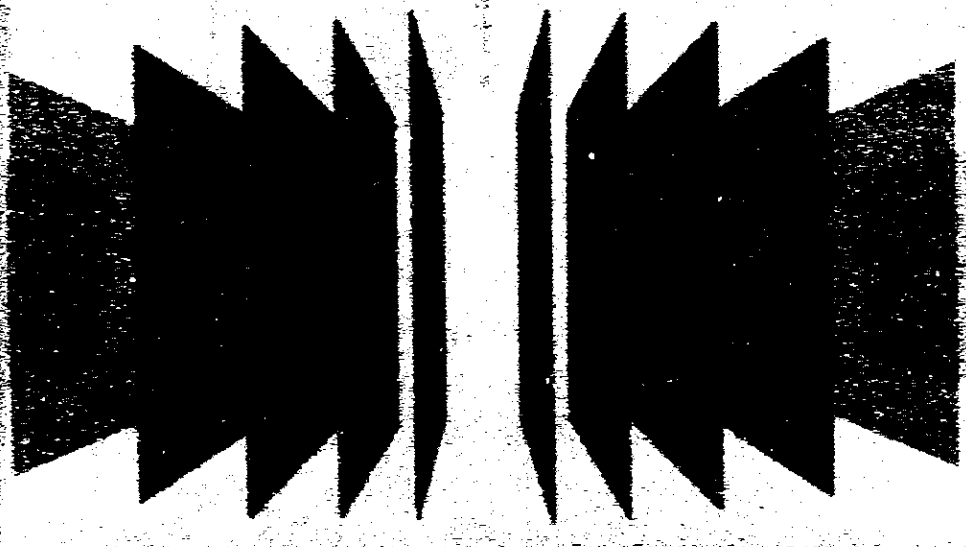
THE STUDY OF THE GUAYAQUIL CITY URBAN TRANSPORTATION PLAN IN THE REPUBLIC OF ECUADOR



FINAL REPORT (SUMMARY)

AUGUST 1983

JAPAN INTERNATIONAL COOPERATION AGENCY

THE STUDY
OF
THE GUAYAQUIL CITY
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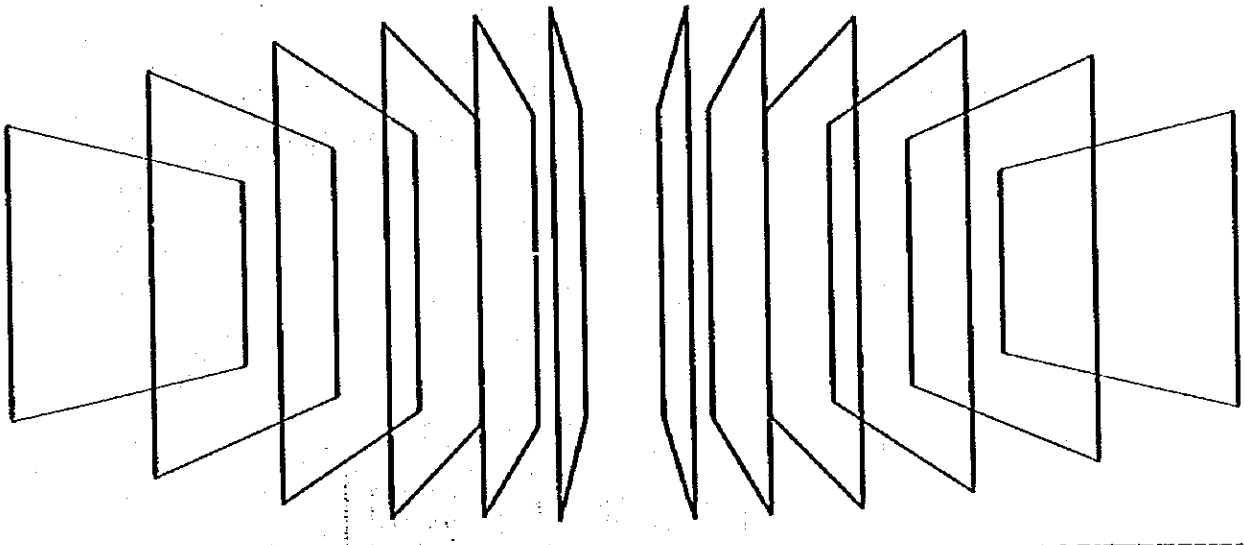

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PREFACE

In response to the request of the Government of the Republic of Ecuador, the Government of Japan decided to conduct a study on The Guayaquil City Urban Transportation Plan and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA sent to Ecuador a study team headed by Dr. Kaoru Ichihara from April 1982 to February 1983 under the guidance of the Supervisory Committee chaired by Dr. Yoshiji Matsumoto, Professor of the University of Tokyo.

The team held discussions with the officials concerned of the Government of Ecuador on the Plan and conducted a field survey in Ecuador. Subsequently, further studies were made in Japan and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

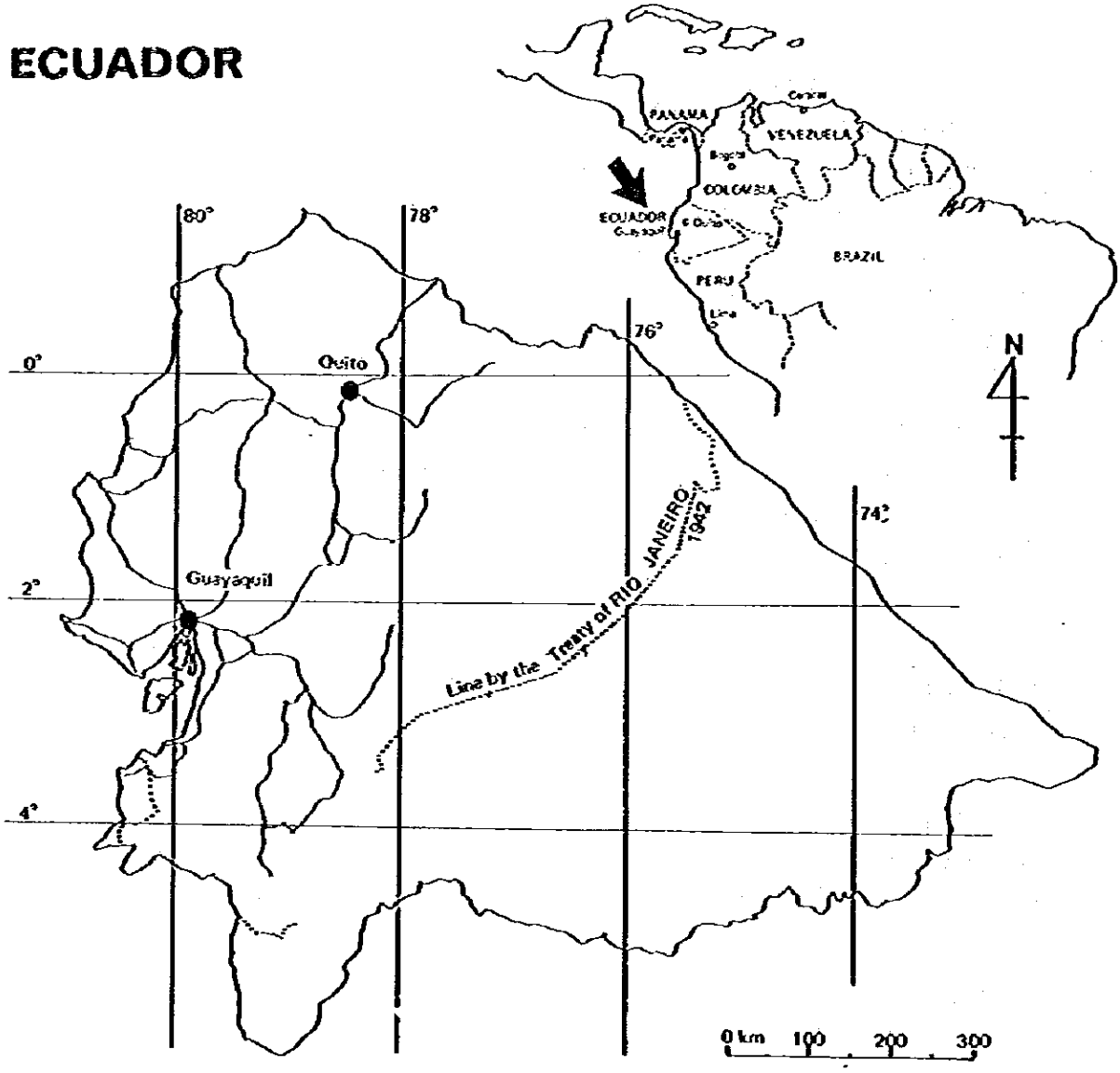
I wish to express my deep appreciation to the officials concerned of the Government of Ecuador for their close cooperation extended to the team.

August, 1983

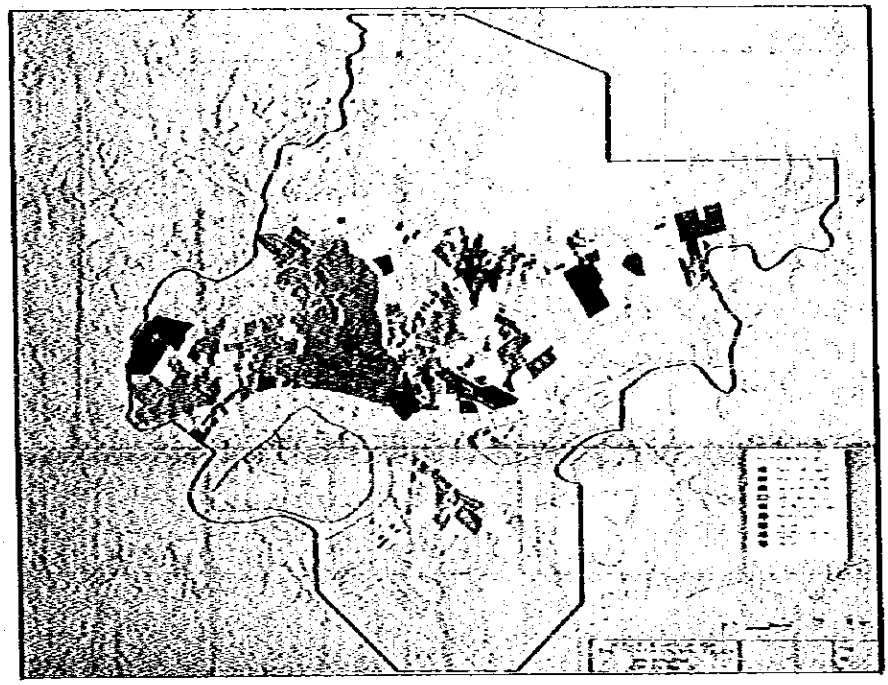
Keisuke Arita

Keisuke Arita
President
Japan International Cooperation Agency

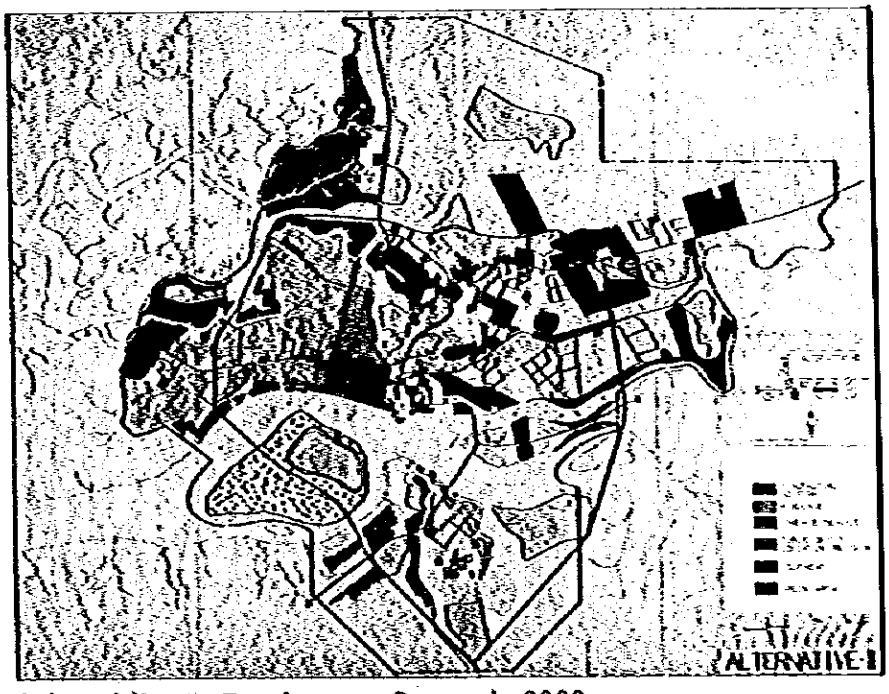
ECUADOR



Area	:	270,670 Km² (after 1942)
Population & Growth Rate	:	8,945,000 (1982), 3.43%/year (74–82)
Gross Domestic Products	:	11,400 Mil. US$ (1980, 24.95 S/$, official rate)
GDP per Capita	:	1,365 US $ (1980)
Productive Structure	:	Agriculture 18.6%, Mine & Manufacture 32.3%, Services, etc. 49.1% (1979)
International Trade	:	Export 1,557 M.US$/Import 1,325 Balance 232 M.US$ (1978)
National Budget of Government	:	2,038 M.US$ (1981, 24.95 S/$)
Index of Consumer's Prices	:	12.6%/year (1980), 13.4 (81)
Foreign Money Exchange Rate	:	US 1 $ = 33 Sucres in official/50 S. in free market (June, 1982)



Existing Conditions of Land Use



Selected Future Development Pattern in 2000
(Alternative–III : Linear Development Type toward the northern area)

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1. INTRODUCTION

1-1 GENERAL SITUATION AND STUDY OBJECTIVE

Due to the intensive economic development and population increase, and in addition, to the very unique geographical configuration of the urban area, Guayaquil city is already confronted with various urban transport problems such as traffic congestion all day long in the central area, bottlenecks around the central area from each direction, insufficient supply of public transport to meet the demand, etc.

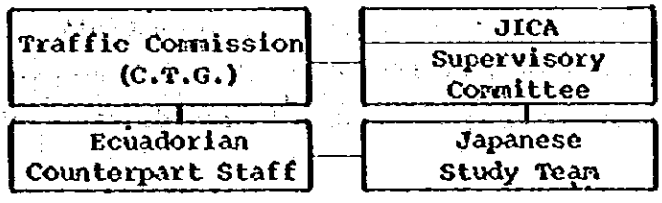
Since the present urban area has high density population, room for new settlement and industrial activities in the future is now being sought mainly in the vast plain left undeveloped in the northern area.

In view of the existing transport problems and to cope with foreseeable future developments, it is imperative for the city that development of the urban transport system be urgently carried out. The objective of the Study, therefore, is to formulate the plan for the urban transport system in Guayaquil, prepare possible solutions and propose their implementation programs under the selected land development pattern in the year 2000. The Study presents its results in two plans:

1. Long-term transportation plan (master plan) which targets the year 2000.
2. Short-term improvement plan which utilizes and develop the existing transport facilities most effectively.

1-2 STUDY ORGANIZATION

The Study was carried out by JICA (Japan International Cooperation Agency) in close cooperation with the Traffic Commission (C.T.G. Comision de Transito del Guayas) that is in charge of the Study under the Government of Ecuador, in coordination with other related agencies. It started in April, 1982 and terminated in July, 1983. The Study organization is as follows:



2. CONCLUSION AND RECOMMENDATION

2-1 CONCLUSION

(1) Long-term Transportation Plan

Combination plans of the road network and MRT (Mass Rapid Transportation system) plan will be an essential condition to solve the present congestion, meet the numerous traffic demands in the future and compose the basic axes for the urban development targetted.

In addition to the combination plans, the proposed improvement plan of bus transport and its coordination with MRT will be also essential to maximize the effect of the palns.

a. Proposed Road Network

The proposed road network, which developed on-going projects by MOP (Ministerio de Obras Publicas) and the Municipality of Guayaquil, is fundamentally composed of a ring and radial system, and it purposes to solve the bottlenecks around the central area, distribute the traffic concentration in the central area and promote the development of the northern area, by the basic form shown in Figure S-8 (page at S-21).

The target and priority of the major pojects in the proposed road network are recommended as shown in Table S-6 (page at S-42).

On executing these projects, prudent considerations should be paid so as to produce the most satisfactory results in coordination with the stages of MRT route construction.

b. MRT Plan

The MRT plan is composed of two basic lines (see Figure S-11, page at S-27), corresponding to the main traffic routes which extend to the four directions from CBD (Central Business District: Casco Central). It purposes to absorb the road traffic dramatically, improve and activate the public transport system in coordination with buses, and

give an important push to promote the desired urban development. As the result of careful examination of several combinations in the route alignment, the target and priority of implementation are recommended as shown in Table S-7 (page at S-43).

As for the alternative MRT systems, any of four systems (Urban Railway, Light Rail Transit (LRT), Monorail and Rubber Tyre Type Railway) except Subway will produce benefits over its cost, and Urban Railway is the most promising in cheap investment, large transport capacity, ease in maintenance, flexibility to cope with more demand in the future, etc.

c. Improvement of Bus Transport and Coordination with MRT

In order to maximize the effects of the above road and MRT plans and to confirm a comprehensive urban transport system, the bus transport which plays very important role in daily traffic is requested to be improved according to the following items:

1. Basic improvement such as increase of transport capacity, augmentation of suppliers, etc.
2. Coordination of bus route with MRT
3. Improvement of public transport system and traffic management in CBD

d. Implementation Program

d-1. Phasing plan of projects implementation

The following implementation program up to 2000 was formulated based on considerations and comparison between project costs and conventional financial sources applicable to transport infrastructure in the Study Area.

Phase-1

1983 - 85 : Preparatory work of phase-2 projects, the half of on-going road projects by MOP and Municipality.

Phase-2

1986 - 90 : 1st-priority projects of both the road and MRT in the long-term transportation plan.

(Note):

Examination of Long-term Transportation Plan at Phase-2 Stage in 1990:

Effectiveness of the long-term transportation plan at the end of this phase-2 stage in 1990 was examined from the engineering and economic aspects, and proved not only to be very useful to meet the traffic demand in 1990 and confirm the urban structual axis toward the northern area, but also to be quite important to realize the final goals of the long-term plan steadily.

Phase-3

1991 - 95 : 2nd-priority projects of the road and MRT in the long-term, the rest half of on-going road projects.

Phase-4

1996 - 2000: Final projects of the road and MRT in the long-term plan

(As for the priority of the projects, see Table S-6 page at S-42 and Table S-7 page at S-43)

d-2. Perspective for financial sources applicable to projects

It is possible to draw the following perspective although the projection was based on unconfirmed factors:

1. If the growth rate of 6.5%/year in national economy set by the National Development Plan (1980-84) shall continue up to 2000, the conventional financial sources applicable to transport infrastructure in the Study Area shall be able to cover the whole road project cost and 2/3 of the MRT cost.

2. If the growth rate in national economy decreases to 5.0%/year, it shall cover also the whole road project cost but only 1/3 of the MRT cost.

(2) Short-term Improvement Plan

The policy of the short-term improvement plan is to make full use of the present traffic and transport system, giving careful consideration in coordinating the short-term programs with the long-term transportation plan.

The following measures should be put into an early action effectively:

a. Traffic Engineering and Management

1. Improvement of intersections
2. Improvement of separators
3. Installation of traffic signals and introduction of control system for them
4. Limiting road side parking and construction of off-street parking lots
5. Other improvements

b. Bus Transport

Many subjects ranging over users' problems, suppliers' and administrative aspect, were grouped into the following programs. These measures also should be put into an early action effectively.

1. Early action programs

   Improvement of bus routes, bus fleets, bus stops, etc., establishment of bus lanes on wide roads, improvement of suppliers' organizations.

2. Re-organization of inter-regional routes after the completion of the Bus Terminal

c. Implementation Program

1. Phasing plan of measures implementation

   Phasing plans to execute measures above-mentioned are shown in Figure S-18 (page at S-52) for the traffic engineering and management, and Figure S-19 (page at S-53) for the bus transport.

2. As for the implementation of the short-term improvement plan, it is recommendable to be executed mainly by C.T.G. and its budget in the same way as it has been done so far.

2-2 RECOMMENDATION

The proposed master plan (Long-term transportation plan) would be essentially effictive for solving the transport problems in this urban area and promising its long-term development for better urban activities. It would be recommended that the plan be put into action as early as possible. At executing the plan, related projects sould 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, the policy of mid-term implementation in 1990 should be set to establish an urban structural axis along the main traffic route in the north-south direction, and construction of the MRT and improvement of the roads along this axis would be an indispensable first step to attain the goals in a short period.

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

3. OUTLINE OF STUDY

3-1 PLANNING CHARACTERISTICS

Planning characteristics that form the basis for the traffic forecasts consist mainly of economic development, size of the population and EAP (Economically Active Population), land development pattern, etc. They are summarized below.

3-1.1 Economic Development

Reviewing the trend of the economic development in the last decade and based on the target of National Development Plan (1980-84) by CONADE[1], the growth rate of Gross National Product per capita for the period 1982-2000 was set at 3.3%/year in net value. Since the population growth rate was estimated to be 3.4%/year in the whole country, that of GNP should require 6.7%/year to achieve the per capita GNP.

As for the EAP rate to the total population in the Study Area, its percentage was supposed to remain around 30%, almost equal to the present figure, until 2000 due to the high population growth rate mentioned below.

3-1.2 Size of Population

From the three kinds of population projections by INEC[2] and its premises on fertility, mortality and international migration, the Team adopted the second projection and distributed it to the Study Area. The size and growth rate are shown as under.

FORECAST OF POPULATION IN THE STUDY AREA

1,000 persons

	1982	1985	1990	1995	2000
Population	1,264	1,439	1,788	2,211	2,726
Growth rate %/year	4.62	4.42	4.44	4.34	4.27
	4.40 for 1982 - 2000				

1) Consejo Nacional de Desarrollo
2) Instituto Nacional de Estadisticas y Censos

3-1.3 Family Income and Vehicle Ownership

On analysing the results of the Trip Production survey, the present average family income and vehicle ownership in the Study Area were estimated to be 16,500 sucres/month in 1982 prices and 82 vehicles/1,000 population respectively.

The former was assumed to grow at 3.3%/year in net value, and the latter was projected to reach 150 vehicles/1,000 population by the year 2000.

3-1.4 Land Development Pattern in Future

Based on careful observation of the existing conditions in the land use by each zone, developing principals targetted in the future and the documents related to the land use laws and regulations, three conceptual alternatives of development patterns were prepared as shown in Figure S-1.

Alternative-III, Linear development type toward the northern area, was selected as the most recommendable to realize the better development and to activate this big city with 2.7 million population in 2000.

Table S-1 COMPARISON OF 3-ALTERNATIVES FOR CONCEPTUAL DEVELOPMENT PATTERN

Target Years 2000

	ALTERNATIVE -I	ALTERNATIVE -II	ALTERNATIVE -III
Type	TREND TYPE	NORTHERN DEVELOPMENT TYPE	LINEAR DEVELOPMENT TYPE
CHARACTERISTICS	• The existing central urban area (CUA), one big core, serving the whole Study Area.	• An additional new big core being developed in the center of the northern area. • Two big cores, the existing and the new, not linked each others.	• The compromise type between I and II. • Development being promoted linearly toward a new center, not big as in II, in the northern area.
POLICIES FOR DEVELOPMENT	• Widening the existing CUA to the peripherals, re-development and construction of highrise	• Transfering the principal functions in CUA to the new core in the north.	• Strengthening the developments oriented to the whole northern area. • Transfering some of the functions in CUA to a new center.
Durán	Developing a sub-core as a district center.		
Pascuales and the corridor along via Daule	Manufacturing industries to be developed in both areas.		

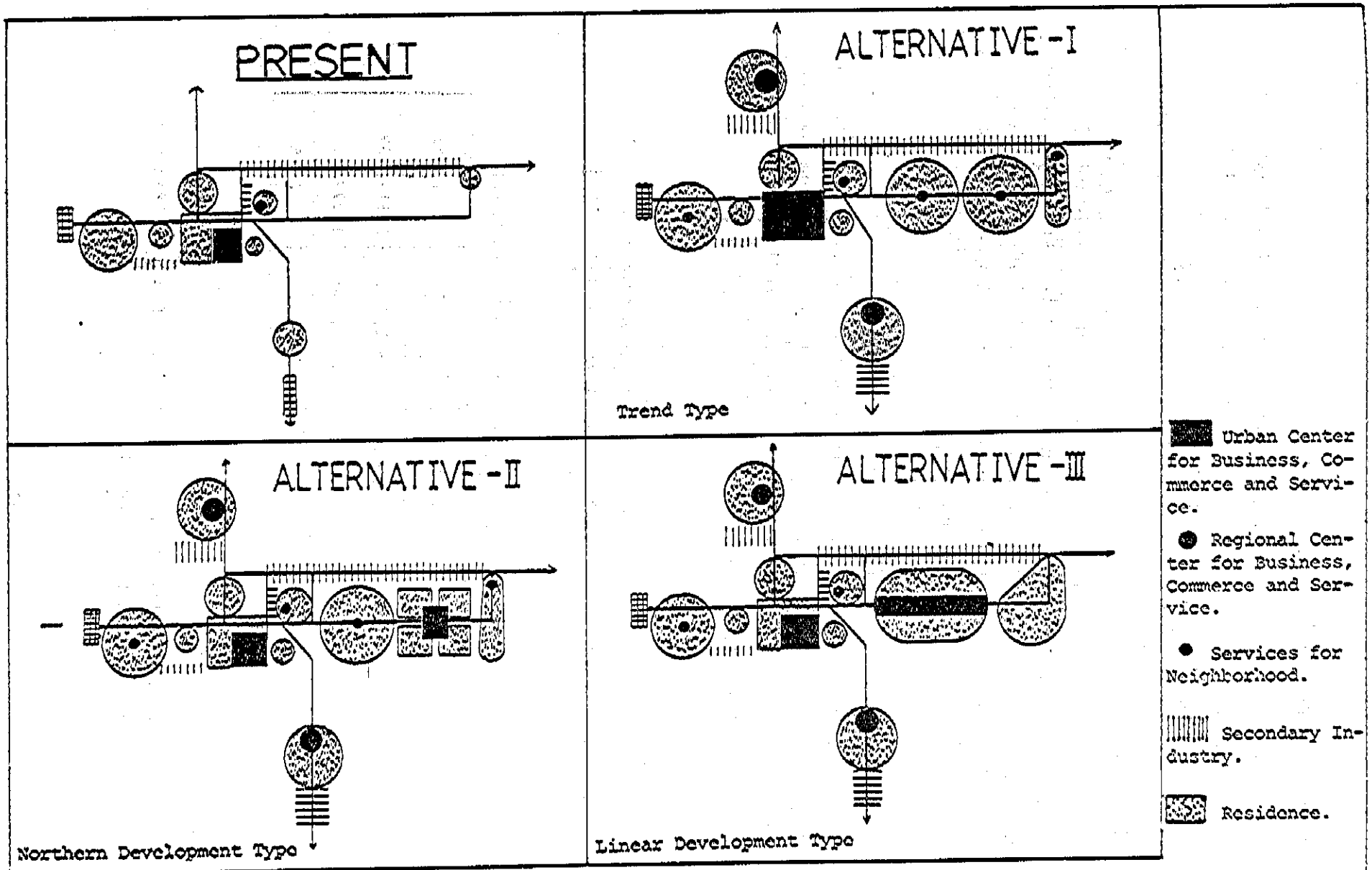


Figure – 1 FUTURE STRUCTURE OF LAND USE IN 20000

3-2 FUTURE TRAFFIC DEMAND

Based on the planning characteristics above-mentioned, future traffic volume was given as under according to the general flow shown in Figure S-2 and the following steps.

3-2.1 Trip Production

Present internal trip production excluding on foot, totals approximately 2,310,000 trips a day, averaging 1.83 trips per person a day. Future trip production was estimated 4,980,000 trips in the year 2000, using unit trip production method, and it also corresponds to 1.8 trips per person.

3-2.2 Trip Generation and Attraction

On formulating the future trip generation and attraction models, high increase of trip generation and attraction was forecast as shown in Figure S-3, especially in the suburban area, reflecting the future population growth.

3-2.3 Trip Modal Split

Trip end model was employed to forecast future trip modal split. The future modal split estimates are shown compared with the present values below.

MODAL SPLIT ESTIMATE RESULTS

Case	Car trip	Taxi trip	Mass transport trip	Total
a. Present	1,050,907	420,069	841,891	2,312,867
b. 2000 (basic case)	1,996,800	906,300	2,076,500	4,979,600
b/a	1.90	2.16	2.47	2.15

3-2.4 Trip Distribution

Future trip distribution was carried out for each transport mode, using the distribution model.

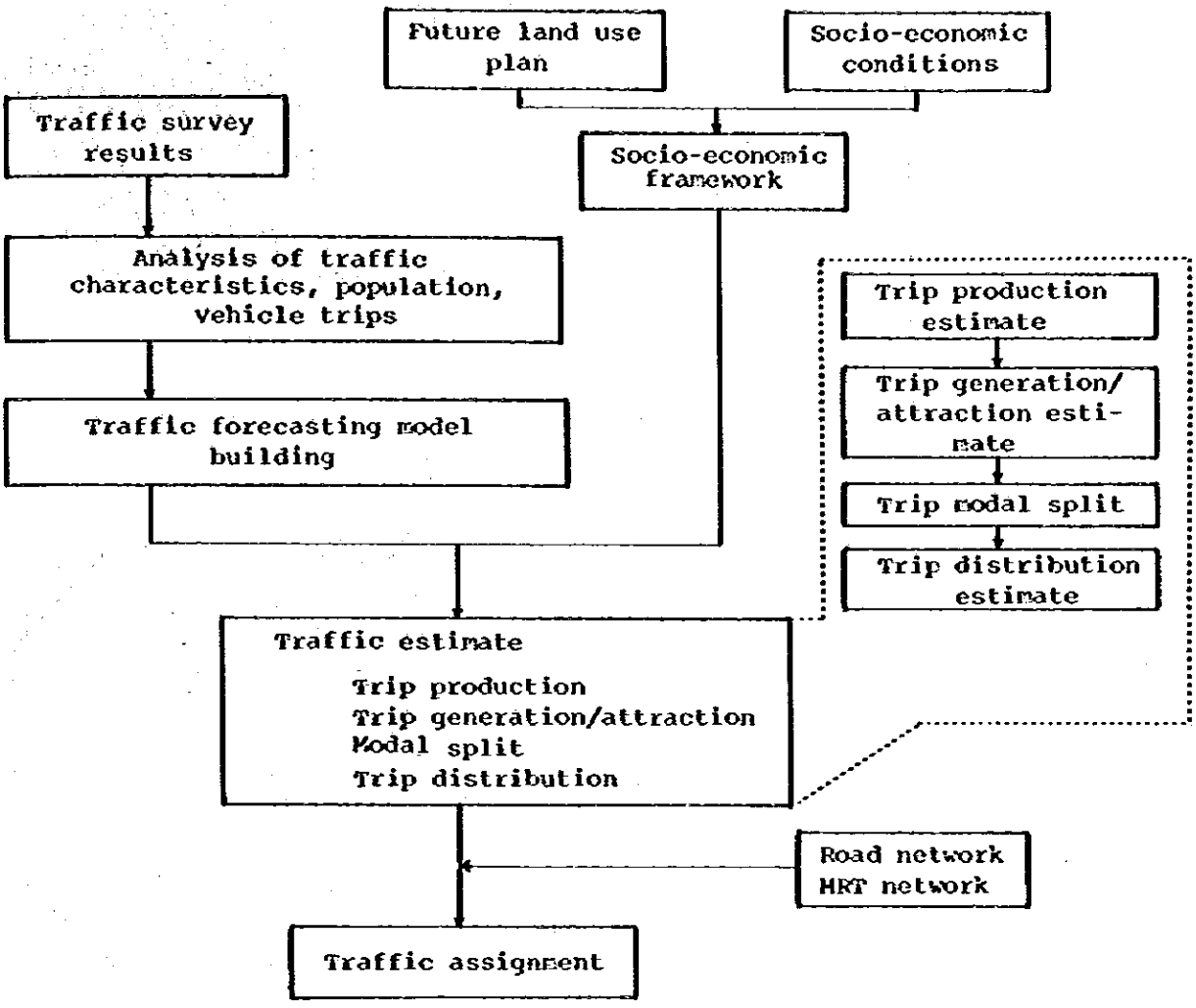


Figure S-2 GENERAL FLOW CHART OF TRAFFIC FORECAST

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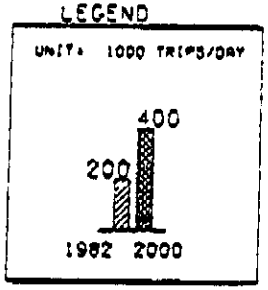
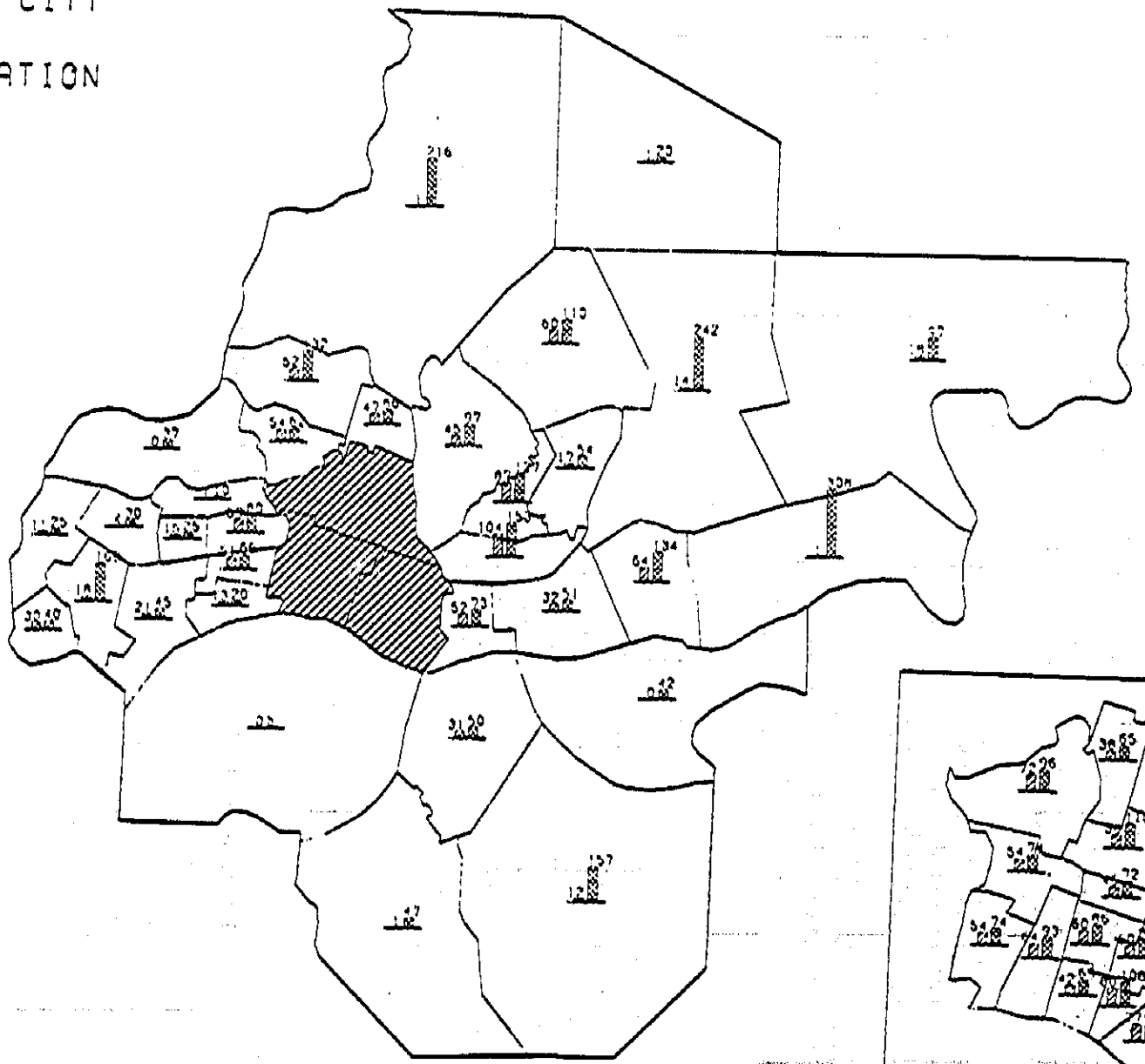




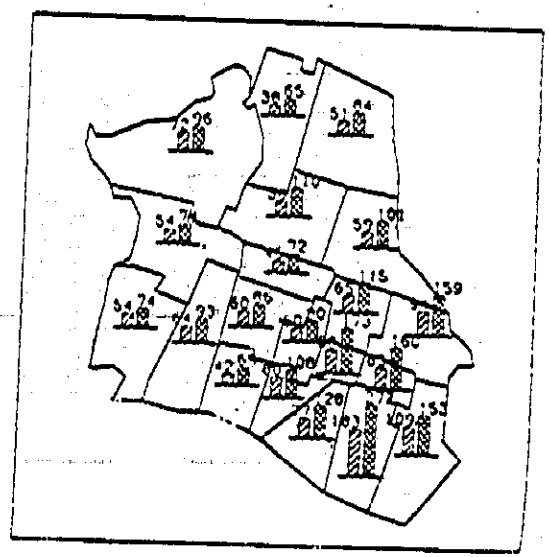


Figure S—3 PRESENT AND FUTURE TRIP GENERATION BY ZONES

3-2.5 Traffic Assignment to Road Network

Incremental assignment method with capacity constraint was employed for traffic assignment to the road network. As a whole the future link volume was forecasted to increase about 3 times the present one and the average congestion rate gets heavier from Figure S-4 to S-5.

Note:

Congestion rate in the Figure S-4, 5, 15 and 16 is calculated by the following expression:

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

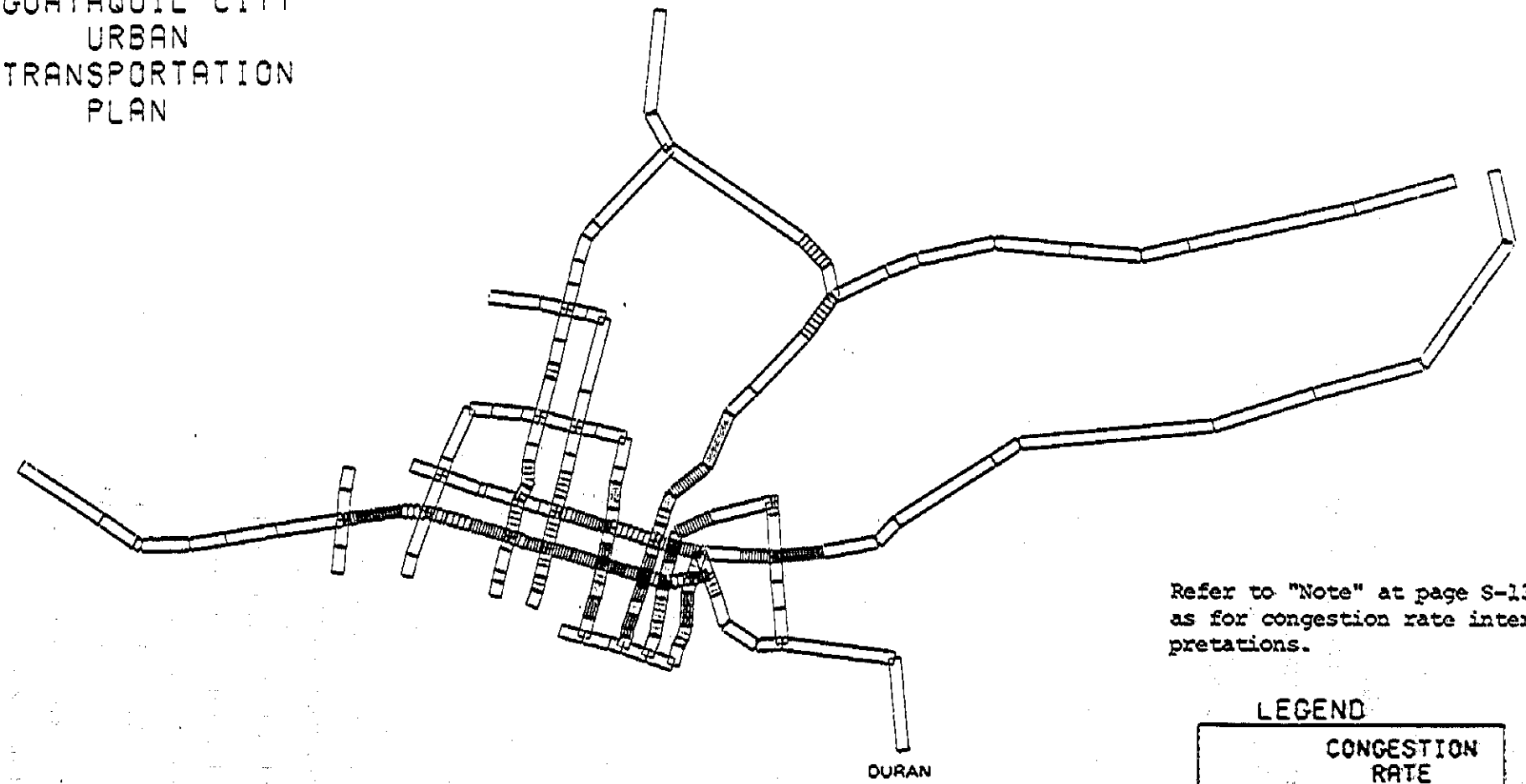
Congestion rate interpretations:

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



Refer to "Note" at page S-13 as for congestion rate interpretations.

LEGEND

CONGESTION RATE	
	0.00--0.75
	0.75--1.00
	1.00--1.20
	1.20--2.00
	2.00--

Figure S-4 CONGESTION RATE PATTERN (PRESENT IN 1982)

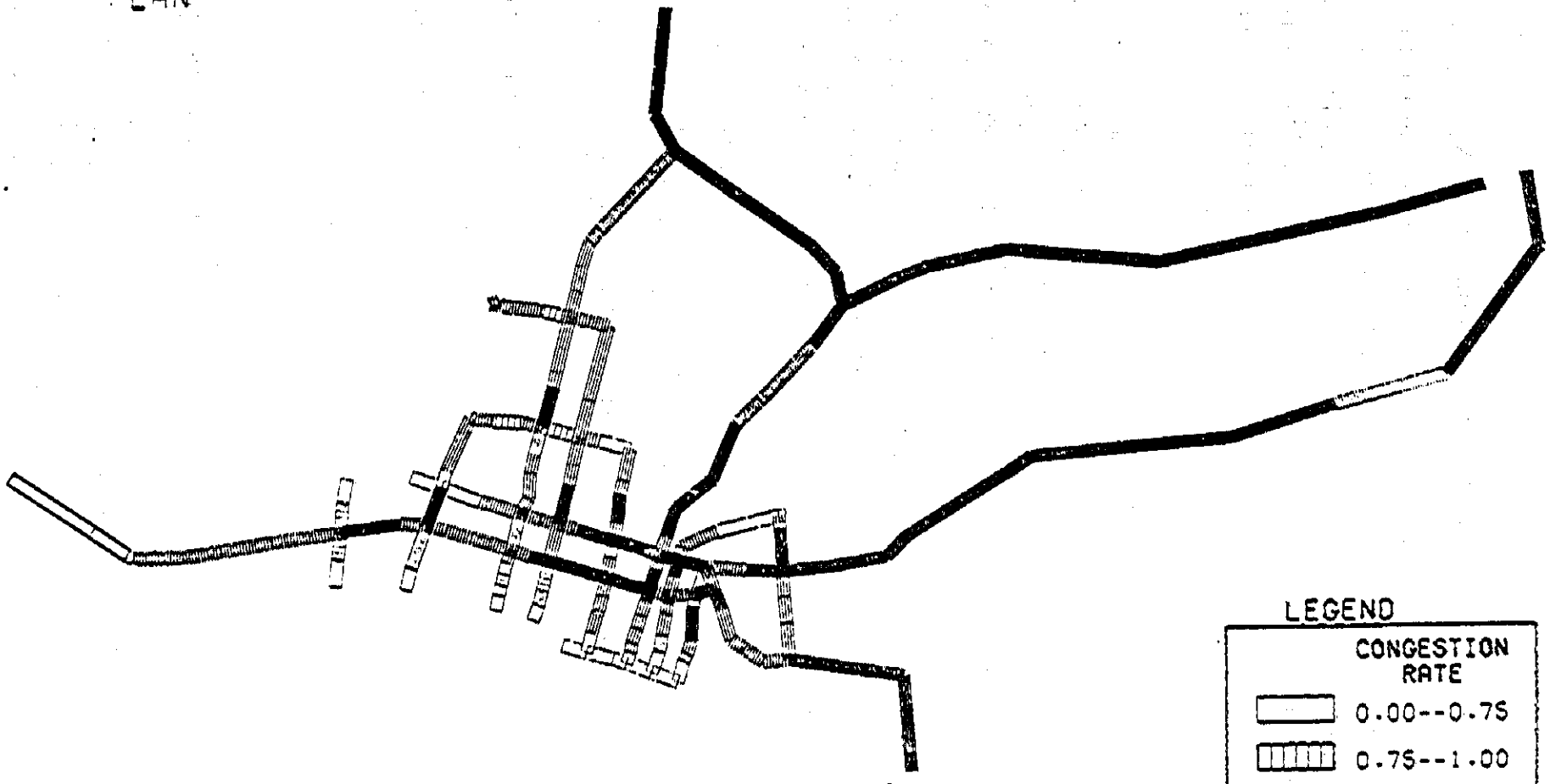


Figure S-5 CONGESTION RATE PATTERN (BASIC CASE IN 2000 WITHOUT ANY ACTION EXECUTED)

3-3 LONG-TERM TRANSPORTATION PLAN FORMULATION

In the light of foreseeable traffic problems and future changes, and based on the basic planning policies, the long-term transportation plan tested was proposed in this section. The plan comprised the proposed road network, the MRT route plan (Mass Rapid Transportation System), and improvement plan of bus transport and coordination with MRT.

3-3.1 Basic Planning Policy

In order to create better urban transport environment, the following basic policies were identified:

(1) Improvement of transport capacity in the Study Area as a whole

(2) Acceleration of land development plan selected (Alternative III, Linear Development Plan toward the northern area)

(3) Improvement of transport efficiency in the Study Area as a whole

(4) Improvement of safety

(5) Conservation of comfortable environment for urban life

To realize the above policies, basic solutions were selected as follows:

(1) Augmentation of transport capacity and resolution of traffic bottlenecks

  a. Construction and orderly arrangement of road network
  b. Introduction of MRT
  c. Improvement of bus transport
  d. Coordination of each transport system

(2) Alleviation of traffic congestion in CBD

  a. Proper layout of urban facilities and promotion of the land development plan selected
  b. Parking constraint and traffic control in CBD

3-3.2 Proposed Road Network Plan

(1) Planning Policy

Taking into account the functions of the various roads and the conditions of the environs, the general basic targets for the road network were summarized as follows;

a. To provide quick and convenient services especially for long distance trips.

b. To ensure a smooth and safe traffic flow.

c. To avoid dividing the community and to maintain a better urban environment.

d. Serving as a good facility available for the people in the neighborhood.

In designing the road network in the Study Area, the following strategies were selected to achieve the above targets:

a. Limitation of passage through CBD by the through traffic.

b. Full utilization of the existing roads, planning and construction of new roads and efficient connection of these roads.

c. Uniformity with the existing and future land use plan.

d. Efficient utilization of the existing roads in CBD, limiting large scale widening and improvemnt of the existing roads.

(2) Conceptual Plan

Bearing in mind the planning policy above-mentioned and traffic demand characteristics, the conceptual plans for the road network were prepared as shown in Figure S-6.

(3) Proposed Road Network Plan

Based on the reconnaissance survey, existing and future origin-destination patterns, traffic volume, development strategy in the landuse, etc., several road network patterns were examined on combining the considerable road links and networks.

These patterns were categorized into three networks: the existing road network, the on-going project network which has been prepared by MOP (Ministerio de Obras Publicas) and the Guayaquil Municipality, and the proposed road network which could cope with the foreseeable traffic problems most effectively. (see Figure S-7 and S-8.)

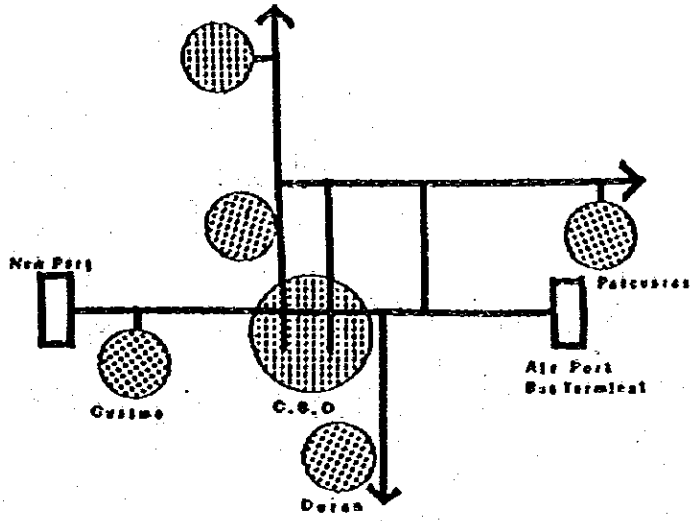
The proposed road network, which developed on-going projects, consists mainly of the following functions:

a. Total length of proposed network by each function

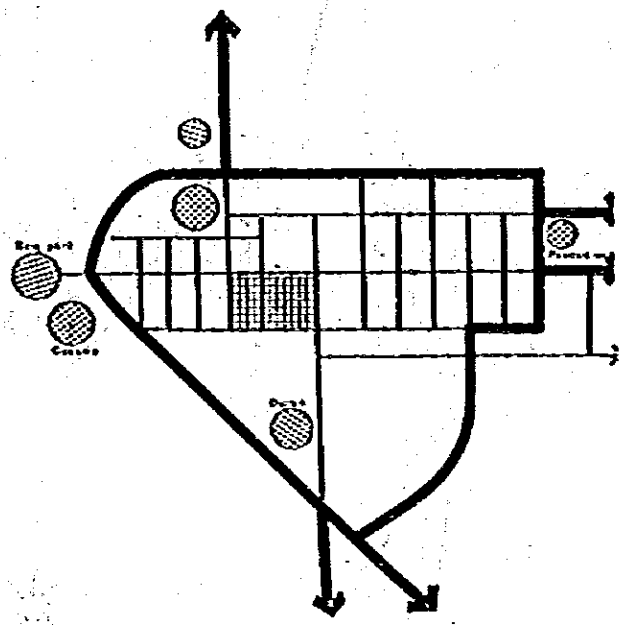
Primary distributors	40.2 km	71.8 km
District distributors	30.3 km	
Local distributors	1.3 km	

b. Large scale re-structure of intersections

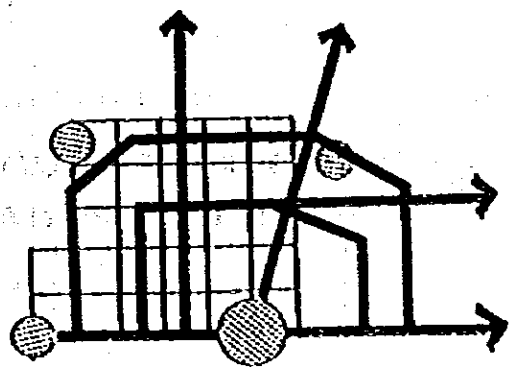
Diamond intersection	12 points	17 points (See Figure S-9)
Full service intersection		
. Trumpet type	2 points	
. Clover leaf type	3 points	



Conceptual Urban Structure in Future



Road Network Pattern for the Whole Study Area



Road Network Pattern in the Urban Area

Figure S-6 CONCEPTUAL PLANNING FOR ROAD NETWORK

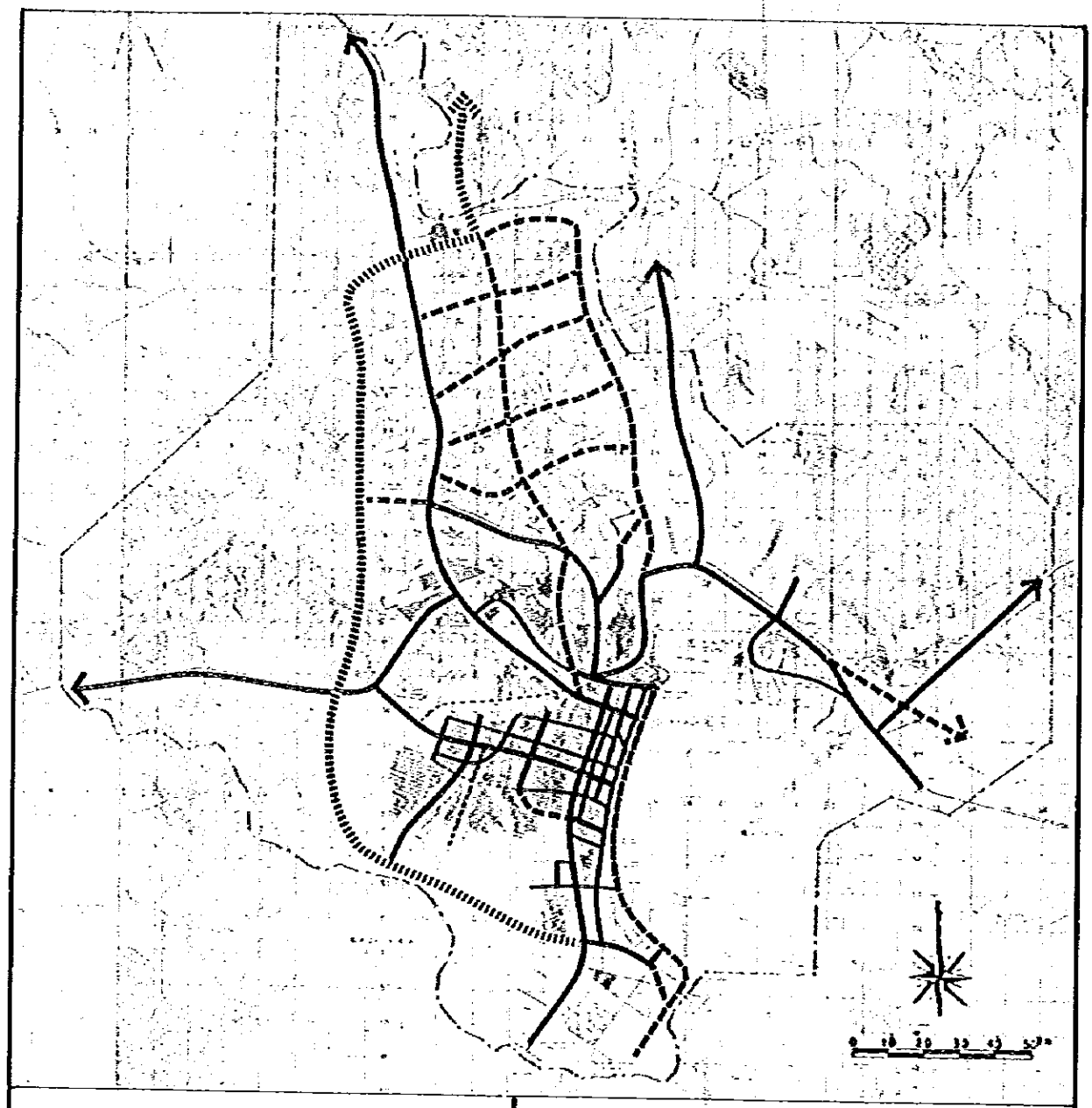


Figure S-7 ON-GOING PROJECT NETWORK

ON-GOING PROJECT

PRIMARY DISTRIBUTOR

DISTRICT DISTRIBUTOR

LOCAL DISTRIBUTOR

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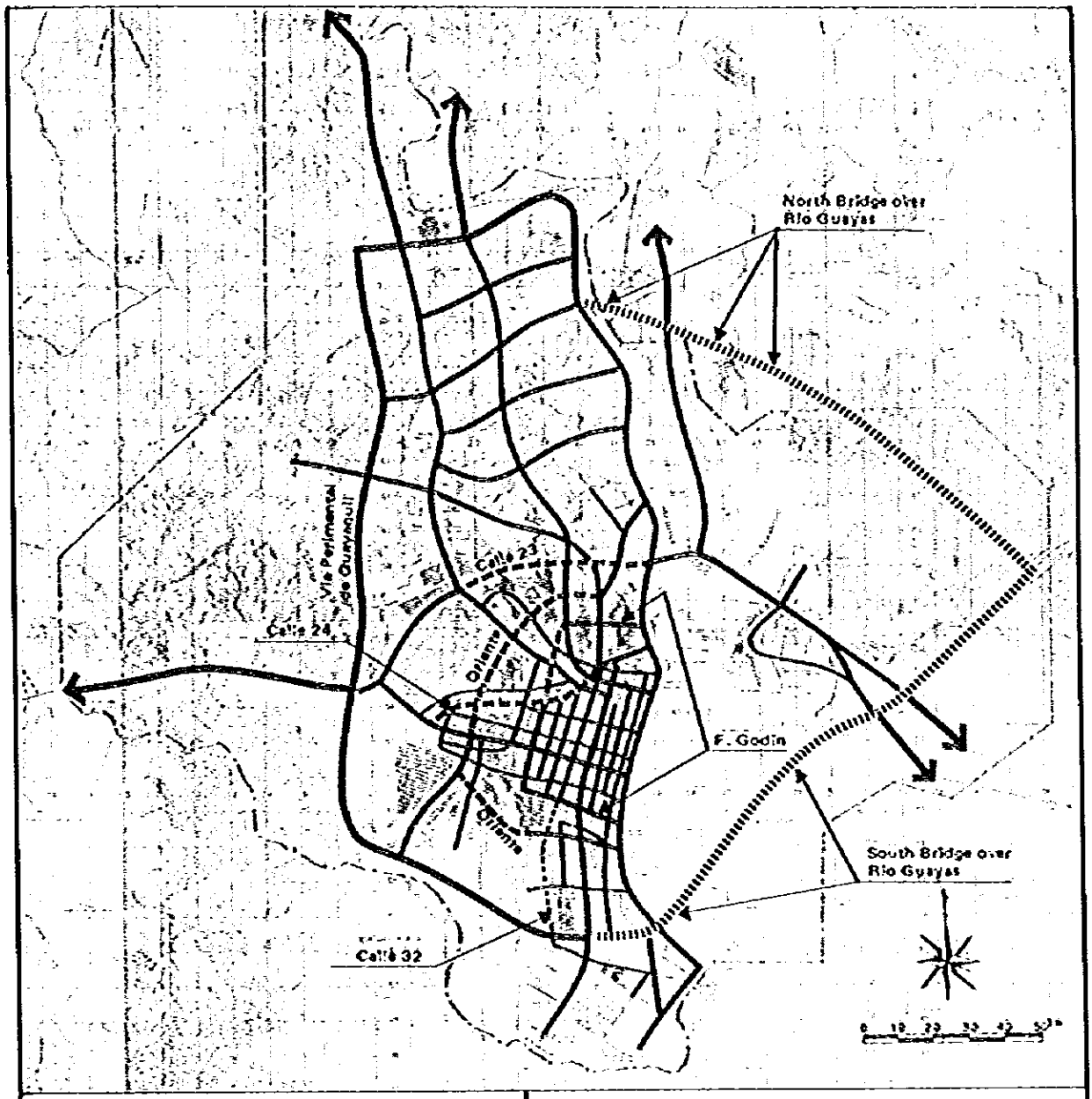

Figure S-8 PROPOSED ROAD NETWORK

		PROPOSED ROAD
▬▬	PRIMARY DISTRIBUTOR	▪▪▪▪▪▪
▬▬	DISTRICT DISTRIBUTOR	▪ ▪ ▪
▬▬	LOCAL DISTRIBUTOR	.....

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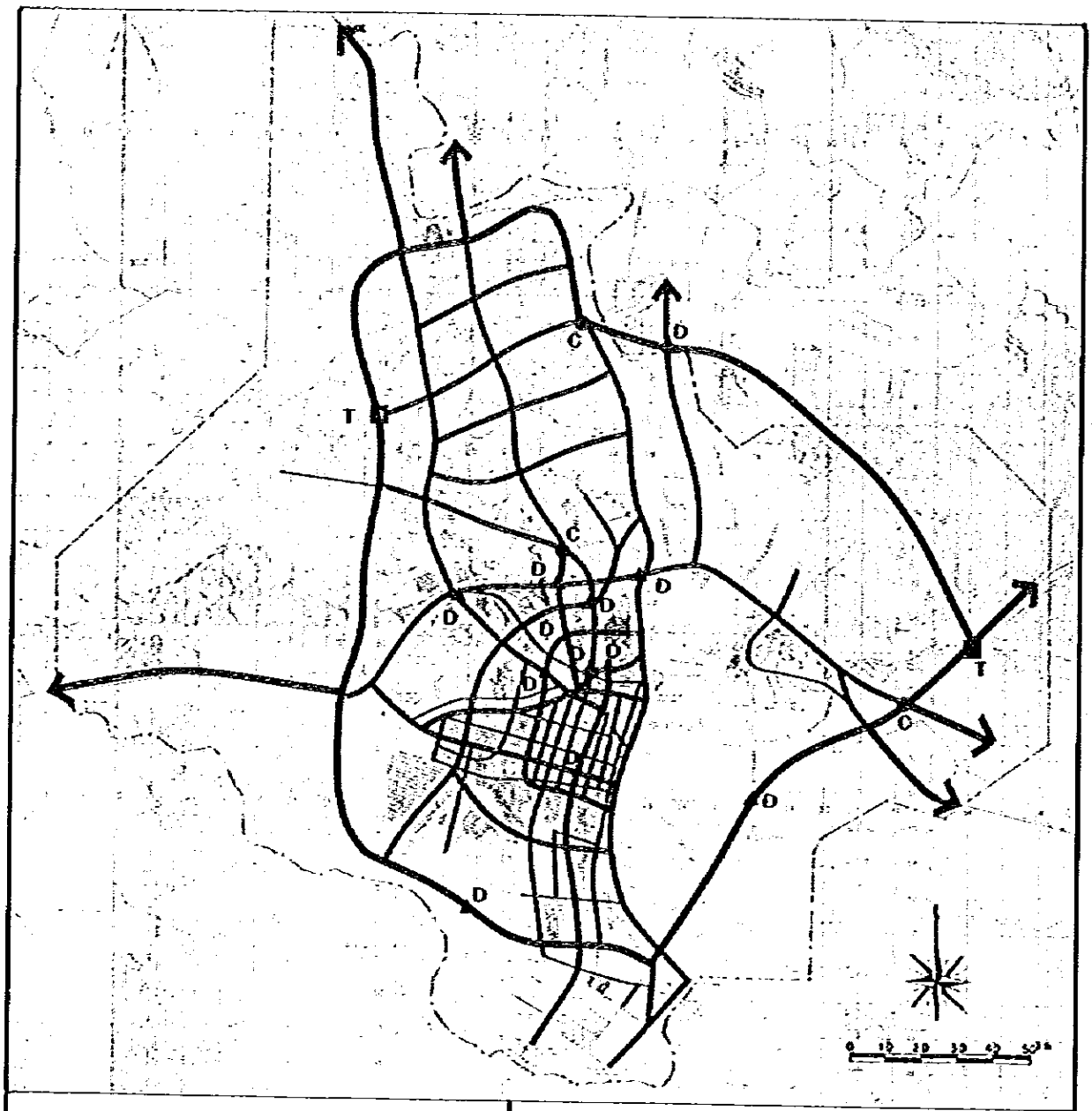


Figure S-9 LOCATION AND TYPE OF INTERSECTIONS

- ● CLOVER LEAF INTERSECTION : C
- ■ TRUMPET INTERSECTION : T
- ▲ DIAMOND INTERSECTION : D

THE STUDY OF THE GUAYAQUIL CITY URBAN TRANSPORTATION PLAN

3-3.3 MRT (Mass Rapid Transportation) Plan

(1) Aim of MRT Introduction

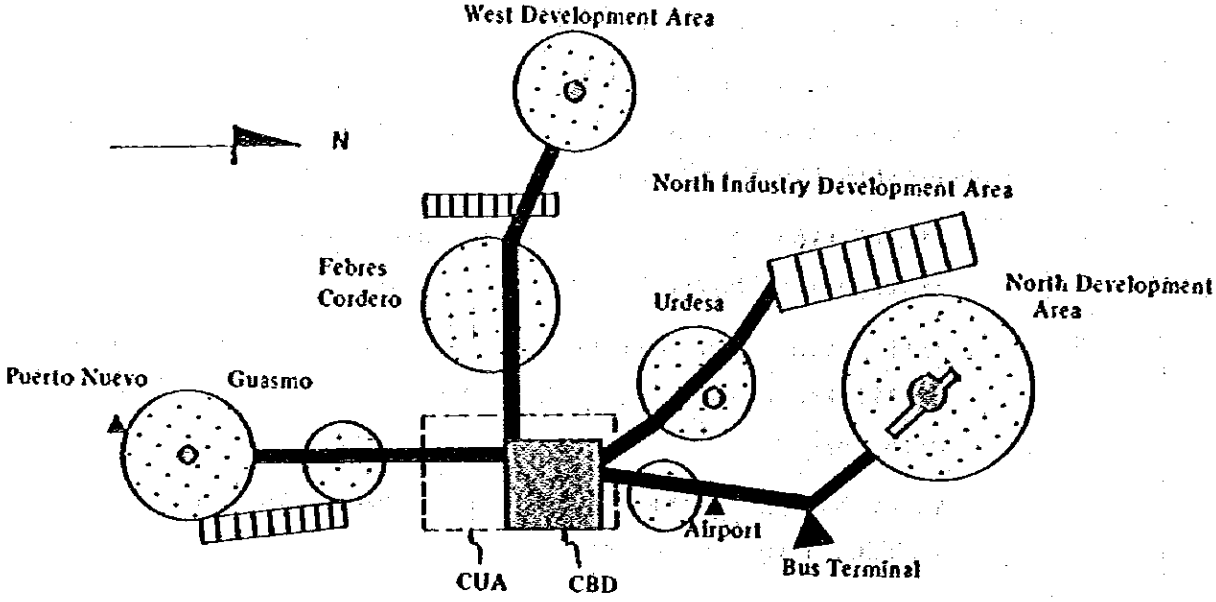
Based on the planning policies and basic solutions selected, the purposes of MRT introduction are summarized in the following three points:

- Alleviation of the road traffic volume (Diversion of car traffic into MRT).
- Activation of the existing bus systems and improvement of public transport service thereof by effective combination with MRT.
- To promote the better land development in the suburbs targetted in the future.

(2) Main Traffic Routes

In order to maximize MRT characteristics such as mass transport capacity and effective utilization of the urban space, it is necessary to layout its routes along with the main traffic routes which have a great traffic demand. Judging from the current flow and the future land use plan, the future main traffic routes were anticipated to be as shown in Figure S-10, being extended from CBD in the four directions.

Based on these main traffic routes and bearing in mind the other various conditions, several route configurations were examined, then categorized into the three patterns shown in Table S-2. Pattern 3 was concluded to be the most suitable to adopt as the MRT route.



(Legend)

Commercial Area

Residencial Area

Industrial Area

Transport Facility

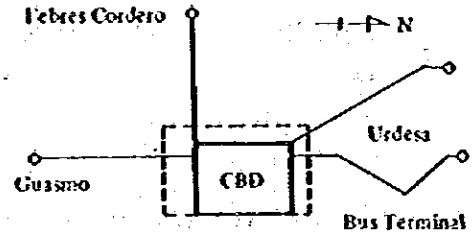
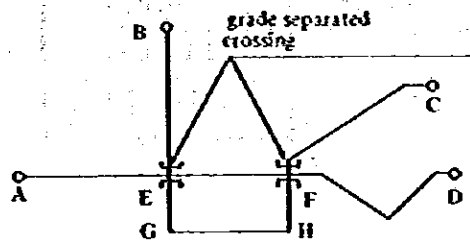
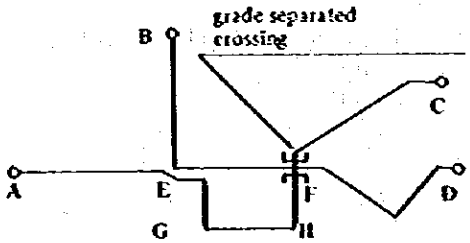
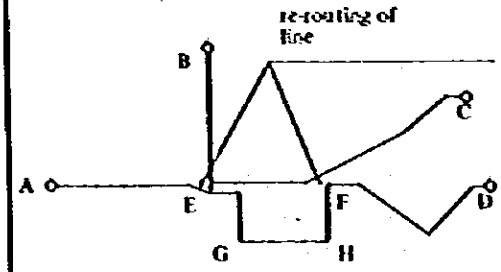
Main Traffic Routes

CBD ..... Central Business District

CUA ..... Central Urban Area

Figure S-10 MAIN TRAFFIC ROUTES

Table S-2 MRT ROUTE PATTERN

Route pattern	Explanation
(Basic pattern)  	
(Pattern 1)  	1. This pattern is suitable to the case of preferential execution of the North-South Route (A-E-F-D). 2. Grade separated crossing of the MRT routes generates at Point E and Point F.
(Pattern 2)  	1. This pattern is suitable to the case of preferential execution of the East-West Route (B-E-F-D). 2. Grade separated crossing of the MRT routes generates at Point F.
(Pattern 3: Recommended)  	1. This pattern is suitable to the case of preferential execution of either route (A-E-F-D, B-E-F-D). However, for the completion of the whole plan it is necessary to re-route the lines operated at the 1-st stage at Point E and/or F. 2. No grade separated crossing of the MRT routes generates.

(3) MRT Route Selection

The MRT routes were finally selected as shown in Figure S-11, taking into account the main traffic routes, width of roads, composition of routes, mutual connection of each route, etc. Dimensions in each route and estimated transport volume in 2000 are shown in the following table.

ROUTE LENGTH AND NUMBER OF PASSENGERS FOR BOTH WAYS (2000)

	Route length (km)	No. of stations	No. of passengers per day
North-South route	26.3	26	629,000
East-West route	24.7	25	543,000
Total	51.0	51	1,172,000

(4) Alternative MRT Systems

The five systems (Urban railway, Light rail transit, Monorail, Rubber tyre type railway and Subway) were selected and compared with one anothers. Table S-3 shows comparison of general dimensions and characteristics of 5 alternative systems.

Bus Terminal
Airport
Urdesa
Febres Cordero
Guasmo
Port
(Legend)
Station
THE STUDY OF THE GUAYAQUIL CITY URBAN TRANSPORTATION PLAN
Figure S-11 MRT ROUTES

Table S-3 COMPARISON OF ALTERNATIVE SYSTEMS

		Urban Railway	Light Rail Transit *	Monorail	Rubber Tyre Type Railway	Subway
Transport Capacity (person/hour/one way) [headway = 150 seconds]		1 train = 4 cars 80 m 35,000	1 train = 3 units 87 m 25,000	1 train = 6 cars 84 m 32,000	1 train = 4 cars 72 m 29,000	1 train = 4 cars 80 m 35,000
Rolling Stock	Length/width (m)	20/2.9	29/2.5	14/3.0	18/3.1	20/2.9
	Maximum capacity (person/car)	360	350	220	300	360
	Maximum speed (km/h)	120	80	80	70	120
	Electric power	1,500 V.DC	750 V.DC	1,500 V.DC	1,500 V.DC	1,500 V.DC
Width of way (m)		9.4	8.5	4.5 (from beam to beam)	9.8	9.0
Minimum curve radius (m)		160(120)	100(25)	100(50)	200(120)	160(120)
Maximum grades (%)		3.5	4.0	6.0	6.0	3.5
Level crossing with roads		Possible	Possible	Impossible	Impossible	Possible
Environment impact	Noise	Δ	Δ	O	O	O
	Vibration	Δ	Δ	O	O	Δ
	Air polution	O	O	O	O	O
	View	Δ	Δ	O	Δ	O
Safety		O	O	Δ	O	Δ
Comfortability		O	O	O	O	Δ
Operation		O	O	O	O	O
Maintenance		O	O	Δ	Δ	Δ
Required train length for the maximum transport volume (34,000 person/hour/one way) in this plan		80 m	116 m	98 m	90 m	80 m
Construction cost (million sucres) [( ) means the cost per km]		28,250 (554)	29,520 (579)	38,930 (763)	43,410 (851)	62,760 (1,231)

(Note): 1. The values in the above Table show standard ones.
The values in parenthesis show those allowable in special cases.

2. O means good and Δ means common.

* Light Rail Transit system has its own right-of-way independent of other transport modes, and its performance is almost equivalent to that of Urban Railway although the vehicle size is small.

** Less than about 100 meters would be desirable in the station length over the roads to minimize influences to the waysides of the MRT route or road traffic.

3-3.4 Improvement of Bus Transport and Coordination with MRT

The target of improving bus transport is to enhance reliance of the users upon the public system, trying to improve transport services by means of coordinating buses with MRT for raising transport efficiency in the urban area as a whole. Since the various countermeasures in a early action are pointed out in the Short-term plan, this section refers to the basic subjects to be improved in the long-term.

They are:

- Basic improvement plan of bus transport
- Coordination of bus route with MRT
- Improvement of public transport system and traffic management in CBD

(1) Basic Improvement Plan of Bus Transport

a. Improvement of the Suppliers' Organizations and Promotion of Small Enterprises

In order to play the important role as a public transport, undertake drastic measures for numerous demands in the future and endure the large-scale investment for improvements, re-organization or reinforcement of the suppliers' associations and promoting of small enterprises will be essential conditions.

b. Augumentation of 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.

c. Orderly Arrangement of Facilities Adequate for the Demand and Improvement of Institutional Aspect

In order to promote enhancement of the bus transport capacity and improvement of the suppliers' organizations, it will be necessary to aid these plans from the public administrative side, not only for the facilities, but also for the aspects of administrative organization, constitutional systems, etc.

(2) Coordination of Bus Route with MRT

In case of introducing MRT into the main traffic routes, re-organization of the bus routes coordinated with MRT is quite important and Figure S-12 shows a basic idea of the coordination of the routes between MRT and buses.

As for transport terminals, ones in the suburban area are required for transfer function and facilities for parking and diversion from buse to MRT, while those in the urban area are required for easy connection of MRT with buses and taxis, and high accessibility to CBD on foot. Figure S-13 shows examples of both kinds of terminals in the suburban and urban area.

(3) Improverent of Public Transport System and Traffic Management in CBD

This purposes to improve smooth transport function and to develop better urban activities in CBD, preserving desirous urban environment under the condition of introduction of MRT.

The basic ideas consist of:

- Traffic control, especially constraint of the traffic passing through CBD
- Provision for high accessibility from MRT stations to CBD on foot
- Orderly arrangement of the station front to make buses and taxies approaching easy
- Buildup of parking lots and space

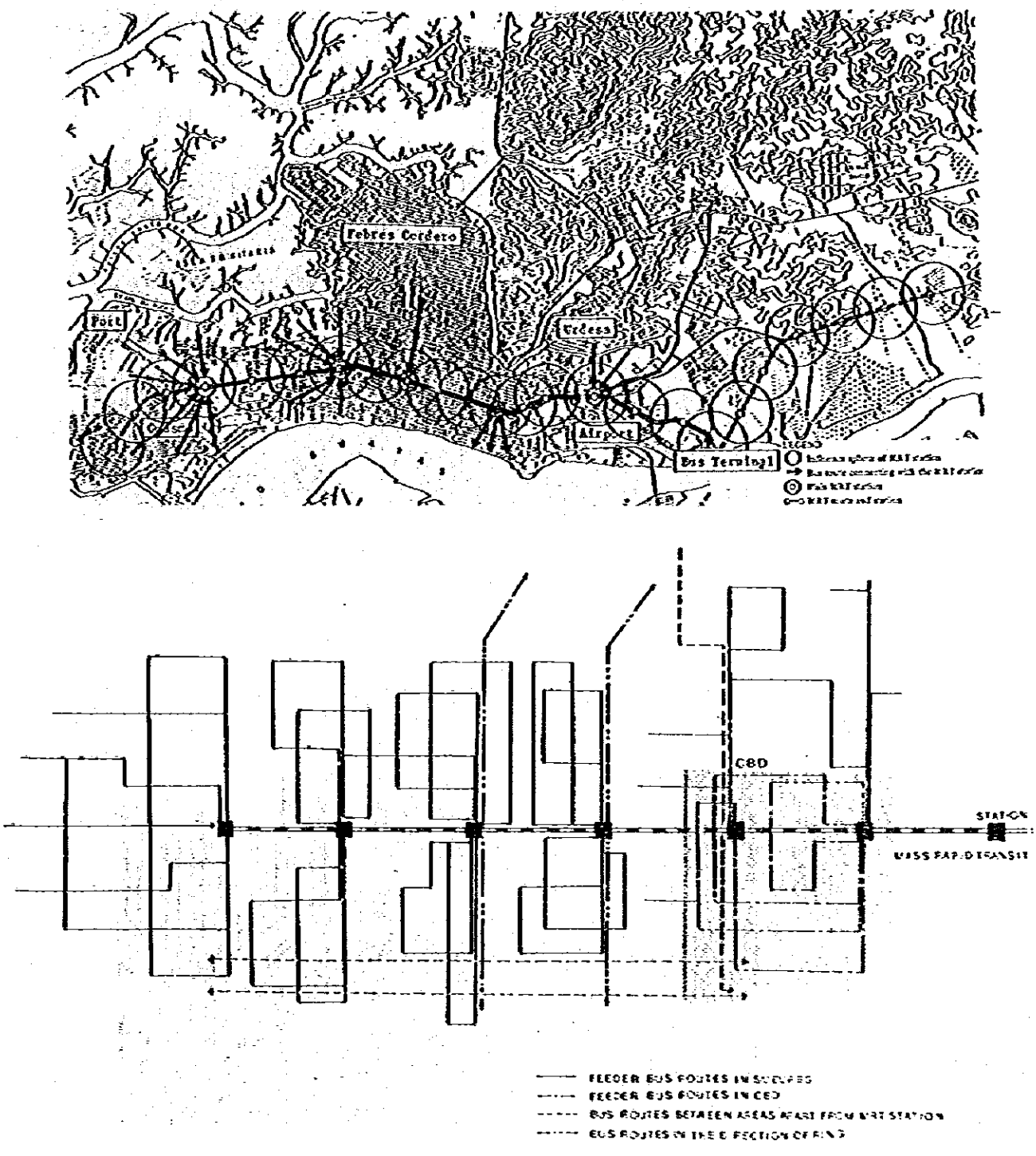
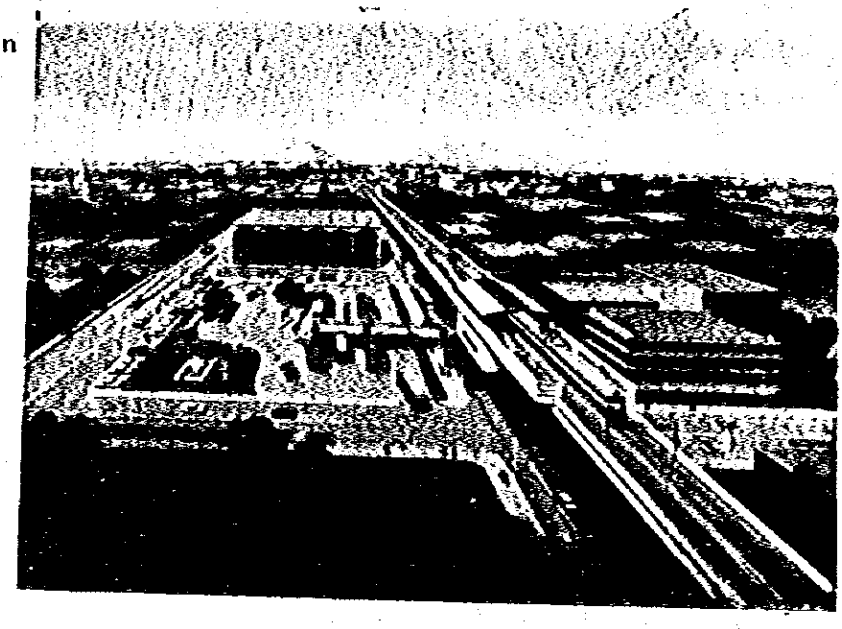


Figure S–12 BUS NETWORK PATTERN COORDINATED WITH MRT STATIONS

(1) Station plaza in the suburban area



(2) Station plaza in the central area

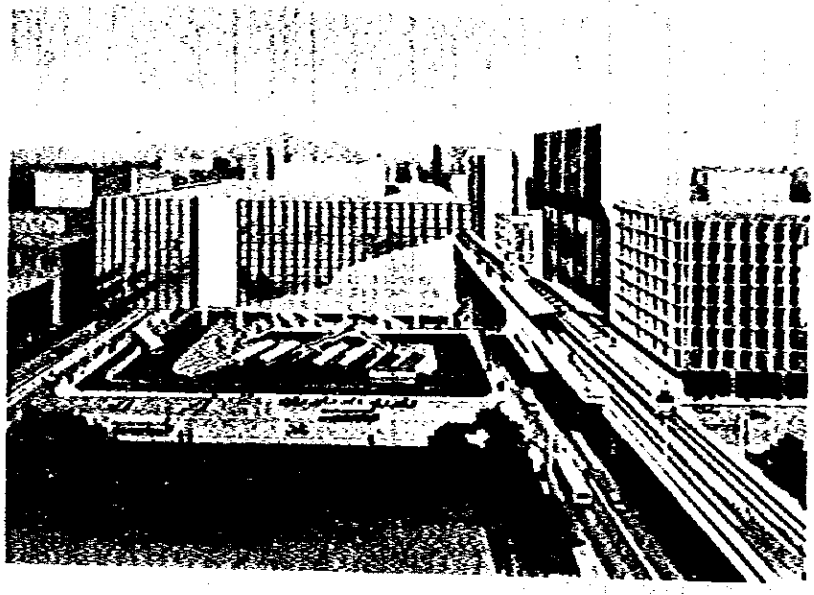
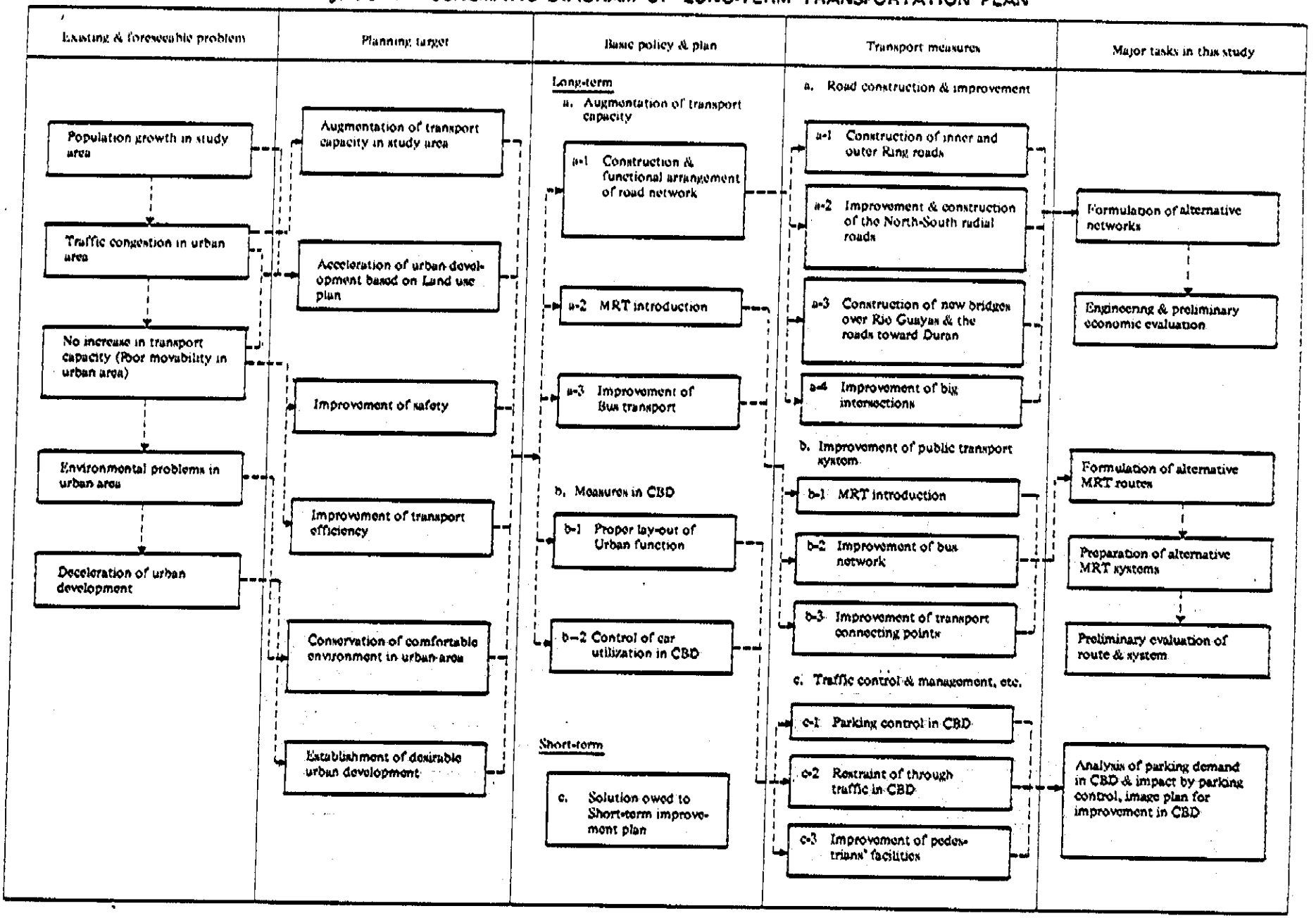


Figure S-13
EXAMPLES OF TRANSPORT TERMINALS IN SUBURBAN AND URBAN AREA

3-3.5 Summary of Long-term Transportation Plan

Taking into account of afore-mentioned matters, the planning target, policy, plan formulation, etc. of Long-term transportation plan is summalized as seen in Figure S-14.

Figure S—14 SCHEMATIC DIAGRAM OF LONG-TERM TRANSPORTATION PLAN



3-4 ELEMENTARY EVALUATION OF LONG-TERM TRANSPORTATION PLAN

The proposed long-term transportation plan, consisting mainly of the road network and the MRT plan and corresponding to the transport master plan in 2000, was justified in this section from the following aspects:

- Engineering examination on solving the foreseeable traffic problems
- Analysis of preliminary economic feasibility
- Examination of MRT projects in financial aspect
- Social and environmental impacts
- Consideration of executing priority of major projects in the plan

3-4.1 General Diagnoses on Traffic Forecasts

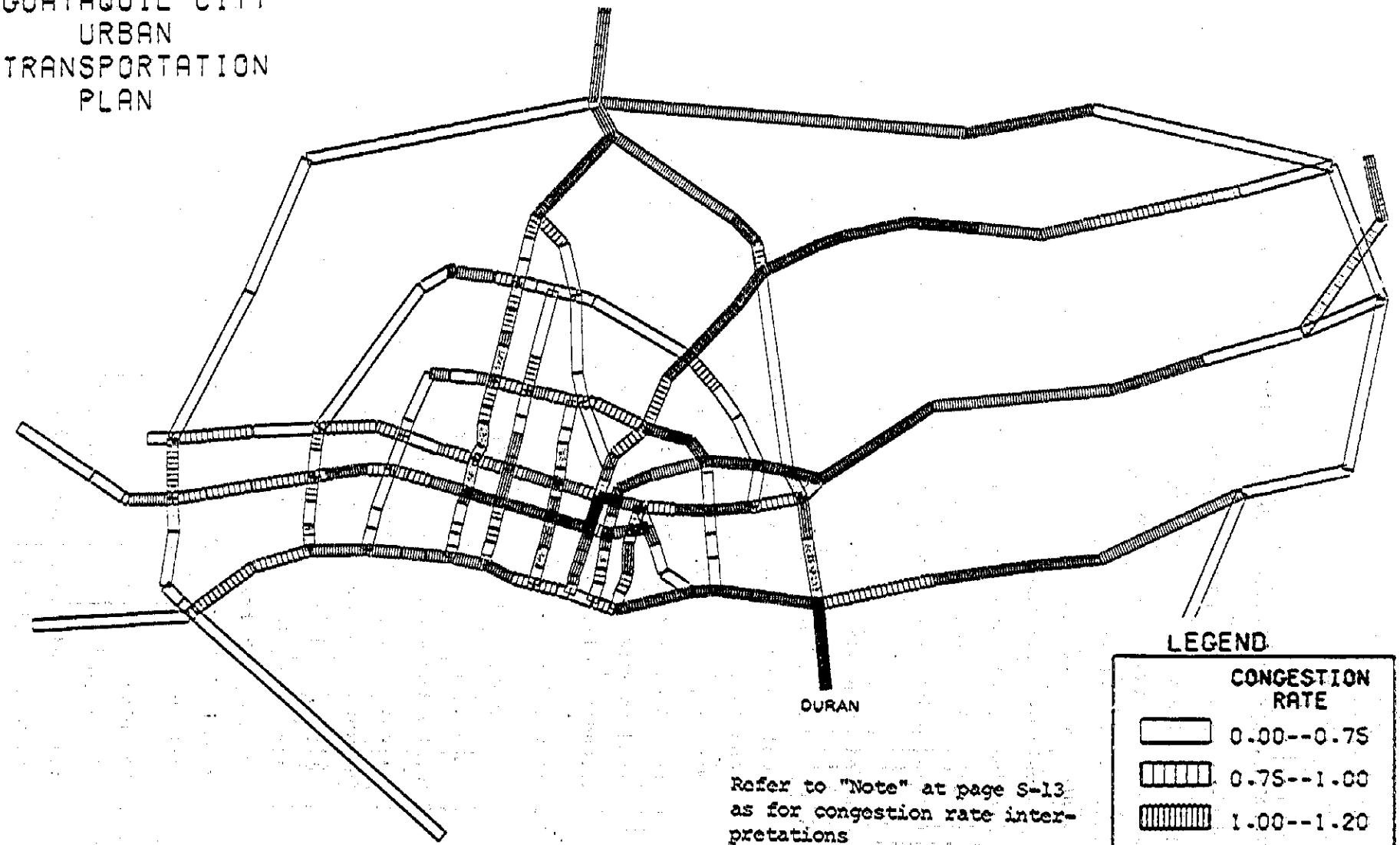
a. The combination of the proposed road network and MRT plan would be essential conditions to meet the traffic demand in 2000 judging from many indicators such as vehicle running conditions, congestion degree, saving of running cost, traffic demand and road supply level by zones, etc., and either the road network or MRT independently could not accomplish the planning policies and targets.

b. Proposed road network

The traffic volume in CBD from the north projected the most severe congestion in the future. For effective transportation three ring roads would play an important role in distributing the concentration around the central area by this network. On the other hand, for the section crossing Rio Guayas, it is recommended that some of its volume should be distributed to two new bridges by some restriction on the existing one from the two viewpoints: alleviation of congestion both in CBD and Duran, and the promotion of the development in the northern area.

c. MRT plan

Introduction of the MRT would not only fully support transport of the numerous demands along the main traffic routes which composed the basic axes of the urban structure, but also contribute to the promotion of the better development in the future.



Refer to "Note" at page S-13 as for congestion rate interpretations

Figure S—15 CONGESTION RATE PATTERN (MASTER PLAN IN 2000 with proposed road network and MRT plan)

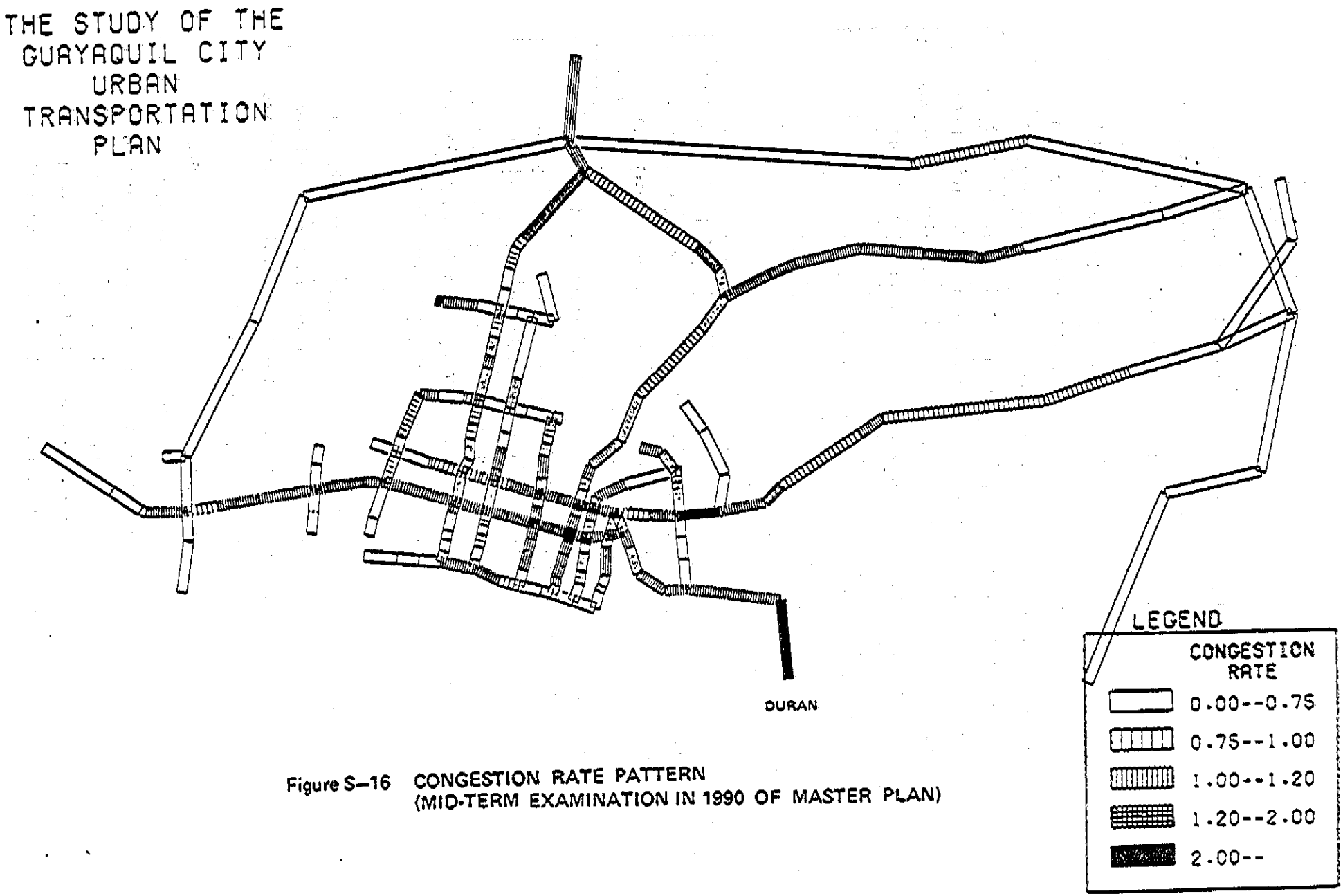


Figure S–16 CONGESTION RATE PATTERN
(MID-TERM EXAMINATION IN 1990 OF MASTER PLAN)

For the verification of the necessity and effectiveness of the MRT, examination was made concerning the substitute by bus transport, but with scarce possibility.

Mid-term Examination in 1990 of Long-term Transportation Plan

The mid-term executing stage in 1990 of the long-term transportation plan, comprising on-going road projects and a part of the proposed road network and MRT projects which corresponded to completion of the phase-2 implementation mentioned later, was also examined from the same points as above, and proved to be very useful with no fundamental transport problems found in the mid-term.

3-4.2 Economic and Financial Examination

a. Economic Examination

Although evaluation was conducted by the simplified method to an annualized single year's benefit and cost, the economic benefit produced by executing the proposed road network and MRT plan was sufficiently effective to their costs.
However, the economic indicators shown in Table S-4 were considerably affected by which one of MRT systems was combined into the road network. Among 5 alternative systems, the Urban railway was the most prominent, the LRT was slightly low, the Monorail and the Rubber Tyre Type System were lower, while the Subway was very difficult economically to be executed.

b. Financial Examination

Under the assumed fare level, a financial indicator (R) (which accounts for an approximate interest rate required for making a project financially feasible) was calculated as shown in Table S-5, also based on the simple method.

The value of R in the most advantageous system (Urban railway) was about 6% in Case-1 (MRT's fare = 6 sucres) under the transport demand of MRT which had been projected on the condition of 10 sucres, and this value roughly means the interest rate necessary to the whole investment cost of the MRT. In Case-2 (MRT's fare = 10 sucres) under the

same transport volume, the value of R goes up to 12%, which means that almost same interest rate shall be applicable to the project (see Table S-5).

Table S-4 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 of master plan in 1990

		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 of master plan	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

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

Table S-5 FINANCIAL INDICATORS IN 2000 & 1990

		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 of master plan in 1990						
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

3-4.3 Social Impacts and Consideration in Environmental Aspects

a. Social Impacts

This master plan aimed at a comprehensive urban transportation system in the present urban area and at the same time, an important leading role in promoting development of the strategic areas around it.

The direct impacts of the above would be not only limited to great strides in improving convenience for movement through the diversification of transport modes and bringing up location of subcenters due to mass rapid transport function of the MRT, but also they would produce a lot of benefit and widely affect on the community.

b. Consideration in Environmental Aspects

Implementation of the projects is concerned with environmental problems of their wayside areas directly and the whole area widely. Some items such as air pollution, effects on lowering energy consumption, etc. would be improved by orderly arrangement of transport system, while other such as noise, vibration, etc. would adversely affect on the community. Therefore, sufficient and cautious consideration should be given to the matters to be affected by them.

3-4.4 Priority of Major Projects Identified in Master Plan

The proposed master plan, comprising mainly the road network and MRT plan, includes many projects. Their executing priority was examined under the selected policy and target from various viewpoints such as necessity and effect of execution, urgency, substitutability by other projects, ease in execution and project cost, etc.

a. Priority of Major Projects in Proposed Road Network

Table S-6 TARGET AND PRIORITY OF MAJOR PROJECTS IN PROPOSED ROAD PLAN

Billion ($x10^9$) sucres in 1982 Prices

Priority	Target	Major projects	Work volume	Rough estimate
1-1	Intensive connection between northern area and CBD	a. Large-scale improvement of intersections by grade separation toward the north	6 places	1.3
		b. Construction and improvement of ring roads within urban area, Calle P. Godin & Oriente	17.8 km	
1-2	Development of northern area and intensive connection between Pascuales and Duran	a. Extension of Via Perimental de Guayaquil (outer ring road)	22.8 km	7.0
		b. North bridge over Rio Guayas		
2	Improvement of the area around CBD and intensive connection with western area	a. Large-scaled improvement of intersections by grade separation	9 places	2.0
		b. Improvement of radial roads (Calle 23, 24 and 32)	12.4 km	
		c. Tunnel under Cello el Carmen	1.3 km	
3	Development of southern area and connection of CBD with southern area and Duran	a. Extension of Via Perimental de Guayaquil	17.5 km	10.6
		b. South bridge over Rio Guayas		
		c. Improvement of Intersections by grade separation	2 places	
Total		Intersections Road projects	17 places 71.8 km	20.9

Note) As for the location of the projects, see Fig. S-8 (page at S-21).

b. Priority of MRT Projects

The whole MRT route in 2000 is composed of two basic alignments with different length. The following priority was derived after careful examination and comparison of 6 combinations of above alignments:

Table S-7 TARGET AND PRIORITY OF MRT PROJECTS

Billion ($x10^9$) Sucres in 1982 prices
1 US dollar = 50 sucres (average in 1982)

Priority	Main targets	Route and Section	Length	Rough estimate
1	Establishment of the urban axis and augmentation of transport capacity in north-south direction	Urban section of North-South route from Bus Terminal to the entrance of Guasmo through Av. Quito	13.5 km 15 stations	8.1
2	Mass rapid transport in the urban area, establishment of the urban axis toward the west	Urban section of East-West route, from Portete bridge, through Portete, S. Bolivar to Urdesa	14.5 km 16 stations	11.9
3	Improvement of public transport system in the whole area	The rest section of the whole route	23.0 km 20 stations	8.2
Total			51.0 km 51 stations	28.2

Note) As for the location of the route, see Fig. S-11 (page at S-27).

As for the alternative MRT systems, proposed four systems (Urban railway, Light rail transit (LRT), Monorail and Rubber tyre type railway) except subway will be possible. Among them, Urban railway is the most promising in cheap investment, large transport capacity, ease in maintenance, flexibility to cope with more demand in the future, etc.

3-4.5 Implementation Program of Long-term Transportation Plan

a. Phasing Plan of Project Implementation

Based on the priorities of the major projects and comparison between project costs and financial sources applicable to transport infrastructure in the Study Area, the term, main target and projects in each phase were worked out as below:

Phase 1: 1983 - 1985

Resolution of the existing transport problems

- A half of on-going road projects by MOP and Municipality, preparatory work of phase-2 projects

Phase 2: 1986 - 1990

Augmentation of transport capacity from CBD toward the northern area

- 1st-priority projects of both the road and MRT in the long-term transportation plan

Phase 3: 1991 - 1995

Improvement of the urban transport system in the central urban area and toward the western area

- 2nd-priority projects of the road and MRT in the long-term, the rest half of on-going road projects

Phase 4: 1996 - 2000

Development toward the southern area and improvement of the urban transport system in the whole area

- Final projects of the road and MRT in the long-term plan

b. Perspective for Financial Sources Applicable to Projects

Although the projection was derived based on unconfirmed factors, comparison was made as below between project costs and financial sources that would be applicable to the transport projects in the Study Area.

COMPARISON BETWEEN PROJECT COSTS AND FINANCIAL SOURCES

(Growth rate of national economy: 6.5%/year) $\times 10^6$ sucres in 1982 prices

Phase	Project costs				Applicable financial sources (2)	Deficits (2)-(1)
	On-going road pro.	Proposed road pro.	MRT pro.	Total (1)		
1 1983~1985	3,770	990	-	4,760	4,600	-160
2 1986~1990	170	5,740	8,120	14,030	9,900	-4,130
3 1991~1995	3,050	3,520	11,910	18,480	13,600	-4,880
4 1996~2000	0	10,650	8,220	18,870	18,600	-270
Total	6,990	20,900	28,250	56,140	46,700	-9,440
	27,890					

Note) MRT' cost: Urban railway

1 us dollar = 50 sucres (average in 1982)

Perspective for financial sources up to 2000

1. If the growth rate of 6.5%/year in national economy set by the National Development Plan (1980 - 84) shall continue up to 2000, the conventional financial sources applicable to transport infrastructure in the Study Area shall be able to cover the whole road project cost and 2/3 of the MRT cost.

2. If the growth rate in national economy decreases to 5.0%/year, it shall cover also the whole road project cost but only 1/3 of the MRT cost.

3-4.6 Conclusion

The proposed master plan was examined from many aspects: the effect of engineering improvement, economic and financial analysis, social impacts, etc., and proved to be very effective. The conclusion is summarized as below:

The proposed master plan would be essentially effective for solving the transport problems in this urban area and promising its long term development for better urban activities. It would be recommended that the plan be put into action as early as possible. At executing the plan, related projects 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, the policy of mid-term implementation in 1990 should be set to establish an urban structural axis along the main traffic route in the north-south direction, and construction of the MRT and improvement of the roads along this axis would be an indispensable first step to attain the goals in a short period.

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

3-5 SHORT-TERM IMPROVEMENT PLAN

3-5.1 Traffic Engineering and Management

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 were given in coordinating the shrot-term improvement programs with the long-term transportation ones. Some of the short-term improvement programs were thus based on the long-term improvement programs.

2) Summary of Short-Term Improvement Programs

Short-term improvement programs were summarized as follows (see Figure S-17).

a. Intersections
   - Airport entrance
   - Circulo Guayas y Quil
   - Circulo De Las Bonderas
   - Front of Laica Univ.
   - Emicido Eloy Alfaro
   - Ovalo De La Pileta
   - Av. C.J. Arosemena y Av. Miloflores
   - Av. Quito y El Oro

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

c. Traffic Signals
   - lst - step

     Installation of signals for pedestrian and data collection

. 2nd - step

Multiple use of existing facilities and real-time system

. 3rd - step

Introduction of line control system and operating system

. 4th - step

Introduction of area control system and information system

d. Parking

. 1st - step

Re-utilization of road side parking meters and raising of parking charge

. 2nd - step

Constraint of road side parking and construction of off-street parking lots

. 3rd - step

Provision of parking regulation and construction of parking buildings

e. 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

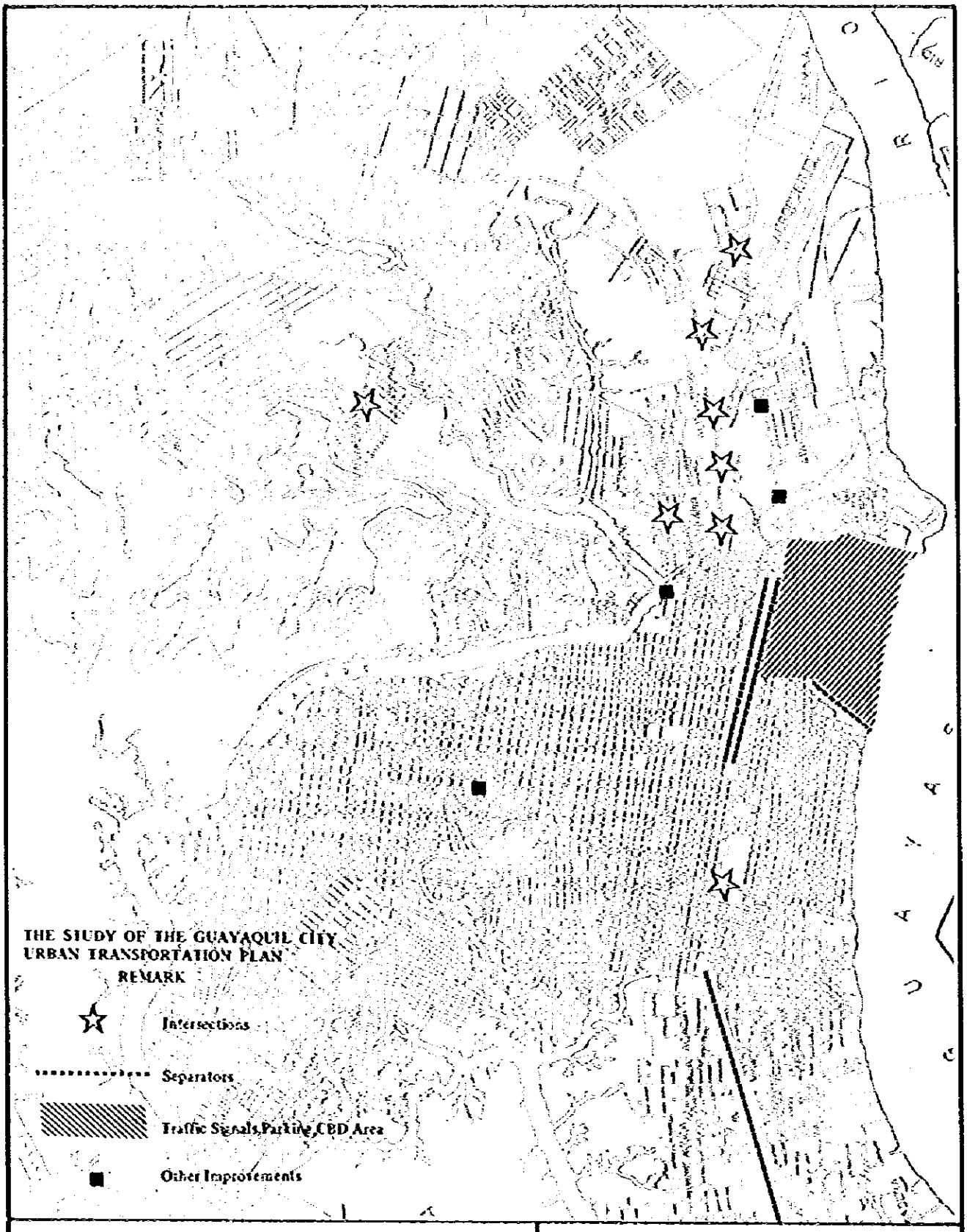


Figure S-17 LOCATION MAP OF SHORT TERM IMPROVEMENT

3-5.2 Bus Transport

1) Improvement Policy

The basic policy of bus transport is to augment or improve the existing transport capacity, service level, operation and management, etc. under the selected long-term transportation plan.

However, since the plans for above improvements range widely and are related to each other in their measures, the following proposals should be executed immediately for some items, while gradually for others with sufficient preparation, and the effectiveness by the execution should be always examined and fed back to the next measures.

2) Summary of Improvement Programs

a. Early Action Programs

a-1. Improvement of bus network

- . Extention of routes toward Urdesa Norte, Alborada Sauces, Portete y Milagro with adequate frequency
- . Division of long routes
- . New routes around CBD

a-2. Improvement of facilities

- . Bus stops with shelters, benches, route maps, and arrangement of bus bays
- . Establishment of bus lanes on wide roads, and exclusive lanes for buses and pedestrians

a-3. Fleet Improvement

- . Improvement of bus fleets and establishment of a reasonable renovation plan

a-4. Improvement of Management and Institution

- . Review of the fare system and pricing policy
- . Planning on the bus suppliers' organizations as they ought to be

b. Re-organization of Inter-regional Routes after Completion of Bus Terminal

From the viewpoints of convenience for passengers and rearrangement of the existing transport system, it was proposed that some routes should be connected to the Bus Terminal, while others to CBD directly before the MRT. After the operation of the MRT, all routes should be connected to the Terminal.

c. Conceptual Proposal after Mid-term

The following proposals were made concerning the principal courses for mid- and rather long-term re-organization of the bus network.

c-1. Introduction of large-size fleets along the trunk lines to CBD from the suburbs, and arrangement of terminal points in CBD. These trunk lines and terminal points could be replaced by the MRT and its stations in the future.

c-2. Improvement of feeder service by small-size buses within CBD and around sub-centers such as Duran, Pascuales as well as for supplementing trunk lines.

c-3. Investigation and research of the fare system, management and institutional aspects to promote the above system and for better services.

3-5.3 Implementation Programs

Implementation programs for the traffic engineering and bus transport are shown in Figure S-18 and 19 respectively, according to same phasing as in the long-term transportation plan.

Most of the measures in the both figures are put into action in the 1st phase and realized without big changes in the transport facilities or large-scale investment, while others are requested to take long time until their final completion in traffic signals, parking, exclusive bus lanes, etc. considering the phasing plan in the long-term.

As for the execution of these measures, it is recommendable to be improved mainly by C.T.G. in the same way as they have been done so far.

Figure S-18 IMPLEMENTATION PROGRAM FOR TRAFFIC ENGINEERING AND MANAGEMENT

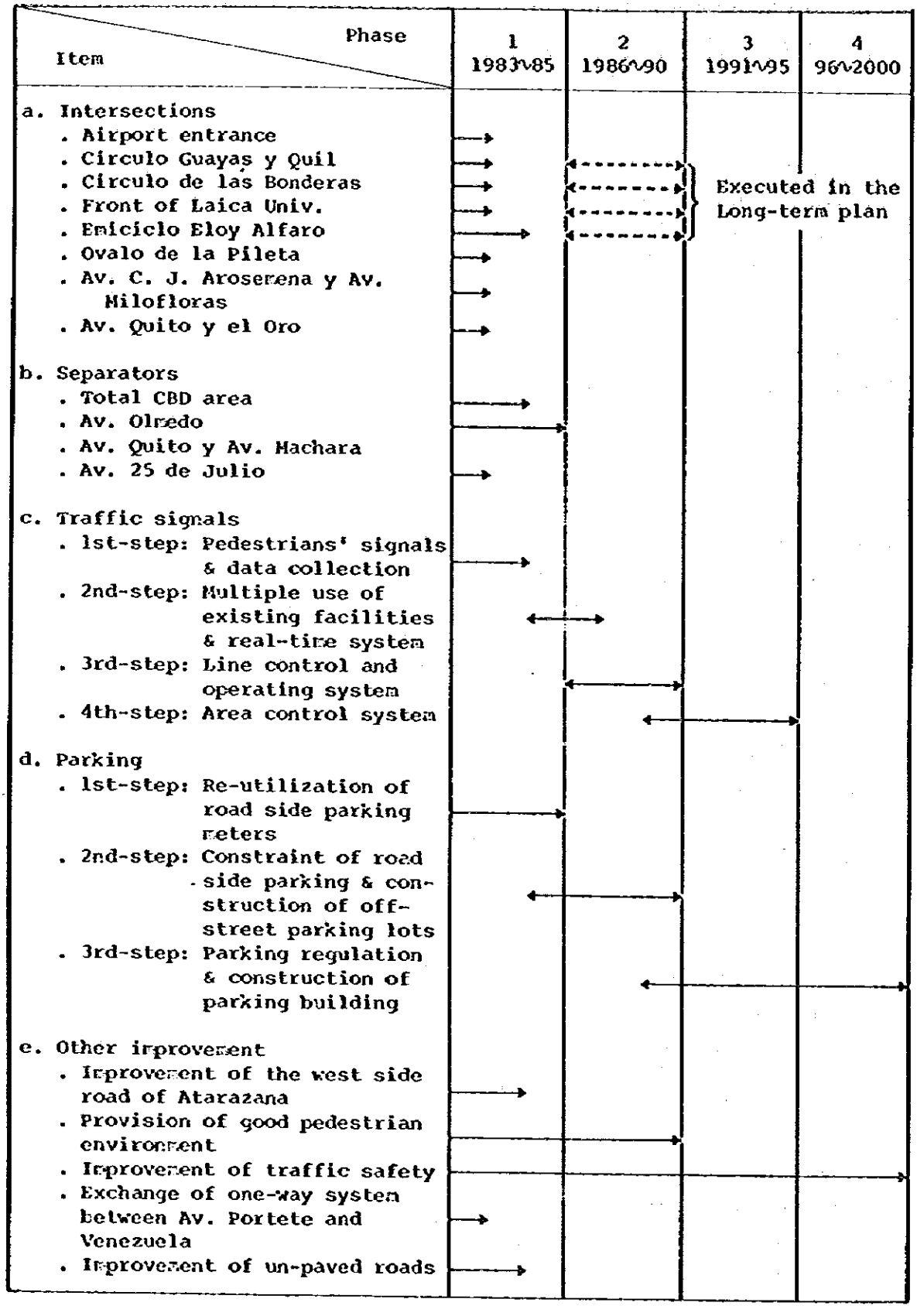
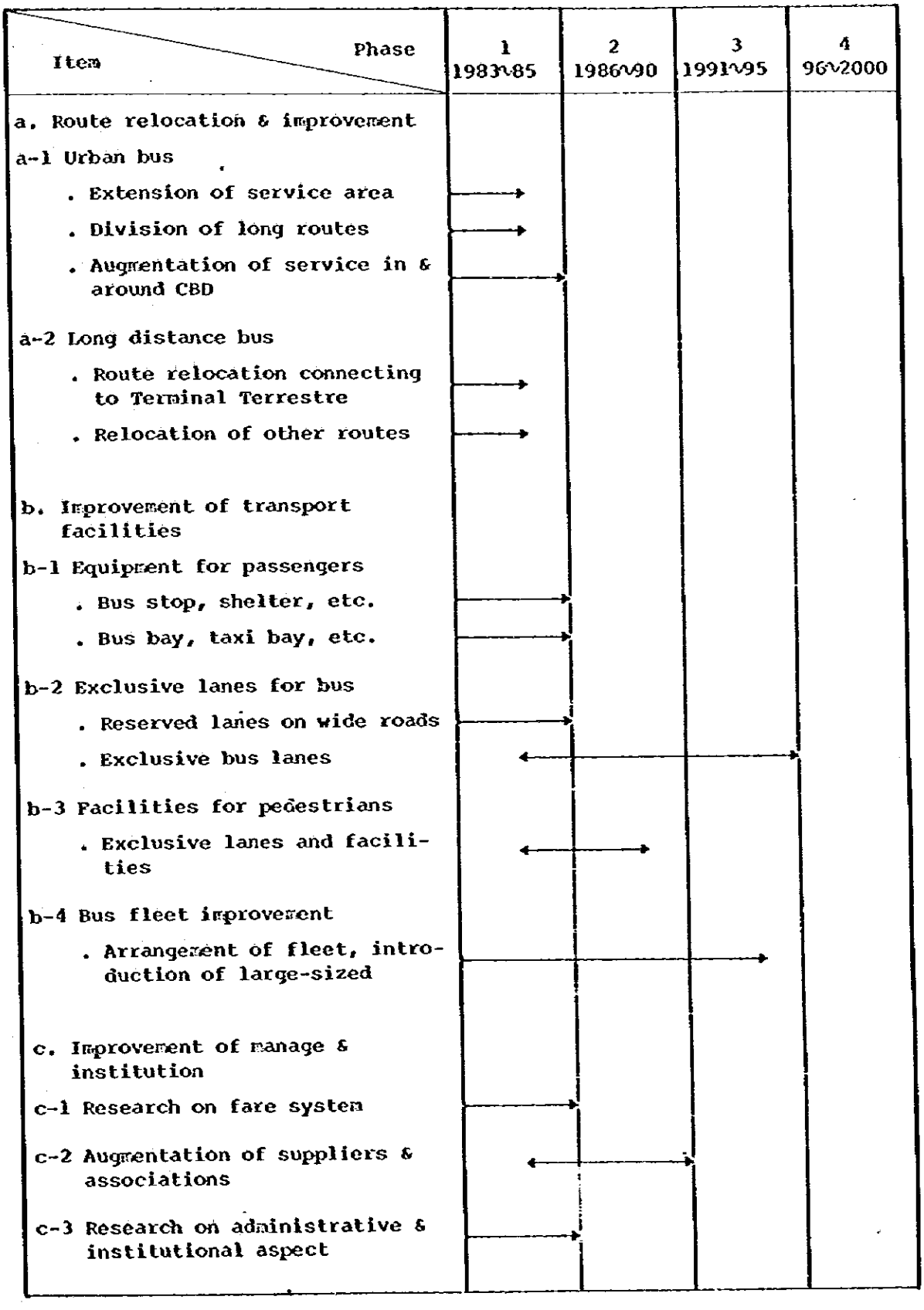


Figure S-19 IMPLEMENTATION PROGRAM FOR BUS TRANSPORT IMPROVEMENT



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