② Guasmo Norte - Centenario Sur

The existing bus route pattern

One group of routes operates to the CBD through Av. Quito and Av. Machala, and another group of routes operates to the CBD through Av. Eloy Alfaro or Av. Chile.

After introduction of the MRT

The former group is linked to the MRT at Guasmo station or Centro Civico station. The latter group is kept to complement the public transport service to the traffic demand between outside areas directly served by the MRT, and is connected to the MRT station in the CBD, to provide the feeder service there.
In case that MRT operation is up to Centro Civico, the former group is connected to Centro Civico station.

③ Los Estero - Las Acacias

The existing bus route pattern

One group of routes operates to the CBD through Av. Quito and Av. Machara, and another group of routes operates to the CBD across Av. Quito through the roads between Av. Quito and Av. Eloy Alfaro.

After introduction of the MRT

Both groups are linked to the MRT stations between Guasmo and Centro Civico. In case that the MRT operates between Centro Civico and Terminal Terrestre, the latter group operates in the roads along Rio Guayas across Av. Quito to complement MRT service.

④ Western area (Av. Milagro - Puente Portete)

The existing bus route pattern

One group of routes runs through the arterial roads like Av. Portete, Av. Venezuela and Gomez Rendon, around the CBD. Another group of routes crosses the MRT route and comes back from the Rio Guayas or the periphery of the CBD.

They provide the high level of service with the routes distributed densely in the western area while provide low level of service with the routes distributed sparsely in the CBD.

After introduction of the MRT

The routes through Av. Portete and Av. Venezuela are connected to the MRT at Centro Civico station. Other routes touch the MRT station and run in the roads along the Rio Guayas to the CBD in case that the route length from the origin to the Rio Guayas is too short.

⑤ Western area (Av. Quito - Av. Milagro)

The existing bus route pattern

Running zig-zag through the roads from west to east and roads from south to north, the routes cross the MRT route obliquely to enter the CBD. They provide high level of service with various routes in the CBD.

After introduction of the MRT

Touching the MRT station, the routes cross the MRT, and run through the roads parallel to the MRT but beyond areas served directly by the MRT.

⑥ North-western areas such as Urdesa, Los Ceibos, and Mapasingue Este, Oeste

The existing bus route pattern

One group of routes runs through Urdesa and Av. Kennedy to the CBD, and another group through Av. Carlos Julio to the CBD. The density of the routes in the CBD is low.

After introduction of the MRT

The former group is connected to the MRT at Policentro station. The latter group is left in Av. Carlos Julio and connected to the stations around the CBD.

⑦ Atarazana and its surroundings

The existing bus route pattern

The routes from Durán and Terminal Terrestre cross or drop by here on the way to the CBD. But their variations are few.

After introduction of the MRT

New routes run between Atarazana and Urdesa, touching the MRT at Policentro station. They are expected to incorporate areas divided by the arterial roads into one community.

⑧ Areas along Av. Tanca Marengo and Via Daule

The existing bus route pattern

Most of the routes run through Av. de Las Americas into the periphery of the CBD. At present residents in this area are small and growing slowly, then the number of routes is small. On the other hand, the number of factories located along Via Daule has increased recently, and a number of factory buses provide service to the CBD for their workers.

After introduction of the MRT

The routes are linked to the MRT at Policentro station. Since the new route pattern is simple and the MRT service is available for every area in the city, the factory bus service can take the place of the public bus.

⑨ Northern area such as Alborada

The existing bus route pattern

Most of the routes run to the CBD, via Terminal Terrestre, but some of them extend to the western areas through the CBD. A few routes operate through Av. Tanca Malengo to the CBD.

After introduction of the MRT

Most of the routes start from Terminal Terrestre station, run through Alborada and extend to the

northern areas, where new housing estates are developing rapidly. The routes through Av. Tanca Malengo are connected to the MRT at Policentro station.

⑩ Durán

The existing bus route pattern

The routes run into the CBD through Atarazana, but their service areas in the CBD are getting smaller. Because the routes are operated through the inter-regional arterial roads congested with heavy traffic, their operations are often disturbed by the traffic jam.

After introduction of the MRT

The routes are connected to the MRT at Terminal Terrestre or Policentro station to avoid operations in the traffic congestion.

⑪ Pascuales

The existing bus route pattern

The routes run through Via Daule and Av. Carlos Julio up to the periphery of the CBD.

After introduction of the MRT

Most of them are connected to Terminal Terrestre station and some are kept in the present routes. Depending on the development of the northern areas, the routes are expanded.

⑫ Areas such as Alban Borja and Costenita

The existing bus route pattern

The variety of routes is not given. The routes from Los Ceibos or Pascuales are serving along Av. Carlos Julio.

After introduction of the MRT

Here is a newly developing residencial and commercial area. New routes connecting this area to Policentro

and Urdesa, or the CBD through Av. Milagro will be provided in future.

⑬ CBD

The existing bus route pattern

The periphery of the CBD is served by the routes from Guasmo, the western area ④, etc.. And the circulating services inside of the CBD are given by the routes from the western areas (⑤ Av. Milagro -Av. Quito). The kernel area of the CBD is not served well because of the traffic congestion.

After introduction of the MRT

The routes are arranged to complement the MRT service or to access to the MRT stations. In the kernel area of the CBD a pedestrian street and small bus routes are prepared for passengers to access to the MRT with ease and safety.

⑭ Access to Terminal Terrestre from CBD

The MRT takes over most routes except for some routes to the north western areas.

Because the bus routes after introduction of the MRT are connecting various kinds of regional commercial centers, they can serve for daily traffic demand like shopping without transfer. While the traffic demand for commuting should be served by the MRT because its flow is too big and too concentrated on the peak time for the bus transport to serve.

A conceptional network of the bus route reorganization above mentioned is shown in Figure 2-1.1.

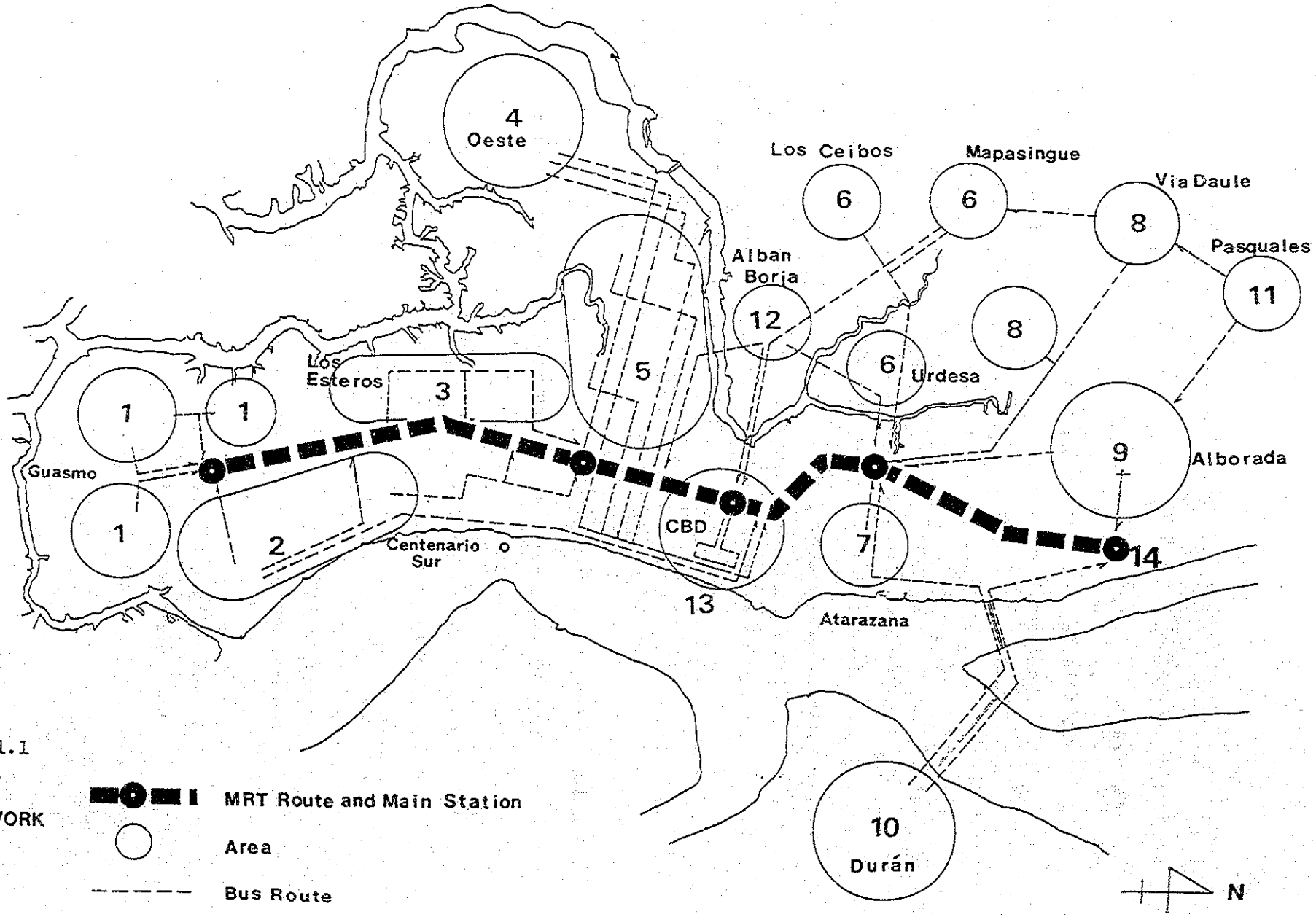


Figure 2-1.1
CONCEPT OF
BUS NETWORK

2-2 Coordination Plan between Bus and MRT in Main Stations

In order to make the MRT work effectively, it is desirable to prepare some transport facilities to coordinate the MRT with the road transport system because of the big volume of passenger transfer between them. It needs to keep the space for passengers to walk to bus stops, to get on/off buses, or to wait at main stations.

The potential of the commercial development around stations increases because of the big volume of passengers and convenient conditions of transportation. The surroundings are also expected to develop more rapidly and become a center of the area.

Each connection point develops differently and contains different facilities, according to the state of the area. The arrangement plan of the facilities in connection points are as follows.

① Guasmo station (Figure 2-2.1)

Characteristics required

This is the base to provide service for the whole of Guasmo.

It is important to connect the MRT with buses, taxis and private cars because of the big hinterland including the new port, as well.

Stage of urbanization

Population settlement is premature, but the structural roads in the area are fixed. The commercial center has been not yet formed firmly.

Planning of terminal facilities

The land acquisition for the terminal facilities seems comparatively easy, because the urbanization around the station projected is still premature. The big terminal facilities are planed, to include the bus terminal, taxi pool, car parking and park.

Prospects of development of surroundings

The surroundings will be developed to the biggest regional commercial center of Guasmo area. New streets, parks, and commercial zones should be planned, to promote desirable development.

② Centro Civico (Figure 2-2.2)

Characteristics required

Before the MRT extends to Guasmo, this station is a big base to provide services for the southern and western areas. After the MRT extends to Guasmo, it is connected to the bus routes bound for the western areas until the east-west line of the MRT starts operation in future. It does not seem important to contain facilities for the private cars.

Stage of urbanization

The residencial use of buildings mixed with commercial use have been mature already but the commercial function is expanding from the CBD to this area. Centro Civico is the biggest park in the urbanized area in Guayaquil and is gathering a fairly large number of people from every area in the city. The roads around the station projected are very crowded, because here is also the juction of road traffic to the western and southern areas.

Planning of terminal facilities

Because there is no large ground unoccupied, it seems very difficult to keep the exclusive land to use for the terminal facilities.

It is conceived to apply a part of Centro Civico to the terminal until the east-west line of the MRT starts operation. The terminal includes the bus terminal, taxi pool and berth excluding car parking. The beautification of the terminal and the MRT station seems important to fit to the view of the Centro Civico park.

The surroundings of this station is expected to develop to one of the big commercial centers because of the high potencial in the city. However, the traffic congestion around the station should be dispersed not to hinder the development.

③ 9 de Octubre (Figure 2-2.3)

Characteristics required

Because the station locates at the intersection of Av. Quito and Av. 9 de Octubre which are both the symbol roads of the city, and the latter locates at the entrance to the CBD, the terminal is expected to be a new symbolic entrance to the CBD. It is expected that the access modes from/to the station will be mainly by walk except that passengers to the areas beyond the walk distance use buses and taxies, restraining private cars which seem to be unsuitable to the circumstances of the city center of Guayaquil.

Stage of urbanization

Urbanization is already mature, but the CBD is expanding with new construction of higher-rised buildings and the surroundings of the station projected are most redeveloping area of the city.

Planning of terminal facilities

It seems very difficult to keep the exclusive space for the terminal facilities. To save the size of terminal space it is desirable for the commuters to be promoted to access by walk maximumly and by small bus like "Buseta" to the areas far from the terminal. It is, therefore, conceived to construct a higher building with the functions like commerce or business including the terminal when the redevelopment is planned.

Prospects of development

The redevelopment around the station projected will continue and this area will be included in the CBD in future and become one of the symbol zones of the city.

④ Policentro station (Figure 2-2.4)

Characteristics required

This is the terminal to access to the north-western areas where the density of population is low, the

housing estates are widely spread, and are served mainly by private cars.

It seems important to provide service facilities for the car access to the station as well as buses and taxies in order to prevent the vehicles from entering the CBD.

The share of passengers to access by walk will be small.

Stage of urbanization

The station is close to Policentro and Urdesa where the commercial and residencial land use is prevailing respectively. Although the commercial zones such as Alban Borja, Urdesa Center and Policentro are dispersed, they form the second biggest commercial center in the city.

The surroundings of the station is reserved unused up to the recent time but a new urbanization is under planning.

Planning of terminal facilities

It is desirable to keep a big terminal including the car parking and distribute the public facilities in the surroundings.

Prospects of development

A new commercial zone is expected to be formed in the surroundings, connected with Policentro, and the population settlement is expected to grow rapidly.

⑤ Terminal Terrestre

Characteristics required

This is the service base for the northern areas such as Alborada where the residential land use is rapidly developing with fairly high level of bus services.

The number of passengers to transfer between the urban transport and the inter-regional transport in this Terminal is expected to grow very high in future.

Stage of urbanization

The impact of introduction of the passenger terminal is still left within the terminal buildings, but it is expected that the surroundings will develop being affected by the terminal.

Planning of terminal facilities

The existing facilities for the access to Terminal Terrestre are available for the MRT too, because the MRT takes over the existing urban buses for access. It is desirable to provide a wide pedestrian bridge between the station and Terminal Terrestre.

⑥ Other stations in the urbanized areas

It is necessary to keep the connection with bus routes but the preparation of big terminal facilities seems difficult. Road side bus bay will be available.

The facilities for the pedestrians like side-walk or the pedestrian crossing should be prepared in order.

The development of commerce around the station is also expected.

⑦ Other stations in the suburbs

The preparation of car parking and bus berths at road side is desired.

Development of the surroundings will be promoted by arrangement of public establishments like public office or schools.

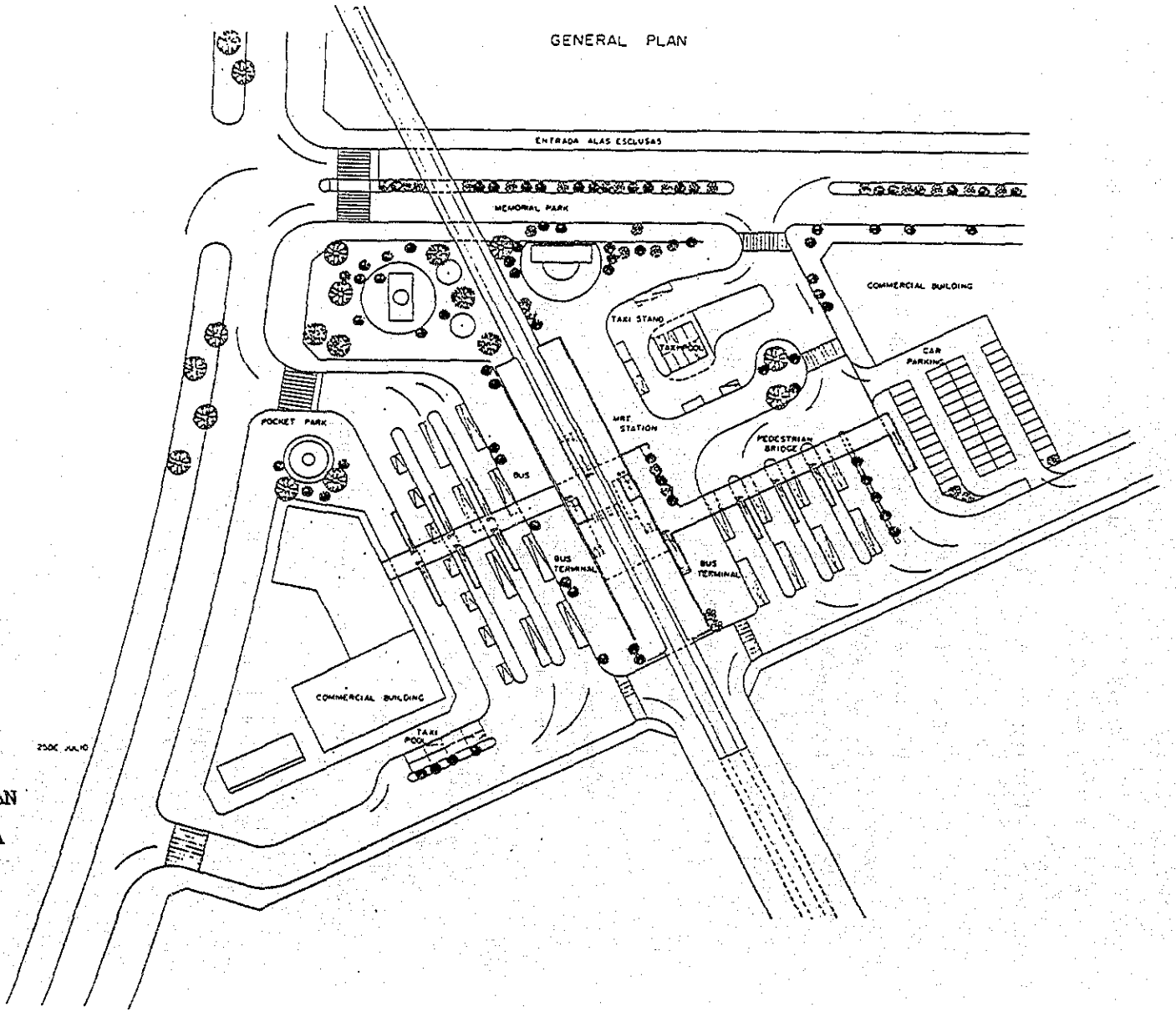


Figure 2-2.1
CONCEPTIONAL PLAN
OF STATION PLAZA
AT GUASMO

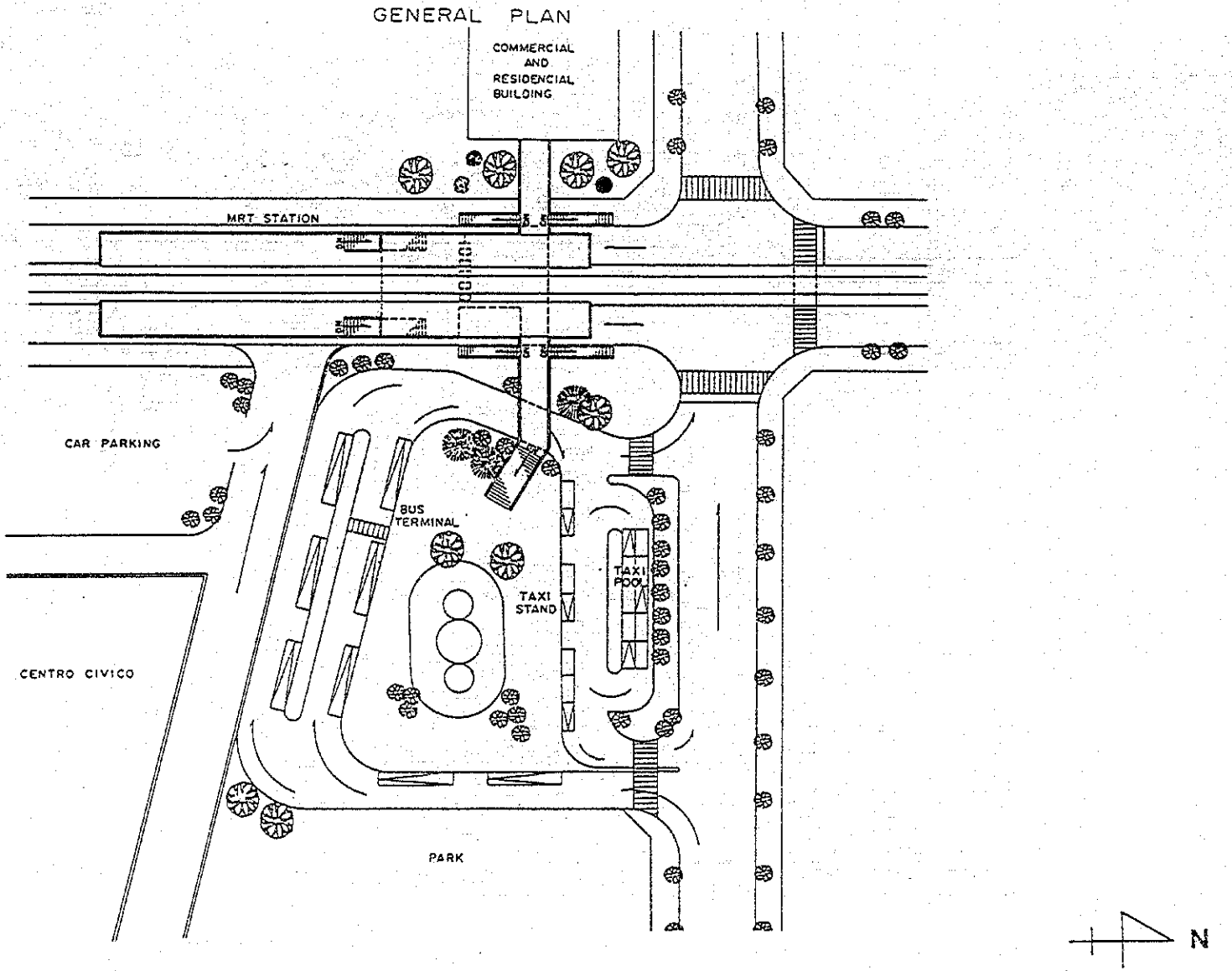


Figure 2-2.2
CONCEPTIONAL PLAN
OF STATION PLAZA
AT CENTRO CIVICO

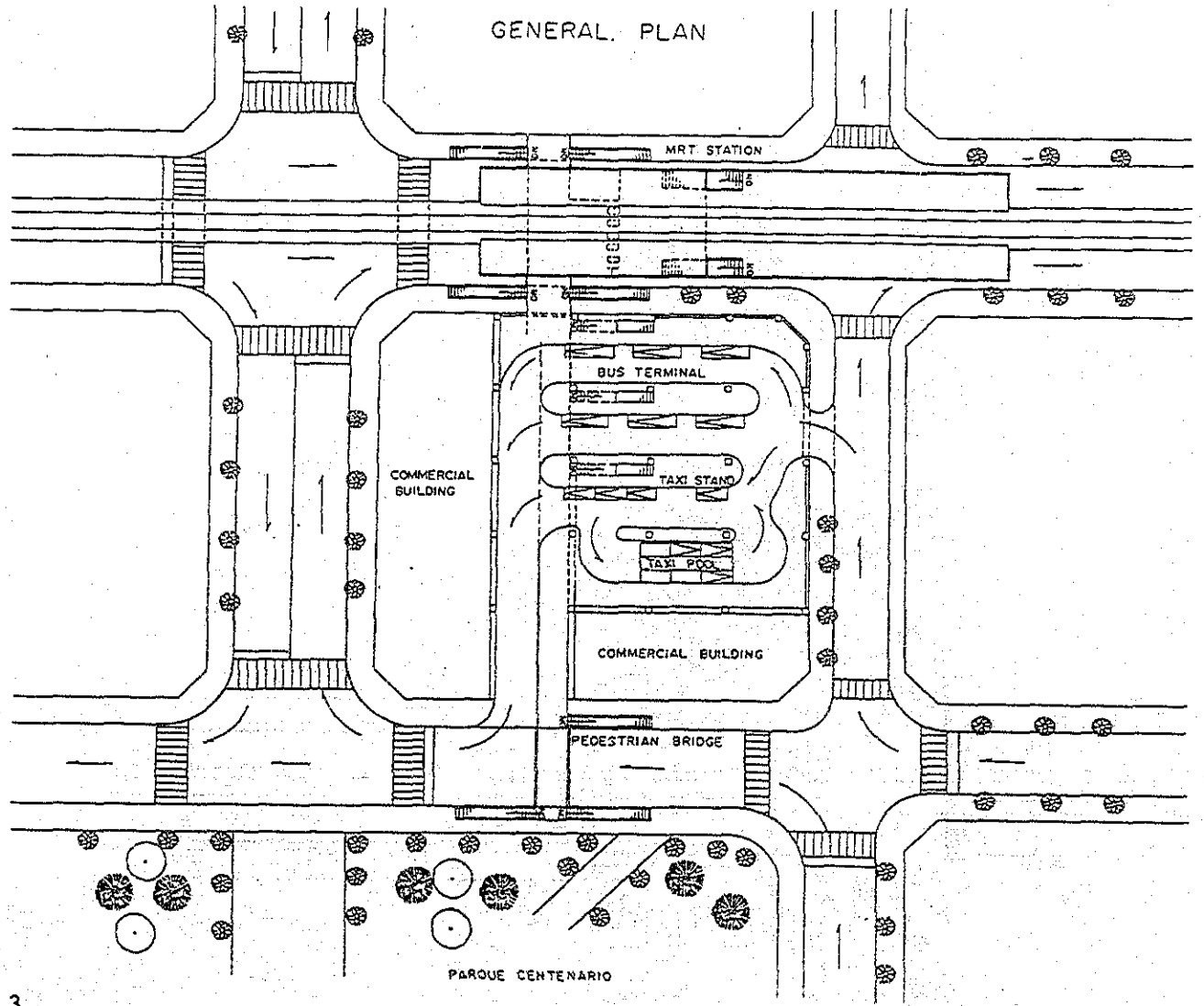


Figure 2-2.3

CONCEPTIONAL PLAN

OF STATION PLAZA AT 9 DE OCTUBRE

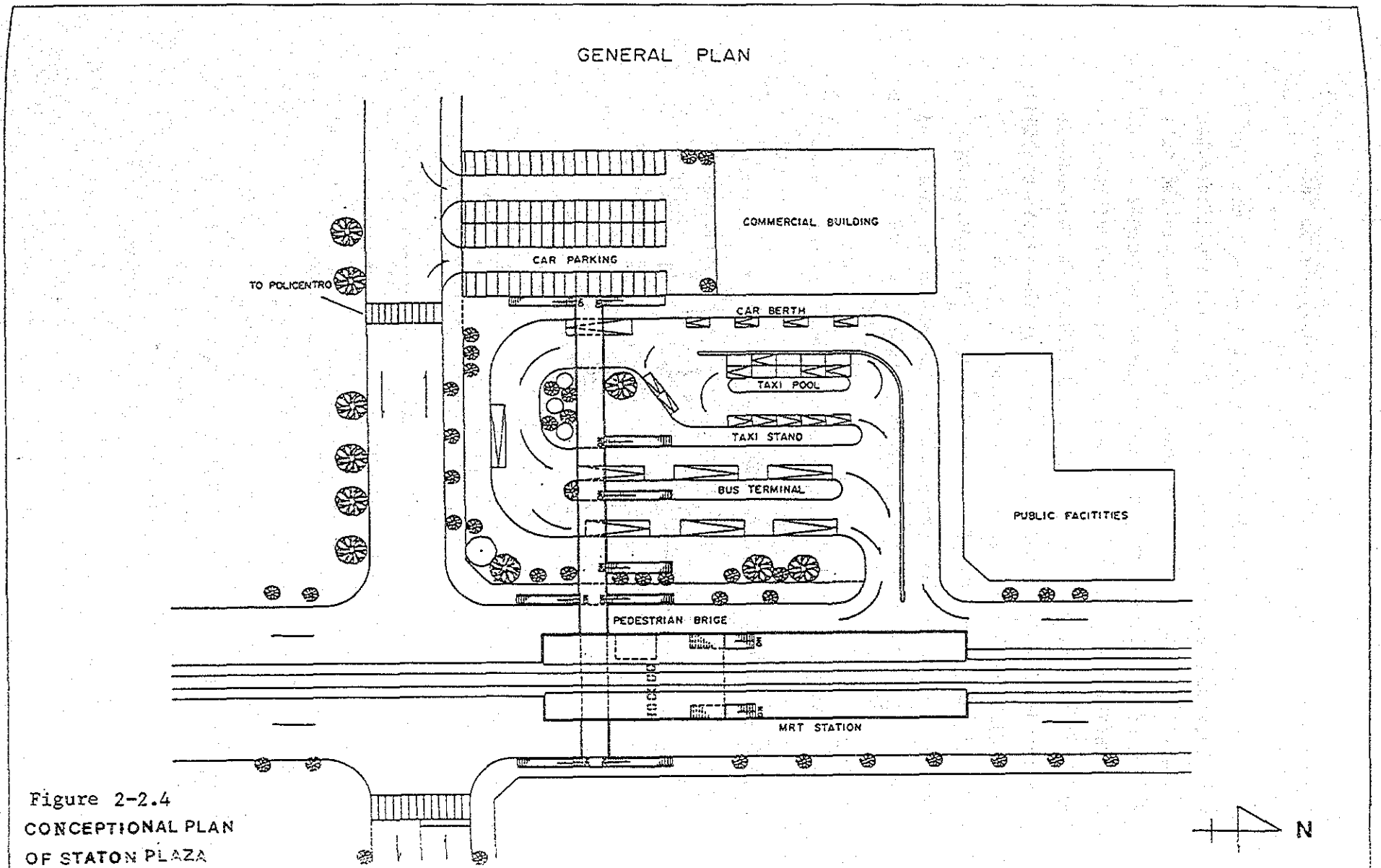


Figure 2-2.4
CONCEPTIONAL PLAN
OF STATON PLAZA
AT POLICENTRO

2-3 Improvement Plan of Accessibility to Rio Guayas from MRT Stations

Although the CBD expands to the south and west the most important functions of commerce, business, and administration are still concentrated on the areas along Rio Guayas and will be left there in future. The distance between Rio Guayas and the MRT stations seems to be a little far as an access distance by walk and the bus access seems to be required. But because of the crowd on roads in CBD, the operation of the access bus will be disturbed, to some extent. (see Figure 2-3.1)

As the countermeasure, it is desirable to promote the access by walk and the arrangement of bus exclusive lane, and transit mall will be one of desirable solutions.

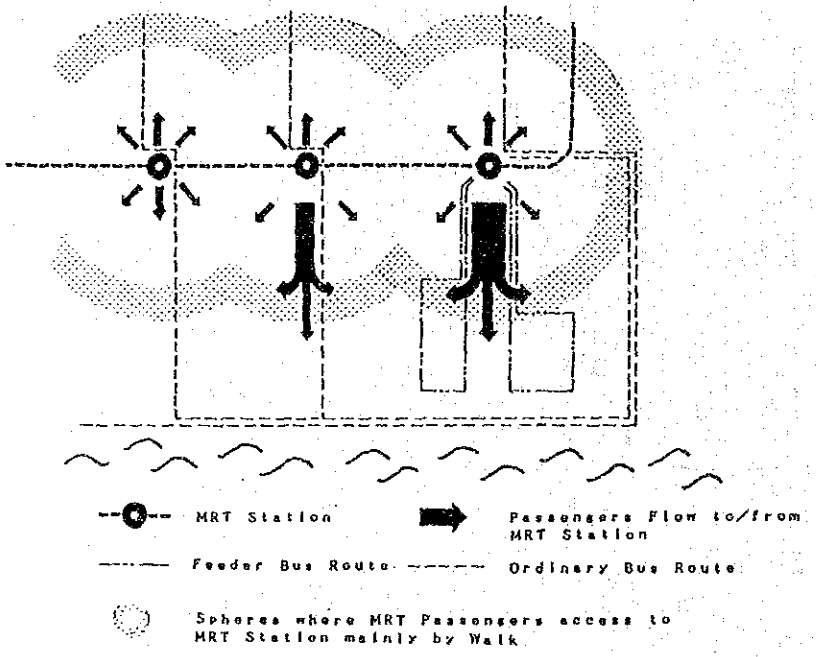


Figure 2-3.1 SCHEMATIC PLAN OF MRT PASSENGERS FLOW

1) Concept of Transit Mall

Transit mall is very popular and introduced into many cities. It contains the pedestrian mall and carriage-way available only for the public transport like buses and taxies, restraining private cars.

The transit mall aims at not only improvement of public transport but also recovery of amenity of the city center and provision of walk shopping or recreation with comfort and safety for the citizens.

It seems suitable to introduce such a transit mall into the CBD of the city in coordination with the MRT.

2) Characteristics required

The transit mall shall provide a symbolic space to attract many people. It admits passage of small-sized buses like "Buseta", taxis and minimum number of private-cars necessary to access the building along the streets. If buses provide free-ride service, the passengers will walk or take buses according to their choice at one time and another, and change it freely on their way.

3) Route Selection

Three alternative streets are selected. They are Av. 9 de Octubre, Av. Velez and Calle Victor Manuel Rendón (see Figure 2-3.2). Preliminary comparison is as follows.

① Av. 9 de Octubre

Existing traffic condition

This is two way street and the traffic volume is the biggest of three but heavy traffic is prevented from entering directly by cranked road around Parque Centenario. The volume of pedestrians is also largest and large even on holidays.

Characteristics

It is a symbol street connecting the popular parks such as Parque Guayaquil, Parque Centenario, Malecon, and other pocket parks.

Situation of street side

The big buildings such as public office, banks, hotels, department stores, movie theatres are distributed and attract people always.

② Av. Velez

Existing traffic condition

It is one way street entering the CBD and traffic volume is smaller than that of Av. 9 de Octubre. Pedestrian volume is fairly large, but small on holidays. Car parking at road side is a little prominent to others.

Situation of street side

The stores for daily goods like retail salers or shopping centers, and restaurants with small scale, and hotels are distributed densely. The city hall, provincial government office and post office are nearer.

Characteristics

It looks like a thriving street linked directly to the daily living, presenting animated appearance in disorder. It is connected with Parque Centenario but not with Malecon directly.

③ Calle Victor Manuel Rendón

Existing traffic condition

It is one way street going out of the CBD, and the traffic volume is smaller than Av. 9 de Octubre. The number of buses is larger, and pedestrian volume is less than the others.

Situation of street side

The small business buildings and stores concerned with daily goods traffic, like wholesale, are located. But in the area near Rio Guayas, some offices of public service and banks are distributed.

Characteristics

The street is connected with Parque Centenario and Malecon but even a small park is not located.
This is the service road for business buildings, goods traffic and public transport but attractiveness for pedestrian seems a little smaller.

Considering the above comparison and the advantages and disadvantages produced when it is changed into the transit mall, Av. 9 de Octubre is recommended to be suitable to the transit mall.

A concept of the transit mall is shown in Figure 2-3.2 and 2-3.3, and its image is given in Figure 2-3.4.

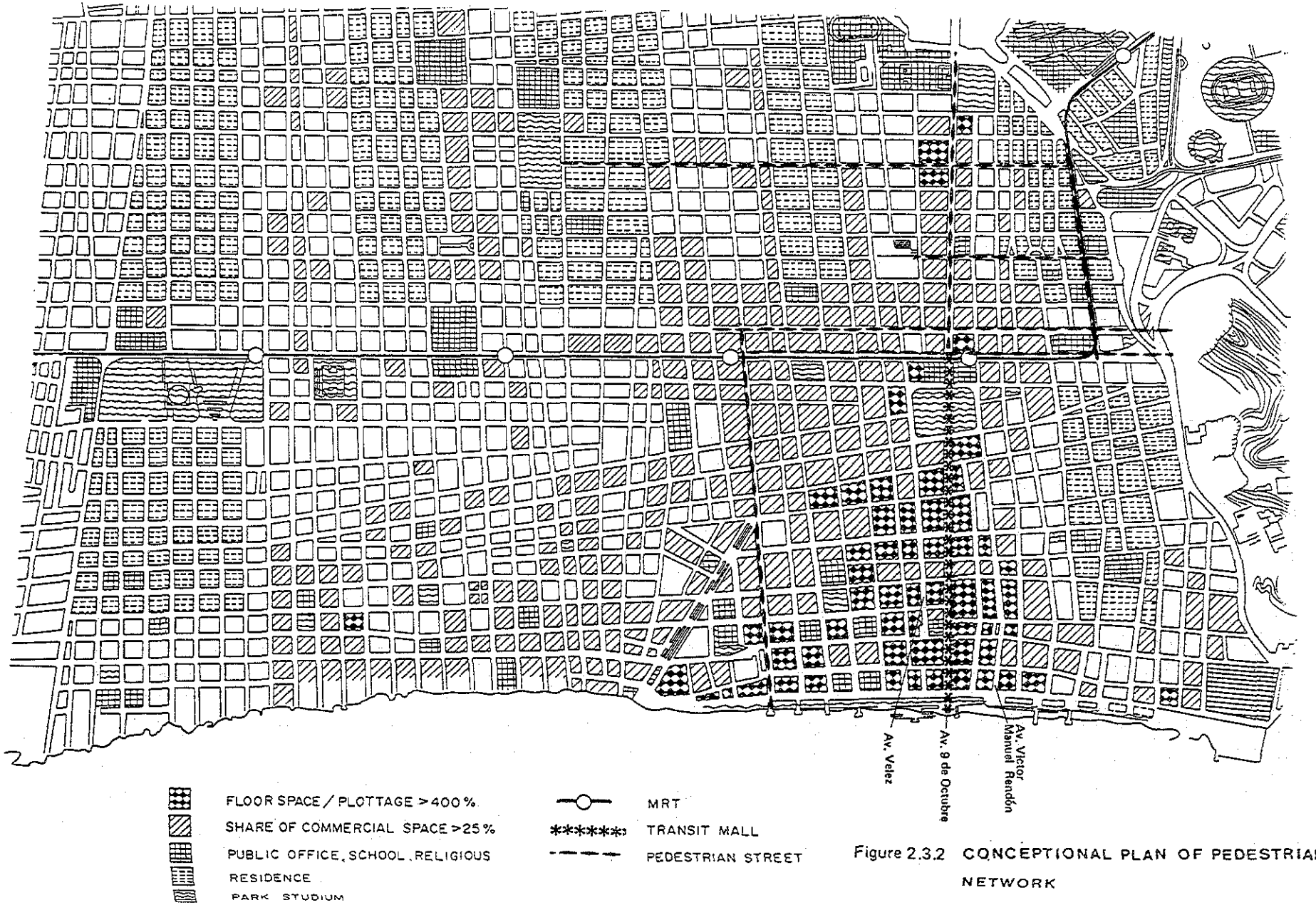


Figure 2.3.2 CONCEPTIONAL PLAN OF PEDESTRIAN NETWORK

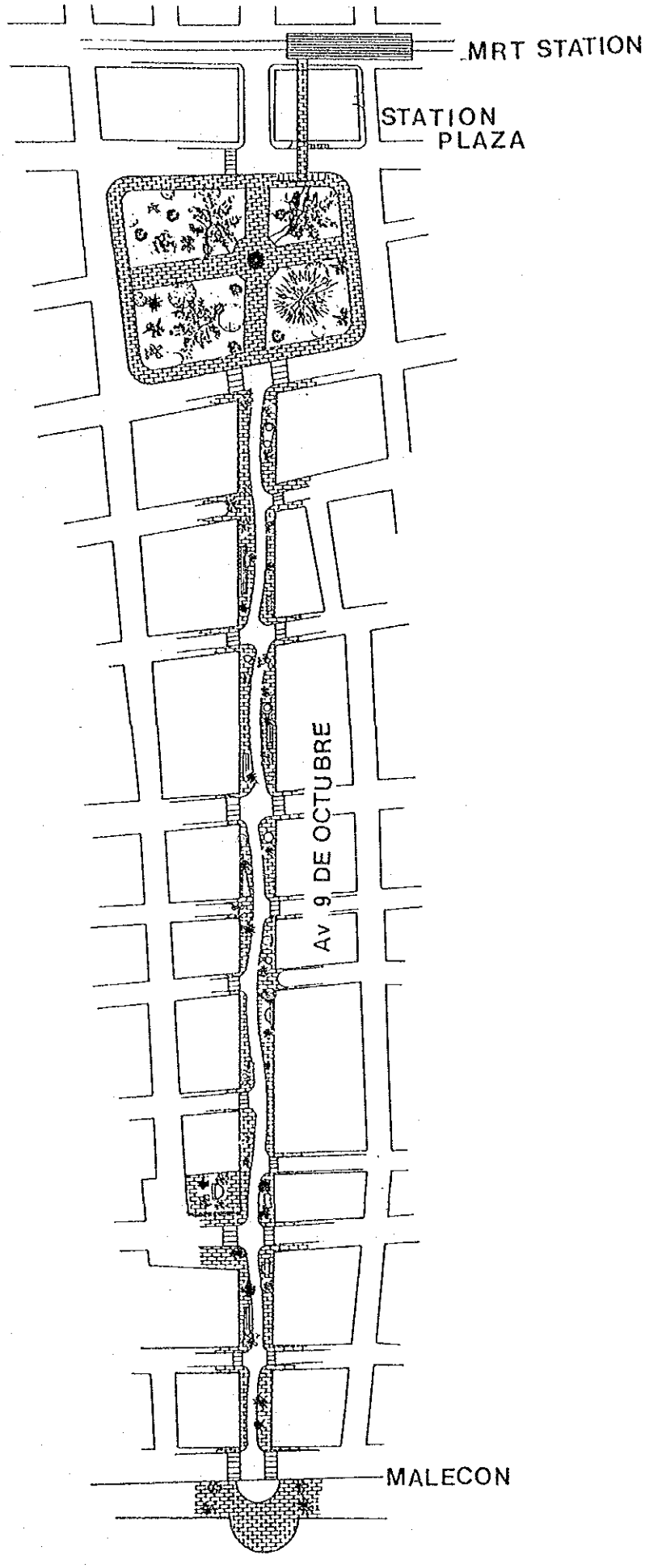


Figure 2-3.3
CONCEPTIONAL PLAN OF
TRANSIT MALL

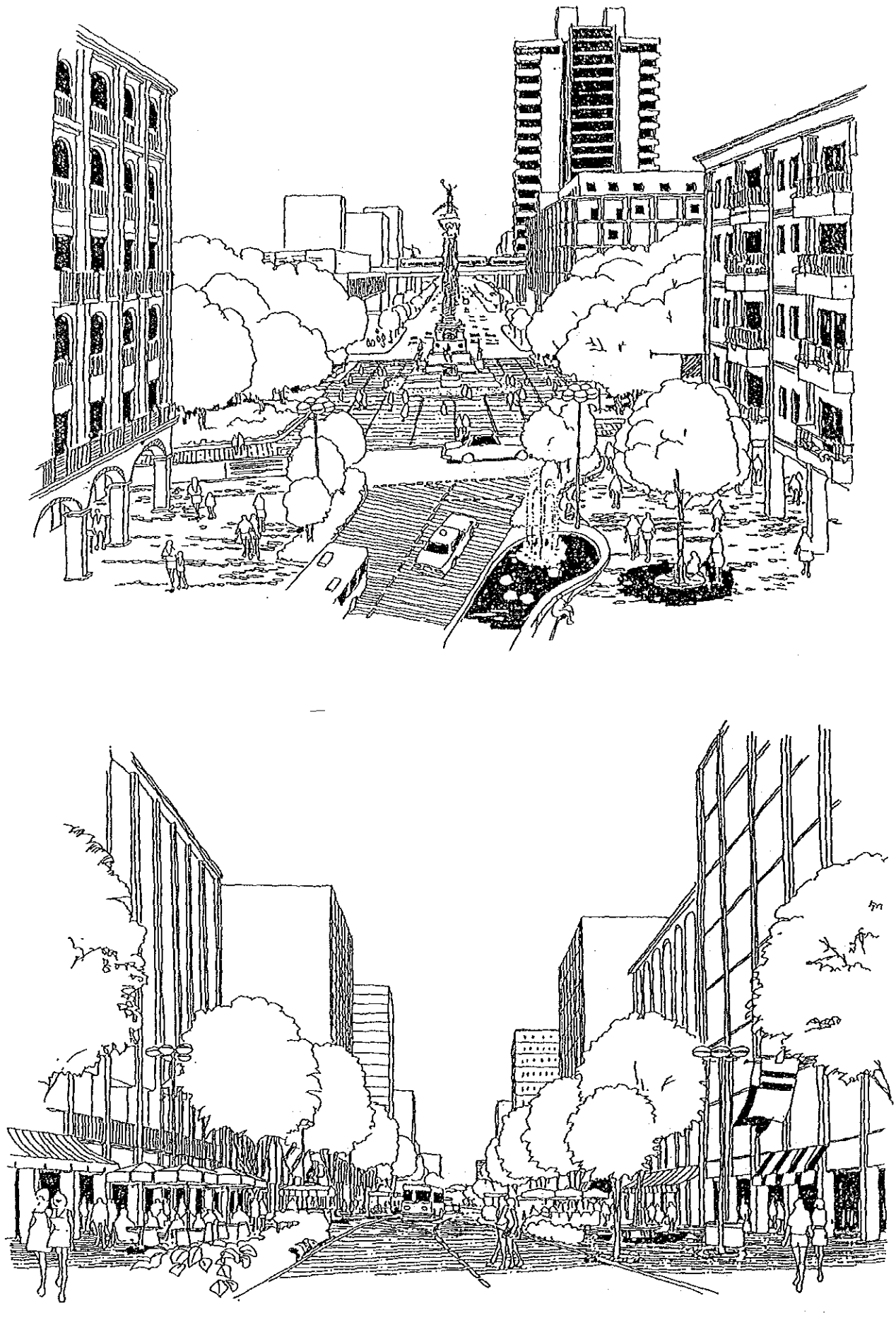


Figure 2-3.4 IMAGE OF TRANSIT MALL

2-4 Provisional Reorganization of Bus Routes and Measures for Terminal Facilities for Partial Opening of MRT Service

For the partial opening of MRT service, the provisional reorganization of the bus routes and the facilities for accepting and controlling the heavy traffic of passengers at the terminal stations will be required. Such terminal facilities are not necessarily essential when the whole system of the MRT is completed but they are important for a certain period of time in the course of the construction work of the MRT.

The planning policy for the provisional measures are as follows:

(1) The bus routes should be reorganized in order not to degrade the service of the public transportation system consisting of the MRT and the bus transportation.

(2) The transport system in each stage should be coordinated with the system when the whole system of the MRT is completed, and the provisional system of transportation during the MRT operation within partial route should take the form which is readily adaptable to the total system of transportation after the completion of the MRT.
In this way, the users of the public transportation system are expected to gradually get accustomed to the new transportation system.

(3) It is necessary to take the measures for reducing the traffic congestion near the stations as far as possible.

(4) In taking the provisional measures, care should be given so as not to apply too large funds for the matters other than those which are essential at the start of the full operation of the MRT.

1) Case of MRT Operation between Terminal Terrestre Station and 9 de Octubre Station.

a. Partial alteration of bus route (see Fig. 2-4.1)

Routes to gain access to the CBD from the southern area such as Guasmo and the western area:
The existing bus route pattern is kept as it is.

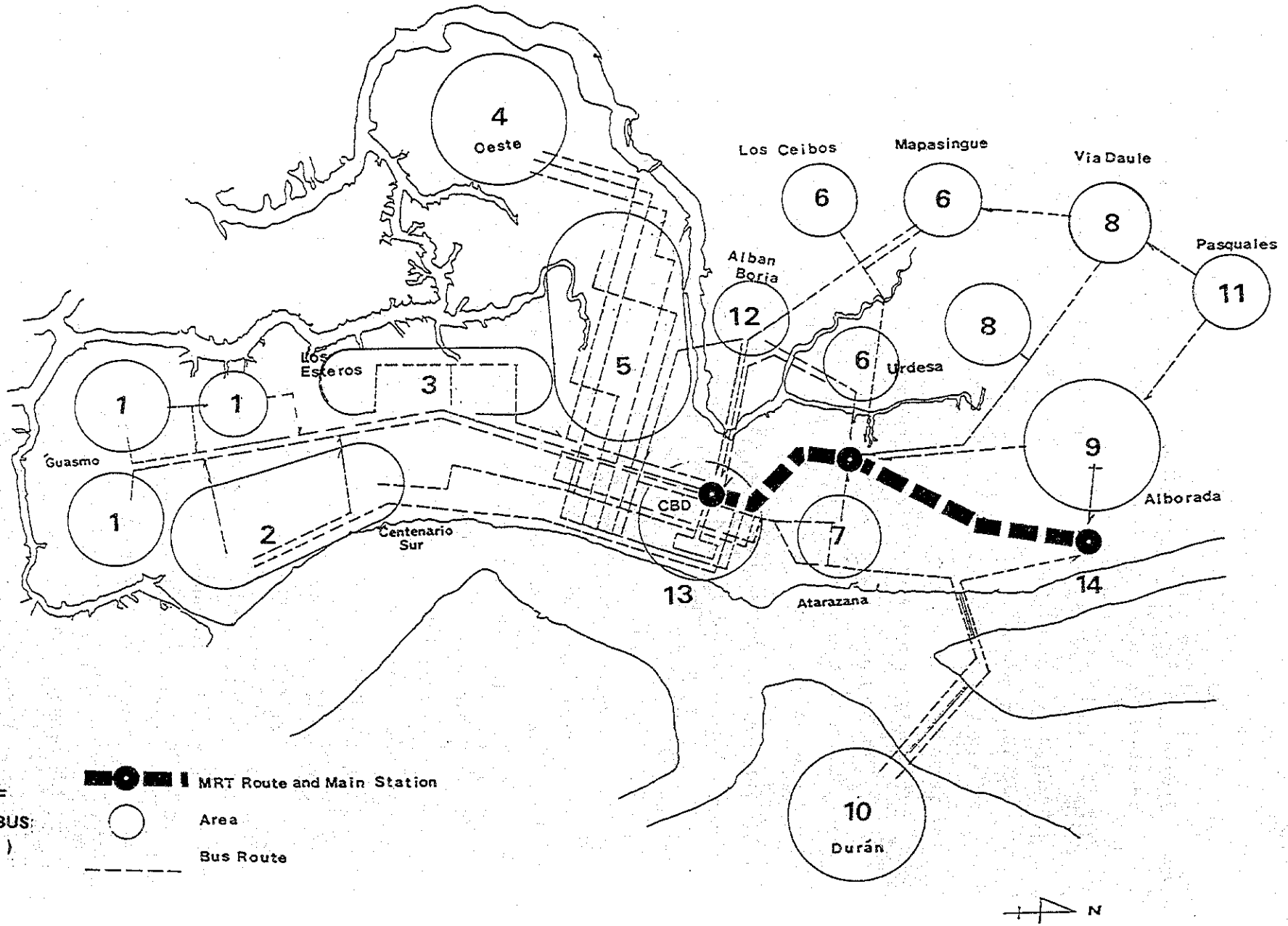


Figure 2-4.1
CONCEPT OF PROVISIONAL BUS NETWORK – (1)

- Northern area (Alborada, Via Tanca Malengo, Via Daule, Pascuales, etc., ⑧, ⑨, ⑪):
  The routes are connected to the MRT at Terminal Terrestre station and Policentro station.

- Northern area (Urdesa, Los Ceibos, etc., ⑥)
  Some of the routes are connected to the MRT at Policentro station. Other routes run into the CBD through Av. Carlos Julio.

- Duran (⑩) :
  Some of the routes are connected with MRT at Terminal Terreste station.
  Other routes run to the CBD. In case that the traffic congestion on the roads used by bus routes has become serious, these routes are connected with the MRT at Policentro station.

- Atarazana (⑦) :
  The bus route from Atarazana directly runs to the CBD like that from Duran, but, in case that the traffic congestion on the road used by bus routes has become serious, the routes are connected with the MRT at Policentro station.

- Access routes to inter-city bus terminal (⑭) :
  Most of the inter-city bus passengers' origins or destinations are in the CBD, so that they can be replaced by the MRT. The routes from Terminal Terrestre to Parque Chille or to Centro Civico by way of 9 de Octubre start from 9 de Octubre sation of the MRT, and the routes are extended, since they become shorter than before.

- Access route from MRT station to CBD (⑬) :
  Before the access route to areas along Rio Guayas is improved, the routes from the southern area and western

area are connected with 9 de Octubre station of the MRT and run into CBD in order to transport the passengers coming into the CBD from the MRT station.

b. Improvement of terminal (see Fig. 2-4.2)

As the roads near Terminal Terrestre station and Policentro station are broad enough, the connection of the bus routes to these stations is considered not to cause the traffic congestion.

9 de Octubre station is supposed to serve as terminal station for some time. The terminal facilities near the station are desired to be constructed as soon as possible. Before completing the construction of the bus terminal in this area, bus berths and taxi berths are provided along the nearby streets in order to let the traffic of the passengers to and from the station flow smoothly.

Facilities improvement plan

Premises

- Number of passengers of MRT a day 200,000/day
- Number of passengers alighting the MRT during peak hour 12,000/hour
- Number of passengers riding on the MRT during peak hour 6,000/hour
- Anticipated rate of share of terminal traffic means

  The distance from 9 de Octubre station to the areas along Rio Guayas is about 1 km, most of passengers will gain access to Rio Guayas on foot. But it is assumed that some 40% of the passengers (of the MRT) use taxis or buses in case that the improvement of the traffic conditions for pedestrians is delayed.

  - Access on foot 60%
  - Access by bus 35%
  - Access by taxi 5%

Determination of Numbers of Necessary Facilities

- Service time

  In case that trains arrive at an interval of less than 5 minutes, the service time should be 5 minutes so that the passengers of the train can transfer to other transportation such as buses or taxis within 5 minutes.

- Necessary number of bus berth

  Where the number of bus passengers = 40 passengers/bus

  Necessary number of bus departure berth = 12,000 x 0.35 x (5/60) x (1/40) = 8.75 = 9 berths

  Where the time required for getting off the bus is 2 minutes.

  Necessary number of bus arrival berth = 6,000 x 0.35 x (2/60) x (1/40) = 1.75 = 2 berths

  Thus, the necessary number of bus berths for departure and arrival is 11 in all.

- Necessary number of taxi berth

  Where the average riding time on taxi = 10 minutes/60 passengers

  Number of taxi passengers during service time = 12,000 x 0.05 x (5/60) = 50 passengers.

  Necessary number of taxi departure berth = (10/60) x 50 + 5 = 1.7 = 2 berths

  Where the average time required for getting off taxi = 30 minutes/60 passengers

  Number of taxi passengers during peak hour = 6,000 x 0.05 = 300 passengers/hour

  Necessary number of taxi arrival berth = (300/60) x (30/60) = 2.5 = 3 berths

- Capacity of the taxi parking lot

  Where the average number of passengers is 1.4.

  Necessary capacity of the parking lot = 50/1.4 = 35.7 = 36 cars/5 minutes

As for the parking lot for taxis, a high turnover rate can be expected, since most of the passengers use taxis for relatively short trips. Thus, the parking capacity for 10 taxis will be sufficient.

For private cars, two to four berths should be provided assuming that there will be the passengers who arrive at or leave the station using private cars though the parking lot for private cars seems to be scarcely necessary for the reason that the station is located in the center of the city.

Thus, the numbers of the necessary facilities are as follows:

• Departure berth for buses	9 berths
• Arrival berth for buses	2 "
Total	11 "
• Departure berth for tasix	2 "
• Arrival berth for taxis	3 "
Total	5 "
• Capacity of the parking lot for taxis	10 taxis
• Departure and arrival berth for private cars	2 to 4 berths

(The berths for private cars are to be used during the off-peak hours).

Fig. 2-4.2 shows an example of the layout of the above facilities. Since the area near the station will be crowded with a number of vehicles such as taxis and buses, it will be necessary to limit the traffic of private cars to some extent.

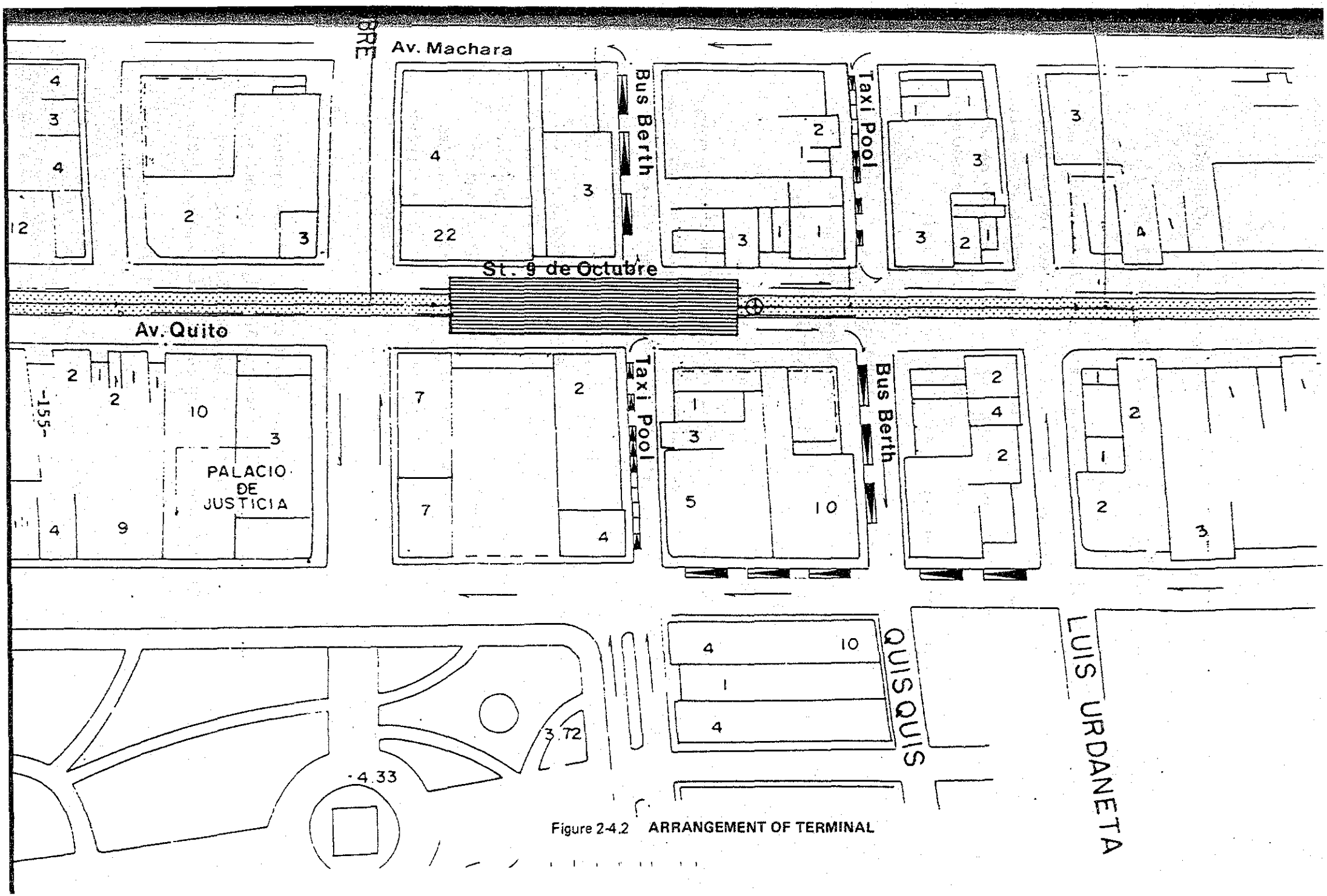


Figure 2-4.2 ARRANGEMENT OF TERMINAL

2) Case of MRT Operation between Terminal Terrestre station and Centro Civico station

a. Reorganization of bus route (see Fig. 2-4.3)

In this stage, the function of the MRT will be fully utilized in the northern area. Thus, the bus routes in the northern and western areas may be reorganized so as to meet the requirements at the start of the full operation of the MRT. The reorganization of the bus routes in the southern area should conform to the following conditions:

- o Guasmo Sur, Oeste and Central (①)

  The routes leading to the CBD from these areas are connected to the MRT at Centro Civico station.

- o Guasmo Norte and Centenario Sur (②)

  As for the routes leading to the CBD from these areas , one leading to the CBD by way of Av. Quito and Av. Machara is connected to the MRT at Centro Civico station and the other reaching the CBD at present by way of Av. Eloy Alfaro and Av. Chile is shifted to a route to run along Rio Guayas and extended to the CBD. Routes to connect the areas out of the service area of the MRT should be provided in order to reinforce the service of the public transportation. These routes follow the arterial road along the outside of the CBD and reach a station in the CBD, and also it is expected to service as an access route within the CBD.

- o Los Esteros and Las Acacias (③)

  As with the cases of the above areas, the bus routes should be reorganized into one leading to the MRT at Centro Civico station and the other extending across the MRT and running to CBD through the road along Rio Guayas.

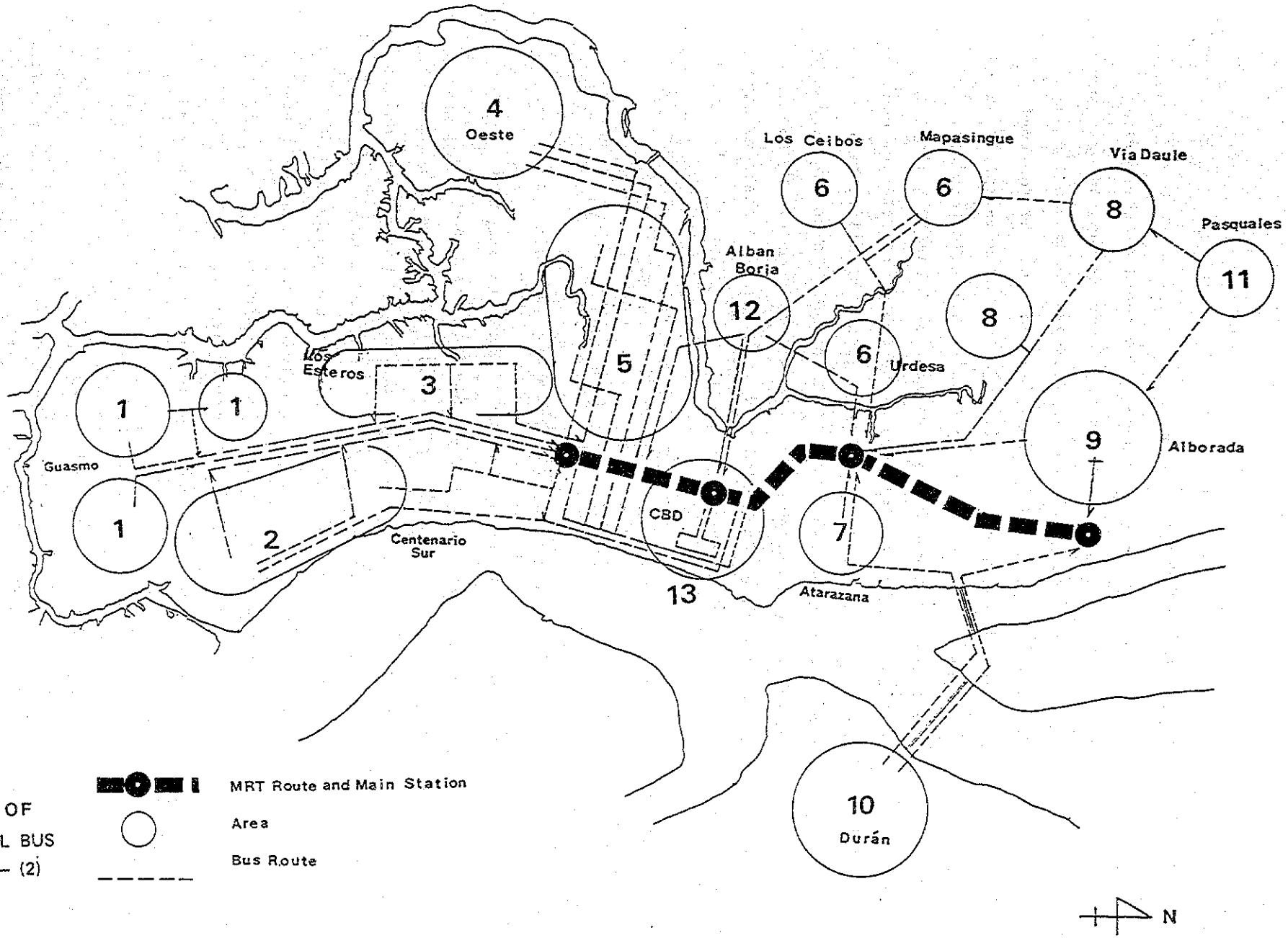


Figure 2-4.3
CONCEPT OF PROVISIONAL BUS NET WORK – (2)

b. Improvement of terminals

Centro Civico station is supposed to serve as the service base of the MRT for a broad area covering the southern and western areas until the MRT is extended to Guasmo station. The area near the station includes the nodes of the road traffic system, and the traffic in this area is apt to be congested, so that it is important to provide terminal facilities in front of the station. In case that the existing open space in front of Centro Civico station can not be used provisionally, there is a possibility that Centro Civico station alone will not be able to function sufficiently as a terminal. Therefore, some of the bus routes should be connected to the MRT at some stations other than Centro Civico station.

3) Case of MRT Operation between Guasmo Station and Centro Civico station

a. Reorganization of bus route (see Fig. 2-4.4)

For the northern area, the bus routes are extended according to the increase in the population and the progress of the urbanization, though the present pattern of the existing bus routes is maintained. The MRT does not arrive at the CBC, so that its function is not fully utilized. Thus, the bus routes from the southern and western areas should be reorganized so that they will be able not only to complement the function of the MRT but also to raise the service level of the public transportation. The reorganization policy by area is as follows:

- Guasmo Sur, Oeste and Central (①)

  All the routes leading to the CBD from these areas are connected to the MRT at Guasmo station, and reorganized as the feeder routes of the MRT.

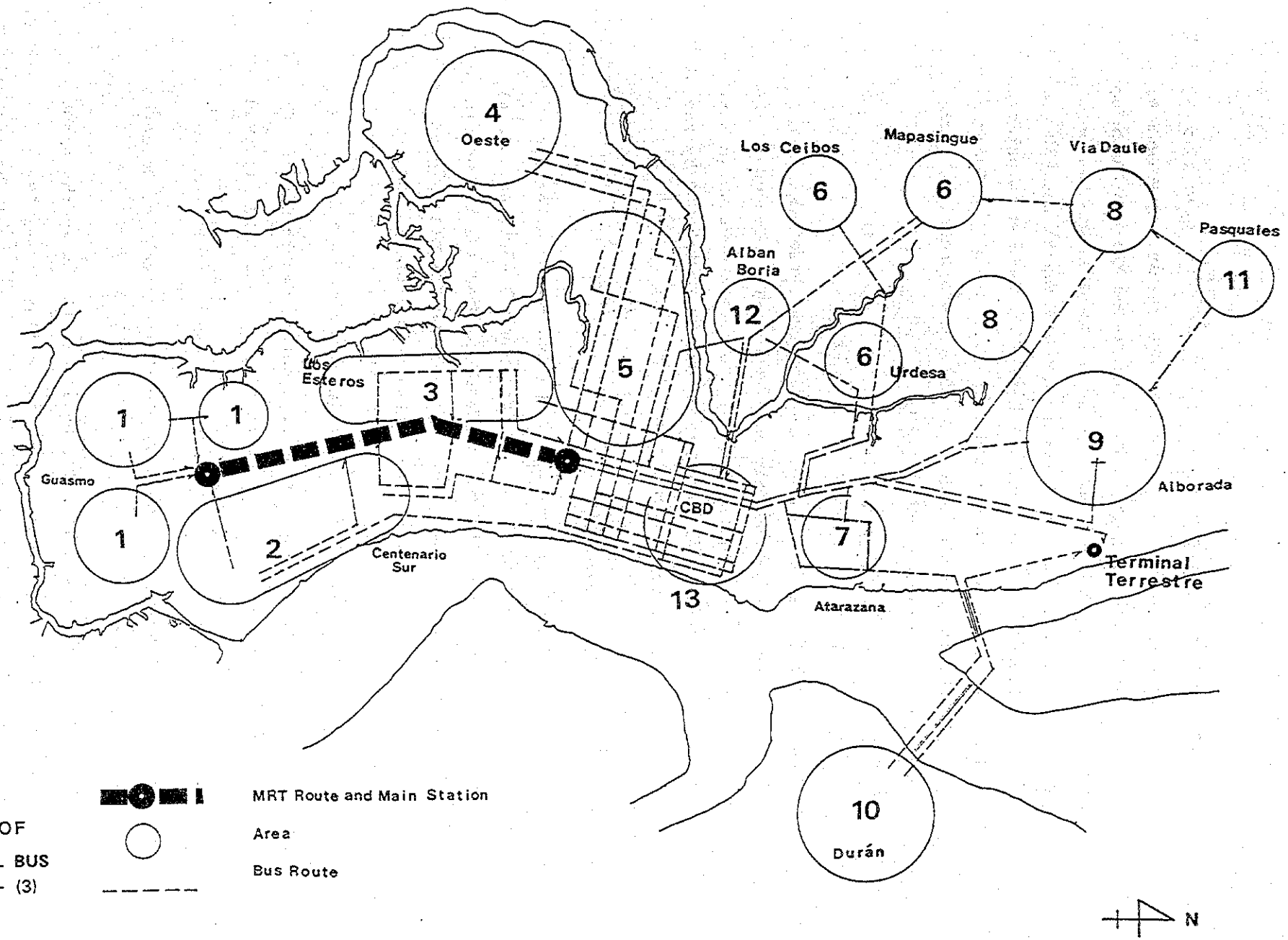


Figure 2-4.4

CONCEPT OF PROVISIONAL BUS NET WORK – (3)

MRT Route and Main Station

Area

Bus Route

o Guasmo Norte and Centenario Sur (②)

The route now leading to the CBD via Av. Quito and Av. Machara is connected to a station of MRT and extended farther to the area such as Los Esteros and Las Acadias. As for the route now leading to the CBD via Av. Eloy Alfaro and Av. Chile, the section in parallel with the MRT is shifted to a route along Rio Guayas, and the present route is used for the section between Centro Civico and the CBD.

o Los Esteros and Las Acacias (③)

The routes leading to the CBD from these areas are connected to the stations of MRT, and extended further to the area, such as Guasmo Norte and Centenario Sur. Some of these routes are connected to the CBD by way of a road running along Rio Guayas.

o Western area (④, ⑤)

Of the routes leading to the CBD from the western area, the routes via Av. Portete and Av. Venezuela are connected to the MRT at Centro Civico station before entering the CBD, whereby these routes are able to serve as access routes to the CBD from the MRT.

b. Improvement of terminal facilities

As the terminal facilities in front of Centro Civico station will become indispensable, it should be improved utilizing a part of the park.

4) Case of MRT Operation between Guasmo station and 9 de Octubre station

The service of the MRT is fully available in the southern and western areas except the accesses to the inter-city bus terminal. Thus, the bus routes in these areas should be adapted to the patterns conforming to the requirements at the time of the full completion of the routes. For the northern area, the

bus routes will basically follow the patterns of the existing routes. In the CBD, many of the bus routes will concentrate in addition to the stations of the MRT, so that the following measures should be taken.

a. Alteration of bus route (see Fig. 2-4.5)

- o Southern and western areas (①, ②, ③, ④, ⑤)

  All the routes connected to the MRT should conform to the requirements at the start of the full operation of the MRT line. As for the bus routes entering the CBD and connected to the MRT at 9 de Octubre station, some of them are connected to Colon station and some other stations of the MRT after crossing Av. Quito and Av. Machara and running around the western block in order to prevent too many bus routes from concentrating at 9 de Octubre station.

- o Northern area (⑥, ⑦, ⑧, ⑨, ⑩, ⑪, ⑫)

  The bus routes within this area will follow the patterns of the existing routes. In the CBD, however, the concentration of all the routes at 9 de Octubre station has to be prevented just like the above areas, so that some of them should be connected to Colon station and some other station of the MRT by approaching these stations using the peripheral roads of the CBD.

- o Access Route to Terminal Terrestre (⑭)

  At present, buses are operated on the routes from Terminal Terrestre to Parque Chile and Civico Centro. It is desirable to connect these route to the MRT at 9 de Octubre station, since most of the bus passengers get off and in around the CBD or transfer to other bus routes. But this route should be extended to some point nearParque Chile station in order to secure the space for the waiting berth for the buses.

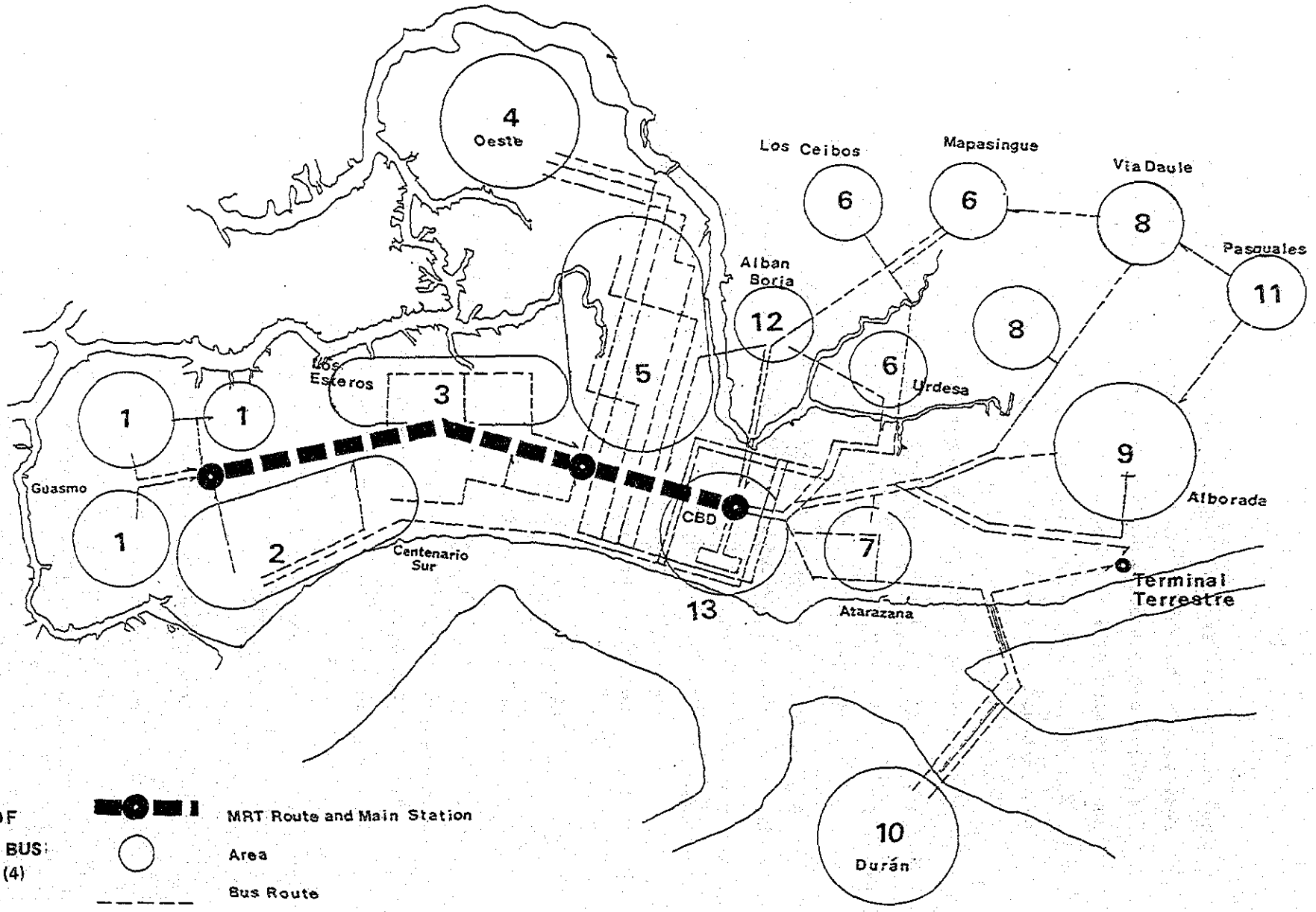


Figure 2-4.5

CONCEPT OF PROVISIONAL BUS NET WORK – (4)

o CBD

In order to complement the function of the MRT as in the case that the MRT starts its full operation, new bus routes are provided for the access to the areas along Rio Guayas from 9 de Octubre station which will be a terminal station of the MRT.

b. Improvement of terminal

Until the extension of the MRT to the northern area is completed, the bus routes and the access routes to the CBD will concentrate at 9 de Octubre station. Thus, it is important to improve or construct the bus berths. The connection of these bus routes to the MRT station will be made by distributing them among two to three stations. The terminals (of the bus routes) at 9 de Octubre station are indispensable at the start of the full operation of the MRT, and so they should be improved in an early stage. The provisional measures to be taken in conjuction with such construction work of the MRT are similar to those of the case mentioned in section 2-4.1).

3. Road Improvement Plans Used for MRT

Since the most part of the MRT route is located over the main roads in the city, the trackway, stations, and their structures should be constructed not to give any hindrance to the existing road traffic and other improvement plans in future. This section refers to three important items between the MRT and road traffic which should be carefully considered in advance.

They are:

(1) Examination to secure full turns safe at the main level crossings on Av. Quito

(2) Coordination plans of the MRT and grade separations of the roads projected in future

(3) Proposal of a community street plan of Calle Manuel Galecio with 18 meters wide

3-1 Configuration of Main Level Crossings on Av. Quito

Although sufficient distance between crossings should be kept, those on Av. Quito are extremely small due to the grid pattern of the streets. Crossing intervals are restricted principally by the following 4 factors:

a. weaving length
b. signal control storage length
c. length of turning lane and deceleration lane
d. limits of driver observation ability

At present, Av. Quito functions as the most important street in the north-south direction both for through-city and local traffic. However, after the completion of the ring road (Via Perimental) under public announcement of the tender, it will serve mainly for the local traffic in the city since the heavy cars like to and from the Puerto Nuevo use the new ring road. Nevertheless, Av. Quito still crosses some main streets in the east-west direction such as Calle Portete, Av. 9 de Octubre, etc., where the above-mentioned conditions should be

satisfied to secure full turns safe to every way, and full turns in other many small crossings will be restricted to some extent, almost in same conditions where they are given at present.

Figure 3-1.1 and 3-1.2 show an example of the crossing configuration, respectively at Calle Portete and Av. 9 de Octubre.

3-2 Grade Separation Plans Related to MRT Route

Of the several grade separation plans proposed in the Master Plan study in 1983 by the Team, three sites are under construction, and the others are still examined and have possibility to be constructed in future.

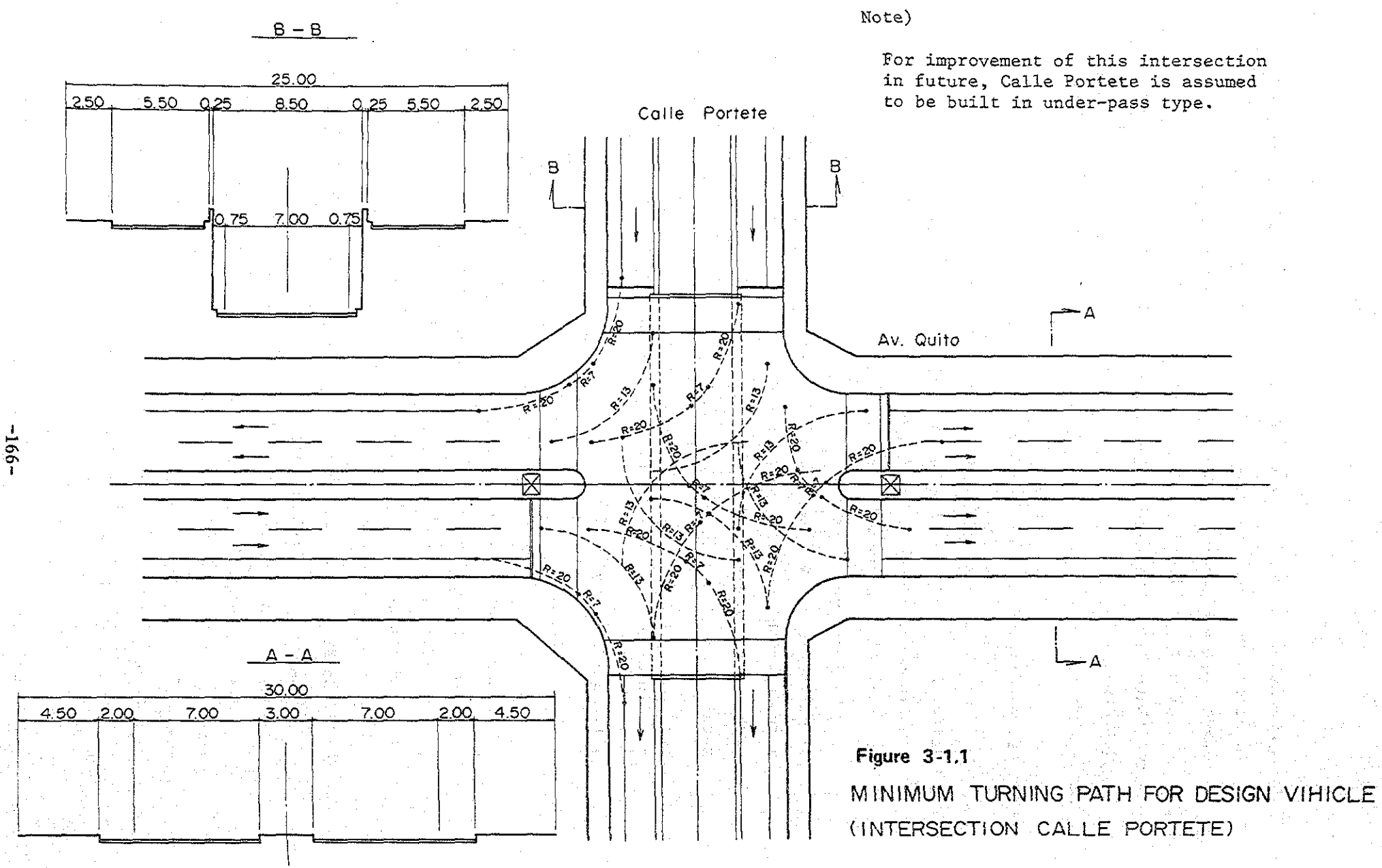
Of these grade separations, the MRT route passes over that of Calle Portete and Av. de los Proceres. Accordingly, it is very important to make a plan of the MRT track structures not to give any hindrance on the grade separation being realized in future.

a. Intersection of Calle Portete and Av. Quito

a-1. Existing conditions

Calle Portete is an arterial road linking the east and west, functioning as the shortest route between Puerto Nuevo and Via la costa.

Present traffic has a high ratio of large size vehicles. Traffic from the eastern residential district to the CBD and its western area converges on this road. It also acts as bus routes. Buildings in the vicinity of the Calle Portete and Av. Quito intersection are densely packed and the grade separation of the intersection be able to be done most economically with a diamond interchange.



Note)

For improvement of this intersection in future, Calle Portete is assumed to be built in under-pass type.

Figure 3-1.1

MINIMUM TURNING PATH FOR DESIGN VIHICLE (INTERSECTION CALLE PORTETE)

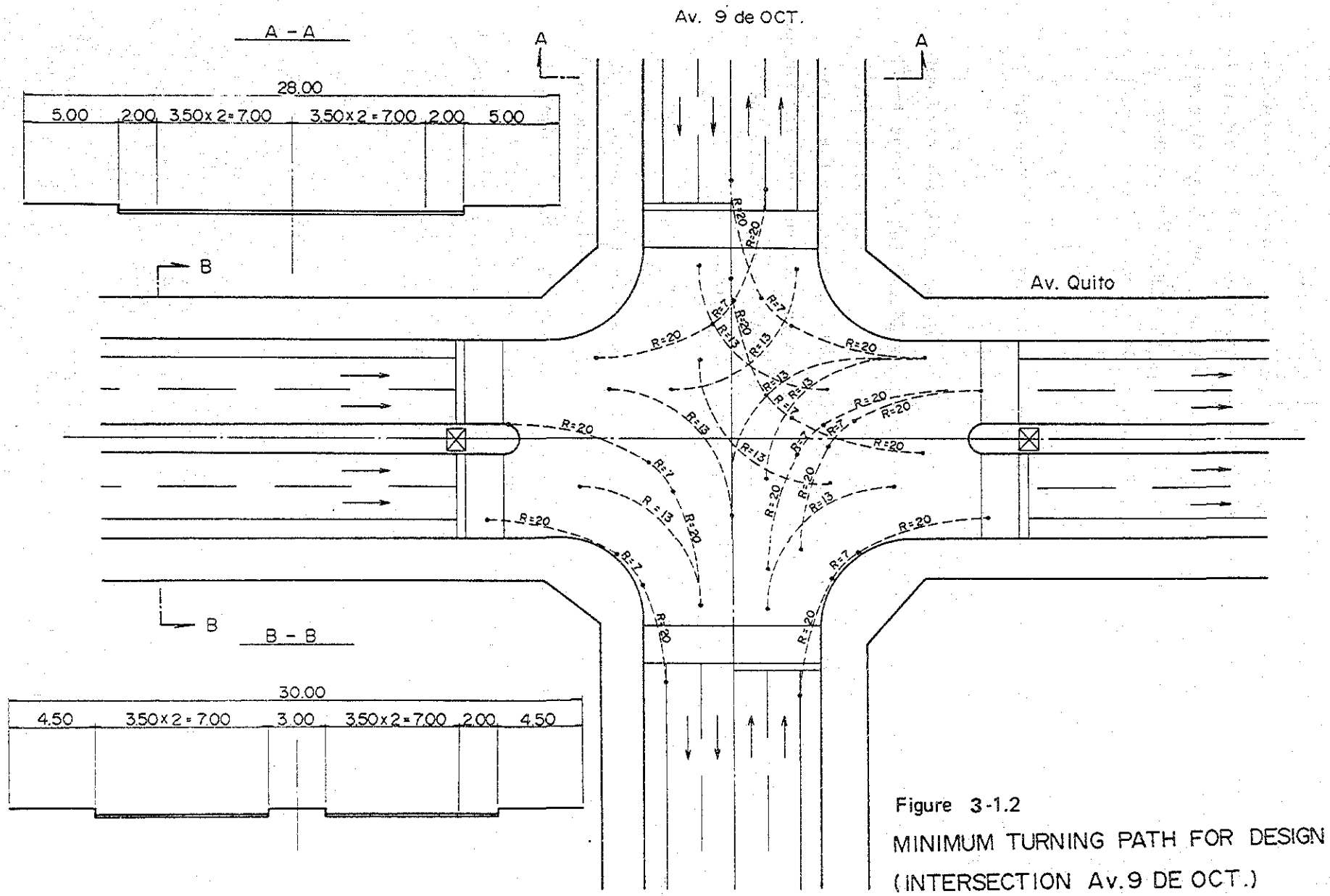


Figure 3-1.2

MINIMUM TURNING PATH FOR DESIGN VIHICLE

(INTERSECTION Av.9 DE OCT.)

a-2. Intersection plan

When the ring road is completed, large size vehicles can be quickly routed through the ring road and out of the center of the city. And as a consequence large size vehicles will disappear from Calle Portete. The proposed grading for this intersection is shown in Figure 3-2.1 and 3-2.2.

b. Intersection of Av. de los Proceres and Av. San Jorge

b-1 Existing conditions

The eastern portion of Av. de los Proceres terminates in a residential area and consequently the present traffic flow is not great. However, according to a future plan, it will become part of the ring road surrounding the urban area. At present it is used to connect the eastern area to the northern area and also used as an approach to the airport, Terminal Terrestre, and Duran.

b-2 Intersection plan

In the area of this intersection, Policentro, a MRT station, and a bus terminal are planned, and consequently a large scale site cannot be guaranteed. Thus, a diamond interchange would be appropriate for this location, too.

The proposed grading for this intersection is shown in Figure 3-2.3 and 3-2.4.

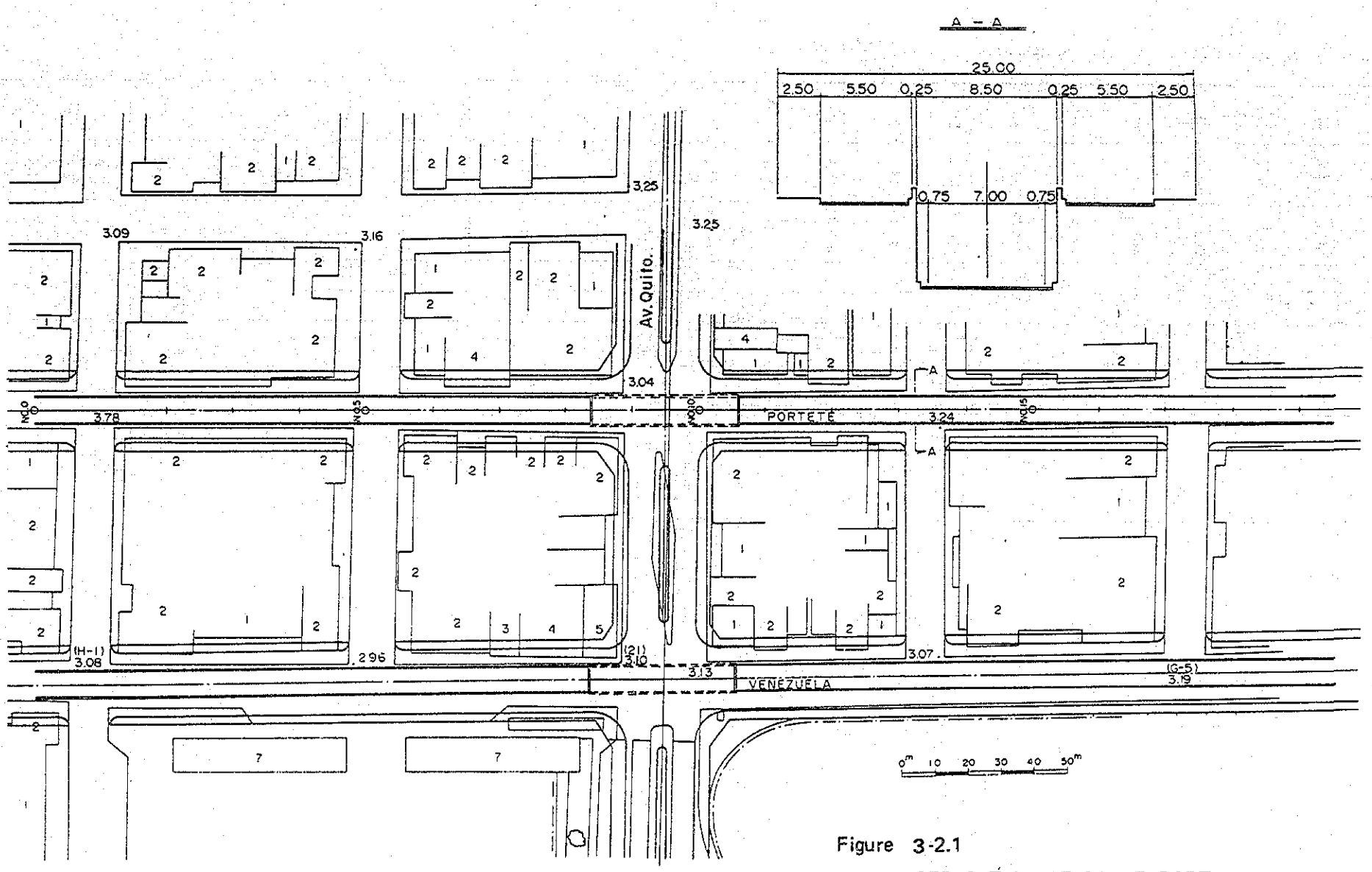
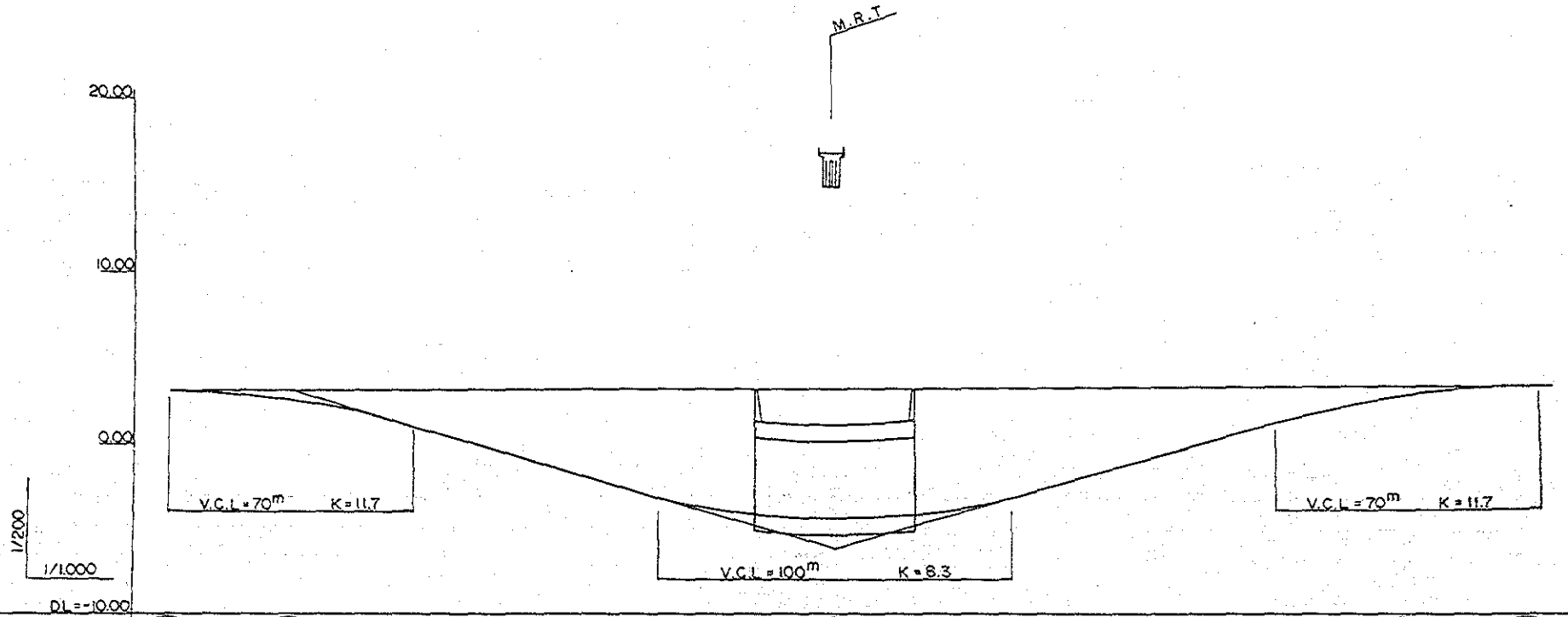


Figure 3-2.1
GRADE SEPARATION OF CALLE PORTETE
(PLAN)



GRADE	3.100	Level L=35m	3.100	i=6.000% L=155m						-6.200		i=5.875% L=160m						3.200	Level L=35m	3.200	
PROPOSED HIGHT (m)	3.100	2.929	2.414	1.557	0.400	-0.800	-2.000	-3.200	-4.163	-4.650	-4.663	-4.200	-3.263	-2.088	-0.913	0.263	1.427	2.350	2.938	3.190	3.200
EXISTING GROUND HIGHT (m)	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
STATION	NO.0	1	2	3	4	NO.5	6	7	8	9	NO.10	11	12	13	14	NO.15	16	17	18	19	NO.20

Figure 3-2.2 GRADE SEPARATION OF CALLE PORTETE (PROFILE)

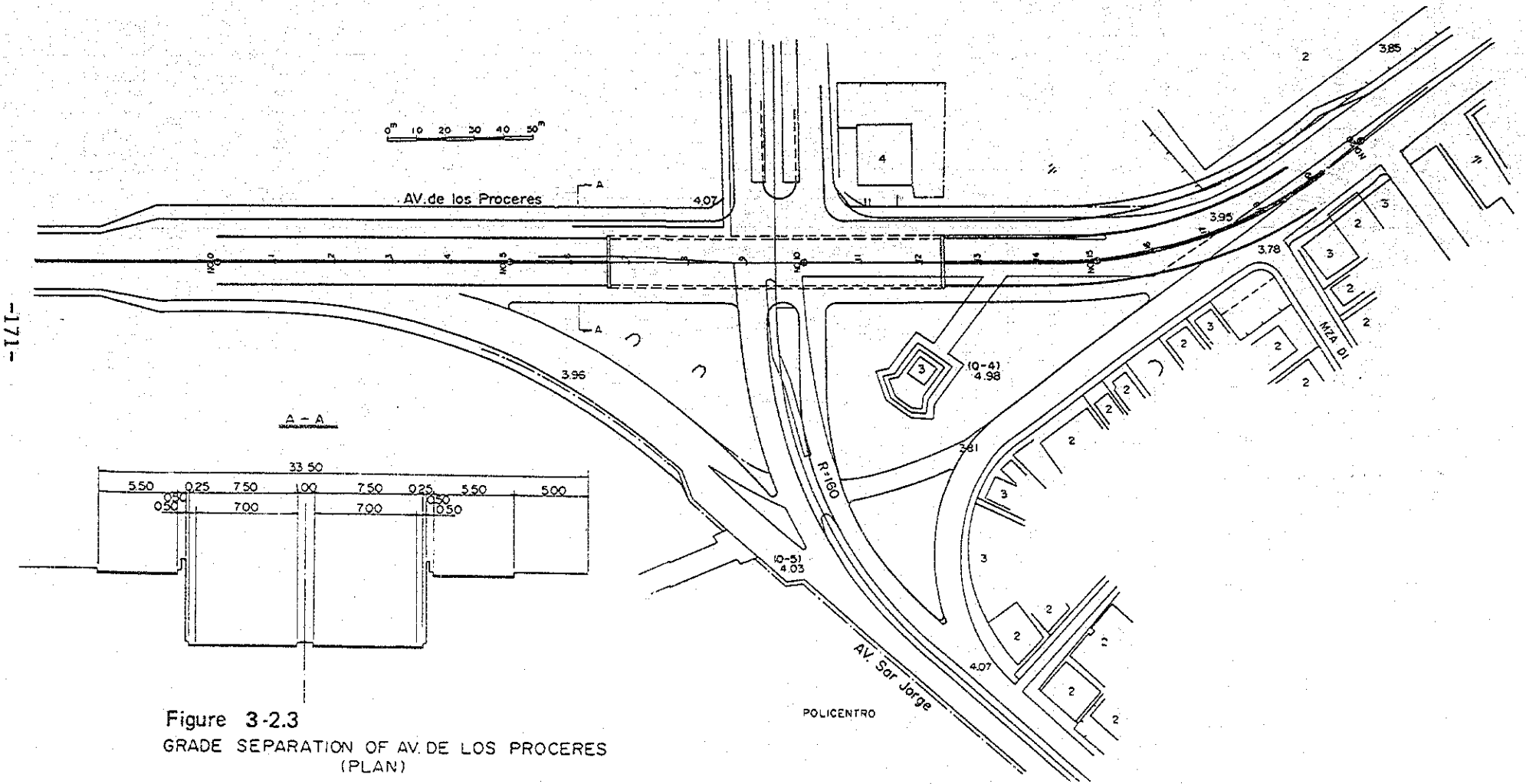


Figure 3-2.3
GRADE SEPARATION OF AV. DE LOS PROCERES
(PLAN)

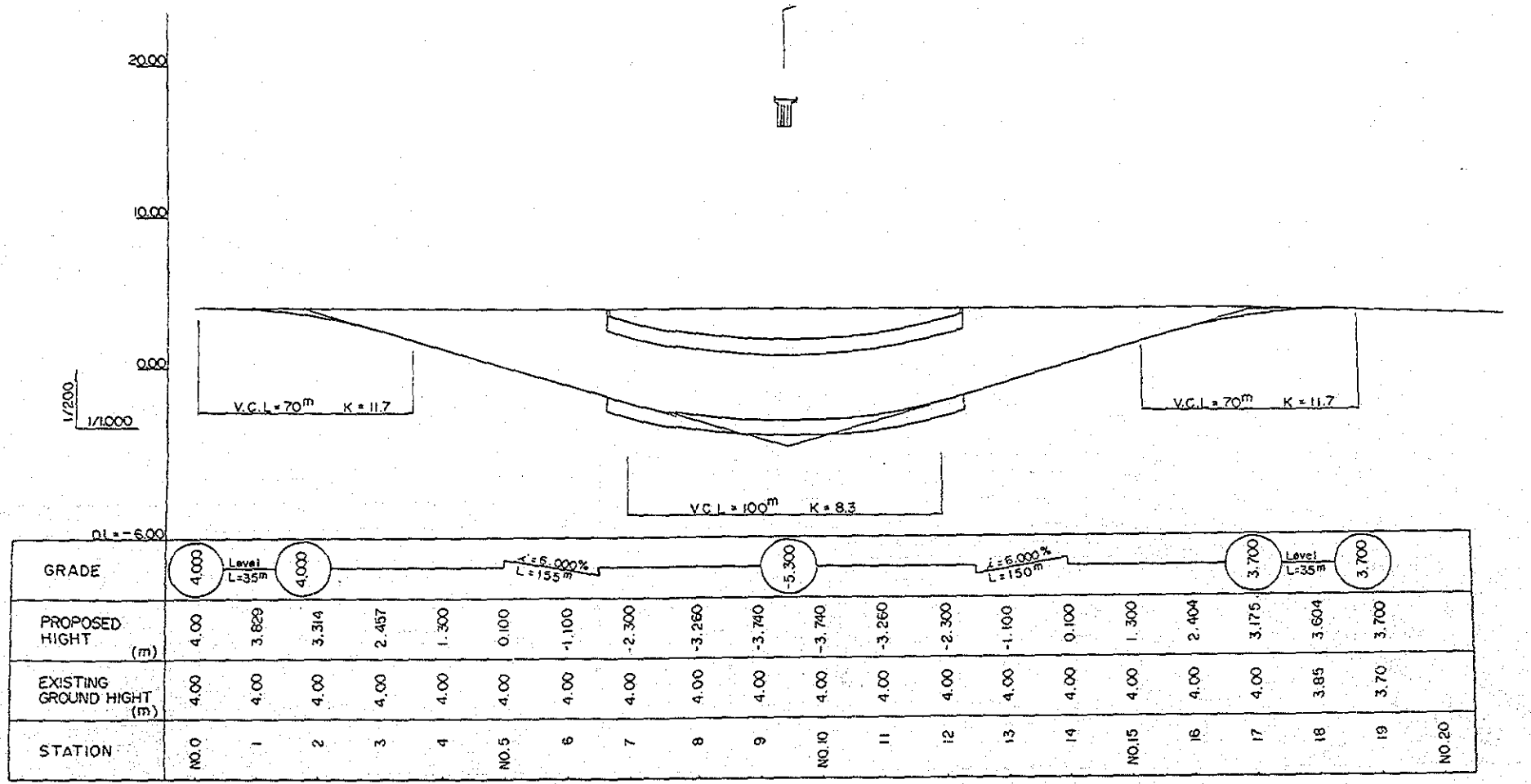


Figure 3-2.4
GRADE SEPARATION OF Av. PROCERES (PROFILE)

3-3 Community Street Plan of Calle Manuel Galecio

a. M. Galecio is not presently an arterial road for heavy through traffic, however there is a fair traffic flow, including buses. A very big traffic flow from the northern area to the Av. Quito and Av. Machara of the CBD mainly use the Julian Coronel grade separation and a part of its flow also use Calle M. Galecio for a shortcut to the CBD. Therefore, this traffic consists of buses and other all kinds of vehicles, flowing in Av. Quito from the northern district, particularly through Av. Kennedy.

In case the MRT will be realized over this Calle M. Galecio, such a short-cut function would be difficult to hold on and through traffic would be obliged to be restrained. Also the character of Calle M. Galecio would have to be changed to that of a service road, providing access to the shops, buildings, etc. along this street.

b. Community street Plan

Buses which are one of main traffic flow, will be easily replaced by the MRT since most of their routes are competing, and other vechicles will preferably be routed through Av. Julian Coronel. However, since it is not necessarily desirable to completely eliminate Calle M. Galecio's function as a shortcut route, this function will be recommended to be kept by improving the surrounding roads.

If Calle Manual Galecio should become a community road, it would bring about another improvement;

- The capacity of the route between Av. Kennedy and Julian Coronel will increase.
- Congestion between Av. los Rios and Av. Alejo las Cano - Av. Quis Quis will be eased.

A plan of Calle M. Galecio for the community street is shown in Figure 3-3.1 and 3-3.2 .

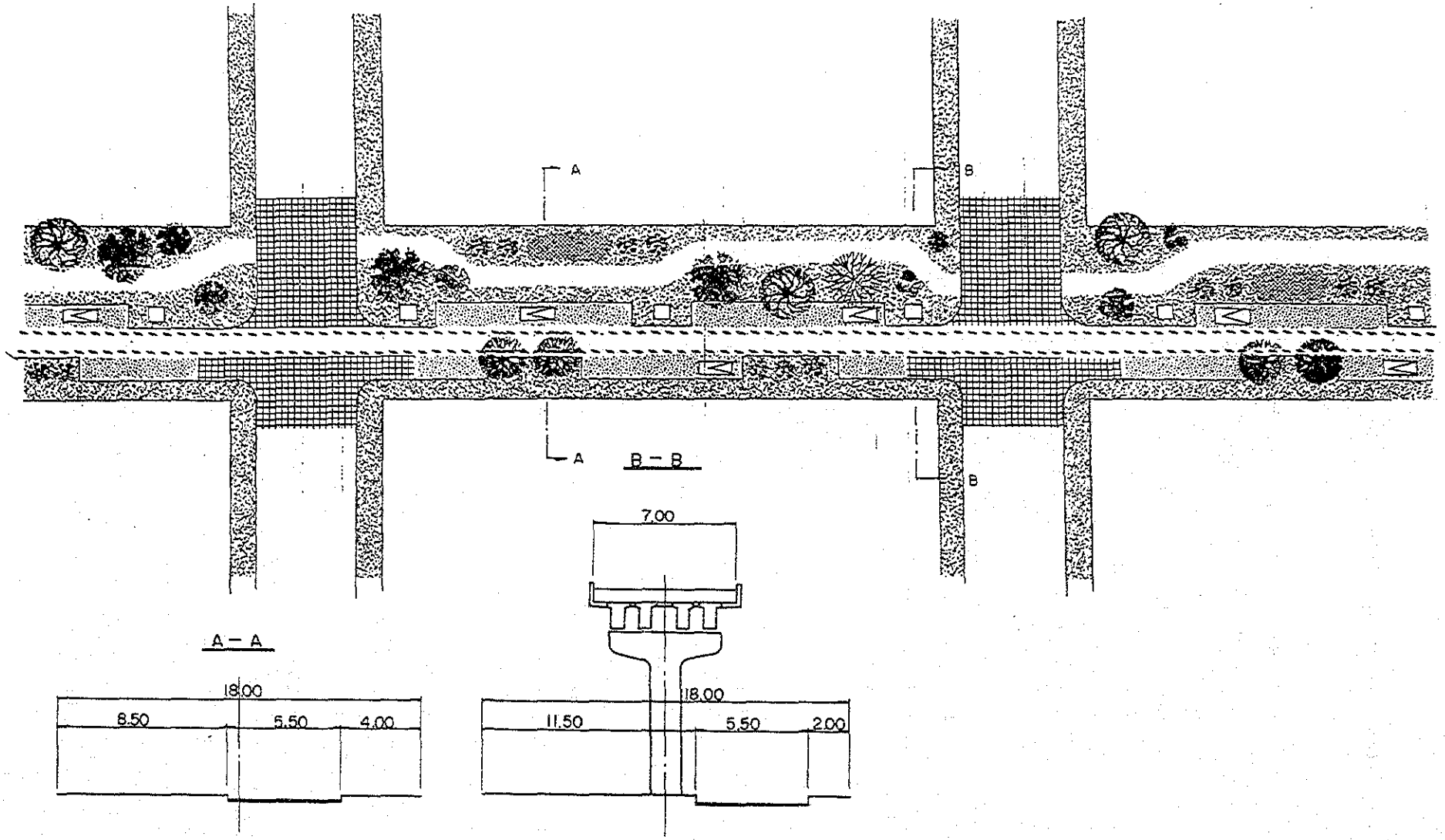


Figure 3-3.1 COMMUNITY STREET CALLE MANUEL GALECIO (PLAN)

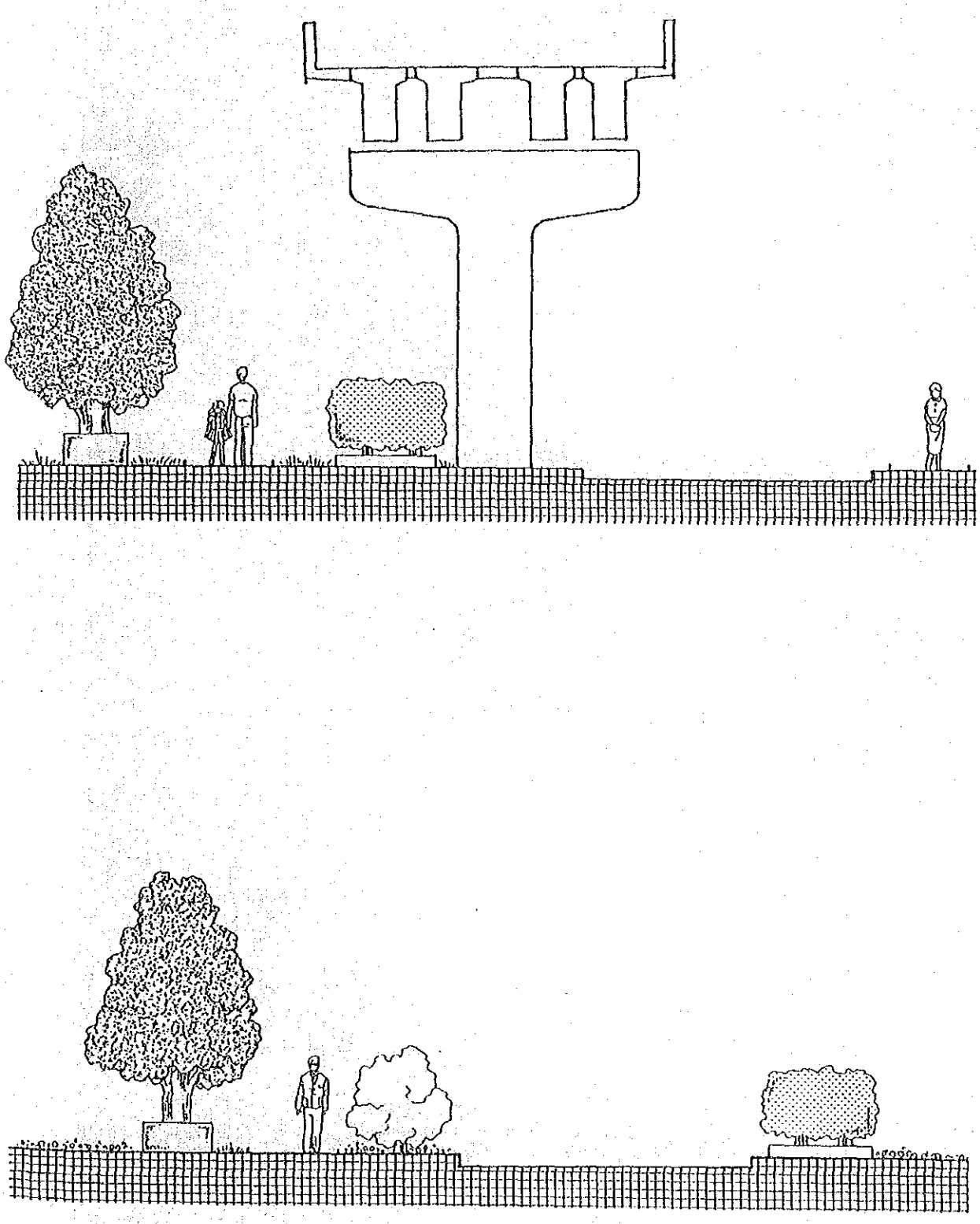
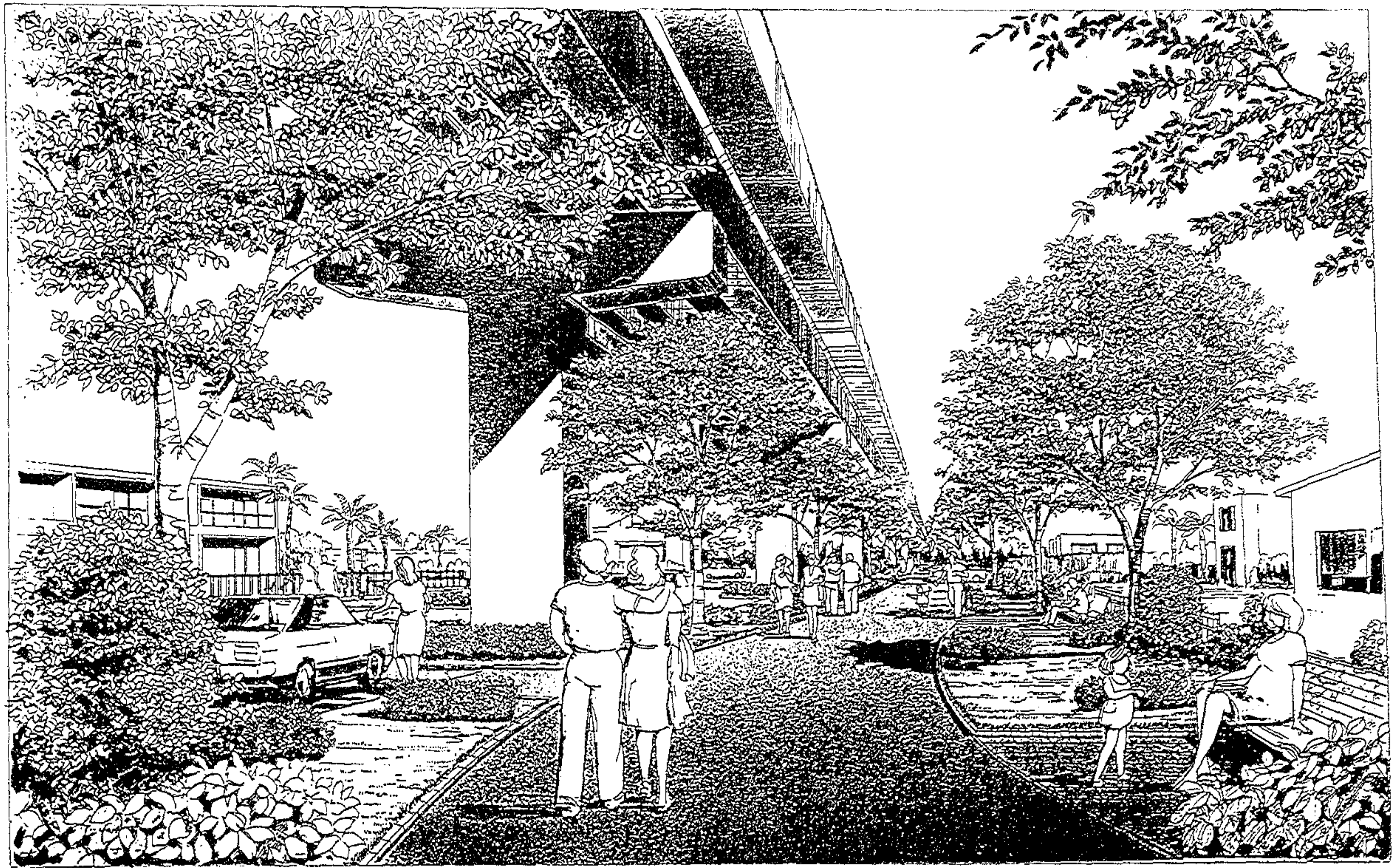


Figure 3-3.2 COMMUNITY STREET CALLE MANUEL GALECIO (CROSS-SECTION)



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

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 3-3.3 COMMUNITY STREET CALLE MANUEL GALECIO (PERSPECTIVE)

4. Examination of Impacts on MRT Wayside Area

4-1 Impacts on Land Use of Wayside

For future land use, it is important to consider various impacts brought about by the MRT such as encouragement to the urban development, re-development and preservation of the existing conditions for good residential area along the wayside area. The considerable points for such impacts are as follows.

1) Impacts by MRT Route

a. Residential Developments

The MRT construction from Terminal Terrestre to the entrance of Guasmo not only improves the settling condition by easy accessibility to the CBD, but also produces good effects for the promising residential development in the northern area and better re-development in the existing urban area.

b. New Urban Centre Project

Conveniences by the MRT will develop public service and commerce around stations, encourages the promising urban center in the northern area and makes it more closely conected with the existing CBD along Av. de las Americas and Av. Fco. de Orellana.

c. Re-development of Guasmo

A new station of the MRT in the southern area, Guasmo will induce a successful situation for the activities of public and many other services and improve the role of urban function of Guasmo area in particular along its wayside.

d. Favorable Residential Area

It is important to consider to preserve the favorable condition of good residential areas already built up by means of improvements of streets or other measures along the MRT route.

e. Developing Project around the Airport

It is necessary to adjust the MRT route fitting to the developing projects in the site of the Airport, particularly to accessibility to various establishments in future.

f. Surroundings of the MRT Depot

Since the MRT depot is located outside the urban area and surrounded with Rio Guayas and a projected trunk road, no negative influence by the depot will be occurred.

g. CBD

If the pedestrian street from stations on Av. Quito towards the Rio Guayas side will be introduced, it will bring about not only prosperity widely along the street, but also safe and comfortable walking environment.

2) Impacts by MRT Stations

Of all MRT stations, 5 are considered as main connective points with bus routes, and have big possibilities to be the future urban or regional centers.

These 5 stations are;

- Guasmo
- Centro Civico
- 9 de Octubre
- Policentro
- Terminal Terrestre

The conceptional plannings for these main stations are already shown in Section 2-2 in PART 2.

4-2 Conservation of Environment and Renovation of Urban Environment

The introduction of the MRT is expected to contribute markedly to the further development of the city of Guayaquil as a whole, but it is possible that such positive effects sometimes involve the negative effects. Such negative effects on the environment, however, can be set off by promptly taking adequate countermeasures, and, by so doing, it is possible not only to conserve the original environment but also to enable the local citizens and the inhabitants along the MRT route to enjoy a better urban environment.

The nature and degree of effects on the environment and the countermeasures against negative effects are as listed in Table 4-2.1.

Table 4-2.1 BASIC CONDITIONS TO BE CONSIDERED IN FORMULATING ENVIRONMENTAL MEASURES

Environmental Impact by MRT	Outline of Influence by MRT on Wayside Area	Existing Condition of Wayside Area	Evaluation	Counter-Measure
Interference in sunshine	o To increase shady time and space by MRT structure (slab, beam, and pillar)	o The city being situated in the equatorial zone, the people there are apt to be subjected to strong sunlight in their daily lives, and so it is important to provide appropriate shades for passengers, and inhabitants.	o Carriage way is under (elevated) railroad track, but this will not cause any problem. o Near the station, MRT make larger shaded areas, but this will not cause any serious problems.	o Terminal facilities and commercial facilities should be located near the station so as not to directly affect the residential area.
Interference in radio (RV) wave	o To interfere in radio wave with reflection or diffraction by MRT structure	o There are many high-rised buildings in the urbanized area in the city. Many of the residential buildings are medium multistoried buildings. o In the suburban area, many of the residences are low buildings, and they are not built up densely.	o In the downtown district, the influences of high-rised buildings are considerably larger than that by the MRT so that comprehensive countermeasures are necessary. o Some of the suburban area will also be affected.	o Problem can be solved by improving the antenna.
Change for land scape	o To change the neighbouring scenery by MRT structure or its facilities particularly around big stations o To transfer inevitably a few memorial statue.	o At present, both the downtown area and the residential area of the city have their own landscapes respectively. o The landscape has been changed from time to time for the reasons such as the construction of the grade separations of roads. o Adequate care has been taken for the better apperance of road.	o Keeping the urban view in good condition is important, and the scene should be improved constantly.	o Scenes in the town should be renovated into modernized ones by altering the functions of the existing roads for various uses such as community streets, pedestrian ways and terminal plazas. o Scenes in the town should be designed to match with the structures of the MRT.

Table 4-2.1 BASIC CONDITIONS TO BE CONSIDERED IN FORMULATING ENVIRONMENTAL MEASURES (cont'd)

Environmental Impact by MRT	Outline of Influence by MRT on Wayside Area	Existing Condition of Wayside Area	Evaluation	Counter-Measure
Traffic noise and vibration	o To decrease road traffic noise because of decrease of car, due to the introduction of MRT. o To cause running noise of MRT vehicle.	o In the downtown area, there is a considerable amount of background noise caused by the commercial and business activities of the people and the traffic of vehicles. o In the suburban area, most of the roads have large widths.	o Will not become problems except for a few places in the downtown area. In the downtown area, the MRT is operated at low speeds, and the noise level is not so high. The noise may become problems in some of the residential area.	o Commercial and business buildings should be located along the wayside of the MRT so that the MRT can be separated from the residential area. o Green belt area should be enlarged for broad roads. o Countermeasures such as the detection of noise sources, construction of sound insulation fence, improvement of coach and improvement in track maintenance can be taken in the future.
Air Pollution	o To be caused by industrial activities and car traffic congestion o To decrease car traffic volume by introduction of MRT	o Factories have been moved to the outside of the city to reduce air pollution. o Measures such as the construction of grade separation systems have already been taken in order to reduce the traffic congestion on the roads.	o Introduction of the MRT will contribute to the substantial reduction of air pollution by reducing the number of cars as the source of air pollution.	o To maximize the effect of the introduction of the MRT, related projects should also be promoted.
Influence under construction of MRT project	o Noise and vibration caused by construction machine. o Lowering of underground water level. o Hindrance to road traffic in the road related with MRT construction		o Only a transient problem. o Use of underground water is relatively small in quantity. o Traffic control for road construction work has been executed at a considerable frequency.	o Noise and vibration during the construction work should be reduced by carefully selecting the construction equipment. o Obstruction of traffic due to the construction work should be reduced by carefully determining the work procedure.

PART 3

ECONOMIC AND FINANCIAL ANALYSIS

PART 3 ECONOMIC AND FINANCIAL ANALYSIS

1. Introduction

The Mass Rapid Transportation (MRT) Project for the city of Guayaquil is expected to greatly contribute to the improvement of the existing urban traffic system in the city. The MRT project, however, requires quite a long period of time and a huge amount construction cost incomparable with the construction project of other ordinary transportation system, so strict and careful studies have to be made to commence this project.

Firstly, the MRT project is one to be promoted primarily at the initiative of the public sector. That is, in promoting this construction project, a large amount of the public funds from the government, the municipality of Guayaquil and other related public bodies will be invested. The amount of investment to be made for this project is not a small one in terms of the present amount of the financial investment in this country, and thus it is necessary to prove that a higher priority should be given to this project in view of the improvement of the public welfare compared with the projects in other sectors such as education, welfare, housing and road system.

With the above-mentioned requirements in mind, the economic analysis is made, aiming at the comparison of the socioeconomic benefit which can be expected from this project with the amount of the investment to be made for this project from the standpoint of the national economy.

Besides, it is one of the characteristics of the MRT project that the project is supposed to be operated as a self-paying and profit-making project by a semi-governmental corporation. In other words, the merit of this project has to be assessed both in the economic and financial terms. More particularly, it is necessary for the parties concerned to verify whether or not the MRT project is of a reasonable scale and able to be operated on a sound financial basis throughout project life.

Thus, the financial analysis is made based on the cash flow analysis.

2. Economic Analysis

2-1 Approach

The economic analysis will be conducted using the cost-benefit calculation based on the "with-without comparison" method. The respective cost and benefit, which should be produced under both different situation of with project and without project, are predicted and compared each other to justify the project.

(1) Definitions of "with-the-project" case and "without-the-project" case

The cases to be used for the economic analysis are as follows:

With-the-project case: A case where the alternative route of the MRT will be constructed and operated.

Without-the-project case: A case where the alternative route of the MRT will not be constructed and the transport demand is substituted by the existing transport systems.

(2) Indicators of economic analysis

As the comparable indicators to be used in the economic analysis, the following three indexes based on the cost-benefit calculation will be taken.

① NPV (Net Present Value)
② B/C Ratio (Cost Benefit Ratio)
③ EIRR (Economic Internal Rate of Return)

(3) Economic life of project

The economic life of the project will be determined based on the lives of structures to be constructed, vehicles,

electric facilities and communications facilities. This economic analysis assumes the life of this project is 30 years.

(4) Discount rate

The economic discount rate to be used in the economic analysis is 12% in net value which is thought to be the capital opportunity interest rate currently practiced in Ecuador.

2-2 Test Cases of Economic Analysis

The construction and operation plan of the MRT project has already been discussed in detail in the section of the technical feasibility study the PART 1. Here, however, the contents of the plan will be summarized in order to set up the test cases for the purpose of the economic analysis.

The whole route proposed by the project covers about 15 km between the bus terminal (Terminal Terrestre) and Guasmo Entrance. As the possible method of the construction of this route, a method starting the construction work from the bus terminal and another method staring from Guasmo Entrance can be considered. As the train depot can be constructed in either case, both may be considered as the possible cases.

As the method of construction, there are two type of implementations, whole line construction plan and stepwise construction plan. Both plans are taken as comparative alternatives. To make the route section of whole line, several main terminals which collects and distributes feeder trips, are selected and the route sections are situated to connect them. For this reason, the two locations, that is, Centro Civico and 9 de Octubre are selected for the terminal stations. The phased sectional construction plan has been drawn up based on the conditions mentioned above.

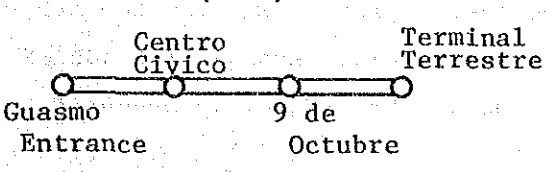
On the other hand, the validity of the bus route reorganization plan which constitutes a part of the MRT construction project will also be verified in the course of the economic analysis of the MRT project. The plan without the bus

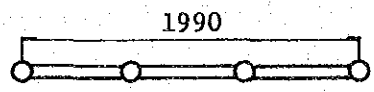
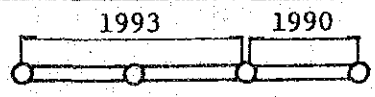
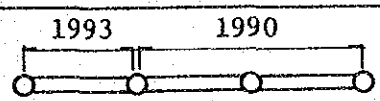
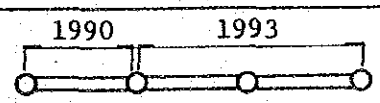
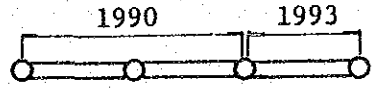
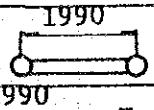
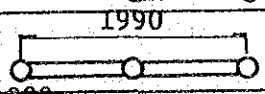
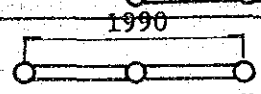
route reorganization as an alternative plan to the basic plan (various plans including the bus route reorganization plans) has been added as a test case to be analysed by the sensitivity analysis.

The fare level has already been referred to as a subject of the demand forecast, and its variation is considered to affect the demand, so that the degree of the variation will be examined also through the sensitivity analysis.

Taking the above into account, the test cases shown in Table 2-2.1 are set up. These test cases include the "without" cases for comparison.

Table 2-2.1 TEST CASES FOR ECONOMIC ANALYSIS

Legend	(Year) 
	The year shows opening year.

Cases	Schematic Layout
Basic Case	
Case A-1	
Case A-2	
Case B-1	
Case C-1	
Case C-2	
Case D-1	
Case E	
Case F	
Case G	

2-3 Benefit Estimation

1) Benefit Items to be Calculated

The benefit resulting from the execution of the project is measured as the difference in the socioeconomic expense between the case where the project is executed and the case where the project is not executed. The objective of this project is to reduce the road traffic, improve the running condition and increase the traffic comfortability through the construction of MRT and trip diversion to MRT derived from it.

Although various effects can be expected from the MRT project, the following effects are selected as those whose benefits can be calculated technically.

LIST OF BENEFIT TO BE SELECTED

Benefit Items	Possibility of Quantification	Selection
1. Running Cost Savings	Possible	o
2. Capital Cost Savings	〃	o
3. Travel Time Savings	〃	o
4. Traffic Accident Reduction	Difficult	
5. Health Improvement effect	〃	
6. Area Development effect	〃	
7. Industrial Promotion effect	〃	

a. Running cost savings

- The MRT with large transportation capacity can reduce the average transportation cost of each trip through mass transportation, and this results in the saving of the total running cost (see Fig. 2-3.1).
- Owing to the partial diversion of the users of the existing road traffic system into the MRT, the congestion of the road traffic decreases relatively.

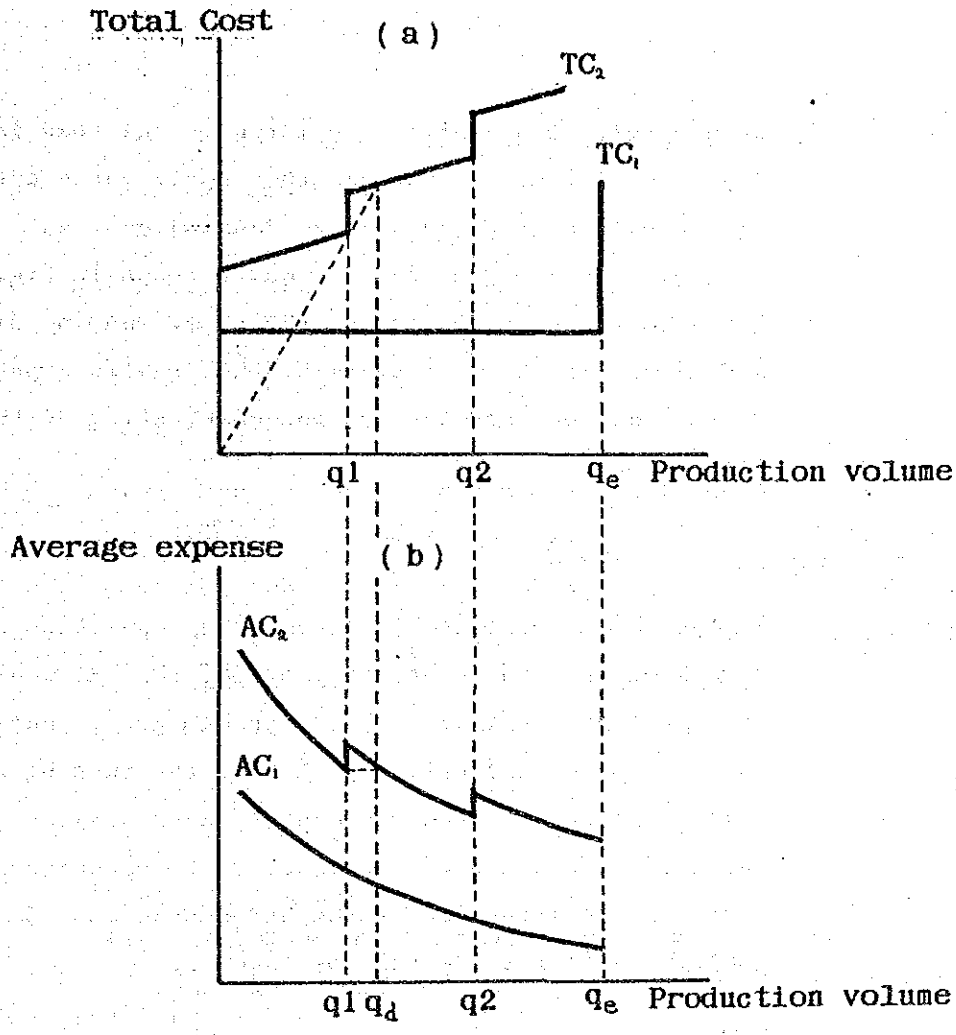
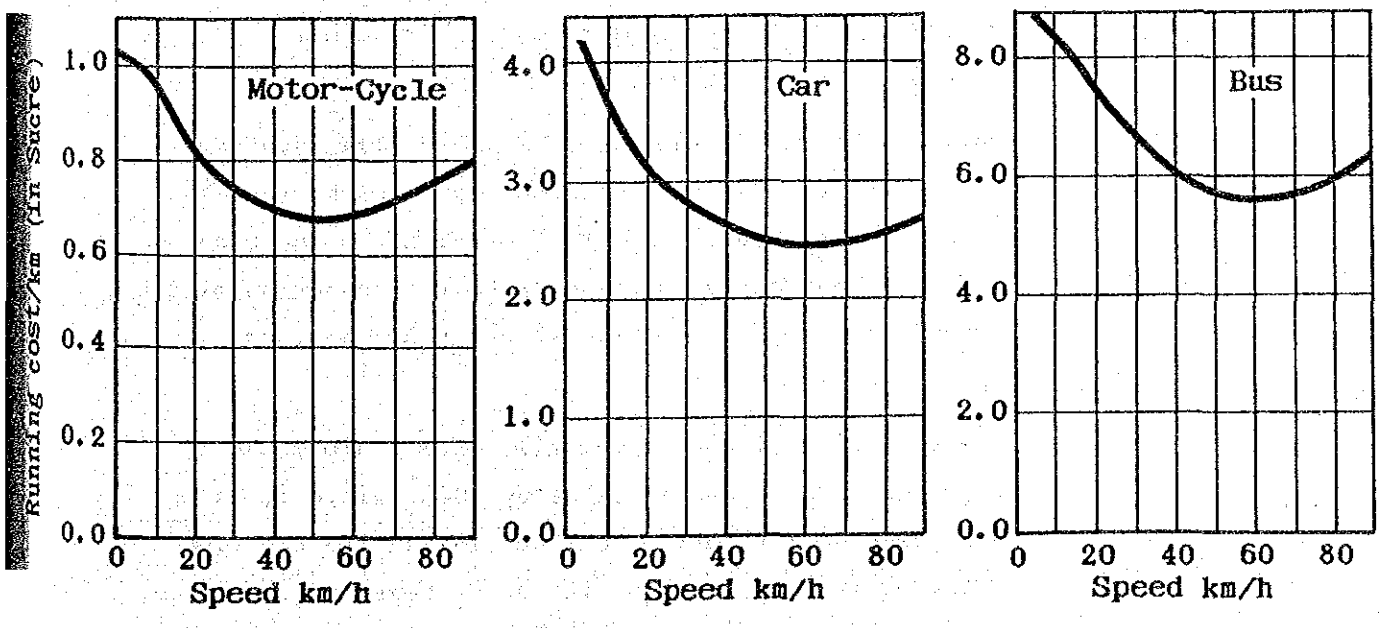


Figure 2-3.1 CHARACTERISTICS OF THE AVERAGE COST OF TRAFFIC FACILITIES



(Source) M/P

Figure 2-3.2 TRAVEL COST-RUNNING SPEED CURVE

As a result, the traffic condition in the road is improved to some extent, and this contributes not only to the decrease in the average running cost as indicated by the running cost curve shown in Fig. 2-3.2 but also to the reduction of the total running distance and time, whereby the saving of the traffic expense can further be enhanced through the combination of these conditions.

b. Capital cost savings

- If the MRT were not constructed, the population who have been assumed to be the users of the MRT would have to depend on the traffic by their own cars, buses and taxis. In such situation, not only the running cost will increase but also the capital cost will be consumed to provide the alternative transportation. Thus, the construction of the MRT can be considered to contribute to the capital cost saving.

c. Travel time savings

- The number of the MRT users is estimated in consideration of the gross time required for the trip. The MRT at least can better benefit the users in terms of the travel time saving compared with other transportation systems.
- On the other hand, the users of the traffic systems other than the MRT will also be benefited by the MRT, since it will reduce the traffic volume on the road, and this indirectly contributes to the reduction of the travel time for the individual users of the road traffic system.
- The reduction of the travel time cannot always be regarded as an economic value by 100%, since it is dependent on the content of the traffic and the time value of individuals, but it can be regarded as an economic value in the case of Guayaquil where the

commercial and economic systems are highly active with careful quantification.

2) Calculation of Benefit

(1) Saving of running cost

a. Calculation formula

The running cost of a vehicle comprises fuel cost and supplies and other direct costs for operating the vehicle when the vehicle is operated by its owner, but other costs such as the driver's salary is included in the case of a commercial vehicle. These running costs can be divided into those increasing in proportion to the distance and those increasing in proportion to travel time.

The running cost saving is calculated as the difference in the total running cost between the case with the MRT project and the case without the MRT project. For this purpose, the total travel distance and the total running time in each of these cases are calculated by traffic assignment to the road systems within the study area. The saving of the running cost is calculated by the following formula. The above is concerned only with the running cost of the vehicle using the road traffic system. Besides the running cost, the operating cost of the MRT has to be considered in the case with the MRT, but such operating cost will not be treated as a benefit but an expense.

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

$$\sum_{ij} (P^1_{ij} \times t^1_{ij} - P^2_{ij} \times t^2_{ij}) \times R_c^2$$

where RB: Saving of traffic cost

L^1_{ij}: Running distance (km) between zone i and zone j in the case without MRT project

L^2_{ij}: The same as above in the case with MRT project.

p^1_{ij}: Traffic volume between zone i and zone j in the case without MRT project

p^2_{ij}: The same as above in the case with MRT Project

Rc^1: Running cost per unit distance (km)

Rc^2: Running cost per unit time (hour)

b. Unit running cost

The unit running cost for the calculation of the running cost is determined by inflating the value indicated in the M/P report. The items of the running costs considered are as follows:

- Running cost (Cost per km)

① Fuel cost
Calculated based on the fuel consumption per 1 km, taking the running speed into account.

② Oil cost
Calculated in terms of the consumption for the run of each km.

③ Tire cost
Cost per km is calculated in consideration of the average life of tire and the annual running distance on the basis of the sample data.

④ Maintenance cost
Calculated by dividing the labor cost and costs of spare parts required for maintenance by the annual running distance.

⑤ Depreciation cost of vehicle

In this study, 50% of the depreciation cost is assumed to be derived from the running and the remaining 50% to be attributable to the running time. The scrap value is assumed to be 15%.

- Fixed cost (Cost per hour)

(1) Required initial investment cost

In this project, the MRT with the whole line of 14.7 km will be constructed. It requires a large amount of investment. Therefore, in the case where the whole line is constructed at stage one, it is necessary to raise the total funds in a short period of time, and it is anticipated that it will be difficult to complete the construction work within the limit of budgetary appropriation.

(2) Technical implementation capability

As there has been no example of the execution of such construction work as the MRT in Ecuador, it may be concluded that Ecuador has neither the technology nor the experience required for such construction work. From this standpoint, the feasibility of the case of stagewise-construction is considered to be higher than the case of one-stage construction. Because it is possible to gain necessary technology for management of operation during the long term of construction work.

(3) Securing the connection facilities of MRT with buses

A great number of passengers are expected to come together to and depart from the starting station and the terminal station at the start of the operation. Therefore, a reasonable size of space will be required for their transfer except for the terminal Terrestre in the north, which kept large space already. In this sense, it is considered appropriate to provide such stations in places other than the center of the city that is subject to space restriction. Moreover, in connection with the above, traffic nodes should be secured by providing the space for terminal in consideration of the connection with the bus system and the role of the regional centers working in the areas. By so doing, the MRT can be utilized more conveniently and the formation of desirable urban areas is made possible.

(1) The FIRR is distributed between 5% and 12%. Supposing that the average interest rate on the raised funds invested in this project is 10% and the plans in which the FIRR becomes lower than 10% are excluded, Case E and Case G will be considered to be inappropriate without reserve. On the other hand, Case C-1 and Case C-2 can be regarded as a plan that can be adopted with reserve. All other plans can be adopted without reserve.

(2) If the test cases are evaluated based on the standard used in Japan for good management of new railway company, in which the yearly net profit including depreciation should treansfer to surplus within 10 years and accumulated one should transfer within 20 years, it is considered possible to adopt the five plans of the Basic case, Case A-1, Case A-2, Case B-1 and Case F from viewpoints of both terms aforementioned.

(3) In view of changes in the balance of the cumulative debt, the plans in which it is impossible to repay the debt within the period of the project (30 years) are the four cases of Case C-1, Case C-2, Case E and Case G, which are considered to be inappropriate. Other plans deserve further examination as the debt can be repaid within the period of the project. Judging from the above results, the four cases of the Basic Case, Case A-1, Case A-2 and Case B-1 can be selected as the final plan from the financial viewpoint, considering that it is more desirable to construct whole line of the MRT.

4-3 Final Evaluation

1) Method of Evaluation

The cases are screened so far based on the economic and financial analysis, but the best case has not yet been selected.

In the following each case is evaluate based on the angles other than the economic and financial aspects in order to determine the best case. The evaluation items taken up here are as follows:

Table 2-3.1 GENERAL CHARACTERISTICS OF ECONOMIC COSTS BY VEHICLE TYPE

in 1985 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)	85	900	750	1,900	4,000	700	2,700
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)	23.3 s./lit. for Gasoline (10.0 s./lit. for Diesel)						
8. Oil cost less tax (s./liter)	300 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)	0.0009	0.0012	0.0014	0.0018	0.0025	0.0014	0.0030
11. Fuel cost (s./km), (7 x 9)	0.86	2.80	3.03	4.43	7.69	3.26	6.29
12. Oil cost (s./km), (8 x 10)	0.12	0.36	0.42	0.54	0.75	0.42	0.90
13. Tires set price less tax (s.)	5,300	16,000	16,000	30,000	75,000	21,200	75,000
14. Tire life time for paved road (month)	30	22	9	12	12	18	9
15. Tire cost (s./km)	0.09	0.38	0.35	0.55	1.36	0.40	0.61
16. Labor hours for maintenance (hour/year)	25	43	105	180	250	55	370
17. Labor cost for maintenance (s./year), 140 (s./hour)	3,400	5,900	14,300	24,500	34,100	7,500	50,400
18. Maintenance & spare parts cost (s./year)	3,500	27,000	74,000	112,000	150,000	40,000	210,000
19. Maintenance cost (s./km),(17+18)/5	0.31	1.43	1.45	2.48	3.35	1.36	2.83
20 Crew wages & others (s./month)	-	-	26,000	38,000	53,000	18,000	64,000
21. Crew wages & others cost (s./h)	-	-	69.71	117.96	163.84	69.71	225.52
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)	10,300	85,000	91,000	161,500	340,000	59,500	255,000
26. Annual interest (s./year)	5,100	54,000	45,000	114,000	240,000	42,000	162,000
27. Kilometerage-related depreciation (s./km), 50% of 25	0.23	1.85	0.75	1.47	3.09	0.85	1.39
28. Time-related depreciation (s./hour)	1.84	17.00	10.34	20.71	43.59	9.60	37.50
29 Interest cost (s./hour)	1.82	21.60	10.23	29.23	61.54	13.55	47.65
30. Administration & overhead							
a. annual cost (s./year)	-	-	80,500	130,200	209,200	57,600	211,500
b. hourly cost (s./hour)	-	-	18.30	33.38	53.64	18.58	62.21

References: No. 3 - 6, 9, 10, 13, 14, 16, 18 obtained from the sampling data in C.T.G.
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 2-3.2 VEHICLE OPERATING COST

(Sucres in 1985 prices)

Vehicle type	Private Vehicles		Passenger Vehicles			Commercial Vehicles	
	Motor cycle	Car	Taxi	Mini-bus	bus	Light Truck less than 2 tons	Truck more than 2 tons
Kilometer related cost (s./km)	1.61	6.82	6.00	9.47	16.24	6.29	12.02
Fuel	0.86	2.80	3.03	4.43	7.69	3.26	6.29
Oil	0.12	0.36	0.42	0.54	0.75	0.42	0.90
Tire	0.09	0.38	0.35	0.55	1.36	0.40	0.61
Maintenance	0.31	1.43	1.45	2.48	3.35	1.36	2.83
Depreciation	0.23	1.85	0.75	1.47	3.09	0.85	1.39
Non-Kilometer related Cost (s./h)	3.66	38.60	108.58	201.28	322.61	111.44	372.88
Crew	-	-	69.71	117.96	163.84	69.71	225.52
Depreciation	1.84	17.00	10.34	20.71	43.59	9.60	37.50
Interest	1.82	21.60	10.23	29.23	61.54	13.55	47.65
Overhead	-	-	18.30	33.38	53.64	18.58	62.21

(3) Trip time savings

a. Calculation formula

The trip time is calculated for each of the case with the MRT project and the case without the MRT project, and the difference is regarded as the saving of the trip time. The time-saving effect is normally quantified by the following formula, assuming that the time saved has a certain economic value.

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

where TB: Benefit resulting from the saving of trip time

p^1ij: Traffic volume from zone i to zone j in the case without the MRT project

t^1ij: Trip time between zone i and zone j in the case without the MRT project.

p^2ij: Traffic volume between zone i and zone j in the case with the MRT.

t^2ij: Trip time between zone i and zone j in the case with the MRT.

V : Time value

Here, Pij and tij are estimated based on the demand forecast. The benefit of the trip time saving can be determined if the value of the time is determined.

b. Calculation of time value

The economic value of the time is largely dependent on the manner of the utilization of the saved time. For example, when the time saved is used for the activities relating to production, a notion such as "Time saved Economic Value" is possible, whereas such notion is not applicable to the case where the same is consumed for nothing, since it will not contribute to the increase in any economic value at all.

The traffic is not always related to the productive activities but it serves for the consumptive purposes, too. Thus, it is important to consider which portion of the traffic should be estimated as the economic values. In this study, the time value is varied depending on the purpose of the traffic, and the average time value is calculated.

The time value to be referred to as the standard is assumed to be equal to the average hourly wage of the trip-maker. Furthermore, the time value is varied depending on the purpose of the trip. For example, the time consumed for the business trip is considered to have an economic value by 100%; the time consumed for commuting is considered to have an economic value by 50%; and the time consumed for the trip of other purposes is not considered to have any economic value at all.

i) Income distribution of transporation users by mode

Monthly Income (Sucres)	Bus %	Taxi %	Car %
4,000	6.5	1.8	0.4
11,550	25.4	8.6	3.1
20,000	32.5	32.2	11.3
37,500	27.6	36.0	34.6
60,000	5.3	16.7	27.0
85,000	2.0	3.5	17.1
100,000	0.6	1.2	6.4
Average	25,500 Sucres	35,200 Sucres	52,700 Sucres

(Source) Transportation users Survey by Study team in 1985

ii) Time value of transportation users by mode

Trip Purpose	Transportation			Trip purpose rate * %
	Bus Sucres	Taxi Sucres	Car Sucres	
Business	100	135	205	26.8
To and from Work	50	68	103	29.6
To and from School	-	-	-	11.2
Others	-	-	-	32.4
Weighed Average	42	56	85	-

(Note) *Percentages of trip purpose (2000) by M/P

iii) Time value by transportion mode

Type	Average Occupancy	Sucres/hour	Note
Car	1.8 Persons/car	153	1.8 × 85
Taxis	1.4	78	1.4 × 56
Buses	30.0	1,260	30.0 × 42
Average		167 Sucres/Car	

3) Other Benefits

The benefits quantified in the manner discussed in the foregoing are the principal effects of the MRT project which are quantifiable as the economic effects. Besides these effects, many other effects can be anticipated, but these effects are not taken as the benefits for the reasons that these effects are difficult to be quantified technically and that the data are not available even though they are quantifiable. These kinds of effects will be discussed in the following, and even these effects will also be considered in the final evaluation of this project.

(1) Traffic accident reduction effect

When the MRT is constructed, the total vehicle traffic volume is expected to decrease, and traffic accidents are considered to decrease proportionally. On the other hand, the chances of accident for the MRT are much less compared with those of buses and passenger cars. Therefore, the total number of accidents and the damages in all the traffic systems will be decreasing.

The damages caused by traffic accidents comprise the losses of human lives and properties, and some of the effects of traffic accident are rather hard to be measured in the economic terms. For this reason, the benefits resulting from the decrease of traffic accidents are not taken in this study. Nevertheless, the effects of the decrease of traffic accidents are important, and it can be considered to have a significance in terms of the promotion of the public welfare besides the economic significance.

(2) Public health improvement effect

The MRT is much less responsible for air pollution compared with the traffic system depending on automobiles, since it produces much less contaminants causing air pollution, thereby contributing to the reduction of damages to the public health, mainly the reduction of diseases of

respiratory organs. Such public health promotion effect may be considered to be quantifiable into an economic value, but the benefit of this effect is not taken in this study, since the scope of the measurement is hard to be defined, and the adequate basic data for the measurement are not available.

(3) Wayside development effect

The areas along the MRT, especially those around the stations, have potentialities to develop more readily than other areas owing to the easier access to the MRT. This will facilitate the utilization of the MRT by the inhabitants in the areas along the lines of the MRT, and also facilitate the development of such areas. Such effect can be considered to have a considerably large economic impact, but this benefit is not taken in this study, since it is a long-term effect and hard to be quantified.

(4) Industry-activating effect

The launching of the construction work for the MRT will create the demand for construction materials and the demand for labor, and these demands further create the new effective demands not only for the construction industry in the city of Guayaquil but also for the related industries. Furthermore, such industry-activating effect is considered to give gradual impact to all the industries through the increase in the secondary consumption.

2-4 Project Cost

The cost of MRT project comprises the construction cost and the operating cost.

These costs have already been estimated in the section of the construction and operation plan in the preceding volume, and the discussion on these subjects from now on will be made based on these estimates. For the economic analysis, however, these costs have to be calculated in terms of the economic prices.

The difference between the market price and the economic price is attributable to the following reasons:

(1) Cost of imported materials

As for the cost of imported materials needed for the project, the imported price is converted into the domestic price at the current foreign exchange rate, and the domestic transpoertation costs are added to it to determine the economic price of the materials. In this case, when the official foreign exchange rate differs from the actual foreign exchange rate, the price of the imported materials cannot be estimated properly, and so it is necessary to use the SER in such case. In Ecuador, the official exchange rate is almost proportional to the actual foreign exchange rate, so that no adjustment is made in calculating the economic price.

In general, the customers duty on the imported materials is treated as a transfer item and not included in the economic cost. Besides, the import duties will be exempted for the imported materials for this project, so that the import duties are not considered even in the financial analysis.

(2) Taxes and subsidies

The taxes including indirect taxes such as commodity tax imposed on domestic products represent the transfer of the domestic price and are not included in the calculation. The subsidies for domestic products to cope with imported products and the subsidies for the protection and improvement of domestic products are also considered to be the transfer of the price, so that they are not included in the calculation. In the case of the MRT project, the subsidy system is applied to the power cost, so that this is taken into account in calculating the economic price.

(3) Wages

As for the cost of labor to be employed for the project, the cost reflecting demand supply relation in the labor

market is used as the economic cost. Especially as for the cost of unskilled labor, there is a possibility that the legal cost based on the minimum wage law differs from the actual cost of the wage, so that adequate care should be taken as to this point.

Such difference in the labor cost is dependent on the demand-supply relation in the labor market, and thus this is problematic in the territories where labor is oversupplied. In the territory of Guayaquil, there seems to be no excessive unemployment as to both skilled and unskilled labors, and the mechanism of the market seems to be reflected on the labor cost. As for the unskilled labor, however, there is a considerable difference between the legal price based on the minimum wage law and the market price, so that necessary adjustment is made. The conversion rate is the market price x 0.75*.

(4) Interest

The interest will have to be paid depending on the conditions of the investment in this project, but the interest is not the subject of the economic analysis.

(5) Land

The land price should be estimated as of the price in the case of the alternative use of the land. The economic price of the land for the MRT project is determined as appraised price of the land at the time when it is assumed to be used for the most rewarding purpose other than the MRT project. Thus, in this study, the land price appraised for taxation is applied to the land of southern car depot while the half of it is applied to northern car depot.

In view of the aforementioned points, the project costs by the test cases are estimated as shown in Table 2-4.1 and 2-4.2.

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* This conversion factor is obtained from the official minimum wage rate.

Table 2-4.1 PROJECT COST BY INVESTMENT YEAR (Economic Cost)

(Unit: Million Sucres in 1985 prices)

Case \ Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996 -1998	1999	2000 -2008	2009	2010 -2015	Total
Basic Case	217	12,037	12,036	0	553	1,291	0	0	1,612	0	518	0	2,360	0	30,624
Case A-1	133	5,748	5,748	213	7,302	7,301	0	0	1,612	0	ditto	0	ditto	0	30,935
Case A-2	133	5,748	5,748	72	2,661	2,660	167	5,480	5,479	0	"	0	"	0	31,028
Case B-1	162	7,630	7,630	167	5,421	5,421	0	0	1,612	0	"	0	"	0	30,921
Case C-1	112	5,841	5,841	241	7,975	7,975	0	0	1,612	0	"	0	"	0	32,475
Case C-2	112	5,840	5,840	71	2,943	2,943	199	5,873	5,873	0	"	0	"	0	32,572
Case D-1	141	8,254	8,253	199	5,577	5,577	0	0	1,612	0	"	0	"	0	32,493
Case E	134	5,756	5,755	0	424	990	0	0	0	0	0	0	441	0	13,500
Case F	162	7,675	7,675	0	423	987	0	0	383	0	0	0	1,993	0	19,298
Case G	141	8,259	8,259	0	300	703	0	0	0	0	0	0	468	0	18,130

(Note) Project cost by investment year is calculated by (Distribution ratio to each investment year) x (cost in each staged year shown in Table 8-2.2 in PART I)

Distribution ratio to each staged year is as bellow:

1) For 1990
   - All cases: 1987 (20% of engineering services); 1988, 1989 (50% of the remind)

2) For 1993
   - Basic Case, Case E, F, G: 1991 (30%); 1992 (70%)
   - Other cases : 1990 (30% of engineering services); 1991, 1992 (50% of the remind)

3) For 1996
   - Case A-2, Case C-2: 1993 (30% of engineering services); 1994, 1995 (50% of the remind)
   - Other cases : 1995 (100%)

4) For 2000 and 2010 -
   - All cases : 1999 (100%); 2009 (100%)

Table 2-4.2 RUNNING COST OF MRT SYSTEM

Unit: 1000 Sucres

Case \ Year	1990 - 1992	1993 - 1995	1996 - 1999	2000 - 2009	2010 -
Basic Case	577,471	624,315	670,213	717,594	835,054
Case A-1	291,486	578,600	670,213	717,594	835,054
Case A-2	291,486	366,803	670,213	717,594	835,054
Case B-1	365,194	624,315	670,213	717,594	835,054
Case C-1	232,230	624,315	670,213	717,594	835,054
Case C-2	232,230	369,342	670,213	717,594	835,054
Case D-1	361,685	624,315	670,213	717,594	835,054
Case E	291,637	308,241	315,672	315,672	338,225
Case F	365,548	394,762	405,233	414,684	483,373
Case G	361,685	369,393	369,393	369,393	408,254