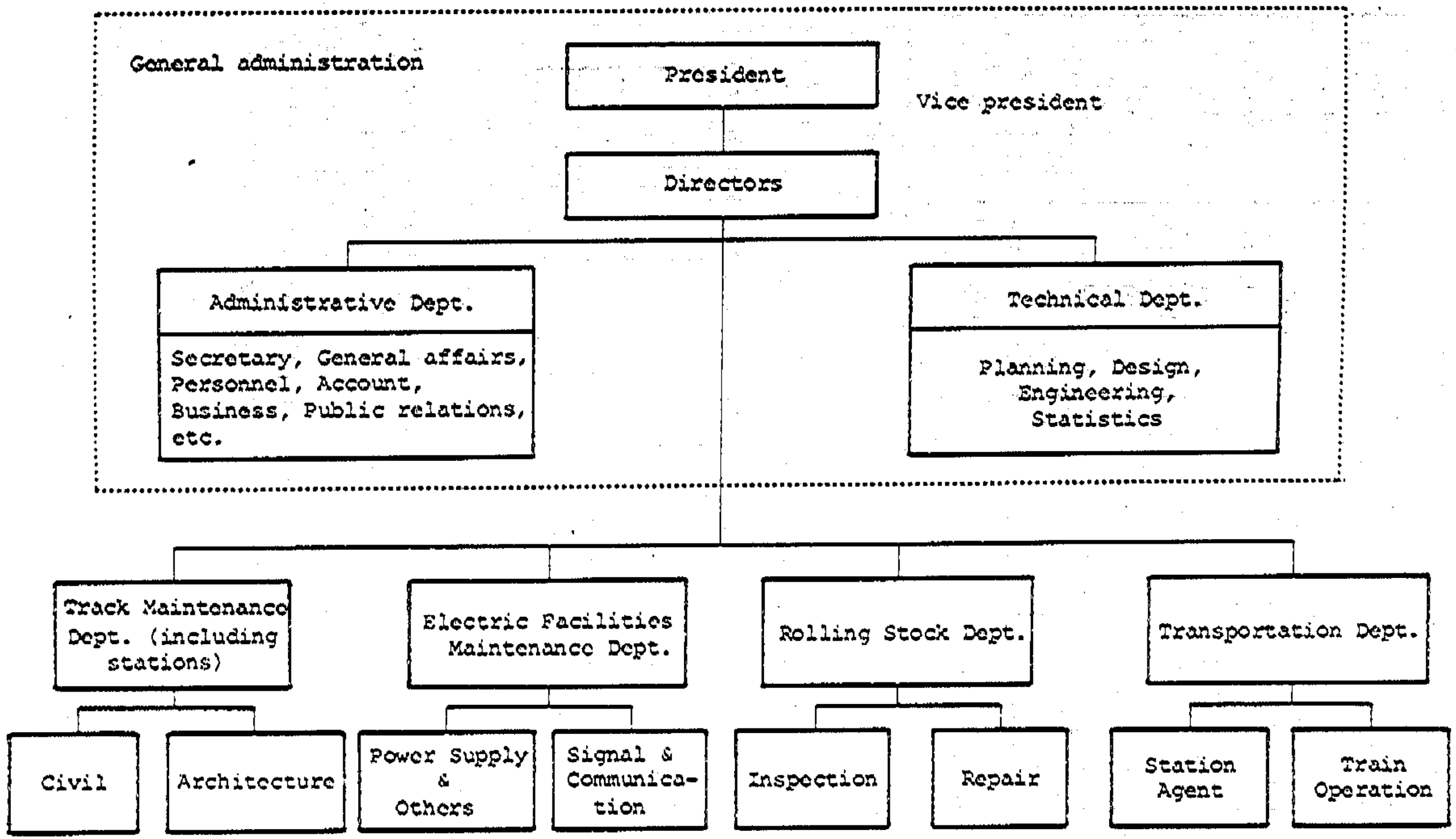


Figure 5-4.1 MRT ORGANIZATION

Table 5-4.1 NUMBER OF STAFFS

Item \ Year		2000		1990	
Operating kilometerage (Km)		51		13.5	
Number of stations		51		15	
Number of passengers per day		1,172,000		335,000	
Number of required cars		272		44	
Track maintenance		110		30	
Electric facilities maintenance		110		30	
Rolling stock inspection and repair		190		30	
Conducting transportation	Train clew	340	1,110	50	280
	station agent	770		230	
General administration		230		60	
Total		1,750		430	

Table 5-4.2 ANNUAL OPERATING REVENUE

(Unit : Million Sucres in 1982 prices)

Fare case \ Year	2000	1990
Case 1 (Fare : 6 sucres/passenger)	2,644	756
Case 2 (Fare : 10 sucres/passenger)	4,406	1,259

2) Annual Operating Cost (C)

The annual operating cost of the Urban Railway system in 2000 and in 1990 are shown in Table 5-4.3, 5-4.4, respectively. Those of the Light Rail Transit, the Monorail and the Rubber Tyre Type Railway will be almost same as that of the Urban Railway and that of the Subway will be estimated 120% of the former.

Table 5-4.3 ANNUAL OPERATING COST IN 2000

(In 1982 prices)

Item		Calculation	Annual Cost (Million sucres)
General administration		230 persons x 200,000 $/Year = 46.0 Million $/Year	46
Track maintenance	Personnel expense	110 persons x 180,000 $/Year = 19.8 "	122
	Material and others	51 km x 2 Million $/Km-Year =102.0 "	
Electric facilities maintenance	Personnel expense	110 persons x 180,000 $/Year = 19.8 "	76
	Material and others	51 km x 1.1 Million $/Km-Year = 56.1 "	
Rolling stock maintenance	Personnel expense	190 persons x 180,000 $/Year = 34.2 "	143
	Material and others	272 cars x 0.4 Million $/car-Year=108.8 "	
Conducting transportation	Personnel expense	1,110 persons x 180,000 $/Year =199.8 "	317
	Material and others	1,172,000 passengers x 100 $/Year =117.2 "	
Power supply	Traction power	*107.2x10^6 kWH/Year x 1.65 $/kWH =176.9 "	186
	Others	(Traction power) x 0.05 = 8.8 "	
Total			890

(Note) * Traction power : 200 trains/day, one direction x 2 x 51 km x 180 t/train x 0.08 kWH/t-Km x 365 days
= 107.2×10^6 kWH/Year

Table 5-4.4 ANNUAL OPERATING COST IN 1990

(in 1982 prices)

Item		Calculation	Annual Cost (Million sucres)
General administration		60 persons x 200,000 $/Year = 12.0 Million $/Year	12
Track maintenance	Personnel expense	30 persons x 180,000 $/Year = 5.4 "	32
	Material and others	13.5 Km x 2 Million $/Km-Year = 27.0 "	
Electric facilities	Personnel expense	30 persons x 180,000 $/Year = 5.4 "	20
	Material and others	13.5 Km x 1.1 Million $/Km-Year = 14.9 "	
Rolling stock maintenance	Personnel expense	30 persons x 180,000 $/Year = 5.4 "	23
	Material and others	44 cars x 0.4 Million $/car-Year = 17.6 "	
Conducting transportation	Personnel expense	280 persons x 180,000 $/Year = 50.4 "	84
	Material and others	335,000 passengers x 100 $/Year = 33.5 "	
Power supply	Traction power	14.2 x 10^6 kWH/Year x 1.65 $/kWH = 23.4 "	25
	Others	(Traction power) x 0.05 = 1.2 "	
Total			196

(Note) * Traction power : 100 trains/day one direction x 2 x 13.5 Km x 180 t/train x 0.08 kWH/t-Km x 365 days
= 14.2×10^6 kWH/Year

5-4.4 Results of Financial Analysis

The results are shown in Table 5-4.5. Since these results are derived by the simplified method, further analysis of each project should be carried out by a complete procedure.

1) Master Plan (in 2000)

a. Relation between the fare level and the financing interest rate

Since even the (R) (means an approximate interest rate required for the project) of the Urban Railway which has the most preferable result is about 6% in the fare of case 1 (6 sucres), low interest financing less than 6% will be necessary. In the fare of case 2 (10 sucres), it is conceivable that it will be possible to manage the MRT by the financing with the interest less than 12%.

However, since the transport demand which was one of basic factors in this analysis has been forecast not based on each fare level, but only on the level of 10 sucres, the relation between the demand and the fare level should be clarified in a further study.

b. Comparison of alternative systems

As for the alternative MRT systems, it is likely to be also financially feasible for any type of four systems except Subway. The Urban Railway, however, is the most predominant of all, the LRT is almost same as the Urban Railway, and the Monorail and the Rubber Tyre Type Railway are worse than the formers. Since the Subway is unfeasible even if in case 2, it is very difficult to execute the Subway project without special consideration on the policy for proceeding with the project.

2) Mid-term examination in 1990

Although it is prospected that the relation between the fare and the interest rate will be improved a little compared with that in the master plan, the trend is almost same as that of the master plan. In comparison of alternative systems, the LRT has a little more advantageous than the Urban Railway because of its cheaper investment at this stage.

Table 5-4.5 FINANCIAL INDICATORS IN 2000 & 1990

(in 1982 prices)

		Total Investment (Million $)	Annual Operating revenue (Million $)	Annual Operating Cost (Million $)	Annual Operating Profit (Million $)	R (%)
Master plan in 2000						
Case-1	MRT-A	28,250	2,644	890	1,754	6.2
	-B	29,520	2,644	890	1,754	5.9
	-C	38,920	2,644	890	1,754	4.5
	-D	43,420	2,644	890	1,754	4.0
	-E	62,760	2,644	1,068	1,576	2.5
Case-2	MRT-A	28,250	4,406	890	3,516	12.4
	-B	29,520	4,406	890	3,516	11.9
	-C	38,930	4,406	890	3,516	9.0
	-D	43,420	4,406	890	3,516	8.1
	-E	62,760	4,406	1,068	3,338	5.3
Mid-term examination in 1990 of master plan						
Case-1	MRT-A	8,120	756	196	560	6.9
	-B	7,910	756	196	560	7.1
	-C	9,190	756	196	560	6.1
	-D	10,210	756	196	560	5.5
	-E	25,330	756	235	521	2.1
Case-2	MRT-A	8,120	1,259	196	1,063	13.1
	-B	7,910	1,259	196	1,063	13.4
	-C	9,190	1,259	196	1,063	11.6
	-D	10,210	1,259	196	1,063	10.4
	-E	25,330	1,259	235	1,024	4.0

Note 1. Case 1: Fare = 6 sucres
Case 2: Fare = 10 sucres

2. MRT-A: Urban Railway
-B: LRT (Light Rail Transit)
-C: Monorail
-D: Rubber Tyre Type Railway
-E: Subway

2. 1 US Dollar = 50 sucres (average in 1982)

5-5 OTHER EVALUATION

The purpose of this section is to evaluate the social and environmental impacts by the proposed master plan on the Study Area. Various kind of items to be evaluated are conceivable but, in the following evaluation, consideration will be given to the three main items shown hereunder:

1) Transportation services and impacts to the main development areas

2) Impacts by the MRT and the related transport improvement plans on the Central Urban Area (CUA)

3) Consideration on the environment and environmental impacts

5-5.1 Transportation Services and Impacts to Main Development Areas

The main development areas in the Study Area consist of the three: the northern, the western and the Duran suburbs area. In addition to these areas, the Guasmo and Febres Cordero are most likely to be selected as re-development areas.

The population increase in these three areas occupies about 70% of the total increase in the Study Area amounting to about 80% of the same in case of the increase in the Guasmo and Febres Cordero areas being included.

Transportation services to these development areas can be summarized as follows:

1) Increase in the road capacity between these development areas and CUA, and exclusion of through traffic in CUA by the large loop-line road (Via Perimental de Guayaquil) which connects the entire development areas.

2) Introduction of the MRT connecting the section between the four major development areas and CUA. Particularly, two routes to be introduced into the northern development area; one route bound for the northeastern area via Bus Terminal and the other bound for the northwestern area via Urdesa.

3) Bus network improvement coordinated with the MRT

The impacts of the abovementioned transportation services on these development areas are as follows:

1) Precedent and unified establishment of the transportation network is very effective as a development strategy since it gives a push to development of these areas. In addition, this development pattern completely matches the linear development plan selected in the master plan.

2) Particularly, development of the wayside of the MRT, which has a mass transport capacity, is rapidly accelerated. Dispersion of population and formation of commercial subcenters result from the above.

3) Due to formation of regional centers, inter-traffic within the development area is increased and traffic concentration to CBD is mitigated.

4) Diversity of traffic routes and modes produces many kinds of benefits to the residents in the region, which are not only improvement of convenience in movement but also selection of occupation, participation to social and calutural activities, etc.

Judging from the abovementioned matters, the proposed master plan will bring about many kinds of effects which are remarkable improvement of accessibility to CUA, promotion of development in each major development area, mitigation of traffic concentration to CUA, etc.

5-5.2 Impacts by MRT and Related Transport Improvement Plans on Central Urban Area (CUA)

Impacts by the MRT and related transport improvement plans which consist of improvements to accessibility to CBD, traffic control, facilities for pedestrians, etc. on CUA are prospected as follows:

1) Re-development of urban areas and expansion of CBD will be promoted along the MRT routes as the urban axis. This will increase economic and social potential of CBD and promote to activate urban activities.

2) As a result of the flow of pedestrians and cars becoming smooth, traffic accidents will be decreased and convenience for pedestrians will be improved as well.

5-5.3 Consideration on Environment and Environmental Impacts

1) Noise and Vibration

Since the impacts of noise and vibration are evaluated differently according to the regional conditions on the wayside and judging criteria of individuals who are affected by these impacts and who are offered services, respective countermeasures will be required as well as general environmental criteria.

Generally, countermeasures for generators of them and ones for easing their impacts are executed. The following items should be considered sufficiently.

a. Against road traffic noise:

(1) Regulation on large-size cars so as to run along the inner side of car lanes, regulation on running speed

(2) Fitting out of rolling stock, maintenance of the road surface

(3) Installation of noise insulation wall, etc.

b. Against MRT noise:

(1) Consideration to track structures (long rail, ballast-bed track, concrete beam, etc.)

(2) Maintenance of track, rolling stock, electric power supply facilities, etc.

(3) Installation of noise insulation wall, etc.

c. Other countermeasures:

(1) Regulation and inducing on land use in the wayside

(conversion of the wayside into commercial areas, etc.)

(2) Conversion of the buildings in the wayside into multi-story ones.

2) Air Pollution

Air pollution caused by traffic congestion and exhaust gas of cars has become one of big urban problems in any cities. So long as no adequate countermeasure is taken against air pollution in Guayaquil City, its influence would conceivably become a serious problem in future. The proposed master plan will contribute greatly to preventing aggravation of air pollution prospected in future by means of dispersing car traffic concentration to CUA, smoothing traffic flow in the whole Study Area, introducting of the MRT operated by electric power.

3) Effect on Energy Saving

It may be safely said that effect on energy saving of the MRT which has mass and rapid transport capability is nearly about twice compared with cars of which transport feature is small unit transport in comparison of energy consumption per passenger.

Fluid situation concerning energy supply, such as energy crisis in past years and overabundance of oil in recent years etc., has been continuing. However, it is important to recognize limits of resources in long term aspect. From the above viewpoint, introduction of the MRT is significant for energy saving.

4) Problem on the View

Environmental and psychological problem caused by construction of transport structures in urban area is an impact on the urban view. Particularly, the elevated structural portions cause trouble on the view. Since the track structure of the MRT proposed in this Study will be an elevated style for almost whole line in urban area, it is necessary to consider harmonization of the shapes, sizes, colors, etc. of the structure with the urban view for their design.

5) Sunshine Obstruction and Radio Wave Interference

As Guayaquil is located on the equator, the impact on sunshine obstruction seems to be very little. As for radio wave interference, there would be no particular problem on radio wave interference caused by the MRT structures since multistory buildings have already been built on the wayside of the MRT routes.

6) Environmental Problems of the Projects under Construction

As the problems of the projects under construction, noise, vibration, hinderance to road traffic, lowering of the underground water level (in case of subway construction) etc. are conceivable. However, any of them is temporary problem and it is possible to reduce its impacts by adopting adequate construction methods.

5-6 CONSIDERATION FOR MAJOR PROJECTS IN MASTER PLAN

Justification of the master plan has been verified from both of the aspect that the anticipated problems can be resolved by implementing this plan and the aspect that it is feasible from the economic point of view. This section will select priorities of the major projects in the master plan.

In comparison with the road projects, the MRT projects are considered more in detail because the latter has various elements such as alternative route plans and systems.

5-6.1 Road Projects

1) General Characteristics of Major Projects

The proposed network is to be added to the road network (called On-going projects) planned by the Ministry of Public Works (M.O.P.) and Guayaquil City, and is composed so as to be able to cope with the traffic demand in the year of 2000 by being combined with the MRT route plans.

The On-going projects expect for the short-term and local effects and prepare bypasses by widespread transport services such as Perimental de Guayaquil, but are no particularly adjusted as a systematic urban transport network. Different from this On-going projects, the proposed road network has been planned so as to intensify connection between CBD and the existing suburban area inclusive of Pascuales and Duran as a principal target based on the prospect that Guayaquil city should expand in future beyond the existing urban area.

2) Selection of Major Projects

Table of roads included in the proposed network and major intersections necessitating improvement has already been shown in Chapter 4 and the reasonableness thereof has already been backed up. These elements were unified and put in order as a project shown in Table 5-6.1.

Table 5-6.1 TABLE OF MAJOR PROJECTS

Project group	Purpose of project	Scope of works	Volume of work
1	Intensive connection between northern area and CBD	a. Large-scaled improvement of intersections by adopting grade separation	6 places
		b. Formation of ring road within urban area	17.8 km
2	Development of northern area, intensive connection between Pascuales and Duran	a. Extension of Via Perimental de Guayaquil (outer ring road)	22.8 km
		b. North bridge over Rio Guayas	
3	Improvement of the area around CBD, intensive connection with western area	a. Large-scale improvement of intersections by adopting grade separation	9 places
		b. Improvement of radial roads (Calle 23, 24 and 32)	12.4 km
		c. Tunnel under Cello el Carmen	1.3 km
4	Development of southern area, connection of CBD with southern area and Duran	a. Extension of Via Perimental de Guayaquil	17.5 km
		b. South bridge over Rio Guayas	
		c. Improvement of intersections by grade separation	2 places

3) Priority of Major Projects

As to each project shown in the above, evaluation of its planning characteristics was conducted from the viewpoints of necessity, urgency measure, etc. and its priority was considered. The results are shown in Table 5-6.2.

As a result of it, the highest evaluation was awarded to the northern linkage project and it is conceived that this project should be considered most urgent taking account of implementation of the HRT projects from the viewpoint of resolving the existing problems and accelerating development toward the northern area. In addition, it is conceivable that the northern development road plan with a high quality should be also brought into implementation properly keeping adjust with the advancing level of the development.

As CBD improvement projects are anticipated to have difficulties in execution of account of the projects being located in the existing urban area and there is a possibility that the projects may be substitued by the institutional countermeasures such as parking control in CBD, etc., the priority of these projects is more or less lowered.

Although the southern linkage project can be evaluated positively from the viewpoint of forming up a by-pass for through traffic in CBD, the priority of this project seems to be relatively low due to a huge amount of its cost, in addition to the fact that the factors of orderly arrangement inherent to the subject area are slightly weak.

Table 5-6.2 PROJECT PRIORITY RATING

Item \ Project group	1 Northern Linkage	2. Northern Development	3. CBD Improvement	4. Southern Linkage
Necessity	In order to resolve the present traffic bottleneck and prepare for future development of the northern area, it is necessary to try to increase the transport capacity. A	It is necessary to push forward development of the northern area and try to disperse the regional functions. B	It is necessary to take countermeasures for making traffic disposal of the existing urban area and developing the western area. A	For development of the southern area, it is necessary to expand capacity of CBD and Duran. B
Urgency measure	Since this point is the biggest problems to be resolved in study area, it has high urgency. A	This item is most important concerning future development but it is the matter after the development starts. B	Although CBD measures are important, its implementation have to be done carefully because of the possibility bringing about the increase in traffic volume as a result of the increase in transport capacity. B	Since the transport capacity of trunk lines has already been preserved like AV. 25 de Julio etc., the project priority should be also considered from the viewpoint of both the advance of development and CBD measures. B
Substitutability	Introduction of MRT would be also display alternative effect. C	Introduction of MRT would partially have substitutability. B	Correspondence in the institutional phase such as parking, etc. would be partially possible. C	Introduction of MRT would partially have substitutability. B
Effect of execution	In connection with the future regional development, the largest effect can be expected. A	The effect is limited to the northern area and Duran. B	It is difficult to give decisive effect since the traffic volume to concentrate to CBD is also big. C	It is effective for the southern area and, in addition, the effect of CBD by-pass is also conceivable. A
Investment amount (million sucres)	1,323	6,930	1,996	10,654
Overall consideration	A	B	B	C

5-6.2 MRT Projects

1) Selection of MRT Projects

The following three plans with two different lengths are selected as the MRT routes to be examined.

(1) Plan 1-A: North-South route
The solid line plus dotted lines shown in Figure 5-6.1.

(2) Plan 1-B: North-south route, the central part of Plan 1-A
The solid line shown in Figure 5-6.1.

(3) Plan 2-A: East-West route
The solid line plus dotted lines shown in Figure 5-6.2.

(4) Plan 2-B: East-West route, the central part of Plan 2-A
The solid line shown in Figure 5-6.2.

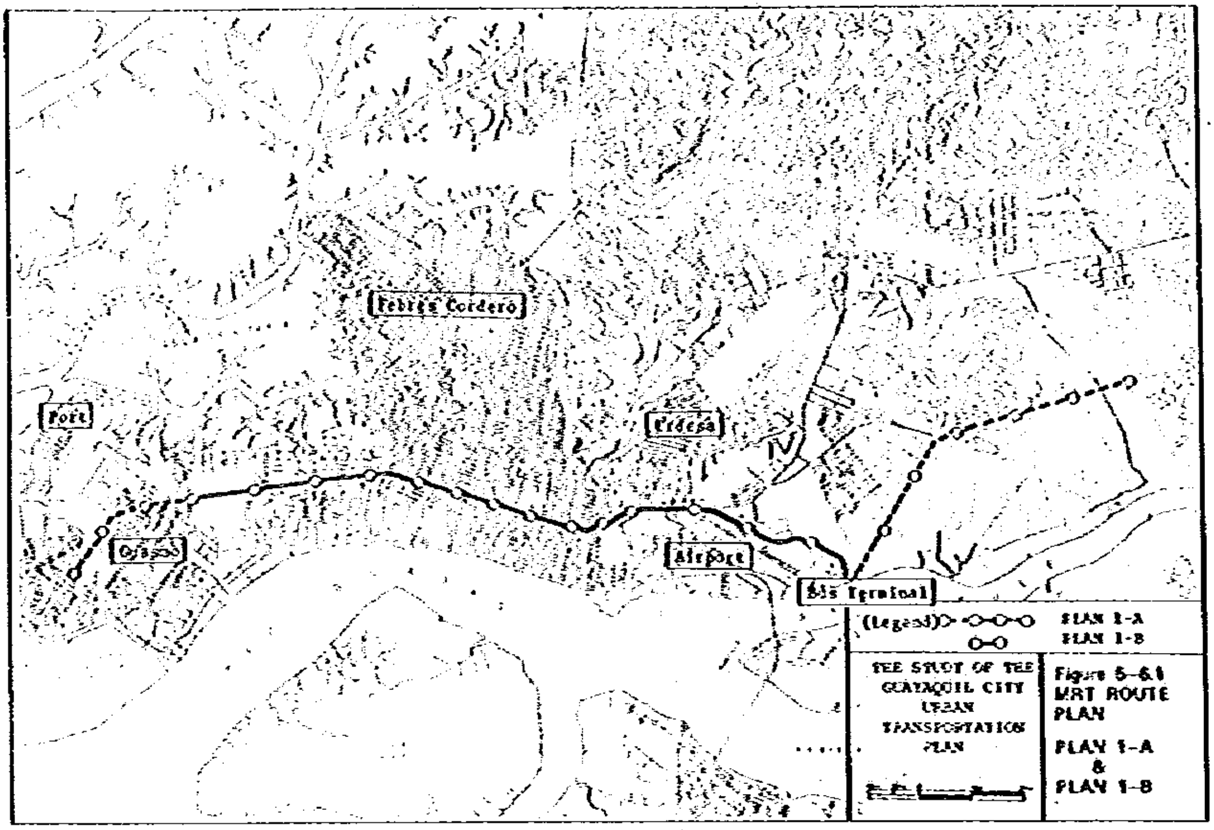
(5) Plan 3-A: The routes based on (Plan 1-A + Plan 2-A)
Solid lines plus dotted lines shown in Figure 5-6.3.

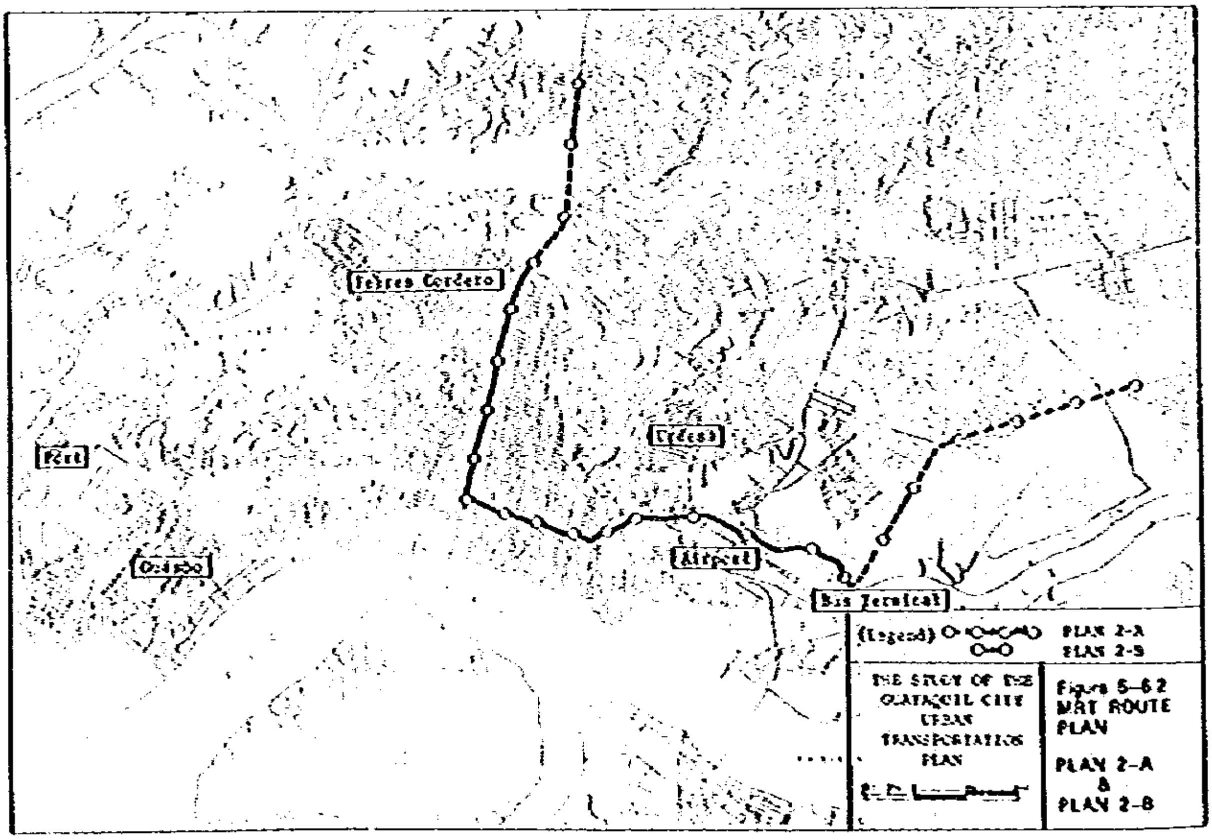
(6) Plan 3-B: The routes based on (Plan 1-B + Plan 2-B)
The central part of respective routes of Plan 3-A. Solid lines shown in Figure 5-6.3.

In selecting the above routes, the following points were taken into consideration:

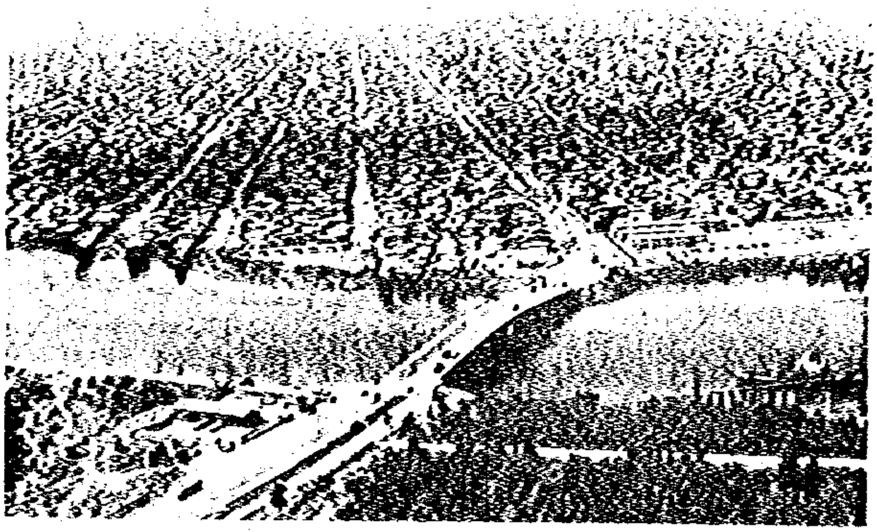
(1) In Plan 1 and Plan 2, the route to extend northward from CBD is planned to pass through the Bus Terminal because it is anticipated that the traffic demand from the Bus Terminal should be big in the northern area as well as that the development potential should be high in the northern development area.

(2) Since the route length of each plan A is considerably long (about 25 km), the routes shall be examined in two divisions, one of which is full length of the route while the other is in the central part of the former.


Febres Cordero
Port
Airport
Bus Terminal
(Legend)
PLAN 1-A
PLAN 1-B
THE STUDY OF THE
GUAYAQUIL CITY
URBAN
TRANSPORTATION
PLAN
Figure 5-61
MRT ROUTE
PLAN
PLAN 1-A
&
PLAN 1-B


Febres Cordero
Port
Airport
Bus Terminal
(Legend)
PLAN 2-A
PLAN 2-B
THE STUDY OF THE
GUAYAQUIL CITY
URBAN
TRANSPORTATION
PLAN
Figure 5-62
MRT ROUTE
PLAN
PLAN 2-A
&
PLAN 2-B

Av. 25 de Julio, the southern part of Plan 1-A & B (North-South route)



Calle Portete and Portete bridge, the western part of Plan 2-A & 2B. (East-West route)

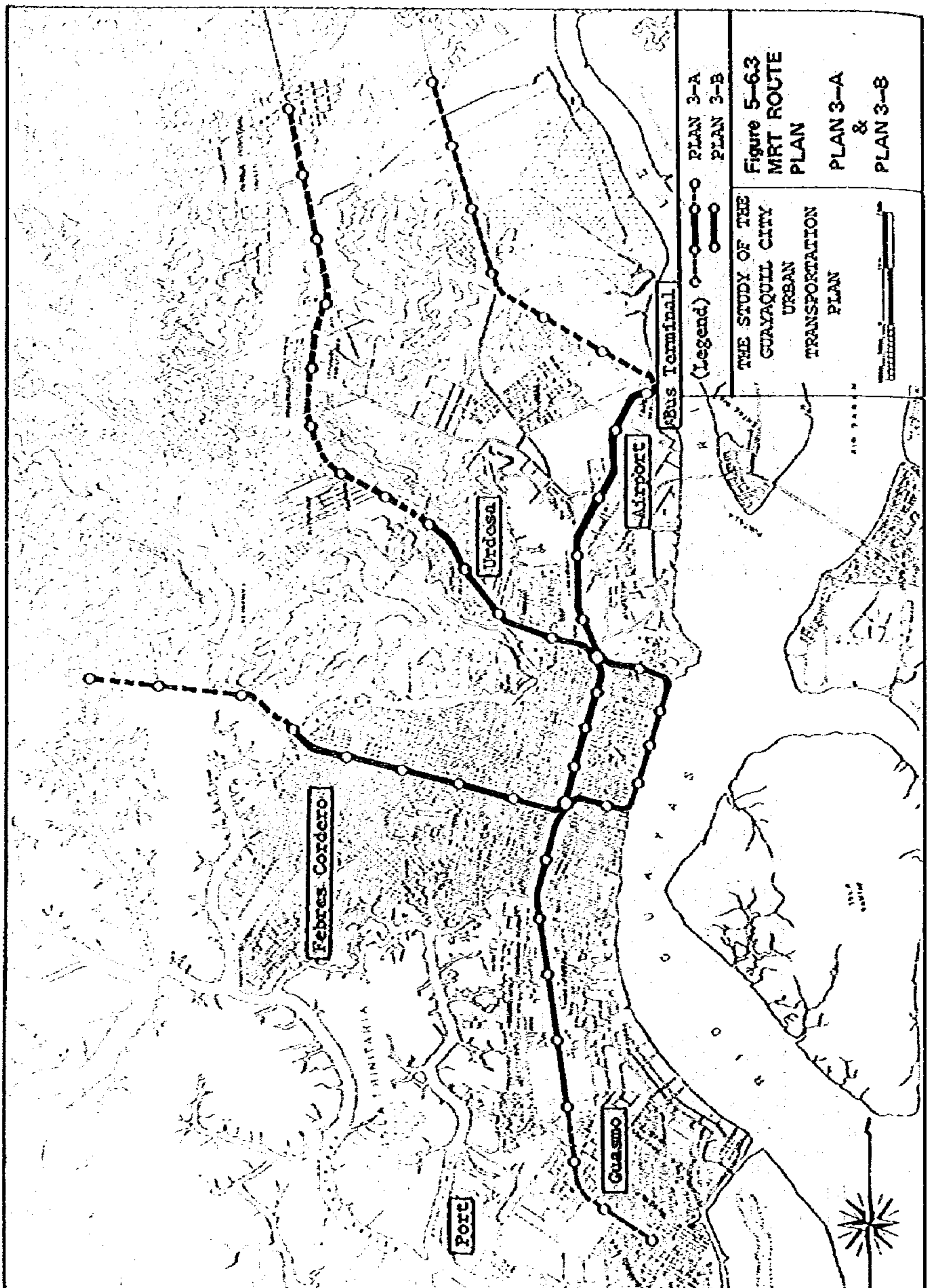


Figure 5-6.3
MRT ROUTE
PLAN
PLAN 3-A
&
PLAN 3-B
THE STUDY OF THE
GUAYAQUIL CITY
URBAN
TRANSPORTATION
PLAN
(Legend)
PLAN 3-A
PLAN 3-B
Bus Terminal
Airport
Urdesa
Febres Cordero
Guasmo
Port

2) Characteristics of Each Route

a. General Characteristics

Main characteristics of each route are as follows:

(1) Plan A (common to Plan 1-A, 2-A, 3-A)

The effect on promotion of development in the suburbs is predominant, though large investment is needed. Taking into account the investment and its effect, however, Plan A should be established after completion of Plan B route since the Plan B covers the existing urban area.

(2) Plan B (common to Plan 1-B, 2-B, 3-B)

Plan B makes MRT give full play to its mass transportation capacity effectively in coordination with bus services. Connection with the places beyond the terminal of each route is made by bus transport.

(3) Plan 1: North-South route (Common to Plan 1-A, 1-B)

- Plan 1 does not cover the western area of the city which is possible to meet the public transport demand by bus services since many streets are useful for bus transport in the section between the western area and CBD.

- Since every streets on which the MRT passes are wide, the MRT is easy to be constructed.

- In addition, since Av. 25 de Julio is very wide (70 m in near future), it is possible to decrease the investment cost by selecting on the ground style structure at the initial stage.

(4) Plan 2: East-West Route (common to Plan 2-A, 2-B)

- Plan 2 does not cover the southern area of the city. It is difficult to meet the public transport demand in this area by bus services since only a few streets are useful for bus transport in the section between the southern area and CBD.

- Since the road width along Calle Portete is narrow, construction of the MRT along this street is difficult and expensive as well.

(5) Plan 3: The routes based on (Plan 1 + Plan 2)
(Common to Plan 3-A, 3-B)

- Since Plan 3 is the maximum one as the MRT routes covering the entire main traffic routes, the route toward the northern industry development area is included in this plan, as well.

- Plan 3 is the most preferable one to meet the public transport demand, although huge investment is needed. It would be recommendable that Plan 3 will be established after the execution of Plan 1 or Plan 2.

b. Dimensions of Each Route

Table 5-6.3 DIMENSIONS IN EACH ROUTE

		Route length (km)	No. of stations	Average distance of stations
Plan 1-A	North-South route	24.0	24	1.04
Plan 1-B	ditto	13.5	15	0.96
Plan 2-A	East-West route	25.0	24	1.09
Plan 2-B	ditto	13.5	15	0.96
Plan 3-A	North-South route	26.3	26	1.05
	East-West route	24.7	25	1.03
	Total	51.0	51	1.04
Plan-3-B	North-South route	15.8	17	0.99
	East-West route	12.2	14	0.94
	Total	28.0	31	0.97

c. Transport Volume

The transport volume estimated from 4-2 in Chapter 4 is as shown in Table 5-6.4.

Table 5-6.4 TRANSPORT VOLUME OF EACH PLAN

Plan \ Transport Volume		No. of passengers per day (A)	Maximum passengers per day in one direction (B)	Maximum passengers per hour in one direction (C)
Plan 1-A	North-South route	714,000	215,000	25,800
Plan 1-B	ditto	497,000	165,000	19,800
Plan 2-A	East-West route	703,000	208,000	25,000
Plan 2-B	ditto	591,000	185,000	22,200
Plan 3-A	North-South route	629,000	283,000	34,000
	East-West route	543,000	222,000	26,600
	Total	1,172,000	-	-
Plan 3-B	North-South route	494,000	222,000	26,600
	East-West route	427,000	175,000	21,000
	Total	921,000	-	-

(Note): Taking for that the concentration ratio is 12% per one peak hour, the value was figured out from the expression (C) = (B) x 0.12

3) Approximate Investment

The approximate investment classified into each MRT plan and system is shown in Table 5-6.5.

Table 5-6.5 TOTAL INVESTMENT IN EACH MRT SYSTEM

(Unit: Million sucres in 1982 prices)

	Urban Railway	Light Rail Transit	Monorail	RubberTyre Type Railway	Subway	Remarks
Plan 1-A	12,330 (514)	12,380 (516)	16,960 (707)	19,140 (797)	29,520 (1,230)	24 km 24 stations
Plan 1-B	8,760 (649)	8,710 (645)	9,930 (736)	11,170 (828)	25,970 (1,924)	13.5 km 15 stations
Plan 2-A	12,890 (516)	13,110 (524)	17,790 (712)	20,120 (805)	29,730 (1,189)	25 km 24 stations
Plan 2-B	9,350 (693)	9,290 (688)	10,630 (788)	12,030 (891)	26,220 (1,942)	13.5 km 15 stations
Plan 3-A	28,250 (554)	29,520 (579)	38,930 (763)	43,420 (851)	62,760 (1,230)	51 km 51 stations
Plan 3-B	20,350 (727)	20,550 (734)	23,400 (836)	25,540 (912)	54,910 (1,961)	28 km 31 stations

(Note): 1. Track style

(1) Urban railway and LRT in the Plan A: (Elevated Style for the whole line in the Plan B)
On-the-ground style for following length in the suburbs
Elevated style for the remain

Plan 1-A ...... 8.4 km (on-the-ground style)
Plan 2-A ...... 9.2 km (ditto)
Plan 3-A ......18.4 km (ditto)

(2) Monorail and Rubber Tyre Type Railway:
Elevated style for the whole line

(3) Subway in the Plan A: (Underground style for the whole line in the Plan B)
On-the-ground style and elevated style for following length in the suburbs
Underground style for the remain

Plan 1-A ..... 8.4 km (on-the-ground style),
2.1 km (Elevated style)

Plan 2-A ..... 9.2 km (on-the-ground style),
2.3 km (Elevated style)

Plan 3-A .....18.4 km (on-the-ground style),
4.6 km (Elevated style)

2. Numbers in parenthese are the investment per km.

4) Priority of MRT Projects

Each aforementioned project was examined from the view-points of the effect of execution, urgency measure, etc. as shown in Table 5-6.6.

Table 5-6.6 PROJECT PRIORITY RATING

Item \ Plan		Plan 1-A Nourth-South route 24 km	Plan 1-B Central Part of Plan 1-A 13.5 km	Plan 2-A East-West route 25 km	Plan 2-B Central Part of Plan 2-A 13.5 km	Plan 3-B Central Parts of N-S and E-W routes 28 km
a. Effect of execution	Level of transport efficiency	C	A	C	A	A
	Contribution to easing congestion	B	B	B	B	A
	Improvement of transport service	B	C	B	C	A
	Effect of promoting development	A	B	A	B	B
b. Urgency measure		C	A	C	A	B
c. Substitutability by other projects		B	A	C	B	B
d. Easiness of execution		A	A	B	B	C
e. Investment (Million sucres)		12,330	8,760	12,890	9,350	20,350
f. Synthetic judgement		C	A	C	B	B

(Note) 1. Investment: Urban Railway System for the transport demand in 2000 (Refer to Table 5-6.5).

Finally, the implementing priority of the projects was summarized as follows:

Priority 1: Plan 1-B (Central part of North-South route; 13.5 km)

Priority 2: Completion of Plan 3-B (Central part of North-South route and Central part of East-West route; 28 km as well as route extension; 14.5 km)

Priority 3: Completion of the MRT project as a whole (51 km and route extension; 23 km)

5-7 CONCLUSION

5-7.1 Summary of Consideration Results

Evaluation of the proposed master plan was considered as to the following 3 sides of the plan; the effect of engineering improvement for the future demand, economic and financial feasibility and the social impacts by this plan.

The conclusion obtained from each of the above viewpoints are as follows:

1) Effect of Engineering Improvement

This master plan would resolve with sufficient effect the traffic problems anticipated in future by easening the bottlenecks in and around CBD, increasing the transport capacity along the north-south urban axis and improving the function to disperse and bypass traffic, and, in addition, the public transportation system of MRT and buses will remarkably improve accessibility from each peripheral zone toward CBD.

2) Economic and Financial Feasibility

Although evaluation was conducted by the simple and convenient method, the economic benefit obtained by executing the proposed road and MRT projects is over the required projects cost. However, the economic indicators are considerably affected by which one of the MRT systems is adopted and, among 5 alternative systems, Urban railway is the most prominent system.

In considering the MRT system from its financial side, it will be recommendable to give preferential treatment in terms of the interest rate of the fund for implementing this project by making the rate slightly lower than ones which are applied to general public works, operating the system with a fare about slightly more than twice as high as that of the current bus (Colectivo) fare.

3) Social Impacts

This master plan aims at orderly arrangement of the transport facilities in the present urban area and, at the same time, plays a leading role in accelerating development of the strategic areas around it. The direct impacts of the above are not only limited to improving convenience for movement due to diversification of the transport modes and bringing up location for subcenters due to mass rapid transport function by the MRT, but also they will bring about a lot of benefit and various spreading effect widely on the community.

On the other hand, since implementation of the projects is concerned with the environmental problems of the wayside areas, sufficient and cautious consideration should be given to the matters to be affected by it.

In this Chapter, in addition to the conclusion of above evaluations, consideration and proposal were made as to the priority of each project composing of this master plan. In order to realize the final goals of the master plan most effectively, for a target to execute the mid-term stage in 1990 of the master plan it is better to attach importance to establishment of the urban axis in the north-south direction and augmentation of transport capacity along it.

5-7.2 Recommendation

The proposed master plan would be essentially effective for resolving the traffic problems in this urban sphere and promising its long term development for better urban activities. Therefore, it would be eagerly desired to put the master plan into action as early as possible, and at the same time, related projects in the plan should be prepared so that they might perform their purposes most effectively not only by each project separately but also by their combination.

In order to make it easy to achieve the final target toward the 2000 year, as a policy of mid-term implementation in 1990 of the master plan, it would be recommendable to construct the urban section of North-South route of MRT and to improve the roads related to this route from the viewpoint to establish an urban structural axis in Guayaquil city at early stage.

For the major projects identified in the master plan, their feasibility should be examined more in detail and immediately since the plan was confirmed based on rather simplified methods.

CHAPTER 6.

SHORT TERM IMPROVEMENT PLAN

Chapter 6 SHORT TERM IMPROVEMENT PLAN

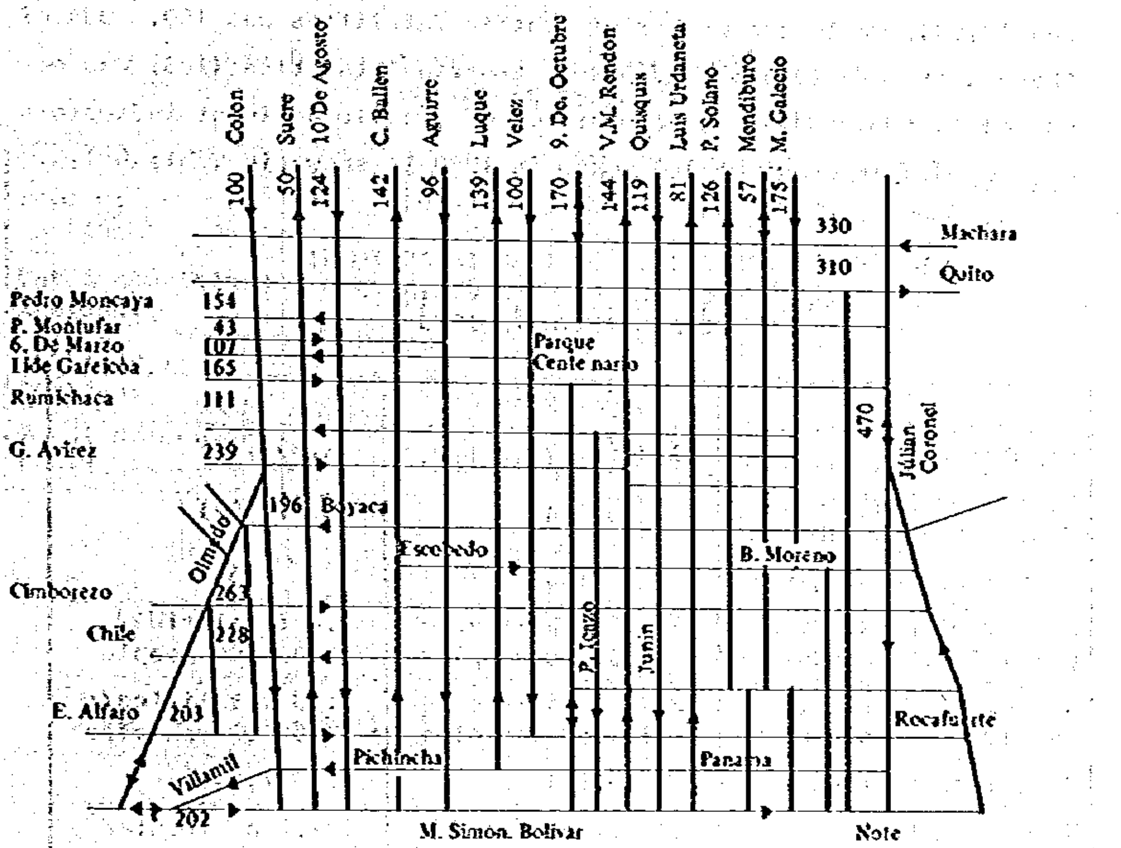
6-1 TRAFFIC ENGINEERING AND MANAGEMENT

6-1.1 Existing Problems in Traffic Engineering and Management Aspect

1) Existing Condition of Traffic Volume

The present traffic volume on major road network in CBD and it's surrounding area are shown in Figure 6-1.1.

Figure 6-1.1 PRESENT TRAFFIC VOLUME



As priority has been given to traffic signal phases for the North-South direction in CBD, traffic volumes on each major road in CBD for the North-South direction are about 20,000 vehicles/day, while they are only about 10,000 ~ 14,000 vehicles/day for the East-West direction (except for Av. M. Galecio (17,500 vehicles/day) and Av. 9 de Octubre (17,000 vehicles/day)). The average composition rate of heavy vehicles in CBD is low about 2.4%. On the other hand, heavy traffic volume can be found in the surrounding area on Av. Julian Coronel (47,000 vehicles/day), which is located in the northern part for the East-West direction. Av. Quito (31,000 vehicles/day) and Av. Machara (33,000 vehicles/day) are carrying a total of about 64,000 vehicles/day for the North-South direction.

2) Traffic Accident

The number of traffic accidents in Guayas Province in 1980 was 10,604, while the number of traffic fatalities was 150. 93% of these accidents (9,875) and 69% of traffic fatalities (103) was occurred in Guayaquil. The comparison of traffic accident indicators between Guayas Province and Tokyo in 1980 is shown in Table 6-1.1.

Table 6-1.1 COMPARISON OF TRAFFIC ACCIDENT INDICATORS BETWEEN GUAYAS PROVINCE AND TOKYO IN 1980

	Guayas Province	Tokyo
Population	1,305,057	11,357,337
Number of Registered Vehicles (all Vehicles)	66,204	3,672,921
Number of Fatalities	150	345
Number of Fatalities per 100,000 Population	11.5 fatalities/ 100,000 people	3.0 fatalities/ 100,000 people
Number of Fatalities per 10,000 Vehicles	22.7 fatalities/ 10,000 vehicles	0.93 fatalities/ 10,000 vehicles
Number of Accidents	10,604	32,046
Number of Accidents per 100,000 Population	812.5 accidents/ 100,000 people	282.2 accidents/ 100,000 people
Number of Accidents per 10,000 Vehicles	1,601.7 accidents/ 10,000 vehicles	87.2 accidents/ 10,000 vehicles

From Table 6-1.1, every traffic accident indicator in Guayas is much higher than that of in Tokyo. The number of fatalities and traffic accidents per 100,000 population in Guayas are about 2.8 ∿ 2.9 times higher than that of in Tokyo, while per 10,000 vehicles are about 18.4 ∿ 24.4 times. In addition, these traffic indicators for the same scale cities with a population of about

1,300,000 in Japan are only 6 ∿ 8 fatalities per 100,000 population and 1.7 ∿ 2.5 fatalities per 10,000 vehicles. From these facts, it is noted that the situation related to traffic accident in Guayas is very grave.

In Guayaquil, traffic accident indicators are also very high, and the number of traffic accidents per 100,000 population and per 10,000 vehicles in 1980 are 805 and 1,000, respectively. The number of traffic accidents in Guayaquil between 1975 and 1980 is shown in Table 6-1.2.

Table 6-1.2 NUMBER OF TRAFFIC ACCIDENTS IN GUAYAQUIL CITY

Type of Accident \ Year		1975	1976	1977	1978	1979	1980	Average Annual Growth Rate
Fatal and Injury Accident	-	1,529	1,808	1,623	1,723	1,843	2,062	6.2%
Non Injury Accident	-	5,325	6,335	5,660	5,853	7,297	7,813	8.0%
Total Number of Accidents		6,854	8,143	7,283	7,576	9,140	9,875	7.6%

From this table, it is noted that the average annual growth rate of the number of traffic accidents is as high as 7.6%.

The numbers of traffic accidents that occurred on major roads are shown in Table 6-1.3.

Table 6-1.3 NUMBER OF TRAFFIC ACCIDENTS ON MAJOR ROADS (1980)

Road Name	No. of Fatal Accidents	No. of Injury Accidents	Road Length (Km)	No. of Accidents/1 Km Road Length
° CBD				
Av. Villamil	0	6	0.2	200
Av. Pichincha	0	22	0.6	172
Av. Pedro Carbo	0	11	0.6	138
Av. Boyacá	1	29	1.6	126
Av. Chile	0	47	2.9	108
Av. Chimbo azo	2	42	2.9	74
Av. Lorenzo de Garaicoa	2	46	3.7	72
Malecón Simón Bolívar	2	33	1.8	63
° Surrounding Area				
Av. Quito	7	146	4.2	161
Av. Puente Cinco de Junio	1	2	0.8	175
Av. Aroserena	10	208	4.5	119
Av. Eloy Alfaro	0	33	2.3	89
Av. 25 de Julio	9	136	7.3	63
Av. Machala	7	63	4.0	63
Av. Los Rios	3	74	4.3	63

3) Traffic Control Devices

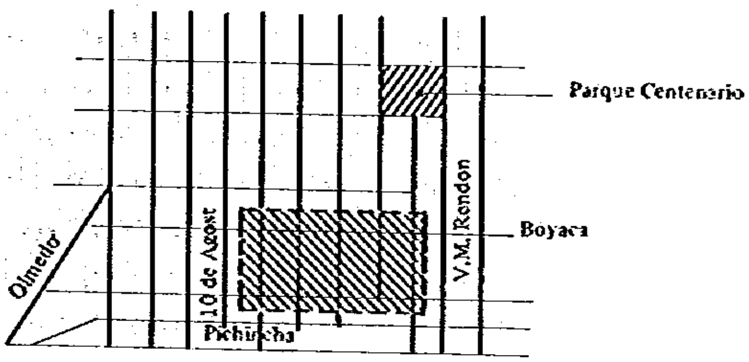
a. One Way Street System

The introduction of one way street system in CBD except for some major roads was completed by 1964. However, due to the increment of the number of traffic accidents as well as the chronic heavy traffic jam in the central area of CBD as a result of the rapid increase of traffic volume, the bus restricted zone system was introduced in the central area with the bus network being modified in 1974. At the same time Av. Malecon, Av. 10 de Agost, Av. V.H. Rendon, Av. Boyaca and other two way streets were converted into one way streets.

b. Bus Restricted Zone and Taxi

The bus restricted zone is shown in Figure 6-1.2.

Figure 6-1.2 BUS RESTRICTED ZONE



The buses stop at any place of the roads to get passengers, causing traffic accidents with vehicles following behind, or disturbing the smooth traffic flow. To solve these problems, the bus restricted zone system was introduced with a service of taxies in this area. In addition, 6 taxi stands were installed in this area since 20 years ago.

After the introduction of the bus restricted zone system, it is noted that the number of traffic accidents have decreased and traffic flows have improved. Therefore, C.T.G. has a plan to expand this bus restricted zone system up to Av. Olmedo.

This policy, however, faces a big problem as it tends to promote a rapid increase of traffic volume, leading to severe traffic jams. Therefore, it is necessary to review the policy for traffic planning in CBD to bring the total traffic volume in CBD under control. Under this policy, it is necessary to improve the service level of buses, to constrain unnecessary traffic movement and to promote the diversion of car usage to buses.

Taxi is also an important mode of public transport in

Guayaquil, especially after the introduction of the bus restricted zone system in the central area of CBD. It has become an alternative mode of transport to buses in the central area. There are 6 taxi stands in the central area of CBD and it is possible to call a taxi from these taxi stands by telephone.

c. Parking Meters and Lots

In 1976, parking meters were installed in CBD by C.T.G. for the purpose of constraining parking demand especially in discouraging full-day parkings. They consisted of 200 sets of double types (for 400 cars) and 97 sets of single types (for 97 cars), and another 194 sets of double types (for 388 cars) were added as new installation. However, the parking meter system was abolished in 1981, and a system of annual parking registration with the Municipality was introduced. It permits roads side parkings for annually registered cars with an annual registration fee of 8,000 Sucre. These registered parking lots are painted with yellow lines.

d. Experiments to Constrain Traffic

Besides these traffic constrain measures, Av. Elsalde and Av. Illingworth in the bank area were once converted into vehicle restricted roads by C.T.G., as there were many pedestrians between the bank area and Av. Pichincha going to/from the bus stops along Av. Malecón. However, many objections were voiced and as a result, this system was abolished within a week. In another case, Av. Aledo and Av. Pedro Cabro Gomez in the surrounding area were converted into parks in 1967 costing some 100,000 Sucre. However, these parks were abused as black markets, and problems related to the environment and security finally forced this system to be abandoned.

4) Traffic Signal

The first traffic signal in Guayaquil was installed at Av. Olmedo in 1950 and installations of most of the present traffic signals were completed by 1972. Multi coordinated type traffic signals are employed. However, the operation system is of only one type, therefore the same cycle as well as split are used for the whole day. Offsets are fixed and they are maintained annually. Traffic signal cycles in CBD are mostly 60 seconds and more sprits (55 ∿ 60%) are provided for the North-South direction.

Overhead type signal is the standard type of traffic signal in Guayaquil and pedestrian signals are installed only at a few intersections. Therefore, it is difficult for pedestrians to identify signal phases at most of the intersections, as a result that pedestrians have to cross the roads at intersections under their own judgement of traffic.

5) Parking Conditions

Parking spaces in CBD are found at road sides, open spaces and in a few parking buildings.

The total parking capacity in CBD is 11,802 lots, of which 52% (6,120 lots) are located at road sides, both registered parking lots and free parking lots, while 48% (5,682 lots) are located at open spaces and in a few parking buildings. Most of the parking spaces other than road sides are located at open spaces and only 15% of them (390 lots) are found in some buildings.

The total parking demand, including illegal parkings, was counted to be 10,817 cars in the daytime peak hour and the demand/capacity ratio is 92%. However, the parking demand for legal parking spaces is 9,368 cars in the daytime peak hour and the occupancy rate of legal parking spaces is calculated as 80%.

These figures show that parking spaces in CBD are almost fully utilized. Parking demands for free parking spaces at road sides and other places are 2,781 cars and 2,277 cars, respectively, while their capacities are 3,157 lots and 2,478 lots, respectively. Therefore, occupancy rates of these free parking spaces are 88% and 92%, respectively. As a result, it is very difficult to find parking spaces near one's destination.

6) Pedestrian Safety and Amenities

a. Pedestrian Signal

Due to the inadequate provision of traffic signals and insufficient traffic safety education, pedestrian safety at intersections is not ensured. Usually, there is no installation of pedestrian signals at intersections, and at the same time, signal displays being facing only the incoming traffic, on most of these one way streets, it is almost impossible for pedestrians from the opposite direction to identify the signal phases.

b. Road Markings

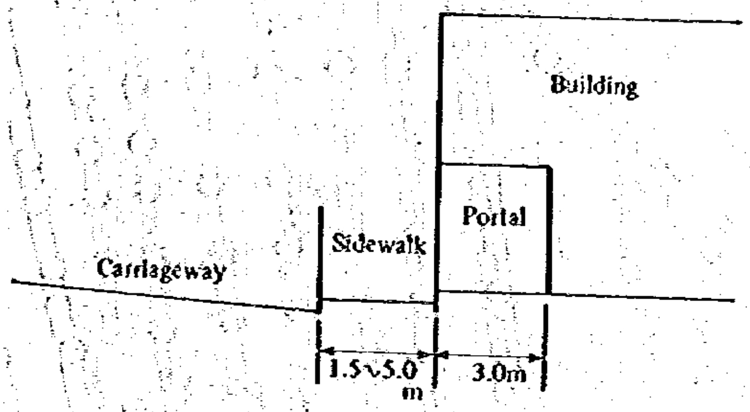
Road markings for pedestrian crossings are provided at most of the signalized intersections, however, visibility of these markings is not good and stoppage lines for vehicles are not provided. As a result, vehicles often stop on the pedestrian crossings and pedestrians have to avoid these vehicles when they are crossing.

Every morning (6:00 ∿ 8:30) and afternoon (12:00 ∿ 13:00), C.T.G dispatch about 300 traffic policemen near to schools to control traffic as well as to ensure the safety of school pupils. Though school zones have been established, there is no special traffic control installations.

c. Sidewalk and Portal

In CBD, ordinary sidewalks (a width of 1.5 ∿ 5.0 m) and spaces called "Portal" (a width of 3.0 m) are provided for pedestrians, as shown in Figure 6-1.3.

Figure 6-1.3 PROVISION OF SIDEWALK AND PORTAL



Every road side building is required to provide the "Portal" as pedestrian spaces under the City Planning Law, with a width of (3.0 m) and of concrete structure. However, the construction of these "Portal" itself depends on each building owner, and as a result, different types of "Portals" have been constructed. The uneven height of "Portals" make it difficult not only for the handicapped people, aged people and children, but also the ordinary pedestrians to walk on these "Portals".

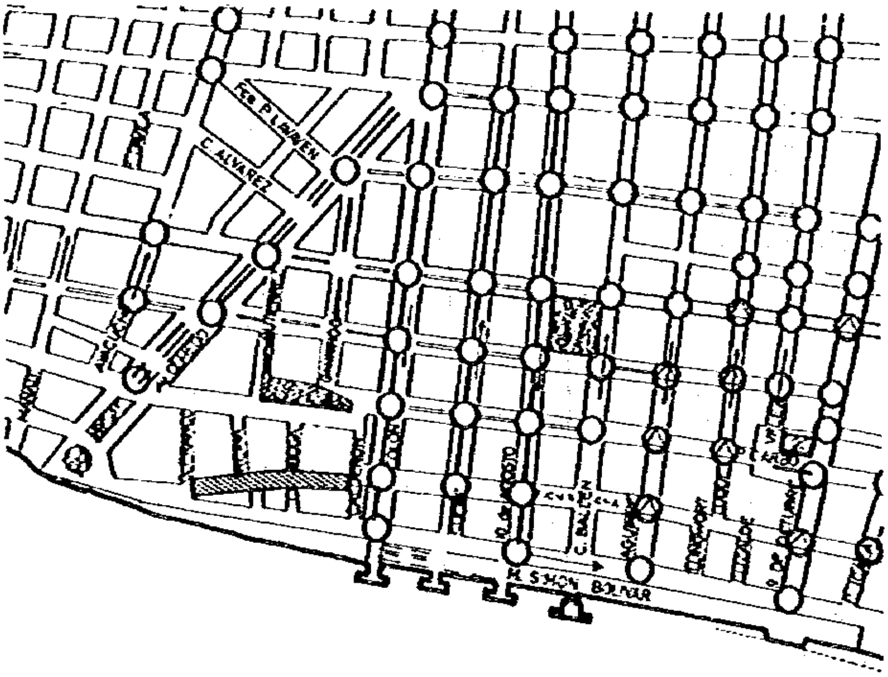
It is necessary to provide a good walking environment as well as amenity for pedestrians in CBD.

7) Existing Traffic Management Problems

a. Av. Villamil

This road is called "BAHIA", attracting many shoppers with its cheap bargains. This road, with many bus routes passing through it, is an one way street towards the south direction, while both H. Simon Bolivar and Av. E. Alfaro - Av. P. Carbo parallel to this road are one way streets towards the north direction. This road contains a concentration of many vehicles, not only buses but also taxies and private cars. This high density of vehicles and pedestrians is the chief

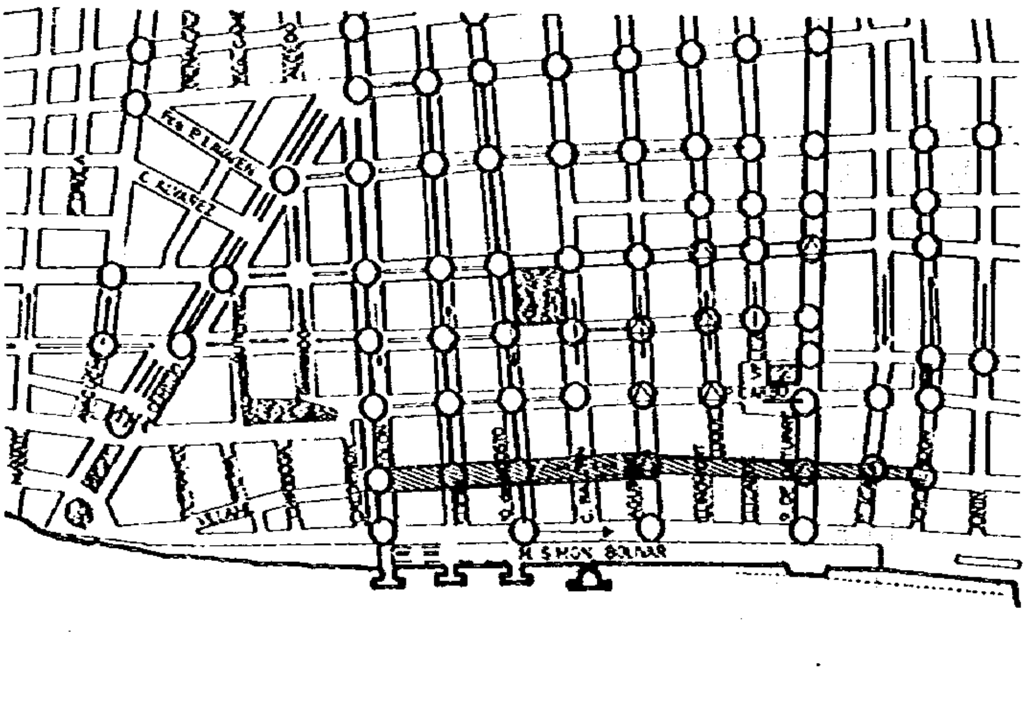
Figure 6-1.4 LOCATION MAP OF AV. VILLAMIL



reason for the poor urban environment with no smooth pedestrian and traffic flows. Many traffic accidents (200 accident/Km. year) have occurred on this road, making it to be known as the most dangerous road in the city.

b. Av. Pichincha

Figure 6-1.5 LOCATION MAP OF AV. PICHINCHA



Located to the northern section of this road, near to Av. 9 de Octubre, are many banks. This agglomeration of banks generates a high volume of pedestrians as well as vehicles, producing severe traffic jams.

At the southern portion of this road, between Av. Colon and Av. Agiurre, the carriageway width is wide but the central part of the carriageway is utilized as parking spaces. Many heavy trucks often park near to Av. Villamil, where many warehouses as well as machine-parts suppliers are located. These parked vehicles are an obstruction to the traffic flow. Many pedestrians are found crossing the carriageway near to the Municipio and the Gobernacion.

c. Av. Olmedo (Figure 6-1.6)

This road is the widest road in CBD, with its carriageway width ranging from 34.6 m (North-West portion) to 51.8 m (South-East portion). However, usages of the carriageway are different at different portion of this road, and hence, vehicles passing through are forced to change lanes everytime they cross an intersection.

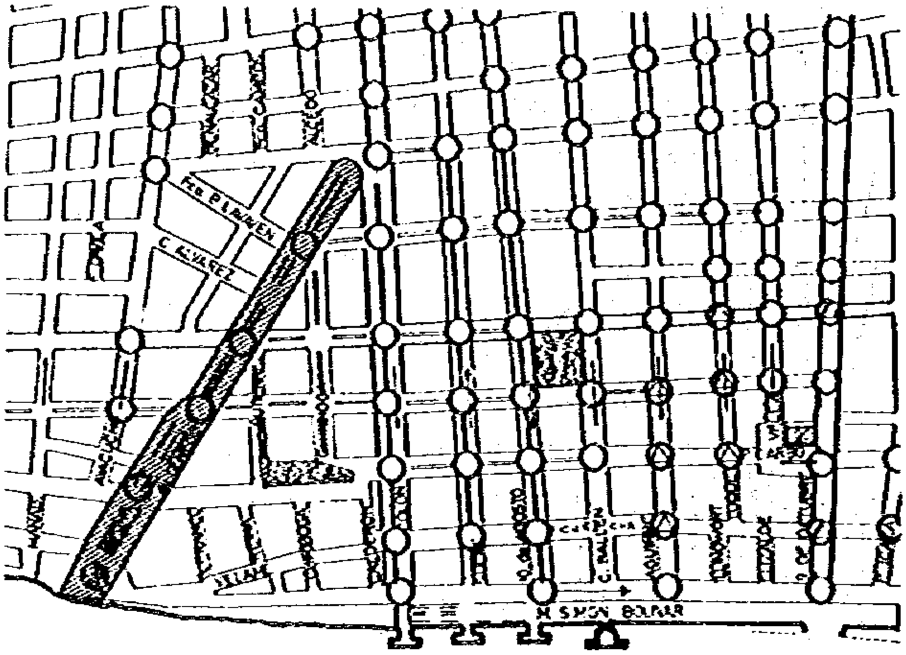
The area of each intersection is very wide, there exists even a 5-leg intersection. Road markings for channeling traffic flow at intersections are not provided. As a result, traffic flows at intersections are often chaotic and this situation is the reason for the frequent traffic jams as well as the many traffic accidents.

It is recognized that the whole stretch of this road needs to be improved.

d. Av. 9 De Octubre (Figure 6-1.7)

This road is the main-street in CBD, where many large and expensive shops, restaurants and hotels are located. This road is the hub of Guayaquil.

Figure 6-1.6 LOCATION MAP OF AV. OLMEDO



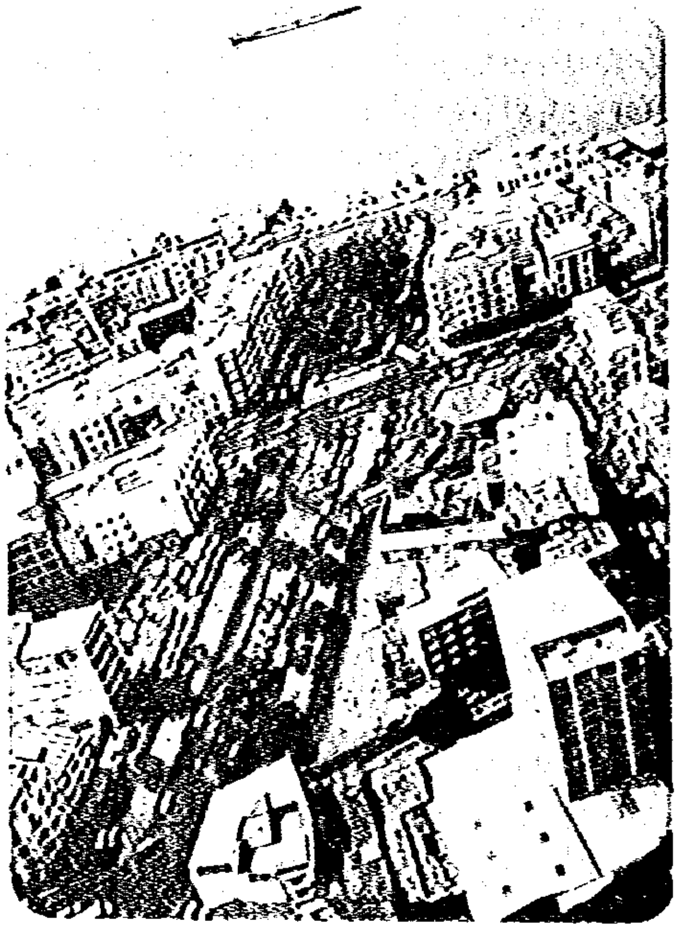
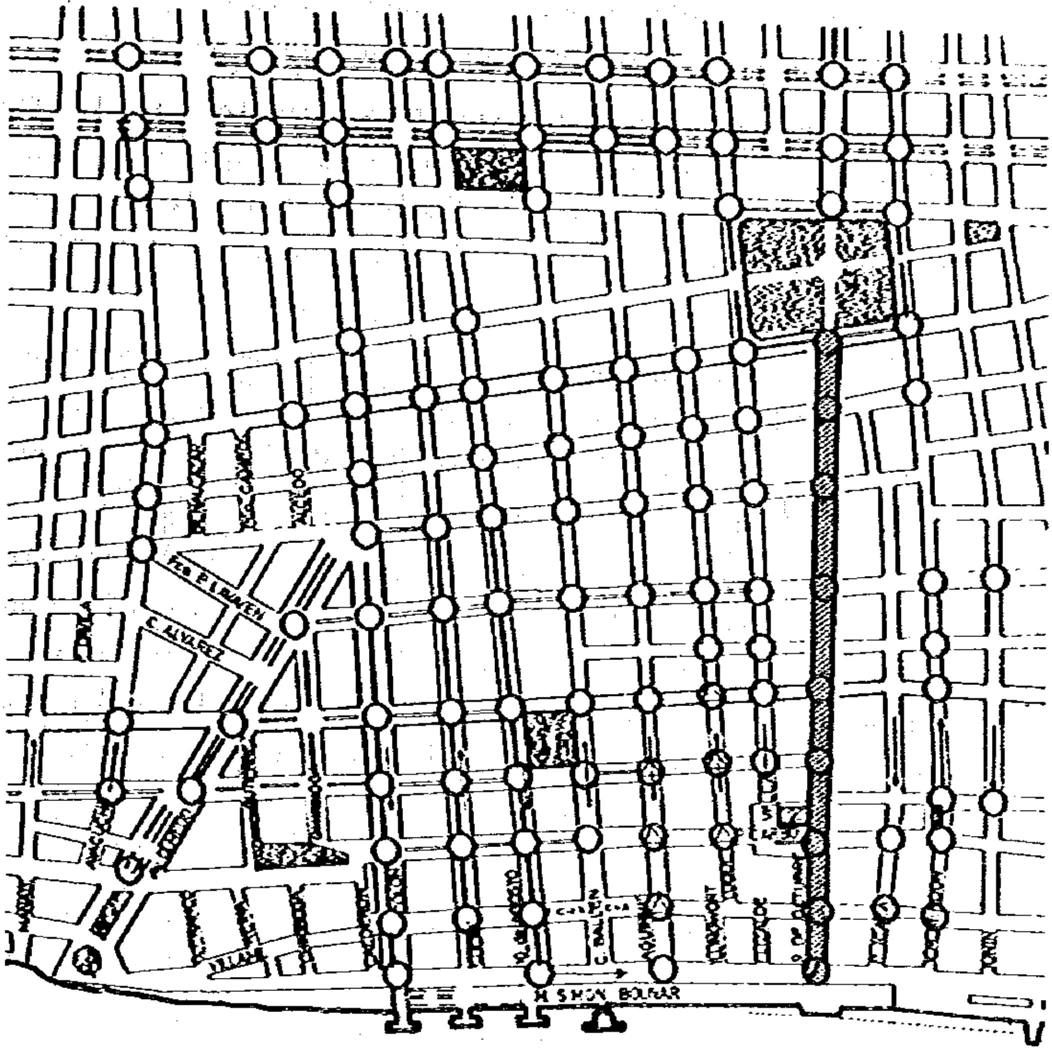


Figure 6-1.7 LOCATION MAP OF 9 DE OCTUBRE



This is the only road that is utilized as a two-way street in an East-West direction. Its traffic volume is rather high, due to the small capacity of other parallel roads.

A large portion of the traffic is diverted into the North-South direction roads, generating many left and right turning movements. In fact, left turning movement on this road at some intersections are forbidden and it is supposed that many vehicles are making detours.

In spite of the heavy traffic volume on this road, many parked vehicles can be found and most of them are parked there for the whole day, while only a short stretch of this road is free of any parked vehicles.

Under these situations, many problems, such as traffic accidents between pedestrians and right turning vehicles and frictions between passing and parking vehicles have arisen. The number of traffic accidents occurred on this road between the Parque Centenario and M. Simon Bolivar (about 1 Km.) in 1980 was as high as 113.

e. Other Problems

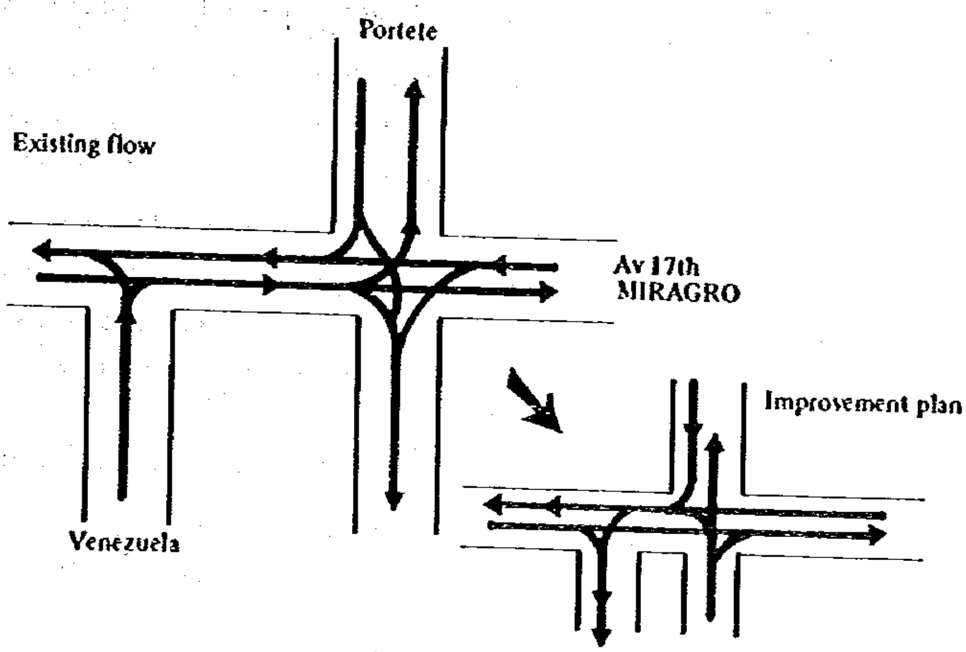
Other problems related to traffic management are described below.

e-1 Av. Portete and Av. Venezuela

Av. Portete is utilized as a two way street west of Av. 17th Milagro, but an one way street east of Av. 17th Milagro with a east bound direction; while Av. Venezuela is utilized as an one way street with a west bound direction (see Figure 6-1.8).

Therefore, traffic flow lines at the two intersections at Av. 17th Milagro with Av. Portete and Av. Venezuela are very complicated (as shown in Figure 6-1.8), leading to frequent traffic jams and traffic accidents. As many as 28 traffic accidents had occurred at these two intersections in 1980.

Figure 6-1.8 TRAFFIC FLOW LINE AT AV. 17TH MILAGRO/ AV. PORTETE/AV. VENEZUELA INTERSECTION



e-2 Separators

Many physical separators have been installed as median dividers on dual carriageway roads as well as dividers separating high speed vehicles from the low speed vehicles, such as buses, in Guayaquil.

Usually, such installations of separators are very effective for long stretches of roads, since they can prevent severe traffic accidents, such as head on collisions, and can improve the running condition of roads by separating low and high speed vehicles. At some points, these separators provide a safer walking environments for pedestrians.

Unfortunately, in Guayaquil, many roads are utilized as one way streets and distances between intersections are very short, as the result that the positive effects of the separator installation in prohibiting traffic from changing and weaving lanes are lost. Traffic changing lanes are concentrated at intersections, and with it are the through traffic, right and left turning traffic, all mixed up at the intersections. This chaotic state is a potential traffic hazard.

6-1.2 Policy and Scheme for Improvement

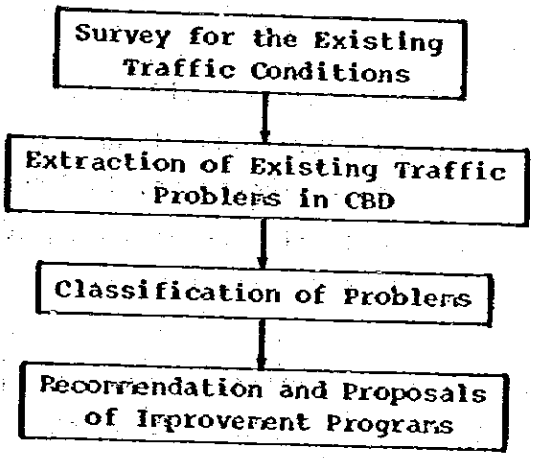
1) Improvement Policy

The basic policy of the short-term improvement programs is to provide plan for improving the existing traffic system, making full use some of the merits of the existing system and for solution of traffic problems, excluding big changes of urban structures and large scale construction work.

Considerations are given in coordinating the short-term improvement programs with the long-term improvement ones. Some of the short-term improvement programs are hence based on the long-term improvement programs.

2) Planning Procedure

The short term improvement programs has been planned by following procedure.



3) Existing Traffic Problems and Major Points for Improvement

Major existing traffic problems in Guayaquil are traffic congestions and traffic accidents. Therefore it is necessary to solve these problems at the first stage.

Countermeasures for traffic congestions can be considered as follows:

(1) Control of traffic generation points
(2) Increments of traffio capacity for traffic lanes

(3) Rectification of traffic flow
(4) Modal change to mass transportation systems.

The control of traffic generation points is considered under the land use plan in this Study and the control of rapid swell of the existing CBD is recommended. And also, introduction of MRT system is recommended in this Study to facilitate modal change.

Therefore, increment of traffic capacity for traffic lines and rectification of traffic flow, by short-term as well as without large scale investment, are recommended under this section.

4) Increments of Traffic Capacity for Traffic Lines

Increments of traffic capacity can be achieved by following procedures.

(1) Widening and improvement of carriageways
(2) Improvement of intersections
(3) Removal of obstructions, such as road side parkings on carriageways.

Within these countermeasures, widening of carriageway require large scale alignment modifications, long-term construction period and large scale investment. Therefore, following countermeasures can be considered as the short-term improvement programs for increments of traffic capacity.

(1) Improvement of carriageways
(2) Improvement of intersections
(3) Removal of obstruction, such as road side parkings on carriageways.

Each countermeasures can be effective by individual implementation. However, it can be more effective if these countermeasures will be implemented jointly.

In Guayaquil, improvement of carriageways can be achieved by demolishment and modification of center dividers, while removal of obstruction can be conducted by road side parking control. In addition, improvement of intersection should be related with improvement of carriageways, such as at Av. Olmedo and Av. 25 De Julio. At the last, it is recommended to modify roundabouts to signalized and cross or right angle intersections.

5) Rectification of Traffic Flow

It can be expected to decrease traffic congestion by rectification of random traffic flow, and following procedures can be considered.

(1) Improvement of intersections
(2) Installation of traffic signals.

Improvement of intersections are based on the long-term improvement programs, which include grade separation for future traffic volume increase, and locations and improvement procedure by the short-term improvement programs are described in the next section.

Individual installation of traffic signals can be effective. However, it is necessary to operate the existing traffic signal system more effectively. Therefore, it is recommended to install traffic signals in parallel with effective operation of the existing system, and implementation should be by stages for improving their functions.

6) Traffic Safety

The situation of traffic accidents in Guayaquil is described in the former section. It is rather difficult to expect improvement effects for traffic safety within the short-term improvement program stage. However, it is necessary to start implementation of countermeasures as soon as possible.

For the traffic safety, it is recommended to consider following countermeasures.

(1) Analysis of traffic accident situation
(2) Traffic safety measures for pedestrians
(3) Improvement of traffic signal operation.

As traffic safety measures for pedestrians, improvement of sidewalks and pedestrian crossings, and installation of pedestrian signals can be considered.

7) Others

Above countermeasures should have close relation between each other and each countermeasure should be implemented in parallel with others.

In the next section, each short-term improvement program is described in detail, which includes location, countermeasures, stages, etc. At the same time, countermeasures for special problems in Guayaquil are also described.

6-1.3 Recommendations and Proposals

1) Intersection Improvement

8 main intersections to be improved are listed on Table 6-1.4.

2) Separators

a. Total CBD Area

Many separators are installed on one way streets and changing lane activities are thus concentrated at intersections. To solve these problems, it is recommended that the existing separators on one way streets be removed and to widen the side-walks. With these countermeasures, it will be possible to regulate traffic flow, to provide a good walking environments for pedestrians and to maintain roadside trees easily.

b. Av. Olmedo

Usages of the carriageway are different at different section of this road. Therefore, vehicles passing through are forced to change lanes everytime they cross an intersection. As a result, traffic flows at intersections are often confusing. To solve these problems, it is recommended that the carriageway and center divider be modified giving a uniform width for the whole length of this road.

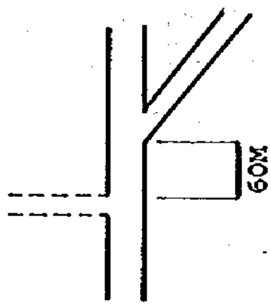
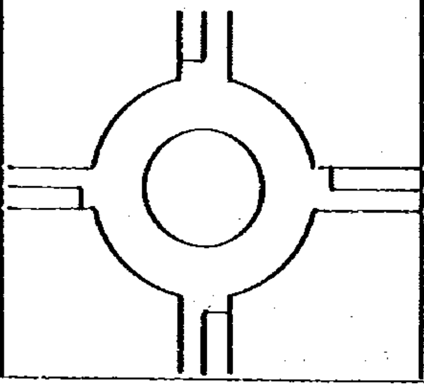
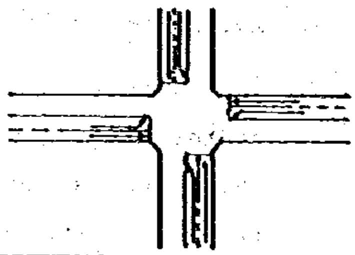
c. Av. Quito & Av. Machara

Both of these roads are utilized as one way streets and are facing the same problem as in CBD. The high running speed of vehicles is creating a dangerous situation. To solve these problems, it is recommended that the separators be removed, and to provide proper road markings and transfer the street lights.

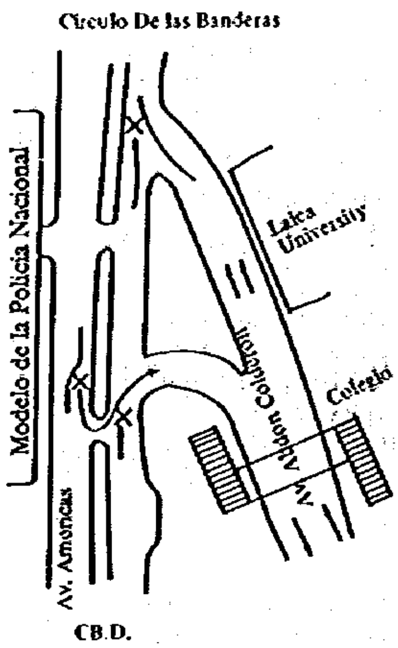
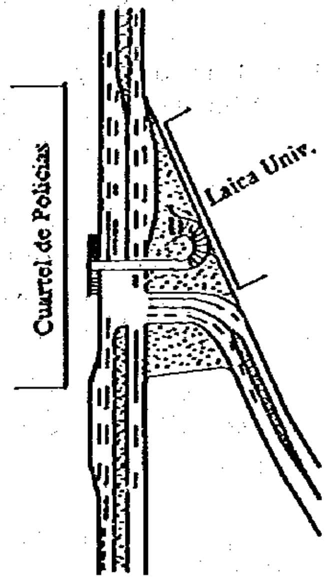
d. Av. 25 De Julio

This road is utilized as a dual carriageway and a wide center divider is provided. However, this center divider is not opened at most major crossing roads as well as major traffic generation points. This generates many detour traffic and

Table 6-1.4 INTERSECTIONS IMPROVEMENT

Name of Intersection	Problems	Countermeasures
a. Airport Entrance	. Wide intersection area. . Diagonal crossings of traffic flow. . No installation of traffic signal.	. To narrow down the airport entrance and exit. . To change it into T-intersection. . To provide additional left and right turning lanes on Av. Americas. . To install traffic signal.
b. Circulo Guayas Y Quil	. Small roundabout with 3 legs. . No installation of traffic signal. . No provision of road markings. . Total daily traffic volume exceeding 50,000 vehicles. . A new road will be constructed in the near future as shown below. 	Stage improvements are necessary for this intersection. . First stage. To classify the priority of each traffic flow, to provide stoppage line and to install traffic signals. . Second stage. To change intersection location to the proposed new road connection point and to install traffic signal. . Third stage. To form a new intersection with a new road. . Forth stage. To build grade separated intersection.
c. Circulo De Las Bandelas	. Signalized small roundabout 	. To change it into a right-angled intersection with provision of additional turning lanes. 

Intersection Name	Problems	Countermeasures
d. Emiciclo Bloy Alfaro	• Total incoming traffic volume is 86,000/16 hours. • Roundabout with traffic signal control. • A bus stop is located in the intersection. • Many pedestrians are found at this intersection. However, road markings and traffic signal for pedestrians are not provided.	• To build grade separated intersection in the long-term • To change it into a right-angled intersection and to provide proper road markings for controlling traffic flow. • To move the bus stop to Av. Americas. • To provide road markings and traffic signal display for pedestrians.
e. Intersection in front of the Laica University	• No installation of traffic signals. • Center dividers are not properly installed. • Pedestrian crossings are not clearly marked. • Many people are concentrated around. This situation is causing problems in road side parkings, bus stops, etc.	• To change intersection into a T-junction and to install traffic signals. • To re-arrange center dividers, and to provide bus bays and an additional left turning lane. • To provide proper road markings and to prohibit road side parkings. • To build grade separated intersection in the long-term.

Intersection Name	Problems	Countermeasures
		
f. Ovalo De La Pileta	. An oval shaped roundabout with traffic signal control. . Different cleanrance time for incoming directions. . Many pedestrians.	. To change the roundabout into a signalized right-angled intersection. . To install traffic signal display for pedestrians and to provide proper road markings.
g. Av. C.J. Arosemena y Av. Milaflores	. Av. Milaflores is utilized as one way street toward Av. C.J. Arosemena, However, traffic control devices toward Av. Milaflores remain on Av. C.J. Arosemena. (Dangerous)	. To widen Av. Milaflores as a dual carriageway or to remove the traffic control devices on Av. C.J. Arosemena.
h. Av. Quito y El Oro	. Signalized roundabout. . 58 accidents occurred in 1980. (Dangerous)	. To change it into a right-angled intersection and to provide proper road marking and warning sign.

U-turn movement causes traffic accidents. To solve these problems, it is recommended that the center divider at major intersections be modified.

3) Traffic Signals

To improve the traffic signal and its system, it is necessary to introduce an improvement program by stages, as shown below.

a. First Stage

- To install signal displays for both sides, even on one way streets.
- To install pedestrian signals.
- To install automatic detectors to collect traffic data for the introduction of multi cycles, splits and offsets system.

b. Second Stage

- To introduce multi cycles, split and offsets system to the existing facilities.
- To connect automatic detectors with traffic signals and to operate them as vehicle actuated signals.

c. Third Stage

- To introduce multi programing type traffic signals and to operate them by a line control system.
- To consolidate the operation system with proper administration.

d. Forth Stage

- To start an operation of an area control system as well as a real time control system.
- To introduce an information system of traffic conditions.

4) Parkings

In CBD, capacity of road networks is greatly decreased due to road side parkings. Besides, the duration of these parkings is usually long because of the cheap registration fee for the parking lots. It is necessary to constrain roadside parkings by stages, as described below.

a. First Stage

- Re-utilization of road side parking meters.
- To increase parking charges at road side, especially for long parking duration vehicles.

b. Second Stage

- To constrain road side parkings.
- To consolidate parking spaces on roads to other places, such as the existing bus terminal site after its transfer, underground parking spaces, etc.

c. Third Stage

- To implement strict order of compulsory provision of parking in buildings fronting certain major roads and the construction of public parking spaces.
- To provide guidance for the construction of parking facilities by private sectors.

5) Other Points for Improvement

a. West Side Road of Atarazana Area

Due to the low capacity of Av. Americas, vehicles tend to converge onto this road giving a heavy traffic volume. Both ends of this road are connected with Av. Pedro Menendez and Av. Urdesa Norte, which are also carrying heavy traffic volumes.

It is necessary to increase the traffic capacity of Av. Americas, and at the same time, it is recommended that traffic signals at intersections of West Side Road with Av. Pedro Menendez and Av. Urdesa Norte be installed.

b. Provision of Good Pedestrian Environment

It is recommended that a good pedestrian environment be provided, such as the introduction of pedestrian malls and widening of sidewalks, so as to decrease traffic accidents and traffic pollutions, securing pedestrian safety and amenity. One of the major objective of this improvement is to prevent any declines and desolation of urban activities caused by the restrain traffic volume; and to promote the upgrading of shopping areas in CBD. Besides, these improvements will be able to eliminate through traffic there.

The following improvements measures are recommended to provide a good pedestrian environment.

a. Utilization of Av. Villamil as a shopping mall.
b. Utilization of Av. Ciriboga and Av. Luzurraga at the school and hospital zones as pedestrian malls.
c. Widening of sidewalks on Av. 9 de Octubre, Av. Pichincha, Av. Olmedo, Av. Boyaca, Av. Chile, and Av. Clemente Ballen.

c. Traffic Safety

To secure traffic safety, the following improvements are recommended.

a. To introduce an authentic reporting system for traffic accidents, and a statistical analysis for them.
b. To set up an organization to conduct traffic safety activities.
c. To conduct a detailed and concrete study for traffic safety measures.

d. Av. Portete and Av. Venezuela

To alleviate the congestion on both roads, it is recommended that the east bound one way of Av. Portete be changed over to a west bound direction, while Av. Venezuela takes over a east bound function.

e. Pavement

Pavements are maintained in good condition in CBD, while not in the surrounding area, especially in the western part (Portete) and the southern part (Guasmo), resulting in concentration to the major roads in good condition. It is recommended that the following roads be paved and maintained well.

a. Bus routes
b. 2 or 3 parallel roads with Av. Portete
c. Av. Monsenor Domingo Camin

6) Summary of Short Term Improvement Programs

Short term improvement programs are summarized as under.

(1) Intersections

- . Airport entrance
- . Círculo Guayas y Quil
- . Círculo De Las Banderas
- . Front of Laica Univ.
- . Emicido Eloy Alforo
- . Óvalo De La Piléta
- . Av. C.J. Arosemena y Av. Miloflores
- . Av. Quito y El Oro

(2) Separators

- . Total CBD area
- . Av. Olmedo
- . Av. Quito & Av. Machara
- . Av. 25 De Julio

(3) Traffic Signals

- . 1st - stage
  Installation of signals for pedestrian and data collection
- . 2nd - stage
  Multiple use of existing facilities and real-time sytem
- . 3rd - stage
  Introduction of line control system and operating system
- . 4th - stage
  Introduction of area control system and information sytem

(4) Parking

- . 1st - stage
  Re-utilization of road side parking meters and raising of parking charge
- . 2nd - stage
  Constraint of road side parking and construction off street parking lots
- . 3rd - stage
  Provision of parking regulation and construction of parking buildings

(5) Other Improvements

- Improvement of the west side road of Atarazana area
- Provision of good pedestrian environment
- Improvement of traffic safety
- Exchange of one way system between Av. Portete and Av. Venezuela
- Improvement of un-paved roads

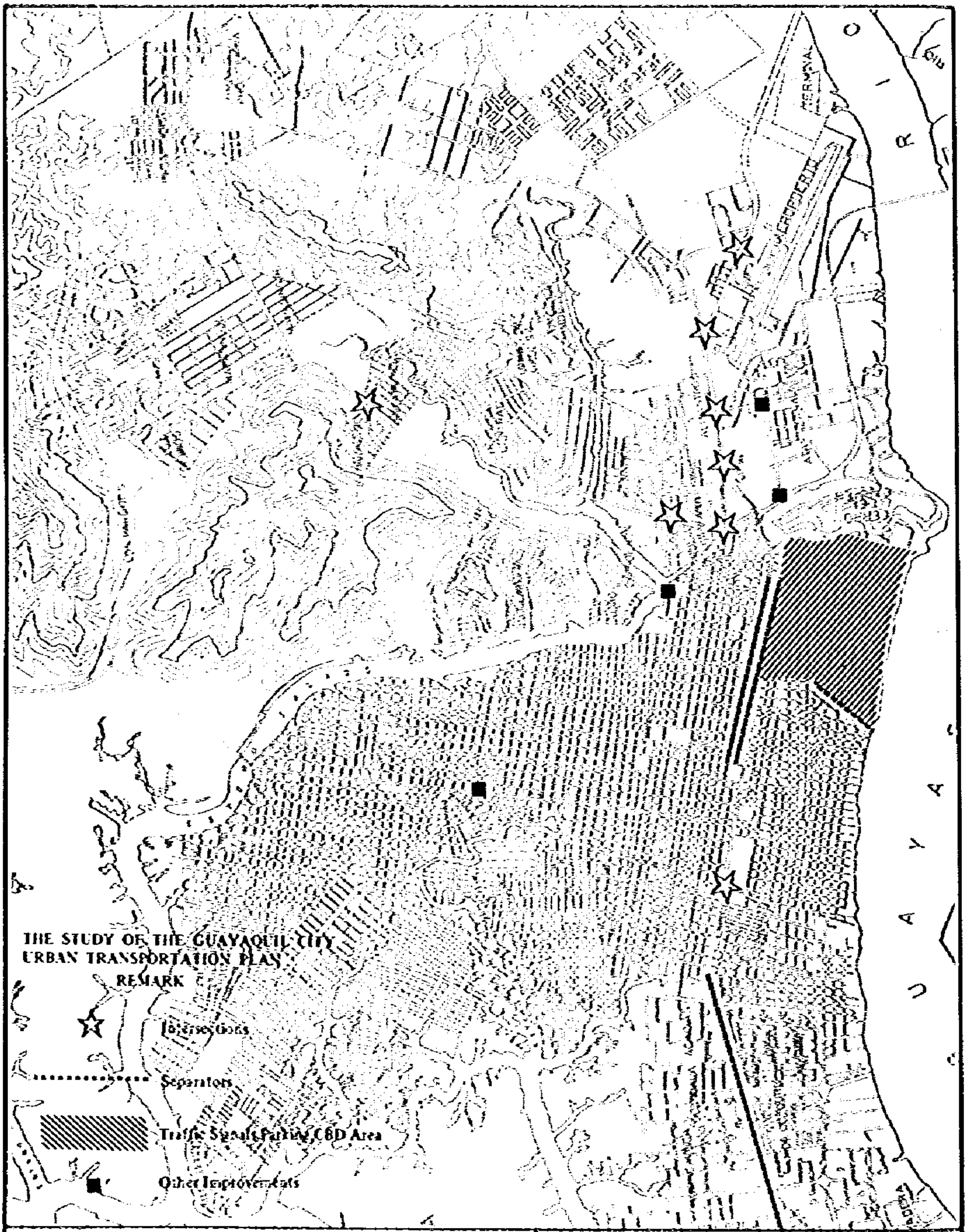


Figure 6-1.9 LOCATION MAP OF SHORT TERM IMPROVEMENT