additional land for construction of grade-separated intersections, because the width of existing roads is narrow for constructing grade-separated intersection.

4) Intersections on Avenida Boyaca (V-1)

There are seven (7) grade-separated intersections installed on Avenida Boyaca. In the Study, a trunk bus system is planned on this road in the short term on the Master Plan. Considering a future development plan, major intersections on Avenida Boyaca should be constructed as a grade separated intersections.

5) Intersections on Avenida 7a (V-2)

There are three (3) grade-separated intersections installed on Avenida 7a. In the Study, an urban expressway is planned on Avenida 7a in the short or mid-term, in the Master Plan. The viaduct type was adopted as the road type of Urban Expressway on Avenida 7a. Considering this future road development plan, it is better to avoid constructing grade-separated intersections on Avenida 7a. The locations of a grade separated intersection plan are illustrated in Figure 11.3-1.

11.3.3 Evaluation of the Grade Separated Intersection Plan.

Generally, evaluation of the intersection improvement plan is done based on economic analysis and the traffic effect on the individual intersection, and these studies are conducted in a Feasibility Study stage. Evaluation of the grade separated intersection at the Master Plan stage is, therefore, done based on the traffic effect between the With Plan and the Without Plan. The traffic effect is compared by the differences in three categories; the travel speed, pcu-km, and pcu-hour. The results of the comparison are shown in Table 11.3-1, and the following traffic aspects are improved.

a) Grade-Separated Intersection Plan(With Plan) is effective to increase the average travel speed from 29.1 km/h to 29.8 km/h in 2001.
b) With Plan is effective to decrease the total pcu-hour from 1,074,000 to 1,052,000 pcu-hour.
c) Grade-separated intersections reduce traffic accidents because traffic flows can be separated on grade separated intersections.

Table 11.3-1 Traffic Effect between With and Without Plans in 2001 and 2010

Items/Case	With Plan (A)		Without Plan (B)		Effect	
	2001	2010	2001	2010	2001	2010
Ave. Travel Speed(km/h)	29.8	29.4	29.1	28.3	+ 0.7	+ 1.1
Total 1,000 PCU-km	31,319	35,754	31,290	35,767	- 29	+ 13
Total 1,000 PCU-h	1,052	1,216	1,074	1,263	+ 22	+ 47

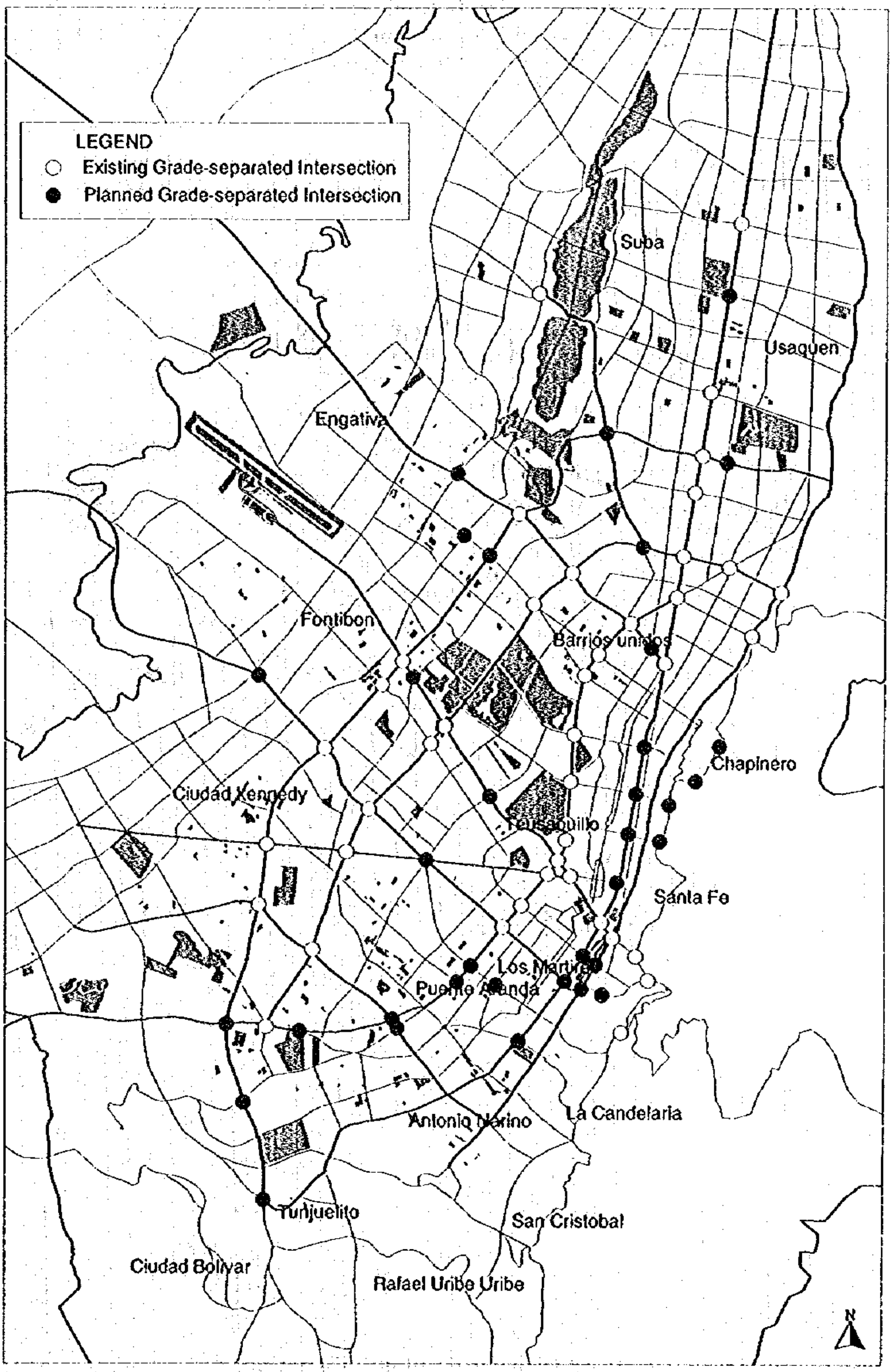


Figure 11.3-1 Location of Grade Separated Intersection Plan

11.4 New Road (At-grade Road) Construction Plan

New road construction plan is carried out based on the selected future road network in the Chapter 10. By the year 2020, a total of about 400 km of road are planned, and the each road length by road class is as follows;

a) V-0 Road -------47 km
b) V-1 Road -------50 km
c) V-2 Road -------123 km
d) V-3 Road -------180 km
e) Total -----------400 km

11.4.1 Design Criteria

Prior to the preparation of the road sector plan, the design criteria should be identified. The road sector study is done based on the following design criteria.

(1) Road Connection System

It is very important to consider the road network system for road planning in order to keep a smooth and safe traffic flow, and to maintain the function and characteristics of each road. In consideration of the function and characteristics of each road, the road network connection system adopted for this study is arranged as shown in Table 11.4-1, and Figure 11.4-1.

Table 11.4-1 Road Connection System

	Freeway	V-0 Road	V-1 Road	V-2 Road	V-3 Road
Freeway	0	0	*	*	*
V-0 Road	0	0	0	*	*
V-1 Road	*	0	0	0	*
V-2 Road	*	*	0	0	0
V-3 Road	*	*	*	0	0

Note; 0 ; Connection
* ; Non Connection

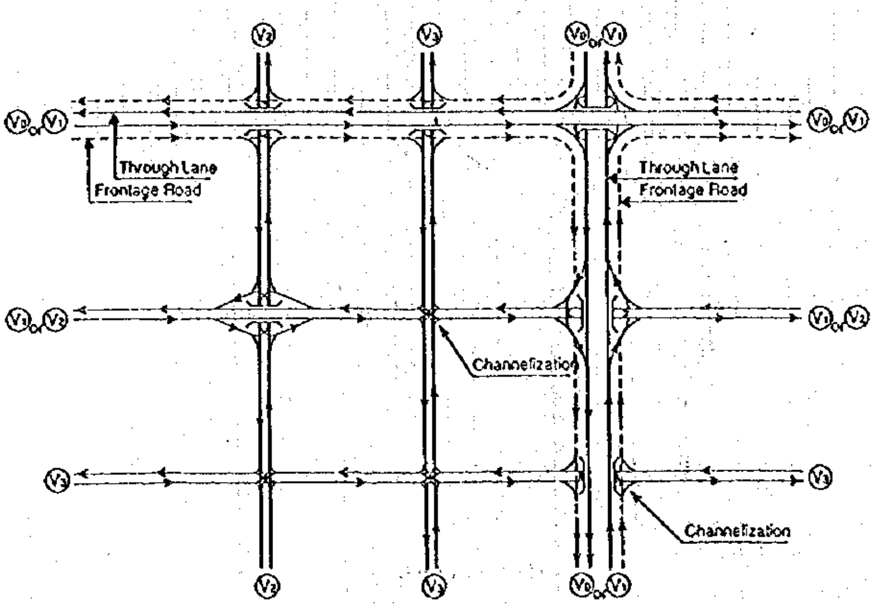


Figure 11.4-1 Road Connection System

(2) Access Control

To ensure traffic safety and maintain a smooth traffic flow, the introduction of a full-access control system is required for freeways, V-0 roads and V-1 roads. However, sometimes sufficient space cannot be found to introduce the full-access control system within the urban area. In this case, a partial-access control system is introduced. Taking into account the functions and characteristics of each road, the following access control is required for each road.

a) Freeway full access control
b) V-0 road full or partial access control
c) V-1 road partial access control or non access control
d) V-2 and V-3 road non access control

(3) Parking Control

A parking restriction system is introduced on arterial roads such as freeways, V-0 roads to V-3 roads in order to maintain traffic safety and a smooth traffic flow on each road.

(4) Road Facility Structure

Basically, road facility structures follow the Colombian Standards. The right of way is adopted as in Colombian Standards.

1) Number of Lanes

Usually, the number of lanes required is decided on the basis of comparative analysis of traffic capacity and planned future traffic volume on a road as shown in formulation (1). However, when the number of lane is decided, the functions and characteristics of a road should be considered. In planning the target period, if the planned traffic volume will not reach the capacity of a road, the right of way should be ensured at the first stage of construction.

Number of Lanes Required $N = V/C$ -----------------(1)
V: future traffic volume
C: traffic capacity of road

Generally, the traffic capacity of road is affected by various conditions such as the width of carriageway, vehicle composition, width of lateral clearance, and land use conditions along the road; in addition, the signal phasing of intersections. The traffic conditions of each road in the urbanized area are different, therefore, it is very difficult to calculate the actual traffic capacity on a road.

In this chapter, the traffic capacities of roads are estimated for determination of the number of lane required on certain road as follows;

a) V-0 Road Central Lane 18,000 pcu/day/lane
b) V-1 Road Central Lane 15,000 pcu/day/lane
c) V-2 Road 12,000 pcu/day/lane
d) V-3 Road 10,000 pcu/day/lane
e) Frontage Road 8,000 pcu/day/lane

2) Elements of Cross Section

Basically, the cross-section elements of individual roads follow the Standards of Colombia, but the shoulder spaces are introduced on both sides of carriage ways in order to ensure traffic safety and maintain a smooth traffic flow. The width of shoulder space of each road is described below;

a) V-0 road right shoulder width = 1.25 to 3.0 m; left shoulder width =0.5 to 1.0 m
b) V-1 to V-3 road right shoulder width = 0.5 to 1.5 m; left shoulder width =0.5 to 1.0 m

3) Right of Way (ROW)

The right of way of each road type is adopted based on the design standard in Colombia as shown below:

a) V-0 Road ------100 m
b) V-1 Road ------60 m
c) V-2 Road ------40 m
d) V-3 Road ------30 m

(5) Design Speed

Basically, the design speed is decided based on the functions and characteristics of a road, geographic conditions, economic aspects, and other elements. However, the design speed of roads in the urban area has been comparatively low due to very high land values and lack of space for construction of new roads. Bogota also shows the same situation. Considering this situation in Bogota, the following design speeds are adopted on individual roads in this study.

a) V-0 Road 80 to 100 km/h
b) V-1 Road 60 to 80 km/h
c) V-2 Road 50 to 60 km/h
d) V-3 Road 40 to 60 km/h

11.4.2 New Road Construction Plans

As mentioned previously, the future road network study is done based on the basic road network prepared by DAPD in 1993 (Alternative Network Plan-A in Chapter 10). As the results of traffic analysis of the Alternative Network Plan-A, the traffic service level of this plan will be very low in 2020. To improve the traffic service level, some roads are added on routes of Alternative Plan-A. This is the selected road network in the Chapter 10.

Based on the design criteria mentioned above, preliminary design of new roads is done. The future road network in 2020 is illustrated in Figure 11.4-1, and Table 11.4-2. Table 11.4-2 shows road name, road length, traffic volume on typical section on road, and number of lanes required.

Table 11.4-2 Summary of New Road Construction Plan in 2020

Road Nam	Road Class	Length (km)	Traffic Vol. (1000pcu/day)	No. Lane Required	N0. of I.C	Original Plan By
01) Av. Cundinamarca	V-0	40.6	80 - 200	6 - 12	2	DAPD
02) Av. Cali	V-1	35.0	50 - 160	4 - 10	7	DAPD
03) Suba-Kennedy Rd.	V-2	34.4	40 - 100	4 - 10	3	New
04) Av. Suba Extension (Av. Boyoca, Av. Low Murtra)	V-1	12.3	20 - 130	2 - 10	2	DAPD
05)Norte-Estoril Rd.	V-2	16.4	20 - 70	4 - 6	------	New
06)Av. San Jose	V-1	7.1	20 - 30	2 - 4	1	DAPD
07)Av. Jose Celestion	V-2	10.2	30 - 90	2 - 8	1	DAPD
08)Av. Americas Ext.	V-0	5.9	100	6	------	DAPD
09)Av. Primera Mayo	V-2	5.9	30	4	2	DAPD
10)Av. Laureano Gomez	V-2	9.9	20	2	------	DAPD
11)Av.Jorge Botero	V-2	7.9	10	2	------	DAPD
12)Av. Santa Barbara	V-2	4.3	40	4	------	New
13)Av. Guaymaral	V-2	4.8	20 - 30	4	2	DAPD
14)Av.Jardin	V-2	5.2	30	4	2	DAPD
15)Av. Los Arrayanes	V-2	6.0	30 - 60	6	2	DAPD
16)Av. Polo	V-3	3.5	30	4	1	DAPD
17)Av. Tibabita	V-3	3.6	10	2	1	DAPD
18)Av. San Antonio Ext.	V-3	3.6	30	4	------	New
19)Av. Cota Ext.	V-2	6.6	50	4	------	DAPD
20)Av. Santa Rosalia	V-3	7.9	10	2	------	New
21)Av. Sirena	V-2	4.3	40	4	------	DAPD
22)Av. Mercedes	V-3	5.3	10	2	------	DAPD
23)Av. Cordoba	V-3	6.5	10	2	------	DAPD
24)Av. Conejera	V-3	6.0	10	2	------	DAPD
25)Av. Cerezos	V-3	3.7	10	2	------	New
26)Av. Villa Maria	V-3	2.8	10	2	------	New
27)Av. Tabor	V-3	1.5	10	2	------	DAPD
28)Av. Iberia	V-3	1.5	10	2	------	DAPD
29)Av. Cedritos Ext	V-3	2.8	10	2	------	DAPD
30)Av. Esmeralda Ext	V-3	3.3	50	6	------	New
31)Av. Salitre	V-3	2.0	60	6	------	DAPD
32)Av. Pablo Ext.	V-2	1.6	60	6	------	DAPD
33)Av.Morisca	V-3	4.9	50	6	1	DAPD
34)Av. Bolivia	V-3	5.3	20	2	------	DAPD
35)Av.Cortijo	V-2	3.7	50	6	------	DAPD
36)Av. Florencia	V-3	1.8	30	4	------	DAPD
37)Av. Alsacia	V-3	5.5	40	4	------	DAPD
38)Av. Tintal	V-3	10.1	10	2	------	DAPD
39)Av. Castilla	V-3	1.7	60	6	------	DAPD
40)Av. Timiza	V-3	6.9	80	8	------	DAPD
41)Av.40 Sur	V-3	1.9	60	6	------	DAPD
42)Av. Santa F	V-3	4.6	10	2	------	DAPD
43)Av.San Bernardino	V-3	1.9	10	2	------	DAPD
44)Av.Terreros	V-2	3.7	20	2	------	DAPD
45)Av. Bosa	V-2	6	40	4	------	DAPD
46)Av. Circunvalar Sur	V-3E	14.3	20 - 30	4	------	DAPD
47)Av. Camino Pasquilla	V-3R	13.5	----	-----	------	DAPD
48)Av. Ciudad Villavicencio	V-2	3.0	60	6	------	DAPD
49)Av. Victoria	V-3E	6.5	60	6	------	DAPD
50)Av. Guacamaya	V-3	8.5	10	2	------	DAPD
51)Av. Caracas	V-3	6.5	40	4	------	DAPD
52)Av. Uval	V-3	5.9	10	2	------	DAPD
53)Av. Mariscal Ext.	V-3	2.0	10	2	------	DAPD

Notes: I.C. ; Grade Separated Intersection

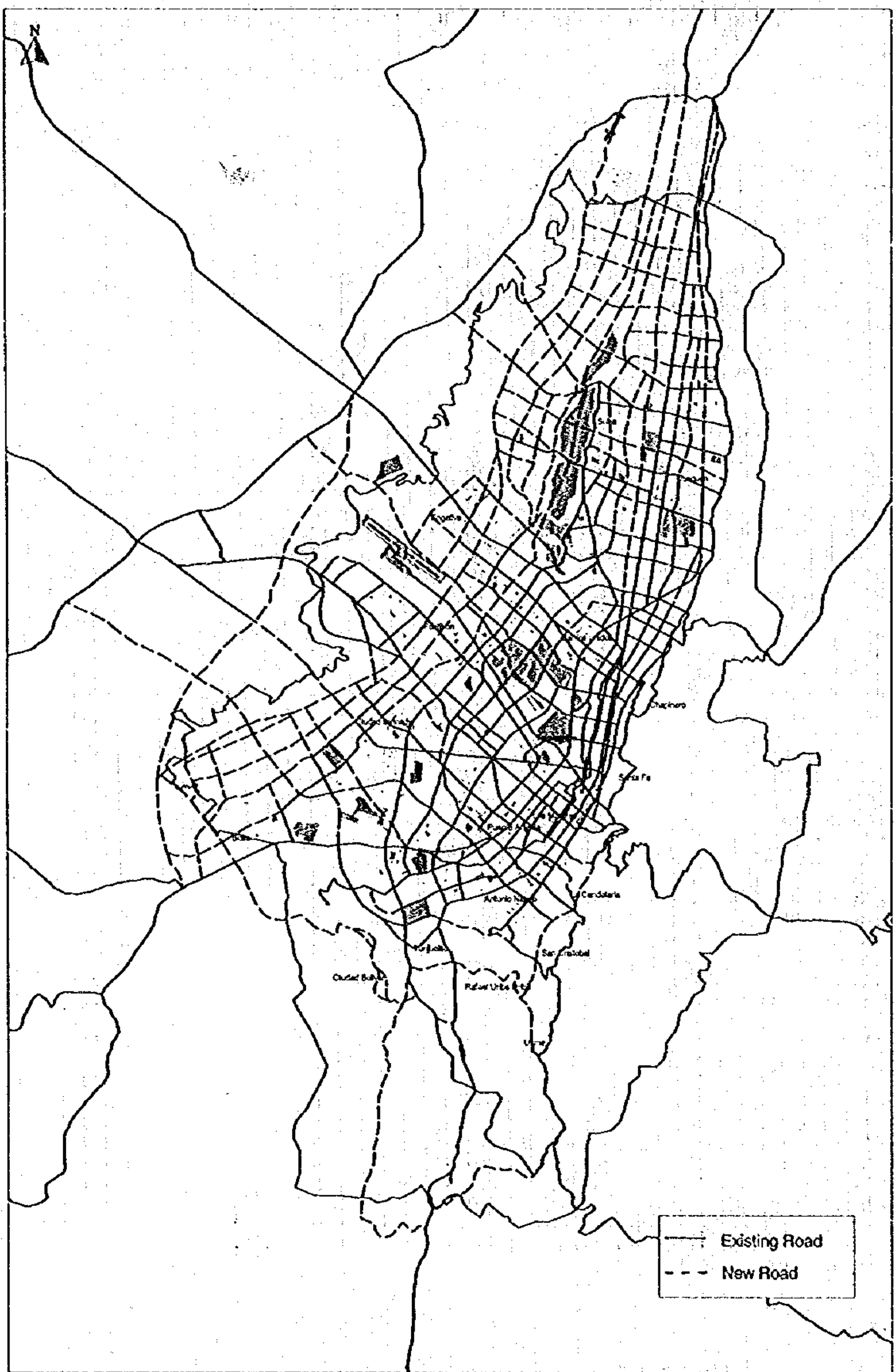


Figure 11.4-2 Location of the New Road Construction Plan

11.5 Urban Expressway Construction Plan

11.5.1 Concept of Urban Expressway Construction Plan

The travel speed surveys on existing major roads were conducted in 1995 by JICA Study Team. Travel speeds on almost all the existing roads such as Avenida Quito, and Avenida 7a were observed at less than 10 km/h. Because of increasing traffic demand, the travel speed on these roads will obviously worsen. In addition, it is very difficult to widen the existing roads, due top shortage of room for construction of new roads or widen existing roads. To mitigate the traffic congestion in the central area and its surrounding roads, the Urban Expressways are planned as a new road construction plan. Taking into account the characteristics of the traffic congested areas, three (3) routes such as 1st Ring Urban Expressway, 2nd Ring Urban Expressway, and four (4) Radial Urban Expressway are planned as an Urban Expressway Network.

11.5.2 Traffic Analysis of the Urban Expressway

(1) Future Traffic Volume Assignment Analysis

The future traffic volumes on the Urban Expressway are shown in Table 11.5-1.

Table 11.5-1 Traffic Volume on the Urban Expressways

Road Segment	Traffic Volume in 2020 (PCU/day)	Capacity (PCU/day/lane)	No. of Lane Required	Remarks
1st Ring on Av. 7a	80,000-100,000	18,000	5	One-way
1st Ring on Calle 24	80,000	18,000	4	One-way
2nd Ring on Canal Molinos	50,000	18,000	4	Both ways
2nd Ring on Calle 68	50,000	18,000	4	Both ways
Radial (Av. 7a)	60,000	18,000	4	Both ways
Radial (Rio Amarillo)	30,000	18,000	4	Both ways
Radial (El Dorado)	40,000	18,000	4	Both ways
Radial (Americas)	40,000	18,000	4	Both ways

(2) Traffic Effect of Urban Expressway

The traffic effect of Urban Expressway is examined based on the three (3) categories.

1) How Traffic Volume on Existing Related Road is Changed

Decreasing effects to the traffic volumes on the major existing roads with the construction of Urban Expressway are examined. The traffic analysis is carried out on the With Plan and the Without Plans based on the future traffic demand in 2020. The traffic volumes of the With Plan and Without Plan on the major roads are shown in Table 11.5-2. Result shows Urban Expressways can contribute to mitigate traffic congestion on the existing roads.

2) How Traffic Conditions on Major Existing Roads are Improved

Changes in the traffic conditions on the existing related roads after the construction of the Urban Expressways are examined. The traffic analysis is carried out to examine the average travel speed, pcu-km, pcu-hour, and V/C on the major existing roads. The future traffic demand is assigned to the network of the With Plan and the Without Plan. The difference in the effect of traffic conditions between the With Plan and Without Plan are shown in Table 11.5-3. The average travel speed on Urban Expressways is estimated at 14.2 km/h in 2020. When the Urban Expressway starts operation, the traffic congestion on existing roads located along the Urban Expressway can be improved.

Table 11.5-2 Traffic Volumes on Major Roads in 2020 (pcu/d)

Items	With Plan (A)	Without Plan (B)	Effect
1) Av. Caracas	42,400	88,700	46,300
2) Av. 7a	45,100	111,500	66,400
3) Av. 7a (norte)	15,800	29,700	13,900
4) Calle 11	21,000	30,300	9,300
5) Av. Quito	169,700	171,400	1,700
6) Calle 100	120,600	157,700	37,100
7) Calle 68	188,000	199,800	1,800
8) Av. Boyaca	101,100	122,500	21,400
9) Auto. Norte	224,000	251,300	27,300
10) Auto. Medellin	78,300	79,900	1,600
11) Auto. El Dorado	170,100	207,700	37,600
12) Av. Americas	142,900	197,500	54,600
13) Auto. Sur	73,400	77,600	4,200

Table 11.5-3 Traffic Conditions on Major Existing Roads (in 2020)

Items/Case		With Plan(A)	Without Plan(B)	Effect
1) Av. Caracas				
	a) Ave. Speed(km/h)	5	5	0
	b) V/C	1.19	1.33	+ 0.22
2) Av. 7a				
	a) Ave. Speed(km/h)	10	5	+ 5
	b) V/C	1.01	1.05	+ 0.04
3) Av. Quito				
	a) Ave. Speed(km/h)	17	16	+ 1
	b) V/C	0.90	0.95	+ 0.05
4) Calle 100				
	a) Ave. Speed(km/h)	47	47	0
	b) V/C	0.95	1.03	+ 0.08
5) Calle 68				
	a) Ave. Speed(km/h)	20	14	+ 6
	b) V/C	1.04	1.11	+ 0.07
6) Auto. Medellin				
	a) Ave. Speed(km/h)	29	18	+ 11
	b) V/C	1.09	1.11	+ 0.02
7) Auto. El Dorado				
	a) Ave. Speed(km/h)	41	33	+ 8
	b) V/C	1.22	1.42	+ 0.20
8) Av. Americas				
	a) Ave. Speed(km/h)	39	37	+ 2
	b) V/C	0.97	1.02	+ 0.05
9) Auto. Sur				
	a) Ave. Speed(km/h)	40	37	+ 3
	b)V/C	1.12	1.21	+ 0.09

3) How Traffic Congestions on the Road Network in 2020 are Decreased

Effects of Urban Expressway in terms of changes in traffic conditions, such as average travel speed, total pcu-km, and total pcu-hour, on the full road network in 2020 are verified. The average travel speed is improved at 4 km/h from 17 km/h to 21 km/h, the total pcu-km is decreased by 122,000 pcu-km, and total pcu-hour is shortened at 698,000 pcu-hour, as shown in Table 11.5-4. Considering the traffic conditions on the full road network in 2020, Urban Expressways can contribute to mitigate traffic congestion.

Table 11.5-4 Traffic Conditions on the Full Road Network in 2020

Items/Case	With Plan(A)	Without Plan(B)	Effect
Ave. Speed(km/h)	21	17	+ 4
Total 1,000 pcu-km	69,748	69,870	+ 122
Total 1,000 pcu-hour	3,346	4,044	+ 698

11.5.3 Design Criteria

(1) Design Standards

Presently, there are design standards for roads in Colombia; however, there are no design standards for the Urban Expressway. Basically, the Colombian design standard follows AASHTO (A policy on geometric design of highways and streets).

(2) Design Speed

The design speed of Urban Expressways is set at 60 km/h to 80 km/h, considering the traffic characteristics of the road and land use conditions of the area where the Urban Expressway is located.

(3) Typical Cross Section

The width of cross section elements are as follows;

a) 3.50 m lane width is adopted, considering design speed and road characteristics.
b) 1.50 m right shoulder width is adopted.
c) 1.00 m left shoulder width is adopted.
d) 1.00 m median width is adopted.

The typical cross-section of each segment of Urban Expressway is illustrated in Figures 11.5-2 and 3. The total width of a 4-lane dual carriageway is 20.00 m and total width of a 4-lane one way carriageway is 16.50 m.

11.5.4 Route Location of Urban Expressways

The routes of the Urban Expressway network consists of 1st Ring, 2nd Ring and four (4) Radial roads. Route locations are shown in Figure 11.5-1.

(1) Route Location of 1st Ring Urban Expressway

To mitigate the traffic congestion in the central area, the 1st ring urban expressway is planned. The heavily traffic congested area covers roads such as Avenida 7a, Avenida Chile (Calle 72), and Avenida Quito. The 1st Ring Urban Expressway is located to improve traffic congestion within this area. The route location study is carried out as follows;

a) The widths of 4-lane dual carriageway and a 4-lane one-way carriageway are about 20 m and 16.5 m. The route should be located on the existing 4-lane roads, with as little additional land acquired as possible.
b) Avenida 7a is classified as V-2 road with 6-lane dual carriageway, and ROW is about 33 to 35 m. The Urban Expressway can be constructed on this road without additional land acquisition.
c) There is no open space for construction of an urban expressway along the Avenida Chile. To mitigate the traffic congestion in the central area, a new route is required along the Avenida Chile, and ROW on Avenida Chile is about 40.0 m. Considering the width of the Avenida Chile, the route of the urban expressway is located on the Avenida Chile.

d) The route should pass through the existing Avenida Quito, considering the open space of the road. However, the railway network is planned on the existing railway on the Avenida Quito. Taking into account the future transport network plan, the route selected is on the existing Carrera 24 and Avenida 28, to avoid passing through the existing Avenida Quito.

e) However, ROWs of the above mentioned three(3) roads are comparatively narrow. Taking into account environmental aspects, a one-way traffic system is planned for the 1st Ring Urban Expressway. The width of a 4-lane one-way carriageway is about 17.0 m.

(2) Route Location of 2nd Ring Urban Expressway

The major purposes of the 2nd Ring Urban Expressway are to mitigate the traffic congestion of the existing urbanized area and distribute traffic to/from the radial roads. Considering the network balance between urban expressways and the existing road network and future land use conditions, the route may be set to pass on the existing Avenida 100, Avenida 68, and Calle 13, however, considering the environment aspects, the routes are selected to use the river areas.

a) Avenida 100 is classified as V-1 road, and this road maintains a good environment with road-side trees (plantation) on the median and on both sides of the sidewalk. To avoid passing through Avenida 100, the route is located on the existing Canal Molinos, located near the existing Calle 115, without additional land acquisition.

b) Avenida 68 is classified as a V-1 and V-2 road, with 8-lane dual carriageway, and ROW is about 40 m. There is no plantation on Avenida 68, therefore, the route is set on Avenida 68, with additional land acquisition.

c) In the future, the West Railway Lane will be relocated to the Avenida Cundinamarca, when this road is constructed. The route of the Urban Expressway is set on this railway area, without additional land acquisition.

(3) Route Location of four (4) Radial Urban Expressway

There are six (6) trunk radial roads in Bogota: Avenida 7a (V-2), Autopista Norte (V-0), Medellin(V-1), El Dorado (V-0), and Sur (V-1). In spite of the improvement of these roads, future traffic volumes on these road reach overcapacity. In addition, the population of suburb of Bogota will grow rapidly, and social and economic activities between Bogota and surrounding cities will become strong. To mitigate the traffic congestion on the existing trunk radial roads and maintain a smooth traffic operation between Bogota and surrounding cities, the Urban Expressways are planned. The route location study is done based on the following conditions.

a) For the traffic from Norte to Central area, Avenida 7a is selected.

b) The future railway network is planned on Autopista Norte in the Master Plan, therefore, the route of Urban Expressway should be avoided.

c) The bus trunk road network is planned on Autopista Medellin by IDU, and construction of this project will commence in 1997. Considering the construction method of Urban Expressway, it is very difficult to construct the Urban Expressway on Autopista Medellin. Therefore, the route of the Urban Expressway is located on the existing Rio Amarillo.

d) Autopistas El Dorado and Americas are classified as V-0 roads, and about 20 m width of median exist. The routes of the Urban Expressway are located on these roads.

e) The railway network is planned on Autopista Sur in the Master Plan. Considering the future transport demand, the Urban Expressway will not be needed.

11.5.5 Environmental Consideration

(1) Introduction of the One-Way Traffic System

In Chapter 11.5.4, 1st Ring Urban Expressway was set on the existing Avenida 7a, Carrera 24, and Avenida 28. Rights of way (ROW) of the existing Avenida 7a, Carrera 24, and Avenida 28 are about 30 m to 40 m, 25 m to 30 m, and 25 m to 30 m, respectively, and there are many building on both sides of these roads.

Considering environmental aspects such as aesthetics and landscape for inhabitants living along these roads, the construction of a narrow cross section width of Urban Expressways is required. Basically, there are two (2) methods for decreasing the cross section width; one is the reduction of the number of lanes like as from, a 4-lane road to a 3-lane road, and the second is the introduction of the one-way traffic system to eliminate a central divider, thus, from a 4-lane dual carriageway to a 4-lane one-way traffic carriageway. The carriageway width of each road is described below;

a) 4-lane dual carriageway width = 20.0 m (1.5+7.0+3.0+7.0+1.5)
b) 4-lane one-way carriageway width = 17.0 m (1.5+7.0+7.0+1.5)
c) 3-lane one-way carriageway width = 13.5 m (1.5+10.5+1.5)

The traffic effect analyses among three (3) cases are conducted to examine the possibility of introducing a one-way traffic system. The results of the traffic analysis are shown in Table 11.5-5. Judging from this table, a one-way traffic system with a 3-lane carriageway can be introduced for the 1st Ring Urban Expressway because there is no difference in traffic conditions among the three (3) cases. However, more detailed study should be needed when the one-way traffic system is introduced for the 1st Ring Urban Expressway.

Table 11.5-5 Traffic Effect among Three Traffic System

Items/Case	4-lane(Both-way)	4-lane(One-way)	3-lane(One-way)
Ave. Speed(km/h)	21	21	21
Total 1,000 pcu-km	69,748	63,063	69,935
Total 1,000 pcu-hour	3,346	3,011	3,382

(2) Construction of Noise Barrier

When the Urban Expressway starts operation, about 70 (dB) of noise at a point 10 m from the edge of the Urban Expressway is expected, according to the calculation of noise level.(The details of a calculation are described in Chapter 15.3). This value is very high for inhabitants who live along the existing roads. Considering environmental aspects, a noise barrier should be constructed on both sides of Urban Expressways to mitigate noise from the road.

(3) Preservation of Roadside Trees

The 1st Ring Urban Expressway is located on the existing Calle 72; there are many trees planted on the center of the existing road. When the Urban Expressway will be constructed, these trees should be cut. A good environment has been maintained along the existing Calle 72, therefore, re-plantation should be done after construction of the Urban Expressway, on both sides of the existing Calle 72.

11.5.6 Proposed Urban Expressway Plan

Results of the Urban Expressway study are summarized in Table 11.5-6 and the route locations are illustrated in Figure 11.5-1. The typical cross sections of segments on the

Urban Expressway are illustrated in Figures 11.5-2 and 3.

Table 11.5-6 Outline of Urban Expressway Plan

Segments/Items	Length (km)	No. of lane	Type of Road	Traffic System	No. of IC	Located Area
a) 1st Ring	17.67	4	Viaduct	One-way	6	On Road
b) 2nd Ring	3.89	4	Viaduct	Both way	3	On Road
c) 7a Radial	6.55	4	Viaduct	Both way	1	On Road
d) Medellin Radial	4.03	4	Viaduct	Both way	2	On River
e) El Dorado Radial	4.45	4	Viaduct	Both way	3	On Road
f) Americas Radial	7.93	4	Viaduct	Both way	3	On Road

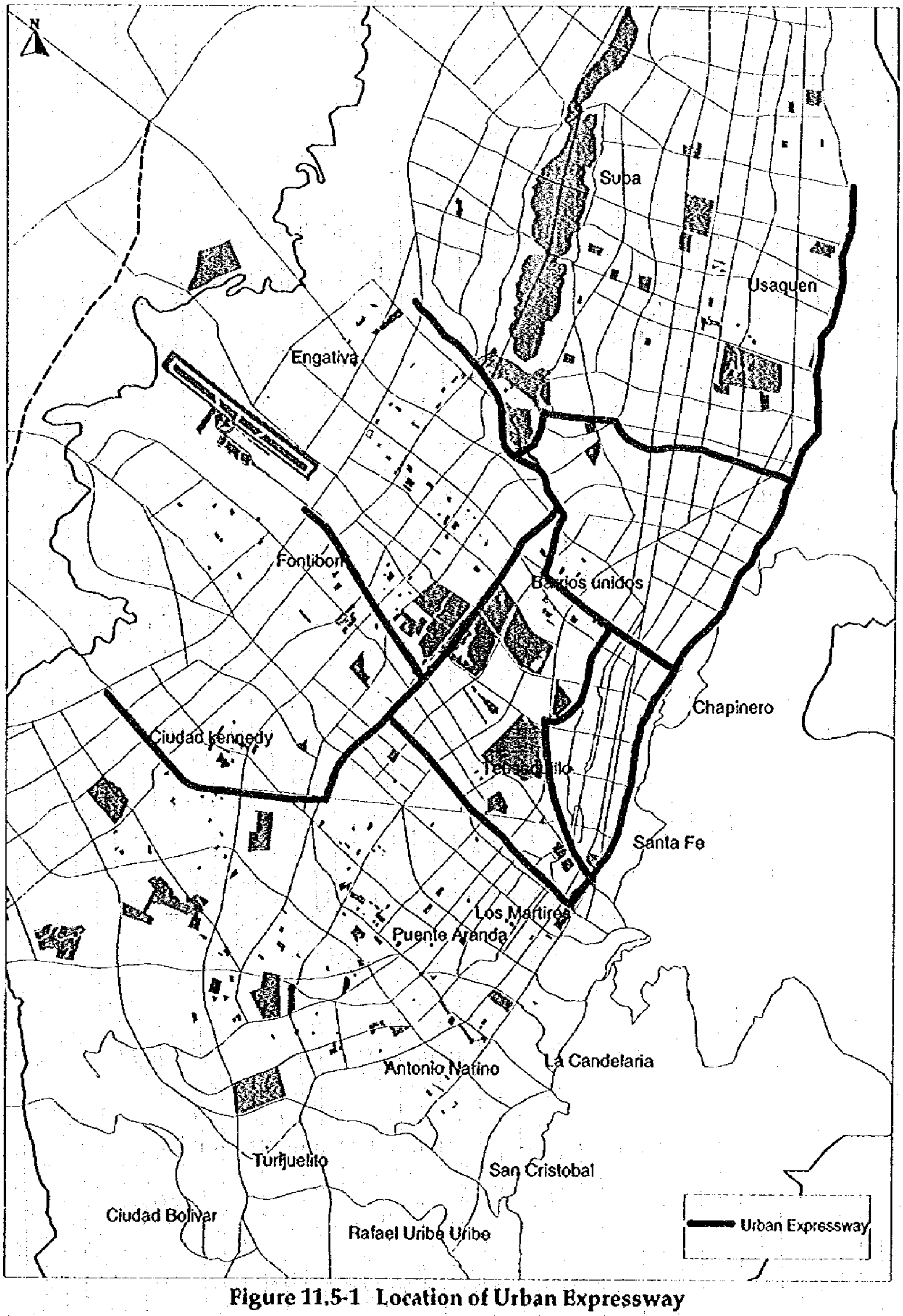
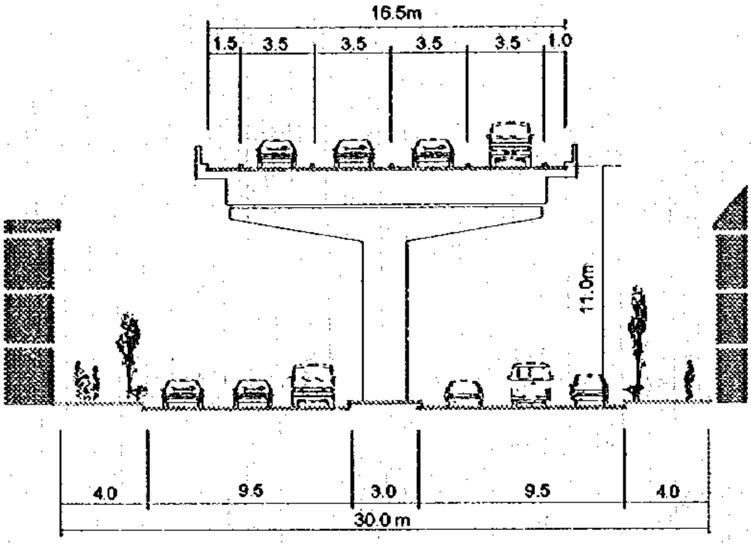
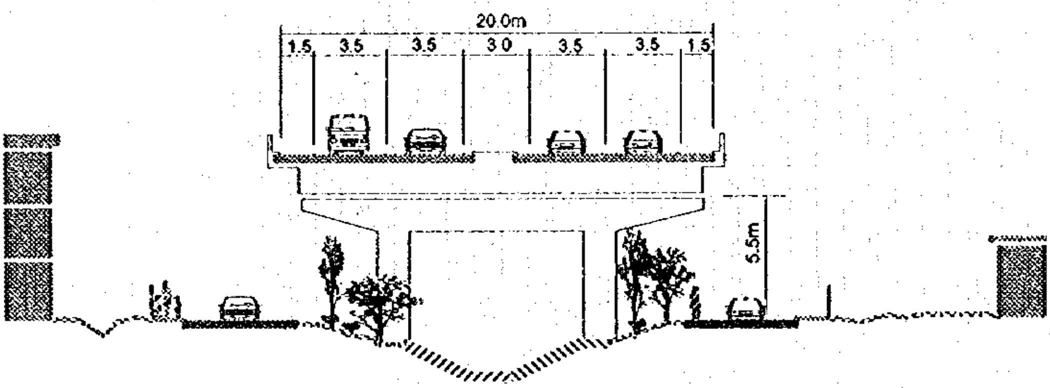


Figure 11.5-1 Location of Urban Expressway

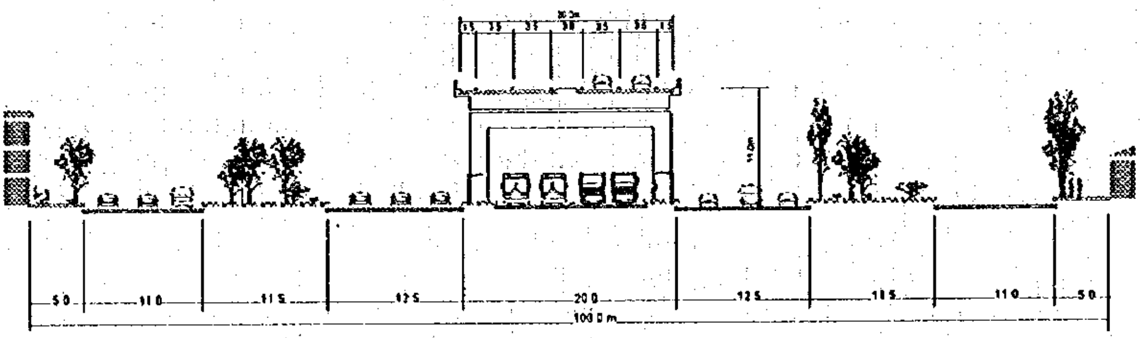


Avenida 7a



Canal Molinos

Figure 11.5-2 Typical Cross Section on Urban Expressway(1)



Avenida Americas

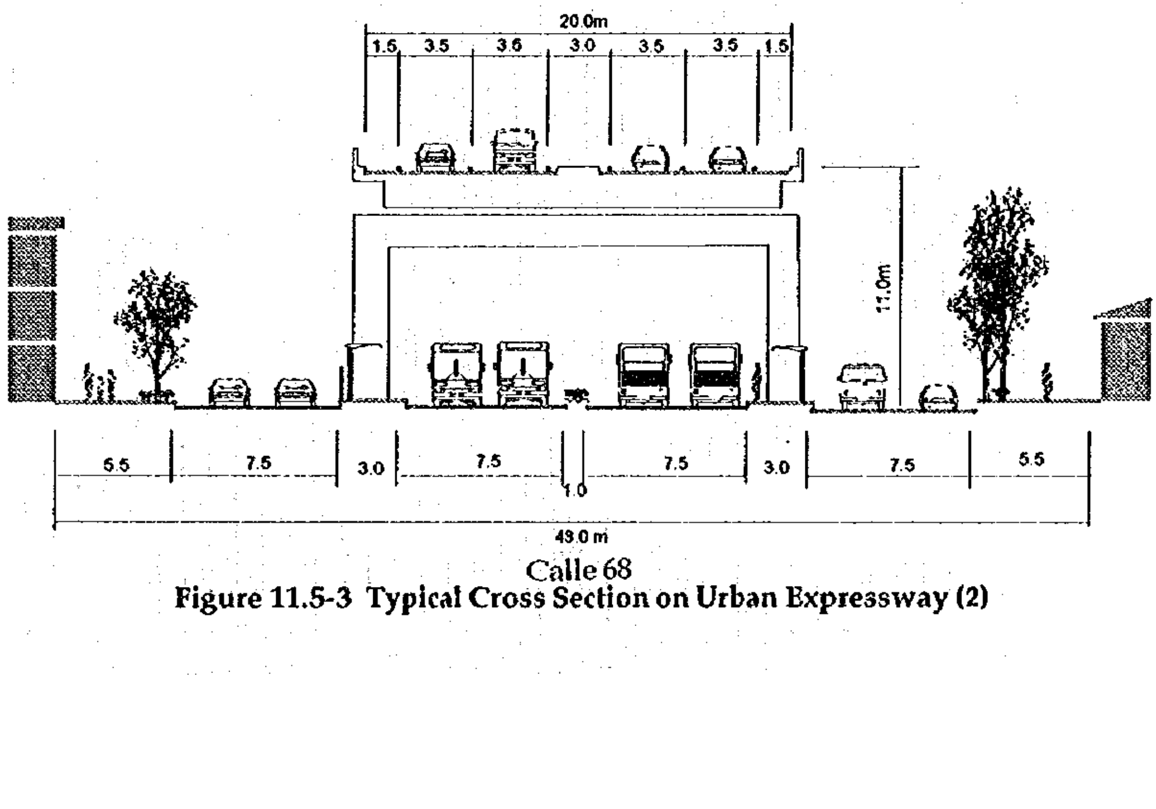


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Figure 11.5-3 Typical Cross Section on Urban Expressway (2)

11.6 Minor Roads(Collector and Local roads) Planning Guideline

Collector and local roads planning is not included in the Master Plan. Considering the importance of the development of these roads, guidelines of collector and local road planning are examined in this section.

11.6.1 Local Road Planning Concept

Arterial road network planning is conducted in the Master Plan Study. The collector and local road network development plan is also a very important item to control the traffic flow and maintain efficiency in the total road network. The function of collector and local roads are to induce housing development and to maintain open space for human life. Therefore, when these roads will be constructed, the following factors should be considered.

a) Establishment of road connection hierarchy system
b) Conformity of future traffic demand
c) Harmony of characteristics of development
d) Identification of road network pattern as shown in Figure 11.6-1
e) Access to the development areas

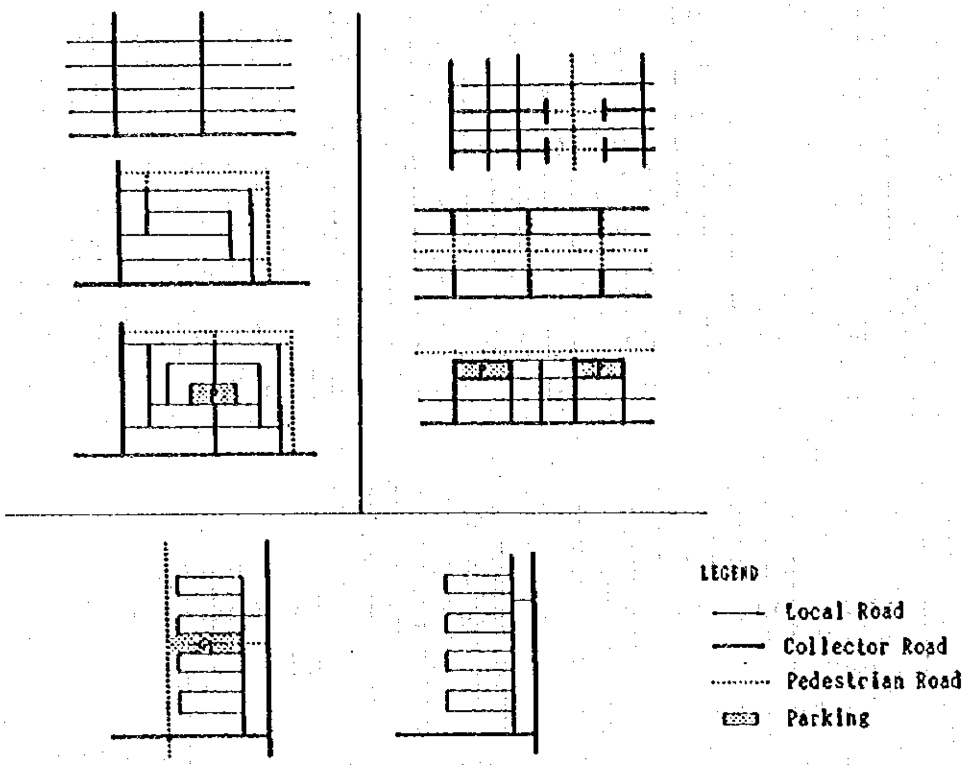

Figure 11.6-1 Conceptual Plan for Collector and Local Road Network

11.6.2 Local Road Length Required in 2020

The future population, space of urban area, and future traffic volume on each traffic zone in 2020 were forecasted in the previous Chapter. Based on these data, the length of collector and local roads required in 2020 are estimated. The estimation method and premises are as follows.

a) Calculation of future habitable area (HS)
b) Calculation of the existing road area(RS)
c) Calculation of the generated and attracted traffic volume (Q)
d) Average traffic capacity of these roads is adopted as 5000 pcu/day
e) Average cross section width of these roads as 16 ms
f) Necessary road area in 2020 is calculated by formulation-(1) (FRS)
g) Required road length in 2020 is calculated by formulation-(2) (FRL)

$$FRS = (Q * \sqrt{HS} * 16) / 5,000 \quad \text{------------(1)}$$
$$FRL = (FRS - RS)/16 \quad \text{------------(2)}$$

The results of calculation are summarized in Table 11.6-1

Table 11.6-1 Required Collector and Local Road Length

Traffic Zone	Habitable Land (Ha)	Road Area(Ha)	Road Ratio(%)	Gen. & Att. (pcu/d)	Access. Road Area(Ha)	Required Road Length (km)
1.Usaquen	4,339	633.6	14.6	523,000	1,100	290
2.Chapinl	427	319.4	22.4	469,000	566	154
3. Santafe	757	135.0	17.8	433,000	381	153
4. S.Crist.	1,669	295.2	17.7	163,000	213	-----
5. Usme	4,228	-----	------	72,000	-----	-----
6. Tunjue	1,049	284.0	27.	122,000	126	-----
7. Bosa	2,386	242.2	10.2	116,000	181	-----
8. Kennedy	3,765	606.0	16.1	387,000	760	96
9. Fontiba	3,266	363.2	11.1	233,000	426	39
10. Engat.	3,443	661.0	19.2	476,000	893	145
11. Suba	9,615	732.0	7.6	565,000	1,772	650
12. B.Unidos	1,199	362.0	30.2	212,000	234	-----
13. Teusaq.	1,352	144.0	10.7	314,000	369	140
14. L.Mart	652	264.0	40.5	182,000	148	-----
15. A. Narino	483	195.0	40.4	114,000	80	-----
16. P.Arandal	730	495.8	28.7	312,000	415	-----
17. Candel.	196	39.0	19.9	54,000	24	-----
18. R.Uribe	979	260.2	26.6	170,000	170	-----
19. C.Bolive.	6,684	284.0	4.3	158,000	413	80
Total	49,217					1,747 (km)

11.7 Project Cost Estimate

11.7.1 Components of Project Cost

The project cost consists of construction cost, land acquisition and compensation, engineering cost, administrative cost, and physical contingency. Component of the project costs is as follows;

1) Construction cost (A) consists of construction material cost, labor cost, and construction equipment cost, including overhead.
2) Engineering cost consists of design and supervision of the project, and cost is estimated as 10% of the construction cost(A).
3) Administrative cost consists of administration of the project, and cost is estimated as 10 % of the construction cost (A).
4) Physical contingency is cost for additional work needed, and cost is estimated as 10 % of the construction cost (A).
5) The project cost estimate is based on US dollars at 1996 prices.

11.7.2 Project Cost Estimate

The construction cost of each plan is estimated based on the discussion with Colombian counterparts; in addition, the construction cost is also compared to the actual similar road and bridge construction cost, conducted by IDU. The project cost consists of construction cost(A), land acquisition cost, and 30 % of construction cost for engineering cost and administrative cost and physical contingency.

(1) Construction Cost

The construction cost is estimated based on the data collected from IDU and related authorities. In addition, the unit construction cost were discussed with counterpart personnel of Colombia.

The following construction cost per kilometer (unit cost) by each road class are estimated as shown below;

a) V-0 Road (12-lane) ---------------------6,026 ,000 US$/ km
---------------502,000 US$/km/ lane
b) V-1 Road (10-lane) -------------------4,533,000 US$/km
---------------453,000 US$/km/lane
c) V-2 Road (6 -lane) -------------------3,044,000 US$/km
-------------------507,000 US$/km/lane
d) V-3 Road (4 lane) -------------------2,036,000 US$/km
-------------------509,000 US$/km/lane
e) Grade Separated Intersection---------3,780,000 US$/vol.
f) Bridge (Viaduct) -------------------1,100 US$/m2
g) Interchange (on-off) ------------------3,780,000 US$/vol.

(2) Land Acquisition Cost

The land acquisition cost is estimated based on the data collected from the Catastro in 1996, and also discussed with the Colombian counterpart personnel of the Study. The land acquisition cost is estimated as road areas times unit land value of the area where the road is located. The land value of the areas adopted are as follows:

a) Within the area of Avenida Quito---- 1,000 US$/m2
b) Within area of Avenida 100 ----------500 US$/m2
c) Along the existing trunk road--------200 US$/m2

d) Suburban areas -----------------------100 US$/m2
e) Usme areas -------------------------50 US$/m2

CHAPTER 12
Public Transport Sector Plan

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12. PUBLIC TRANSPORT SECTOR PLAN

12.1 Planning Subject and Approach

12.1.1 Planning Subject

The Master Plan Study aims principally to provide the responsible administrations with a policy and investment guideline for Short, Medium and Long-Term development and management. In the field of public transport in Bogota, there are many issues to be solved urgently, as identified in Chapter 5.8. The main subject of the Short-Term plan is to find how to solve those issues. On the other hand, how to cope with the increase in transport demand will be the main subject in the longer term. More specifically, the following items will be the planning subjects for the respective terms.

(1) Short Term Planning (5 years)

1) Reorganization of Bus Routes

Current bus routes are excessively numerous, long and complicated. They need to be reorganized properly, adjusting to demand. The route reorganization plan should be planned to improve the financial viability of the bus business by mitigating present overheated competition, as well as to meet the demand and road network capacity.

2) Reconsideration of Current Tariff System

The level of current tariffs is too low to sustain bus operation in financially sound conditions. In addition, ongoing flat rate system is not reasonable under the present condition, with such long bus routes. From this point of view, a new tariff system should be planned.

3) Increased Capacity and the Regional Integration of Public Transport Administration

Present capacity of STT is not enough to administrate the public transport system in Bogota in every respect: budget, staff, information and data, planning tools, etc. To cope with tremendous issues of public transport in Bogota, it is indispensable to improve the administrative and planning capacity of STT.

The urbanized area of the Bogota is now growing beyond the city boundary and transport demand beyond the city boundary is also increasing rapidly. Nevertheless, the public transport service between Bogota and its surrounding cities is not functioning well. Intermunicipal administrative coordination should urgently be established.

4) Structural Reform of Bus Operators Organization

The traditional bus operating system in Colombia is composed of three bodies: companies, bus owners and drivers. Although this system has merit and worked well while the size of Bogota was small or medium, deficiency has become prominent as the city grows. Now, the bus operation system needs to be modernized.

5) Replacement of the Bus Fleet

As pointed out in Chapter 5, most of the bus fleet operated in Bogota has become very old, which not only makes the buses operation rate lower due to frequent break-down, but also prevent car users to convert to bus use. Replacement of old buses should be promoted by some policy measures and also by improvement of the financial conditions of bus business.

(2) Medium and Long Term Planning (5-20 years)

1) Formulation of the Mass-Transit Network Master Plan

It is apparently impossible to develop a complete network covering the entire city area and its suburbs within 20 to 25 years. Such a mass-transit network will take more than half a century to develop. Practically speaking, the first line or the second line at most can be expected to be built before 2020.

Nevertheless, even for the construction of the first line, a network master plan should be established, foreseeing the future urban structure beyond 2020. Otherwise, a well-balanced network can hardly be expected in the long run.

2) Identification of the Top Priority Line

Each line should be evaluated by simulating future traffic demand and forecasting its socioeconomic and environmental impact. Giving a relative priority to each line, the top priority line will be selected for the initial implementation.

3) Preliminary Study on the Top Priority Line

A preliminary study will be conducted for the top priority line from economic, financial, environmental and engineering points of view. While the evaluation made in the previous step 2) is a relative one, this evaluation is the absolute one.

4) Guideline to Compose Feeder Line Network

The public transport network will be extensively affected by the introduction of the first mass-transit line. Therefore, the old network should be properly modified. The first thing to do after opening the mass-transit line is to provide feeder line service connecting with the mass transit line, in order to make the line function better.

12.1.2 Planning Approach

The public transport sector plan will be developed to find a solution for the subjects stated above or as a guideline to solve them. The planning process is summarized in Figure 12.1-1. Transport demand analysis will be done using the public transport passengers OD matrix in 1995 for the Short-Term plan and the OD matrix in 2020 for the Long Term plan. Future OD matrix is forecast in Chapter 9.

In the Short Term plan, one of the main tasks is to develop a bus rerouting plan and its evaluation. Prior to composing a new bus network, potential demand on each road link is estimated by assigning present passenger OD trips on the present road network by the all-or-nothing method. A trunk bus network is planned based on this potential demand and physical road conditions such as width of right of way and number of lanes. And then, on this network, a number of bus routes are planned, referring to the OD trips and the assigned traffic volume. Once bus routes are set, OD trips are again assigned on the bus routes by multi-pass loading method. This assignment considers access/egress time, route-to-route transfer impedance, competitive route, tariff impedance, etc. This assignment of trips on a public transport route is generally called " transit assignment" and is done in this study, using a software package named "JICA-STRADA" recently developed by JICA.

Based on the results of this transit assignment, demand for each bus route can be estimated and then the number of buses to be allocated to the route is calculated.

When the demand grows beyond the capacity of the trunk bus service, the route will become a candidate for a mass-transit route. Therefore, future O-D trip data are loaded on the same trunk bus network and based on the result, together with the mass-transit networks proposed in the past, several alternative networks are prepared. In the next step, these alternatives are evaluated by comparing their potential demand, and the most promising one is selected. The result of this work is already stated in Chapter 10.3.

In this chapter, further study is made of the selected alternative, to compose the final master plan network, with proper modifications. Finally, each route the network consists of is prioritized through a comparative study of demand, construction cost and consideration of the environmental impact.

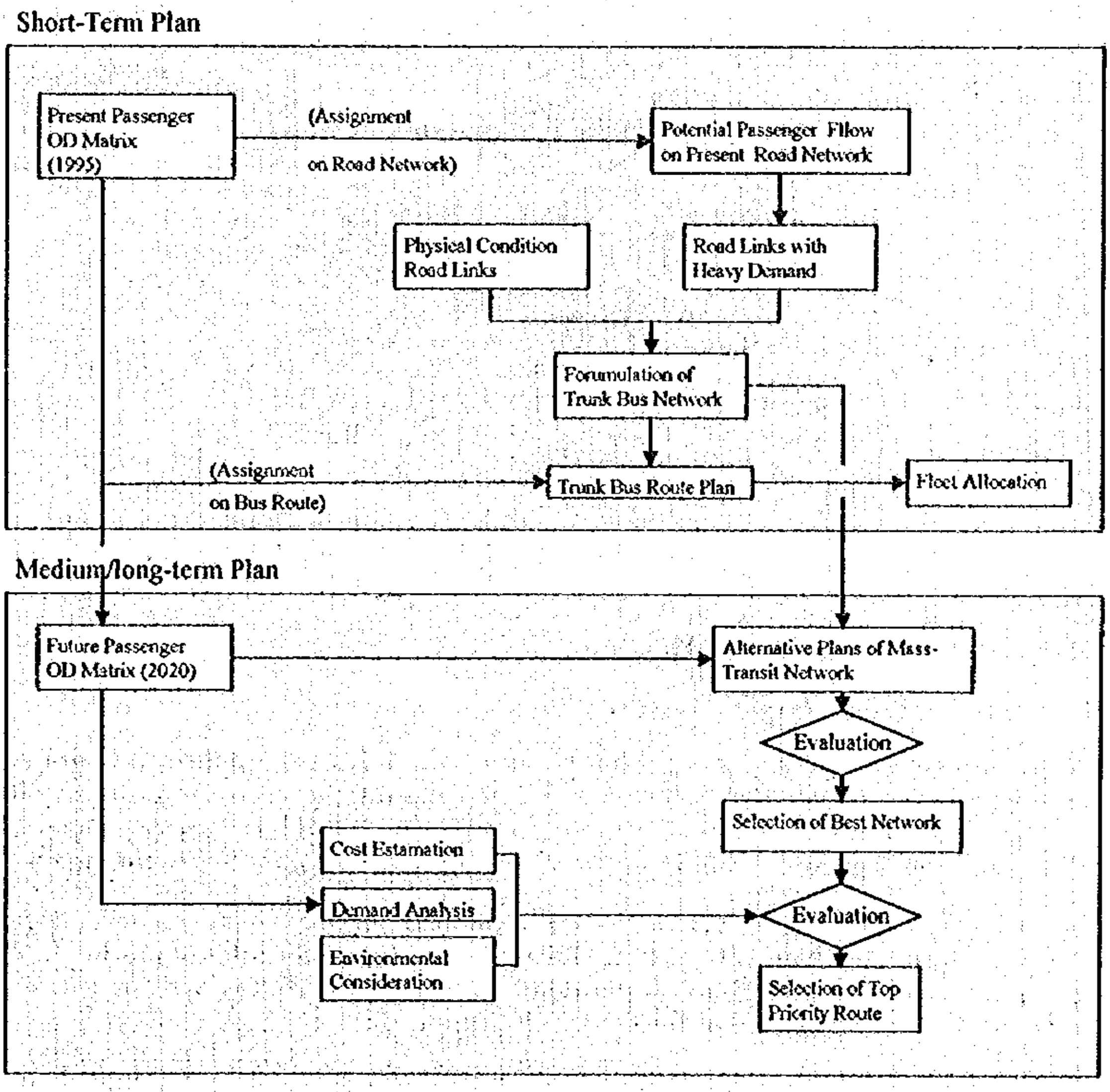


Figure 12.1-1 Approach for Public Transport Planning

12.2 Short Term Plan

In this section, a guideline is shown for the five Short Term planning subjects pointed out in 12.1.1 (1) reorganization of bus routes, (2) Reconsideration of the current tariff system, (3) increased capacity and regional integration of public transport administration, (4) reform of bus companies and (5) replacement of the old bus fleet.

These issues, especially the first three issues, are strongly inter-related. Solution of one problem will help another and any one problem will be hardly solved by itself. For example, a new tariff system will not be welcomed by passengers without introducing new and better transport service and replacing the superannuated bus fleet will become possible only with a new tariff system to make the bus business financially self-sustainable. In all these mutual relations, reinforcement of the STT is a necessary precondition of all other planning subjects. Therefore, the following proposals should be considered as a set of measures to be undertaken within five years. This is illustrated schematically as a triangle, shown in Figure 12.2-1.

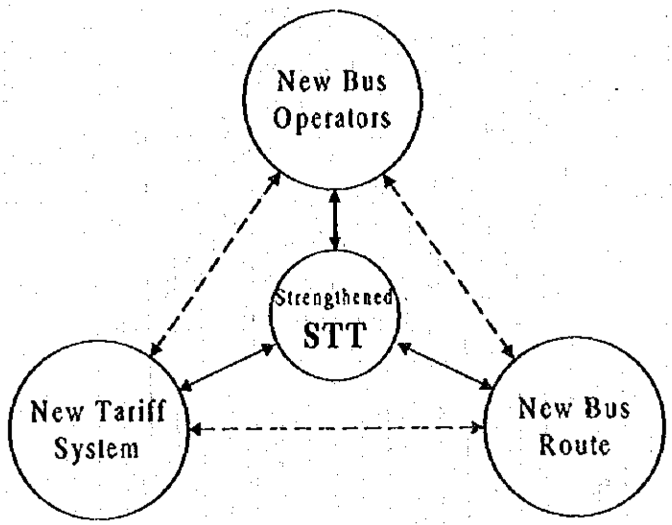


Figure 12.2-1 Trinity of Short-Term Subjects in Public Transport Plan

12.2.1 Bus Route Reorganization Plan

(1) Evaluation of the Present Bus Network

Bus operators generally insist that the bus service is already oversupplied in Bogota and causes the financial deficit of bus operation. Prior to making the bus route reorganization plan, this will be verified comparing the supply and demand of bus service. Due to the limited data, suburban buses to and from adjacent cities are not included in this analysis.

STT investigated actual bus services concerning hourly service frequency and allocated fleet of each route on 6th and 8th of June, 1995. It identified 865 routes (counting a route going and returning as two routes) operated legally and 153 routes operated illegally. The result of this survey is used as the bus service supply data.

On the demand side, the person trip survey result will be used as explained in the previous chapter, where the daily demand for public transport is counted at 8.3 million passengers in total, of which 7.9 million passengers make trips inside Bogota.

There may be two ways to compare the demand and supply of public transport: one is to assign the demand shown in the OD matrix onto each bus route and compare it with the transport capacity of the route, and the other is to integrate all the bus routes on a zone-to-zone basis to estimate inter-zonal transport capacity and compare it with the OD demand directly. Here, the latter method is adopted, because there are too many routes to attain an acceptable accuracy of transit assignment results, with the purpose of this analysis being to obtain the general pattern of demand-supply gaps in the entire Bogota.

First, bus route data consisting of a sequence of road network nodes is converted to a sequence of zone numbers through which the bus route passes, and the transport capacity is estimated taking the following steps:

1) Step 1: A bus route(i) passing n-zones is shown as a sequence of $Z_{i1}, Z_{i2}, \cdots, Z_{in}$

2) Step 2: A bus operated in this route will serve a passenger moving from Zij to Zik (i=1, 2, $\cdots$,n and k>=j), then the number of zone pairs served by this bus is: $d_i = n(n+1)/2$.

3) Step 3: The transport capacity of this bus assigned to a zone pair Zij - Zik is B_i / d_i,

4) where B_i is the capacity of the bus.

5) Step 4: Inter-zonal capacity is calculated by the following formula.

$$C = \Sigma_i R_i D_i B_i / d_i$$

where: C : Transport Capacity
R_i: Average rotation of passengers of route i
D_i: Number of dispatched buses on route i

As the number of illegally operated routes is significant and cannot be neglected, buses on them are counted in the most similar legal route. Average rotation is assumed to be 1.5 to 3.0 according to the route length. Capacities of bus units are 60 passengers for a regular bus, 45 passengers for an executive and super executive bus, 35 passengers for regular busetas, 28 passengers for executive busetas and 12 passengers for microbuses (colectivos).

The estimated inter-zonal transport capacities (C) are shown in Table 12.2-1, while the OD matrix (D) of public transport is presented in Table 12.2-2. From those, the capacity/demand ratio (C/D ratio) is deducted as shown in Table 12.2-3, and also illustrated in Figure 12.2-2.

The overall average C/D ratio is 1.4, which means that supply is exceeding demand by 40%. However, it may be risky to conclude simply by this that the bus service in Bogota is oversupplied, because the daily average loading factor (seat occupancy ratio) can hardly reach 100%, but usually lies in the range of 60 - 70%.

The said capacity of each type of public transport vehicle is averaged to 41.9 passengers, also weighting the existing fleet size. On the other hand, the overall average number of passengers is 21.5 per unit according to the result of the screen line survey. This fact shows the average loading factor is 51%, which is rather low and also indicates that the supply inordinately exceeds demand.

There are 9 zones out of 27 zones seemingly oversupplied with the C/D ratio over 1.5: zone 9 (with the ratio of 1.6), 12 (4.7), 13 (4.0), 20 (2.0), 22 (2.1), 23 (2.9), 24 (1.9) and 25 (1.9), all of which are located in the area south of Avenida 81 and west of Avenida Caracas (except for zone 25 in the Centro), where the car ownership ratio is relatively low.

In contrast, 8 zones out of 27 are undersupplied, with the C/D ratio below 0.8. They are zones 4 (0.8), 5 (0.7), 8 (0.6), 10 (0.8), 11 (0.8), 15 (0.8), 18 (0.8) and 19 (0.5), which are mostly located in the south and west periphery of the city with rapid increase of the population, or in the newly developed business district north of the Centro.

As mentioned above, it is observed that the densely inhabited areas where people traditionally depend on public transport tend to be oversupplied, and newly developed areas are less well supplied. This suggests that public transport operators may overestimate traditional demand and underevalue demand in the newly developed area.

In Table 12.2-3, there are 24 zone pairs where the C/D ratio is over 5.0. Table 12.2-4 shows the list of bus routes available between such zone pairs. The highest ratio is 38.0 between zone 12 and 13 where 68 routes are operated, followed by 13.0 between zone 12 and 26, and also between zone 17 and 23. When developing a new bus route plan, those routes should be reviewed in particular.

Using the same data of the STT's aforementioned survey, bus traffic volume can be obtained by assigning dispatched units on each route. Fig.12.2-3 shows the assigned daily traffic of public transport, excluding traffic to/from neighboring cities. Heavy traffic is observed along Autopista del Sur, Avenida Ciudad de Quito, Avenida Caracas, Avenida Boyaca, Avenida 10, Avenida de las Americas and Autopista El Dorado, most of which exceed 10,000 units/day.

Table 12.2-1 Interzonal Transport Capacity of Buses in 1995
(in 1,000 passengers)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	14	14	23	6	4	9	3	3	2	1	3	4	4	1	3	1	9	7	1	9	8	2	5	5	1	6	3	142
2	14	41	38	15	12	15	7	3	5	3	6	8	9	1	5	1	13	7	1	14	14	2	6	8	1	8	5	254
3	23	38	122	25	20	27	11	6	10	6	15	14	15	6	9	3	31	11	4	30	31	7	15	22	2	17	10	520
4	5	13	25	41	18	16	9	1	2	2	7	3	4	3	3	2	6	2	2	7	13	1	2	8	2	3	2	197
5	4	10	19	18	67	35	18	1	5	1	9	0	2	5	8	3	8	2	2	17	24	7	7	13	3	8	2	297
6	9	14	27	15	29	221	53	5	19	9	31	12	17	18	33	15	15	4	7	49	65	62	42	57	18	45	15	900
7	2	6	10	9	18	58	86	2	11	7	19	9	14	10	16	9	4	1	2	17	25	32	20	32	1	32	6	450
8	3	3	6	1	1	5	2	11	5	0	3	4	4	1	4	2	4	1	1	5	6	3	5	7	0	10	2	97
9	3	6	11	2	4	16	9	5	71	6	15	20	20	7	17	7	12	1	3	19	23	20	17	38	2	27	19	300
10	1	3	6	2	1	8	5	0	7	25	19	11	6	7	4	3	5	0	2	4	6	10	7	18	2	7	7	175
11	3	6	13	6	8	29	15	3	12	18	92	23	14	12	14	8	10	1	3	12	22	30	14	55	7	15	7	451
12	3	7	13	2	1	13	10	4	19	9	23	100	38	24	15	11	13	1	4	13	17	16	7	34	5	13	12	429
13	3	9	15	3	2	19	13	4	20	5	15	37	86	20	20	10	13	1	6	15	32	20	6	28	4	14	13	439
14	0	2	6	2	4	18	8	1	7	6	11	24	22	57	9	8	16	0	15	16	22	17	9	21	4	12	6	321
15	2	5	8	3	12	35	16	3	17	4	13	15	21	8	91	23	10	1	8	37	41	20	22	27	2	26	14	482
16	1	1	3	2	4	14	7	2	9	3	8	11	10	7	22	28	2	0	1	15	17	11	12	13	0	14	7	221
17	10	14	35	5	8	15	3	3	10	4	10	11	11	17	9	2	69	5	12	24	21	8	13	18	0	15	9	366
18	7	7	11	3	2	4	1	1	1	0	1	2	2	0	1	0	4	3	0	4	4	1	2	2	0	3	1	67
19	1	1	4	2	2	7	2	1	2	1	2	3	5	13	7	0	11	0	16	10	9	3	4	6	1	5	2	122
20	9	15	31	10	24	45	12	5	19	4	10	12	14	16	38	16	26	4	10	136	66	24	36	47	1	38	17	681
21	8	15	32	11	22	64	21	5	24	6	19	16	27	21	42	19	22	4	9	73	190	42	41	63	4	46	18	861
22	2	3	6	2	6	53	26	2	21	10	33	16	18	14	21	12	7	1	3	25	41	165	34	114	12	31	11	687
23	6	7	16	3	6	43	20	4	18	7	15	8	5	8	23	12	14	3	4	36	43	31	125	53	1	63	14	587
24	5	8	21	8	11	51	27	5	34	18	61	32	25	20	28	15	19	2	5	40	68	105	49	272	12	41	16	1000
25	1	1	2	2	3	17	1	0	2	2	6	5	3	3	2	1	1	0	0	2	4	12	1	12	17	0	0	100
26	6	8	17	3	8	48	32	9	33	7	19	14	11	12	27	11	16	3	5	40	40	32	66	50	1	141	18	688
27	4	6	10	1	2	14	6	2	22	7	10	13	13	7	11	7	10	2	2	17	19	12	14	20	0	21	30	233
Total	141	253	522	198	236	806	421	91	407	171	473	423	421	317	483	232	306	67	127	692	878	606	577	1038	103	661	272	1122

Table 12.2-2 OD Matrix of Public Transport Passengers in 1995
(in 1,000 passengers)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	Total
1	15	23	11	6	5	4	3	2	1	1	2	1	2	1	9	2	9	4	3	6	7	2	0	4	1	2	2	131
2	24	35	22	13	18	23	3	3	2	3	6	1	3	2	10	5	12	7	5	9	10	2	1	4	2	4	5	231
3	13	21	18	11	13	11	11	5	5	4	11	2	3	4	18	9	11	5	14	11	6	3	3	8	2	7	7	236
4	6	13	13	7	21	14	11	6	6	5	13	3	2	7	24	11	7	5	10	14	12	4	2	11	1	10	8	246
5	5	17	11	18	25	24	22	7	10	8	29	6	4	14	47	19	15	7	13	22	20	10	8	26	3	15	13	419
6	4	24	11	14	28	65	50	17	33	20	58	11	11	21	56	29	15	5	15	29	27	29	21	60	10	45	31	757
7	3	4	11	13	22	59	65	4	6	3	13	2	4	4	8	3	3	1	2	10	11	20	12	23	7	22	5	341
8	2	3	5	6	8	18	4	26	10	1	7	1	2	3	4	2	2	0	1	4	7	10	7	10	2	15	3	163
9	1	2	5	6	9	30	6	11	28	13	13	2	3	3	7	3	3	0	2	6	11	12	10	20	2	21	20	249
10	1	3	5	5	8	19	3	1	12	42	23	2	4	5	6	2	2	1	1	5	8	10	6	19	1	5	10	209
11	2	6	11	14	29	60	14	6	13	22	142	11	5	12	19	5	8	2	5	14	32	25	14	59	7	16	17	570
12	1	1	2	3	6	12	3	1	2	1	10	8	1	3	4	2	1	1	2	2	6	3	2	8	1	1	2	80
13	2	2	2	2	5	14	4	2	2	3	6	1	4	8	11	3	1	0	2	4	7	4	2	5	2	2	4	104
14	1	2	4	9	15	25	3	2	3	4	12	4	8	61	17	7	2	0	4	5	13	9	3	21	3	5	4	216
15	9	11	19	25	47	55	8	4	6	6	18	4	11	17	131	43	15	6	23	40	41	15	5	24	8	7	9	613
16	2	5	11	13	20	28	3	2	3	2	5	2	3	9	43	32	5	1	9	15	19	10	2	10	2	2	2	260
17	10	11	11	7	15	15	2	2	3	2	8	0	1	2	15	4	16	8	15	8	10	4	1	6	3	2	4	185
18	4	7	6	5	6	5	1	0	0	1	2	1	0	1	5	1	9	12	2	3	6	1	1	3	1	1	0	84
19	4	5	15	10	14	15	1	2	2	1	5	2	2	4	23	10	14	2	55	23	13	4	2	9	1	3	2	243
20	6	9	11	13	22	31	10	4	6	5	14	2	4	7	37	15	8	3	23	43	21	10	6	14	3	10	7	344
21	8	9	5	11	21	30	14	7	10	7	32	6	7	14	42	18	9	6	13	21	32	13	9	24	6	11	13	401
22	3	3	2	4	11	31	20	10	12	8	25	3	5	10	17	9	3	1	4	11	13	22	9	29	5	15	15	300
23	0	1	3	3	8	20	11	8	10	6	14	2	3	3	5	2	2	1	2	6	9	10	16	15	3	23	10	196
24	4	4	8	13	25	73	21	9	18	17	58	9	5	20	24	9	6	3	9	15	21	31	17	78	7	22	22	548
25	1	3	3	2	2	9	8	2	2	2	7	1	2	2	8	2	3	1	2	4	5	4	4	6	1	4	3	93
26	2	4	7	13	14	45	21	15	23	5	18	1	2	5	7	2	2	1	3	8	14	15	23	24	4	58	18	357
27	3	5	8	9	13	31	5	3	20	10	17	2	5	5	8	3	4	0	2	7	12	16	11	24	3	17	47	290
Total	136	233	243	255	400	706	310	161	248	202	568	90	106	247	608	252	187	83	241	345	402	208	197	553	91	318	283	7913

Table 12.2-3 Supply / Demand Ratio of the Inter-zonal Bus Service

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	Total
1	0.9	0.6	1.6	1.0	0.8	2.3	1.0	1.5	2.0	1.0	1.5	4.0	2.0	1.0	0.3	0.5	1.0	1.1	0.3	1.5	1.1	1.0	-	1.3	1.0	3.0	1.5	1.1
2	0.6	1.2	1.7	1.2	0.7	0.7	2.3	1.0	2.5	1.0	1.0	8.0	3.0	0.5	0.5	0.2	1.1	1.0	0.2	1.6	1.4	1.6	6.9	2.0	0.5	2.0	1.0	1.1
3	1.8	1.8	6.8	2.3	1.5	2.5	1.0	1.2	2.0	1.5	1.4	7.0	5.0	1.5	0.5	0.3	3.1	2.2	0.3	2.7	5.2	2.3	5.0	2.8	1.0	2.4	1.4	2.2
4	0.8	1.0	1.9	5.9	0.9	1.1	0.8	0.2	0.3	0.4	0.5	1.0	2.0	0.4	0.1	0.2	0.9	0.4	0.2	0.5	1.1	0.3	1.0	0.7	2.0	0.3	0.3	0.8
5	0.8	0.6	1.7	1.0	2.7	1.5	0.8	0.1	0.5	0.1	0.3	0.0	0.5	0.4	0.7	0.2	0.5	0.3	0.2	0.8	1.2	0.7	0.9	0.5	1.0	0.5	0.2	0.7
6	2.3	0.6	2.5	1.1	1.0	3.4	0.9	0.3	0.6	0.5	0.5	1.1	1.5	0.9	0.6	0.5	1.0	0.8	0.5	1.7	2.4	2.1	2.0	0.8	1.8	1.0	0.5	1.2
7	0.7	1.5	0.9	0.7	0.8	1.0	1.3	0.5	1.8	2.3	1.5	4.5	3.5	2.5	2.0	3.0	1.3	1.0	1.0	1.7	1.8	1.6	1.7	1.4	0.1	1.5	1.2	1.3
8	1.5	1.0	1.2	0.2	0.1	0.3	0.5	0.4	0.5	0.0	0.4	4.0	2.0	0.3	1.0	1.0	2.0	-	1.0	1.3	0.9	0.3	0.7	0.7	0.0	0.7	0.7	0.6
9	3.0	3.0	2.2	0.3	0.4	0.5	1.5	0.5	2.5	0.5	1.2	10.0	6.7	2.3	2.4	2.3	4.0	-	1.5	3.2	2.1	1.7	1.7	1.9	1.0	1.3	1.0	1.6
10	1.0	1.0	1.2	0.4	0.1	0.4	1.7	0.0	0.6	0.6	0.8	5.5	1.5	1.4	0.7	1.5	2.5	0.0	2.0	0.8	0.8	1.0	1.2	0.9	2.0	1.4	0.7	0.8
11	1.5	1.0	1.2	0.4	0.3	0.5	1.1	0.5	0.9	0.8	0.6	2.1	2.8	1.0	0.7	1.6	1.3	0.5	0.6	0.9	0.7	1.2	1.0	0.9	1.0	0.9	0.4	0.8
12	3.0	7.0	6.5	0.7	0.2	1.1	3.3	4.0	9.5	9.0	2.3	12.5	38.0	1.0	3.8	5.5	13.0	1.0	2.0	6.5	2.8	5.3	3.5	4.3	5.0	13.0	6.0	4.8
13	1.5	4.5	7.5	1.5	0.4	1.4	3.3	2.0	10.0	1.7	2.5	37.0	21.5	2.5	1.8	3.3	13.0	-	3.0	3.8	4.6	5.0	3.0	5.6	2.0	7.0	3.3	4.2
14	0.0	1.0	1.5	0.2	0.3	0.7	2.7	0.5	2.3	1.5	0.9	6.0	2.8	0.9	0.5	1.1	8.0	-	3.8	3.2	1.7	1.9	3.0	1.0	1.3	2.4	1.5	1.3
15	0.2	0.5	0.4	0.1	0.3	0.6	2.0	0.8	2.8	0.7	0.7	3.8	1.9	0.5	0.7	0.5	0.7	0.2	0.3	0.9	0.9	1.3	4.4	1.1	0.3	3.7	1.6	0.8
16	0.5	0.2	0.3	0.2	0.2	0.5	2.3	1.0	3.0	1.5	1.6	5.5	3.3	0.8	0.5	0.9	0.4	0.0	0.1	1.0	0.9	1.1	6.0	1.3	0.0	7.0	3.5	0.9
17	1.0	1.3	3.2	0.7	0.5	1.0	1.5	1.5	3.3	2.0	1.3	-	11.0	8.5	0.6	0.5	4.3	0.6	0.8	3.0	2.1	2.0	13.0	3.0	0.0	7.5	2.3	1.9
18	1.8	1.0	1.8	0.6	0.3	0.8	1.0	-	-	0.0	0.5	2.0	-	0.0	0.2	0.0	0.4	0.3	0.0	1.3	0.7	1.0	2.0	0.7	0.0	3.0	-	0.8
19	0.3	0.2	0.3	0.2	0.1	0.5	2.0	0.5	1.0	1.0	0.4	1.5	2.5	3.3	0.3	0.0	0.8	0.0	0.3	0.4	0.7	0.1	2.0	0.7	1.0	1.7	1.0	0.5
20	1.5	1.7	3.1	0.8	1.1	1.5	1.2	1.3	3.2	0.8	0.7	6.0	3.5	2.3	1.0	1.1	3.3	1.3	0.4	3.2	3.1	2.4	5.8	3.4	0.3	3.6	2.4	2.0
21	1.0	1.7	6.4	1.0	1.0	2.1	1.5	0.7	2.4	0.9	0.6	2.7	3.9	1.5	1.0	1.1	2.4	0.7	0.7	3.5	5.9	3.2	4.6	2.6	0.7	3.3	1.4	2.1
22	0.7	1.0	3.0	0.5	0.5	1.7	1.3	0.2	1.8	1.3	1.3	5.3	3.6	1.4	1.2	1.3	2.3	1.0	0.8	2.3	3.2	7.5	3.8	3.9	2.4	2.1	0.7	2.3
23	-	7.0	5.3	1.0	0.8	2.2	1.8	0.5	1.8	1.2	1.1	4.0	1.7	2.7	4.6	6.0	7.0	3.0	2.0	6.0	4.8	3.4	7.8	3.5	0.3	2.7	1.4	3.0
24	1.3	2.0	2.6	0.6	0.4	0.7	1.3	0.6	1.9	1.1	1.1	3.6	5.0	1.0	1.2	1.7	3.2	0.7	0.6	3.3	2.8	3.4	2.9	3.5	1.7	2.0	0.7	1.8
25	1.0	0.3	0.7	1.0	1.5	1.9	0.1	0.0	1.0	1.0	0.9	5.0	1.5	1.5	0.3	0.5	0.3	0.0	0.0	0.5	0.8	3.0	0.3	2.0	17.0	0.0	0.0	1.1
26	3.0	2.0	2.4	0.2	0.6	1.1	1.3	0.6	1.4	1.4	1.1	14.0	7.0	2.4	3.9	7.0	8.0	3.0	1.7	5.0	3.5	2.1	2.1	2.1	0.3	2.4	1.0	1.9
27	1.3	1.2	1.3	0.1	0.2	0.5	1.2	0.7	1.1	0.7	0.6	6.5	2.6	1.4	1.8	2.3	2.5	-	1.0	2.4	1.6	0.8	1.3	0.8	0.0	1.2	0.8	1.0
Total	1.0	1.1	2.1	0.8	0.7	1.2	1.2	0.6	1.6	0.8	0.8	4.7	4.0	1.3	0.8	0.9	2.0	0.8	0.5	2.6	2.2	2.3	2.9	1.9	1.1	1.9	1.0	1.4

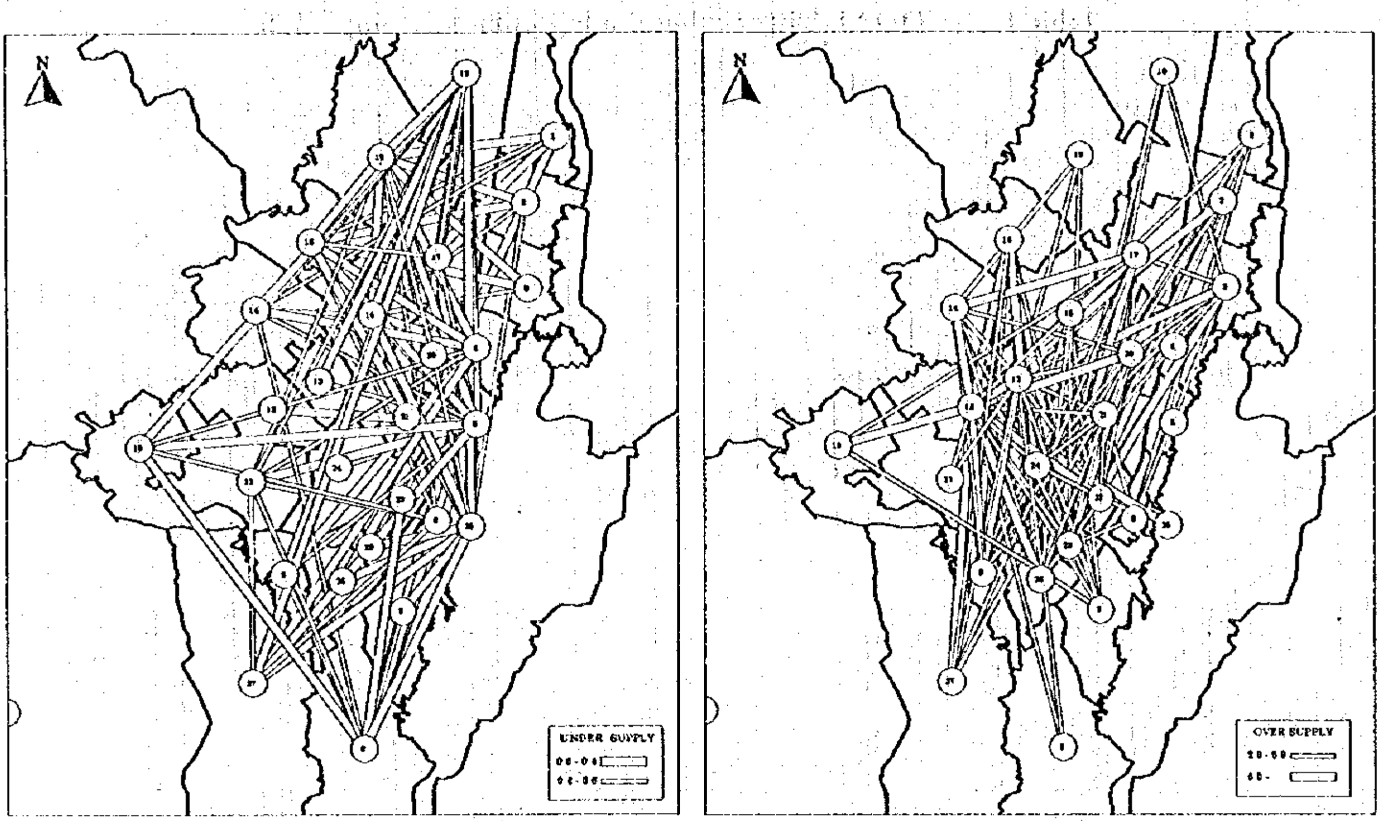


Figure 12.2-2 Supply/Demand Ratio of the Inter-zonal Bus Service

Figure 12.2-4 presents the results of trip assignment of public transport passengers (in 1995 on a 135 x 135 OD matrix) on the shortest path in the present road network, by the all or nothing method. The assigned volume shows the potential demand of each road link. Therefore, the flow pattern will be similar to the traffic pattern shown in Figure 12.2.-3, if the route and fleet allocation are adequately arranged.

The maximum demand is observed along Avenida Ciudad de Quito and Autopista del Sur, exceeding half a million passengers , followed by Avenida Caracas, Avenida Boyaca and Avenida de las Americas, with 300,000 to 400,000 passengers. At a glance, both figures show similar patterns

The number of the demand passenger flow in Figure 12.2-4 is converted to the number of buses required to transport the demand, by dividing 21.5, which is the average occupancy. Figure 12.2-5 illustrates the ratios of supply over demand by road link. White bands represent undersupplied links and black ones, oversupplied links, and band width shows their degree. This information will also give us the hints for developing a bus rerouting plan.

Table 12.2-4 Zone Pairs and Routes Oversupplied by the Public Transport Service

Zone A	Zone B	S/D Ratio	Public Transportation Route available between Zone A and B													
2	12	8.0	125	165	174	260	283	330	342	382	383	384	412	423	634	639	648
			661	690	743	781	782	805	806	846	847	C92	E16	E44	E54	E60	E70
			E77														
3	12	7.0	125	141	160A	165	174	260	283	284	330	342	382	383	384	412	423
			581	634	639	648	661	690	722	743	781	782	805	806	846	847	870
			873	C53	C92	C97	E16	E44	E52	E54	E60	E70	E77				
3	13	5.0	125	141	160A	165	174	231	260	283	284	33	330	342	382	383	384
			412	423	581	634	639	648	661	690	722	743	781	782	805	806	846
			847	870	873	C53	C92	C97	E16	E44	E54	E60	E70	E77	Z11	Z3	ZE8
3	21	5.2	107	108	123	137	145B	159	160A	163	164	17	174	218	231	234	282
			283	284	321	33	331	341	342	344	345	346	37	376	378	382	384
			41	412	421	422	423	442	497	501	54	544	579	584	628	634	639
			648	661	662	690	722	728	729	782	805	845	846	847	848	870	873
			875	98	98B	C17	C33	C53	C54	E16	E24	E26	E44	E5	E52	E54	E57
			E59	E68	E69	E70	E72	E77	Z11	Z2	Z3	Z7	Z8	ZE8			
3	23	5.0	111	137	163	164	17	234	28	282	321	331	341	344	345	37	376
			378	41	422	442	501	579	584	592	50	628	662	728	729	845	848
			875	98B	C97	E24	E5	E57	E59	E68	E69						
9	12	10.0	141	152	165	189	205	227	260	271	283	284	288	290	330	36	362
			364	382	383	384	412	445	446	464	539	540	578	581	582	586	603
			634	635	636	638	639	648	661	673	690	736	737	743	782	795	802
			805	806	846	847	850	873	876	88	90	91	921	950	C101	C32	C32
			C32	C53	C55	C7	C92	E16	E44	E46	E70	Z9					
9	13	6.7	126	141	152	165	189	205	227	260	271	283	284	288	290	330	36
			362	364	382	383	384	412	445	446	464	539	540	546	550	551	573
			578	581	582	586	634	635	636	639	648	661	673	690	701	736	737
			743	782	795	802	805	806	82	84	846	847	850	873	876	88	89
			90	91	950	C101	C30	C32	C32	C32	C53	C7	C92	E16	E44	E46	E70
			Z9														
10	12	5.5	125	174	202	206	283	342	364	423	464	549	578	581	582	585	586
			603	634	635	636	702	780	781	782	786	823	90	91	C32	C32	C9
			E58	E60	E77												
12	13	38.0	101	114	125	133A	141	146	149A	152	160A	161	165	167	174	189	205
			227	228	229	232	233	235	240	260	271	283	284	288	290	330	342
			348	34D	36	362	364	382	383	384	387	412	423	435	445	446	464
			502	504	539	540	578	581	582	585	586	634	635	636	639	648	661
			673	690	722	736	737	743	780	781	782	795	802	805	806	823	846
			847	850	86	870	873	876	88	90	91	950	C100	C101	C11	C125	C16
			C20	C23	C24	C32	C32	C32	C42	C44	C53	C61	C62	C63	C7	C92	C97
			E16	E31	E4	E44	E45	E46	E54	E58	E60	E70	E77	Z9			
12	14	8.0	101	114	152	160A	161	202	206	227	228	229	232	233	235	240	27S
			348	362	450	502	504	549	578	585	586	702	736	737	780	786	795
			850	876	91	921	C100	C20	C24	C32	C32	C32	C55	C61	C62	C63	C9
			E45	E46	E52	E58	Z9										
12	20	6.5	101	149A	152	160A	167	174	189	227	283	284	342	348	34D	36	362
			364	382	384	412	423	445	464	578	582	585	634	636	639	648	661
			673	690	722	736	737	780	782	795	805	823	846	847	850	86	870
			873	876	88	91	C101	C11	C42	C53	C63	E16	E4	E44	E54	E70	E77
12	22	5.3	101	114	133A	146	161	167	228	229	232	233	235	240	264	265	290
			387	435	502	504	603	617	635	638	90	C100	C125	C16	C20	C23	C24
			C62	C7	E31	E4	E45										
12	25	5.0	161	232	233	240	265	603	617	635	638	C100	C125	C20	C23	C24	C62
			C7	E45													
12	26	13.0	114	133A	189	205	227	229	266	27S	290	36	387	504	540	603	648
			661	673	690	806	846	847	873	876	90	921	950	C16	C55	C61	C97
			E31	E4	E44	E46	E70	Z9									
12	27	6.0	141	152	165	260	271	283	284	288	330	362	364	384	412	445	446
			464	504	539	549	578	581	582	586	603	634	635	636	736	737	743
			782	795	802	805	847	88	90	91	C101	C32	C32	C7	C9	C92	
13	17	13.0	125	141	152	160A	165	174	189	227	260	283	284	33	330	383	412
			581	585	586	736	737	743	780	781	795	806	846	847	850	870	873
			876	91	C32	C32	C32	C63	C92	C97	E16	E44	E46	E58	E60	E70	E77
			Z11														
13	24	5.6	101	114	118	121A	133A	146	149A	152	160A	161	167	174	189	227	228
			229	232	233	235	236	240	283	284	288	290	293	342	348	34D	36
			362	364	382	384	387	412	423	431	435	445	449	464	502	504	548
			551	552	578	582	585	634	635	636	639	648	661	673	690	722	736
			780	782	795	805	846	847	850	86	870	873	876	88	90	91	950
			C100	C101	C11	C125	C16	C20	C23	C24	C30	C42	C53	C61	C62	C63	C7
			C70	C97	E10	E16	E18	E27	E31	E4	E44	E45	E54	E70	E77	Z9	
13	26	7.0	114	118	121A	126	133A	189	205	227	229	290	313	36	387	504	540
			546	550	551	573	648	661	673	690	701	703	806	82	84	846	847
			873	876	89	90	950	C16	C27	C30	C61	C97	E15	E27	E31	E4	E44
			E46	E70	Z9												
14	17	8.0	152	160A	227	312	314	315	318	319	33	350	352	400	403	468	585
			556	594	595	597	598	599	720	736	737	780	795	838	841	848	850
			875	876	902	903	91	C32	C32	C52	C63	C64	E1	E12	E17	E21	E33
			E36	E43	E46	E52	E58	E64	E67	E74	Z11						
16	23	6.0	114	118	133A	143	199	200	201	280	316	34	349	38	387	411	444
			536	537	552	556	574	637	640	647	651	658	663	664	667	77	79
			804	81	84	C10	C16	C74	E29	E31	E4	E51					
16	26	7.0	114	118	133A	199	200	201	280	316	34	349	36	38	387	444	530
			537	540	546	551	556	573	574	640	647	651	658	663	664	667	77
			79	804	81	82	84	C10	C16	C74	E15	E29	E31	E4	E51	E62	
17	26	7.5	163	164	17	189	227	234	282	314	315	318	319	320	321	350	352
			37	41	442	501	579	584	593	594	595	597	598	599	60	644	662
			720	728	729	806	838	841	845	846	847	848	872	873	875	876	902
			C64	C97	E21	E24	E44	E46	E57	E59	E62	E64	E67	E70			
17	23	13.0	137	163	164	17	234	282	314	315	318	319	320	321	341	350	352
			37	41	442	501	579	584	592	593	594	595	597	598	599	60	644
			662	720	728	729	838	841	845	848	872	875	902	98B	C64	C97	E21
			E24	E57	E59	E67	E68	E69									
20	23	5.8	112	126	127	134	135	135A	136	137	140	143	147	163	164	17	198
			199	200	201	203	234	272	280	282	314	315	316	317	318	319	320
			321	331	34	341	344	345	349	350	352	37	376	378	38	41	411
			422	442	443	444	452	46	493	501	536	537	556	574	577	579	584
			59	592	593	594	595	597	598	599	59A	621	628	637	640	642	644
			647	650	651	658	659	660	662	663	664	667	668	674	720	721	728
			729	77	78	79	796	797	804	81	838	839	840	841	845	848	849
			872	875	902	98A	98B	C10	C25	C64	C74	C8	E21	E24	E27	E29	E4
			E5	E51	E57	E59	E67	E68	E69	Z4							

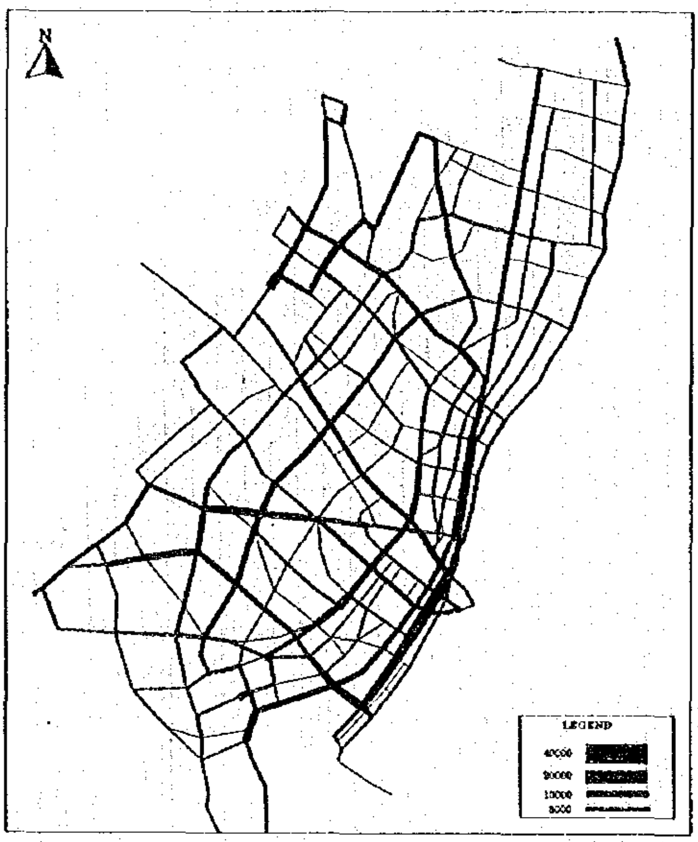


Figure 12.2-3 Actual Traffic of Public Transport in 1995

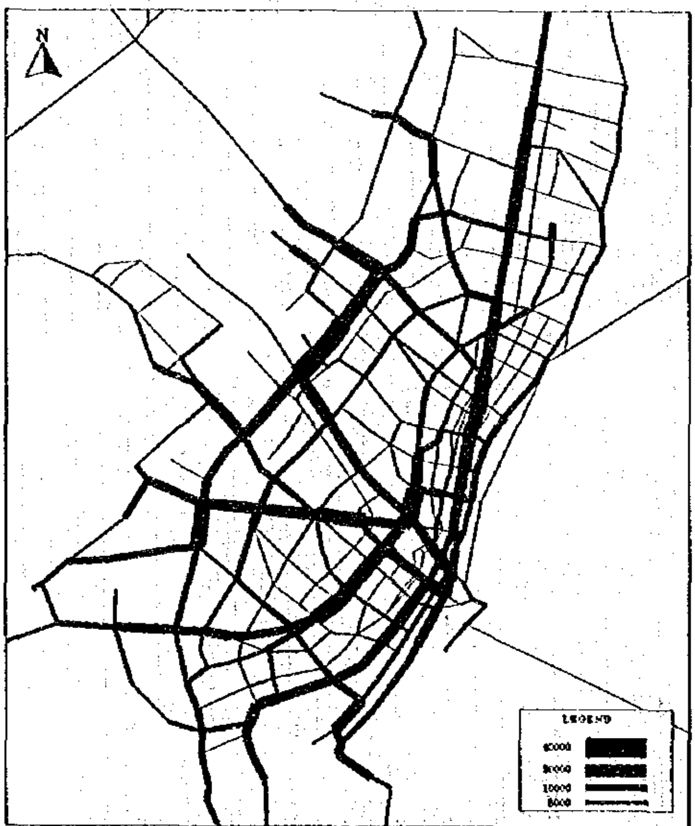


Figure 12.2-4 Potential Demand for Public Transport in 1995

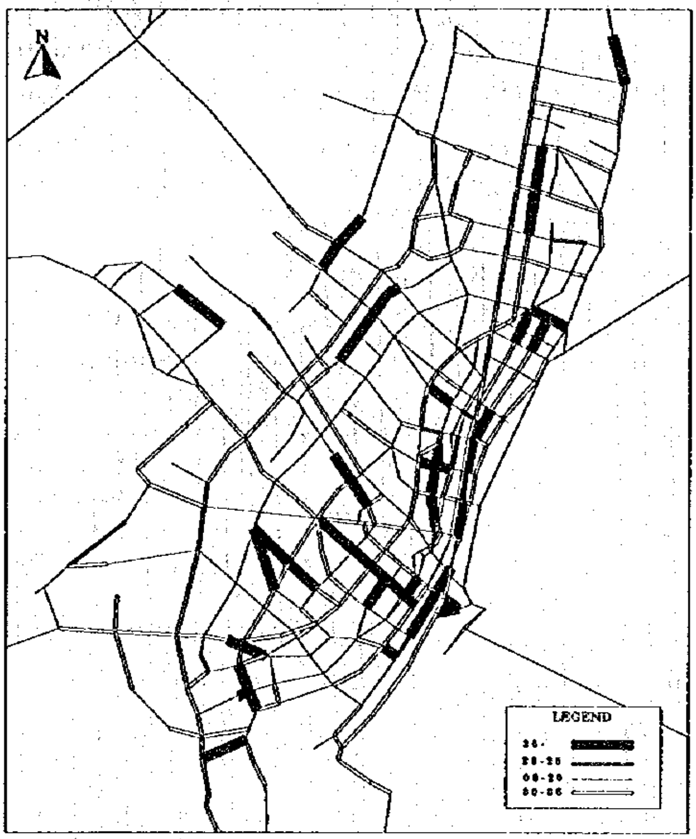


Figure 12.2-5 Supply/Demand Ratio by Link, 1995

(2) Purpose of the Bus Route Reorganization

As stated in Chapter 5, the present bus system in Bogota is not necessarily satisfactory. People complain. that buses are hard to catch, not clean, slow and dangerous because of rough driving manners. On the other hand, the public transport business is not so attractive, partly because of low operability due to road congestion and too lengthy routes, and partly because of the low tariff system. Revenue can hardly cover full cost, and so then owners cannot renew or maintain their fleet in good conditions, while drivers are forced to operate in a hazardous way. Thus, people are discouraged to take a bus and stick to private car whenever available which worsens traffic congestion. The reorganization of bus routes will give an opportunity to cut into this vicious circle.

The most direct purpose of the reorganization is to adjust the service to the demand quantitatively. It will undoubtedly improve the average occupancy and then the financial conditions of the public transport business.

Another purpose is to simplify the present bus routes by reducing them in number and in length. The present system has too many routes. This is the results of introducing new routes or extending existing routes connecting the CBD and the outskirts of the city, as the city has expanded outward. Consequently, passengers can move from a point to another in one ride without changing a bus in most cases. This convenient system may be applicable to small or medium-sized cities with populations up to one or two million at most. The Bogota Metropolitan Area has a population of over 6 million, and it has become difficult and uneconomical to maintain the service from any point to any other.

A new tariff system should be planned at the same time as the reorganization of routes. The current flat rate system is not adequate for such a large city as Bogota, where the longest route is over 40 km. It is apparently illogical that the same fare is applied to a passenger who rides a bus for 30 to 40 km and to another passenger for 3 to 4 km. The riding distance should reflect on the fare.

Lastly, the reorganization would provide a good opportunity to introduce new public transport services with higher quality and reliability, which can encourage people to shift from the private mode to the public mode.

(3) Basic Policy for the Bus Route Reorganization Plan

The basic policy of bus route reorganization is to classify the present routes into two service categories; trunk lines and feeder lines, while shortening each line in accordance with demand. The existing urbanized area of Bogotá should be divided into 10 to 15 zones (hereinafter referred to as "bus zones") and the trunk lines connect each bus zone center and will operate large buses with minimum stops. Feeder lines are planned inside a bus zone or to connect with adjacent zones and served with medium- and small sized buses. A zone fare system is applied to a trunk bus where a fare is charged according to the number of zones passed, while a flat rate is adopted for feeder buses. The basic policies are summarized as follows.

a) To establish a new bus system composed by trunk bus and feeder buses
b) To Assign normal or large buses to a trunk line and busetas or smaller ones to a feeder line.
c) To divide the city into 10 to 15 bus zones and provide each zone with a bus terminal or large bus stops.
d) To operate trunk buses from a terminal to another and feeder buses inside a bus zone around the central terminal.
e) To facilitate trunk bus lines with priority measures such as a bus priority / exclusive lane to secure a high operating speed.
f) To introduce a new zone fare system, adopting zone to zone rate for trunk buses and flat rates for feeder buses.

(4) Trunk Bus Line Network

Trunk buses should be planned as the most essential urban transport mode which the majority of people would depend on in the Short and Medium Term. It should encourage private car users to shift their mode to public mode. For this purpose, the trunk bus should be provided with every kinds of supportive measure, such as bus-exclusive roads/ lanes, bus priority lanes and where necessary, grade separations at congested intersections in order to maintain a higher speed than other modes.

Trunk bus will be allowed to stop for loading/ unloading service only at designated bus stops and terminals, located every 500 to 1,000 meters, longer than the intervals for traditional buses. This rule for stopping should be strictly kept in order to maintain the planned speed and for the convenience of connections with feeder bus services.

To compose a trunk bus network, class V0 to V2 roads seem to have an adequate width to accommodate trunk bus lines. Most of such roads are covered by the network planned for the Metrobus system reviewed in the previous section. The Metrobus network is properly planned to serve the present demand, with desirable intervals. Therefore, the Metrobus network is recommended as a basis of the trunk bus network. The network was modified and strengthened with several supplementary and extended lines.

The proposed trunk bus network is as illustrated in Figure 12.2-6. Main modification of the Metrobus network was made on the following points:

a) The existing bus exclusive lanes along Avenida Caracas are extended to Autopista Norte up to Chia.
b) The trunk bus line on Cra.7 is extended to the north up to Autopista del Norte La Caro.
c) Avenida Suba is included in the network
d) The line on Avenida 81 is extended west to Siberia.
e) The route planned on the abolished south railway line is included. The right of way should be used for an urban railway system in the future. Until the urban railway system is constructed, the space is used as a trunk busway route.
f) The line on Autopista del Sur is extended to Soacha.

There are two types of trunk bus lanes; one is the Avenida Caracas type which is applicable to an arterial road with more than eight lanes or which has a right of way wide enough to accommodate more than eight lanes, of which four lanes can be used as exclusive bus lanes (Figure 12.2-7, Type A). The other is for a 6-lane road where outer lanes will be used as bus priority lanes (Type B). Such lanes can be planned to be used also as exclusive lanes during peak hours. Type B is applied to Carrera 7, Carrera 10, Calle 170, Avenida Suba, Autopista El Dorado and Avenida 1° de Mayo, of which total length is 62.7 km. The other sections will follow the "Avenida Caracas" type (Type A) with a total length of 152.1 km.

Trunk bus stops will be located, in principle, at 1.0 to 1.5 km intervals, with comparatively shorter intervals in the central part of the city, and longer ones in the suburbs. This interval, much longer than that of ordinary buses, aims at a higher operating speed for trunk buses. Figure 12.2-6 also shows an example of bus stop distribution and locations of trunk bus terminals.

Bus terminals are classified into two types; one is located at the end of a route in the suburbs as existing ones and the other is located at main nodal points in the urban center to facilitate transfer to another bus. The latter type is important also to avoid an extremely long bus route.

(5) Trunk Bus Route on the Network

Figure 12.2-8 shows the same trunk bus network in simplified way, with code numbers of terminals and bus stops at route intersections. Using this map, proposed bus routes are shown. The bus route plan is developed based on the followings:

a) Every bus route is planned from a terminal to another. In case a route is a loop, the destination terminal is the same as the origin.
b) A route is planned, in principle, not to exceed 20 km in extension. This is because the longer the route, generally, the lower the seat occupancy rate and profitability.
c) Many routes are to be planned as links with large potential demand in terms of trips assigned by all-or-nothing method.
d) Present bus routes are also referred to.

Planned trunk bus routes are presented in Table 12.2-5. The route name has an initial letter "R", followed by two digit figures standing for the origin terminal and again followed by two digit figures for the destination terminal. The last one digit figure is the sequential number of routes with the same terminal pair. If a terminal pair has only one route, the last code of the route is zero. There are 94 routes listed in the table. If a route from B to A is counted independently of the route from B to A, there are 188 routes in total.

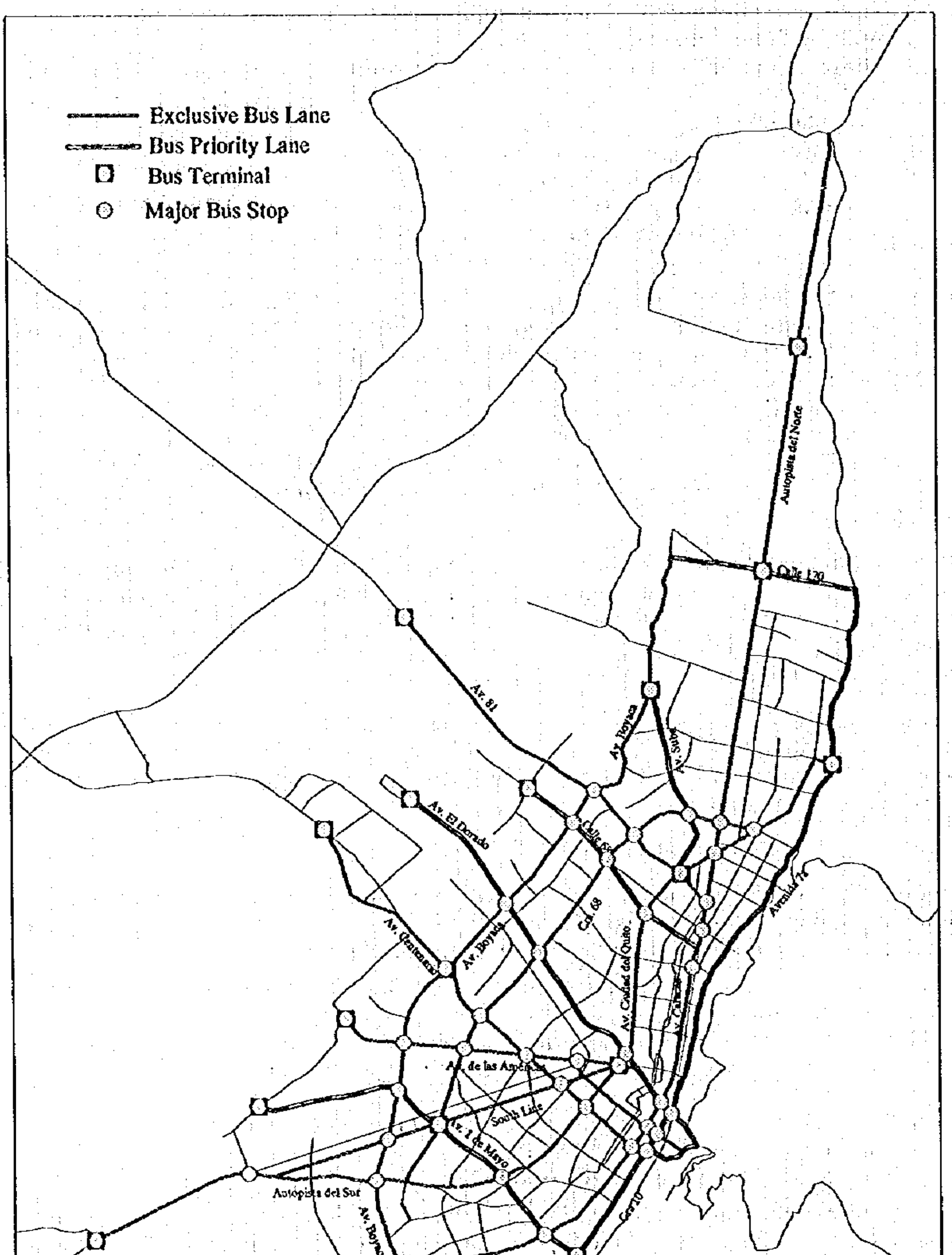
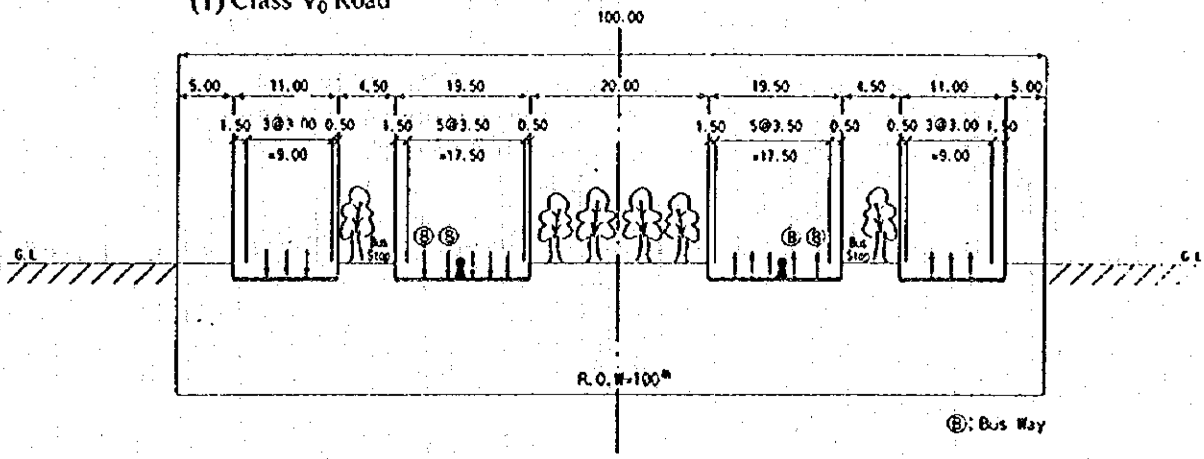


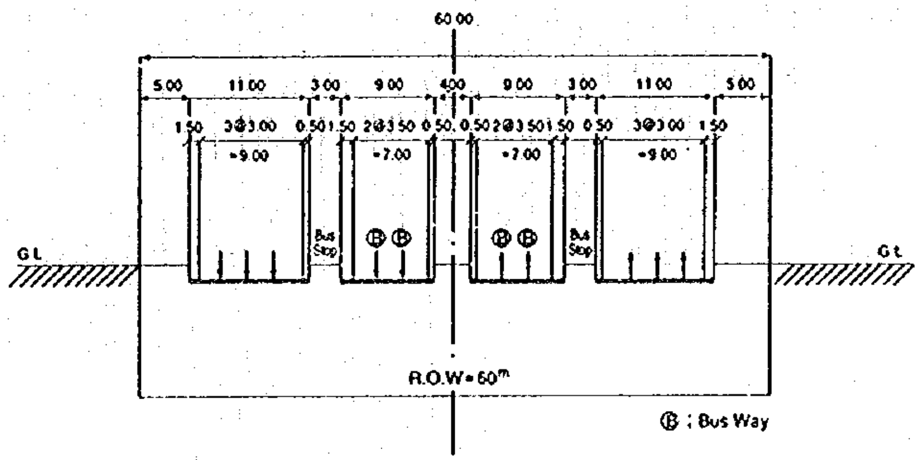
Figure 12.2-6 Trunk Bus Network Plan

Type A (Av. Caracas System)

(1) Class V_0 Road



(2) Class V_1 Road



Type B (Allocate outer lanes as bus priority lanes during Peak-time period)

- In case road width is limited.
- To maintain greenery in center-median

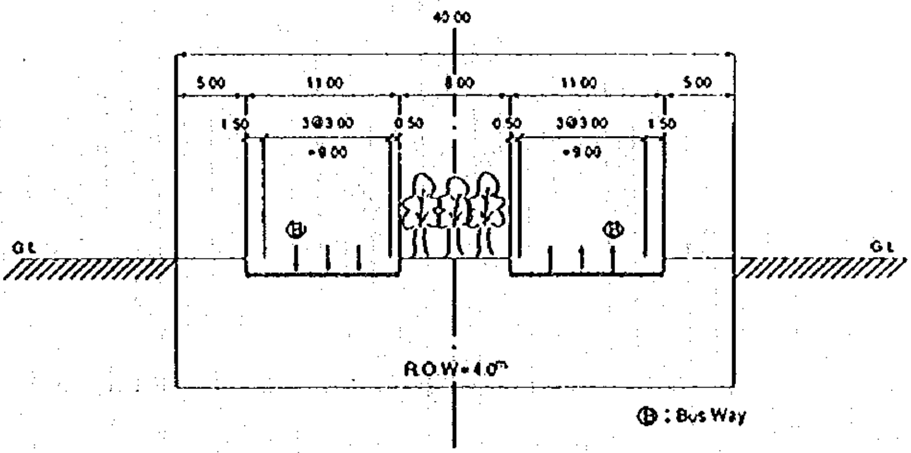


Figure 12.2-7 Road Cross-Section to Accommodate Exclusive Bus Lane and Bus Priority Lane

To analyze the demand on each route, OD trips in 2001 by public transport are assigned on those routes, using a software package, "JICA-STRADA". Table 12.2-6 summarizes the results. The largest demand is about 200,000 passengers a day on R04-15-3 and R05-15-0, both of which run on Avenida Caracas.

Total number of passengers on all routes is 10.2 million, while the total of OD trips is about 8.0 million. This means that 27.5% of passengers transfer to another trunk bus. As the total transported is 96.5 million passenger-kms, average riding distance is estimated at 9.5 km per passenger.

Although an accurate estimate requires more detailed analysis, the necessary fleet size can be roughly estimated in the following way: As the average occupancy is currently 26 passengers/vehicle, the total operating distance is 3.7 million vehicle-km (96/6/26). Assuming the daily operating distance is 200 km, 18,600 vehicles will be needed in the year 2001.

Table 12.2-7 presents the required bus fleet and frequency of operation which meet the future demand in the year 2001. This analysis assumes the average bus speed of 25 km /hour, peak hour ratio of 8% and the bus capacity of 60 passengers including standing passengers.

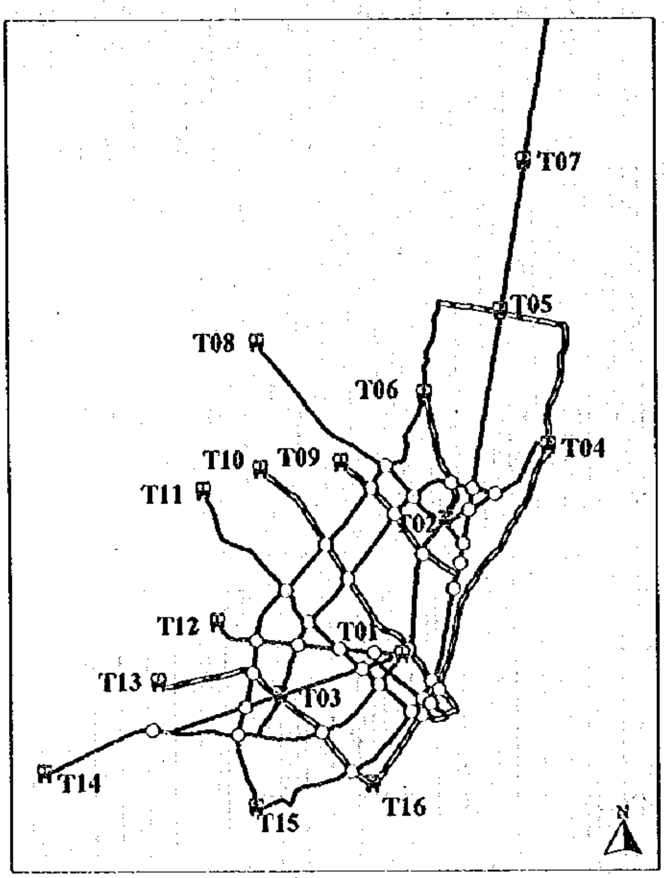


Figure 12.2-8 Code of Trunk Bus Terminals and Bus Stops at Route Intersections

Table 12.2-5 Proposed Trunk Bus Route

No.	Route Name	Route	No.	Route Name	Route
1	R01-04-0	T01-15-14-13-T04	48	R04-14-2	T04-01-02-03-06-11-16-26-27-T03-33-34-T14
2	R01-05-1	T01-15-10-T02-04-02-T05	49	R04-14-3	T04-01-04-T02-10-15-T01-23-30-33-34-T14
3	R01-05-2	T01-15-10-T02-04-01-T04-T05	50	R04-14-4	T04-01-04-05-08-09-14-19-22-23-30-33-34-T14
4	R01-05-3	T01-15-10-T02-03-T06-T05	51	R04-14-5	T04-13-18-21-T16-29-30-33-34-T14
5	R01-07-1	T01-15-10-T02-04-02-T05-T7	52	R04-15-1	T04-01-02-03-06-11-16-26-27-T03-33-T15
6	R01-08-0	T01-15-10-T02-06-07-T08	53	R04-15-2	T04-01-04-T02-06-07-12-17-28-31-32-33-T15
7	R01-10-0	T01-15-16-17-T10	54	R04-15-3	T04-01-04-05-08-09-14-19-22-29-T15
8	R01-11-0	T01-20-25-26-T11	55	R04-15-4	T04-13-18-21-T16-29-T15
9	R01-12-0	T01-20-25-T27-T12	56	R04-16-1	T04-01-04-T02-10-15-T01-23-30-29-T16
10	R01-13-1	T01-15-14-13-18-21-T16-29-30-T03-31-T13	57	R04-16-2	T04-13-18-21-T16
11	R01-13-2	T01-20-25-27-28-31-T13	58	R05-08-0	T05-T04-01-04-T02-06-07-T08
12	R01-14-1	T01-24-T03-32-34-T14	59	R05-09-0	T05-T04-01-04-T02-10-11-12-T09
13	R01-14-2	T01-23-30-33-34-T14	60	R05-10-0	T05-02-04-05-08-09-14-15-16-17-T10
14	R01-15-1	T01-23-22-29-T15	61	R05-11-1	T05-02-04-T02-10-15-T01-23-24-25-26-T11
15	R01-15-2	T01-24-T03-32-33-T15	62	R05-11-2	T05-T06-07-12-17-T11
16	R01-16-0	T01-19-18-21-T16	63	R05-12-0	T05-T06-07-12-17-28-T12
17	R02-02-0	T02-04-01-T04-T05-T06-03-T02	64	R05-13-1	T05-02-03-06-11-16-26-27-T03-31-T13
18	R02-08-0	T02-06-07-T08	65	R05-13-2	T05-T06-07-12-17-28-31-T13
19	R02-10-0	T02-10-15-16-17-T10	66	R05-14-0	T05-T06-07-12-17-28-31-32-33-34-T14
20	R02-11-0	T02-10-5-T01-20-25-26-T11	67	R05-15-0	T05-02-04-05-08-09-14-19-22-19-T15
21	R02-12-0	T02-10-15-T01-20-25-27-28-T12	68	R05-16-1	T05-02-04-05-08-09-14-19-22-29-T16
22	R02-13-0	T02-10-15-T01-24-T03-31-T13	69	R05-16-2	T05-T04-13-18-21-T16
23	R02-14-0	T02-10-15-T01-23-30-33-34-T14	70	R06-13-0	T06-07-12-17-28-T13
24	R02-15-0	T02-05-08-09-14-19-22-29-T15	71	R06-14-0	T06-03-T02-10-15-T01-23-30-33-34-T14
25	R02-16-0	T02-05-08-09-14-13-18-21-T16	72	R06-15-1	T06-07-12-17-28-31-32-33-T15
26	R03-03-0	T03-33-T15-29-30-T03	73	R06-15-2	T06-03-T02-05-08-09-14-19-22-29-T15
27	R03-04-1	T03-30-29-T16-21-18-13-T04	74	R06-16-0	T06-03-T02-05-08-09-14-13-21-T16
28	R03-04-2	T03-24-T01-15-10-T02-04-01-T04	75	R07-08-0	T07-T05-T06-07-T08
29	R03-04-3	T03-27-26-16-11-06-03-02-01-T04	76	R07-13-0	T07-T05-T06-07-12-17-28-31-T13
30	R03-05-1	T03-27-26-16-11-06-03-02-T05	77	R07-15-0	T07-T05-02-04-05-08-09-14-19-22-29-T15
31	R03-05-2	T03-31-28-17-12-07-T06-T05	78	R07-16-0	T07-T05-T04-13-18-21-T16
32	R03-05-3	T03-24-T01-15-10-T02-04-02-T05	79	R08-14-0	T08-07-12-17-28-31-32-33-34-T14
33	R03-06-0	T03-27-26-16-11-06-03-T06	80	R08-15-0	T08-07-06-T02-05-08-09-14-19-22-T15
34	R03-07-0	T03-27-26-16-11-06-T02-04-02-T05-T07	81	R08-16-1	T08-07-06-T02-05-08-09-14-13-18-21-T16
35	R04-06-0	T04-01-04-T02-03-T06	82	R08-16-2	T08-07-06-11-16-26-27-T03-30-29-T16
36	R04-07-0	T04-T05-T07	83	R09-15-1	T09-12-17-28-31-32-33-T15
37	R04-08-0	T04-01-04-T02-06-07-T08	84	R09-15-2	T09-12-11-10-01-09-14-19-22-29-T15
38	R04-10-1	T04-13-14-15-16-17-T10	85	R09-16-0	T09-12-11-10-01-09-14-13-18-21-T16
39	R04-10-2	T04-01-04-05-08-09-14-15-16-17-T10	86	R10-15-0	T10-17-28-31-32-33-T15
40	R04-10-3	T04-T05-T06-07-12-17-T10	87	R10-16-0	T10-17-16-15-14-13-21-T16
41	R04-11-0	T04-13-18-21-22-23-24-25-26-T11	88	R11-15-0	T11-28-31-32-33-T15
42	R04-12-1	T04-01-04-T02-10-15-T01-20-25-27-28-T12	89	R11-16-1	T11-26-27-T03-30-29-T16
43	R04-12-2	T04-01-02-03-06-11-16-26-27-28-T12	90	R11-16-2	T11-28-31-T03-30-29-T16
44	R04-12-3	T04-13-18-19-20-25-27-28-T12	91	R11-16-3	T11-26-25-24-23-22-21-T16
45	R04-13-1	T04-01-04-T02-10-15-T01-23-30-T03-31-T13	92	R12-14-0	T12-28-31-32-33-34-T14
46	R04-13-2	T04-01-02-03-06-11-16-26-27-T03-31-T13	93	R12-16-0	T12-28-31-T03-30-29-T16
47	R04-14-1	T04-01-04-T02-10-15-T01-24-T03-32-34-T14	94	R14-16-0	T14-34-33-30-29-T16

Route name Code: Rxx-yy-z

- z: Sequential No. with same terminal pair
- yy: Destination Terminal
- xx: Origin Terminal

Table 12.2-6 Demand for Trunk Bus Routes in Year 2001

No.	Route Name	Km	Passenger	Pax-Km	No.	Route Name	Km	Passenger	Pax-Km
			(1000/day)	(1000/day)				(1000/day)	(1000/day)
1	R01-04-0	11.3	131.4	809.2	48	R04-14-2	25.0	183.5	2,496.6
2	R01-05-1	12.1	162.7	1,073.0	49	R04-14-3	26.7	158.0	2,291.6
3	R01-05-2	15.4	138.8	1,163.0	50	R04-14-4	29.3	187.6	2,988.4
4	R01-05-3	16.2	113.8	1,004.3	51	R04-14-5	31.5	138.0	2,362.7
5	R01-07-1	19.3	167.9	1,762.0	52	R04-15-1	22.4	155.4	1,891.9
6	R01-08-0	17.1	73.1	680.6	53	R04-15-2	24.0	176.8	2,310.3
7	R01-10-0	7.7	96.4	402.5	54	R04-15-3	18.8	202.4	2,069.2
8	R01-11-0	9.1	108.0	534.3	55	R04-15-4	19.5	161.6	1,714.7
9	R01-12-0	6.8	150.1	556.6	56	R04-16-1	14.7	132.8	1,060.4
10	R01-13-1	13.1	52.9	378.0	57	R04-16-2	14.0	176.9	1,345.8
11	R01-13-2	5.6	131.9	405.0	58	R05-08-0	17.9	102.5	999.7
12	R01-14-1	17.0	103.8	958.6	59	R05-09-0	13.1	86.8	619.2
13	R01-14-2	19.2	136.4	1,423.3	60	R05-10-0	19.3	118.7	1,245.8
14	R01-15-1	7.1	122.9	475.5	61	R05-11-1	23.4	108.4	1,379.8
15	R01-15-2	8.0	142.2	616.4	62	R05-11-2	14.6	47.1	373.0
16	R01-16-0	4.1	66.8	148.8	63	R05-12-0	14.1	86.2	658.7
17	R02-02-0	12.8	46.9	325.6	64	R05-13-1	15.9	72.6	626.3
18	R02-08-0	5.5	68.3	205.8	65	R05-13-2	16.5	65.6	588.2
19	R02-10-0	7.2	33.1	129.0	66	R05-14-0	27.5	135.8	2,028.8
20	R02-11-0	10.5	90.8	518.4	67	R05-15-0	22.7	197.2	2,435.3
21	R02-12-0	8.0	114.4	500.6	68	R05-16-1	17.3	177.3	1,669.6
22	R02-13-0	9.9	98.1	530.4	69	R05-16-2	19.9	141.4	1,528.3
23	R02-14-0	17.4	116.9	1,107.6	70	R06-13-0	14.3	134.9	1,051.1
24	R02-15-0	13.2	147.9	1,060.8	71	R06-14-0	23.8	96.0	1,239.9
25	R02-16-0	10.6	158.1	908.6	72	R06-15-1	17.2	88.6	826.4
26	R03-03-0	9.4	67.9	348.2	73	R06-15-2	17.0	141.4	1,308.1
27	R03-04-1	17.2	158.8	1,481.4	74	R06-16-0	15.4	114.5	961.7
28	R03-04-2	15.2	133.9	1,107.1	75	R07-08-0	17.4	109.2	1,032.6
29	R03-04-3	18.4	115.7	1,160.1	76	R07-13-0	24.9	32.4	437.9
30	R03-05-1	23.1	139.5	1,752.6	77	R07-15-0	22.9	144.5	1,802.5
31	R03-05-2	21.7	154.3	1,822.3	78	R07-16-0	19.9	159.4	1,727.5
32	R03-05-3	22.8	177.6	2,198.4	79	R08-14-0	19.1	38.8	404.0
33	R03-06-0	15.8	85.9	738.4	80	R08-15-0	16.1	72.0	631.4
34	R03-07-0	29.1	149.6	2,366.7	81	R08-16-1	17.3	82.8	777.4
35	R04-06-0	10.1	120.3	659.4	82	R08-16-2	17.9	24.3	236.9
36	R04-07-0	11.6	108.0	680.4	83	R09-15-1	14.0	75.5	576.6
37	R04-08-0	15.0	59.5	483.8	84	R09-15-2	16.4	71.6	639.0
38	R04-10-1	16.7	86.6	787.1	85	R09-16-0	13.2	31.4	225.6
39	R04-10-2	20.7	130.3	1,466.3	86	R10-15-0	10.5	65.1	371.7
40	R04-10-3	14.3	40.6	315.1	87	R10-16-0	14.0	21.4	162.7
41	R04-11-0	25.2	140.0	1,920.8	88	R11-15-0	11.2	13.8	84.4
42	R04-12-1	21.7	163.5	1,929.4	89	R11-16-1	15.1	18.0	147.8
43	R04-12-2	19.1	119.3	1,238.9	90	R11-16-2	15.1	19.2	157.8
44	R04-12-3	17.1	138.5	1,284.4	91	R11-16-3	11.1	39.7	240.6
45	R04-13-1	18.7	147.9	1,503.7	92	R12-14-0	9.1	29.9	147.2
46	R04-13-2	21.4	95.9	1,115.1	93	R12-16-0	8.1	46.9	207.4
47	R04-14-1	24.3	148.1	1,953.5	94	R14-16-0	13.4	69.9	509.3
						Total	-	10,209.1	96,582.8

Table 12.2-7 Service Frequency and Required Bus Fleet

No.	Route Name	Km	Frequency (Bus/hour)	No. of Buses to be assigned	No.	Route Name	Km	Frequency (Bus/hour)	No. of Buses to be assigned
1	R01-04-0	11.3	92	84	48	R04-14-2	25.0	129	259
2	R01-05-1	12.1	114	111	49	R04-14-3	26.7	112	238
3	R01-05-2	15.4	97	120	50	R04-14-4	29.3	132	310
4	R01-05-3	16.2	80	104	51	R04-14-5	31.5	97	245
5	R01-07-1	19.3	118	183	52	R04-15-1	22.4	109	195
6	R01-08-0	17.1	51	70	53	R04-15-2	24.0	125	240
7	R01-10-0	7.7	66	41	54	R04-15-3	18.8	143	215
8	R01-11-0	9.1	75	55	55	R04-15-4	19.5	114	178
9	R01-12-0	6.8	104	57	56	R04-16-1	14.7	94	110
10	R01-13-1	13.1	37	39	57	R04-16-2	14.0	124	139
11	R01-13-2	5.6	92	42	58	R05-08-0	17.9	72	103
12	R01-14-1	17.0	72	99	59	R05-09-0	13.1	61	64
13	R01-14-2	19.2	96	148	60	R05-10-0	19.3	84	129
14	R01-15-1	7.1	86	49	61	R05-11-1	23.4	76	143
15	R01-15-2	8.0	100	64	62	R05-11-2	14.6	33	38
16	R01-16-0	4.1	45	15	63	R05-12-0	14.1	60	68
17	R02-02-0	12.8	32	33	64	R05-13-1	15.9	51	65
18	R02-08-0	5.5	47	21	65	R05-13-2	16.5	46	61
19	R02-10-0	7.2	22	13	66	R05-14-0	27.5	96	210
20	R02-11-0	10.5	63	53	67	R05-15-0	22.7	139	253
21	R02-12-0	8.0	80	52	68	R05-16-1	17.3	125	173
22	R02-13-0	9.9	69	55	69	R05-16-2	19.9	99	158
23	R02-14-0	17.4	82	115	70	R06-13-0	14.3	95	109
24	R02-15-0	13.2	104	110	71	R06-14-0	23.8	67	128
25	R02-16-0	10.6	111	94	72	R06-15-1	17.2	62	85
26	R03-03-0	9.4	47	36	73	R06-15-2	17.0	100	136
27	R03-04-1	17.2	112	154	74	R06-16-0	15.4	81	100
28	R03-04-2	15.2	94	115	75	R07-08-0	17.4	77	107
29	R03-04-3	18.4	81	120	76	R07-13-0	24.9	23	45
30	R03-05-1	23.1	98	182	77	R07-15-0	22.9	102	187
31	R03-05-2	21.7	108	189	78	R07-16-0	19.9	112	179
32	R03-05-3	22.8	125	228	79	R08-14-0	19.1	27	42
33	R03-06-0	15.8	60	76	80	R08-15-0	16.1	50	65
34	R03-07-0	29.1	105	246	81	R08-16-1	17.3	58	80
35	R04-06-0	10.1	84	68	82	R08-16-2	17.9	17	24
36	R04-07-0	11.6	75	70	83	R09-15-1	14.0	53	59
37	R04-08-0	15.0	41	50	84	R09-15-2	16.4	50	66
38	R04-10-1	16.7	60	81	85	R09-16-0	13.2	22	23
39	R04-10-2	20.7	91	152	86	R10-15-0	10.5	45	38
40	R04-10-3	14.3	28	32	87	R10-16-0	14.0	14	16
41	R04-11-0	25.2	98	199	88	R11-15-0	11.2	9	8
42	R04-12-1	21.7	115	200	89	R11-16-1	15.1	12	15
43	R04-12-2	19.1	83	128	90	R11-16-2	15.1	13	16
44	R04-12-3	17.1	97	133	91	R11-16-3	11.1	28	25
45	R04-13-1	18.7	104	156	92	R12-14-0	9.1	21	15
46	R04-13-2	21.4	67	115	93	R12-16-0	8.1	32	21
47	R04-14-1	24.3	104	203	94	R14-16-0	13.4	49	52
						Total	-	436	9,996

(6) Feeder Bus Service

As trunk bus stops are located at intervals of 1.0 to 1.5 km, the final destination may be too far to walk for many passengers. Therefore, feeder buses should be introduced to provide a local service from a bus stop to an adjacent area. The feeder bus routes are illustrated schematically in Figure 12.2-9. The basic idea in planning a feeder bus network is as follows:

a) The feeder bus network should be arranged so as to make the maximum walking distance within 500 m, to any point in the city.

b) A feeder bus route should be included in a bus fare zone as a rule and extends over two zones only exceptionally.

c) Route-length should be less than approximately 5 km.

d) Small sized vehicles such as busetas and colectivos will be assigned to feeder bus service.

e) The tariff system of feeder bus should be a flat rate, for example, 100 peso/ride.

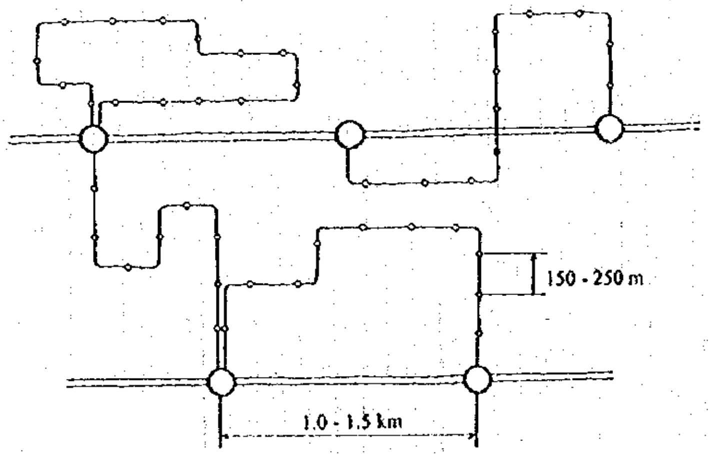


Figure 12.2-9 Concept of the Feeder Bus Network

(7) Trunk Bus Project and Cost Estimate

As shown in Figure 12.2-10, the trunk bus network is divided into 15 projects for the convenience of cost estimation and implementation scheduling. A project is composed so that the project can function by itself.

Table 12.2-8 presents estimated costs of the trunk bus projects. Unit cost is assumed to be 100 million pesos/km for Type A (the "Avenida Caracas" type) and 80 million pesos/km for Type B. In case of BP02 (Avenida Caracas/Autopista del Norte), cost is counted only for 23.3 km section as the work has been completed for the 14.2 km section. BP07 (Villa del Rio-Cundinamarca) will use the land of south railway line and then 960 million pesos for land and 1,520 million pesos for 4-lane road construction are estimated..

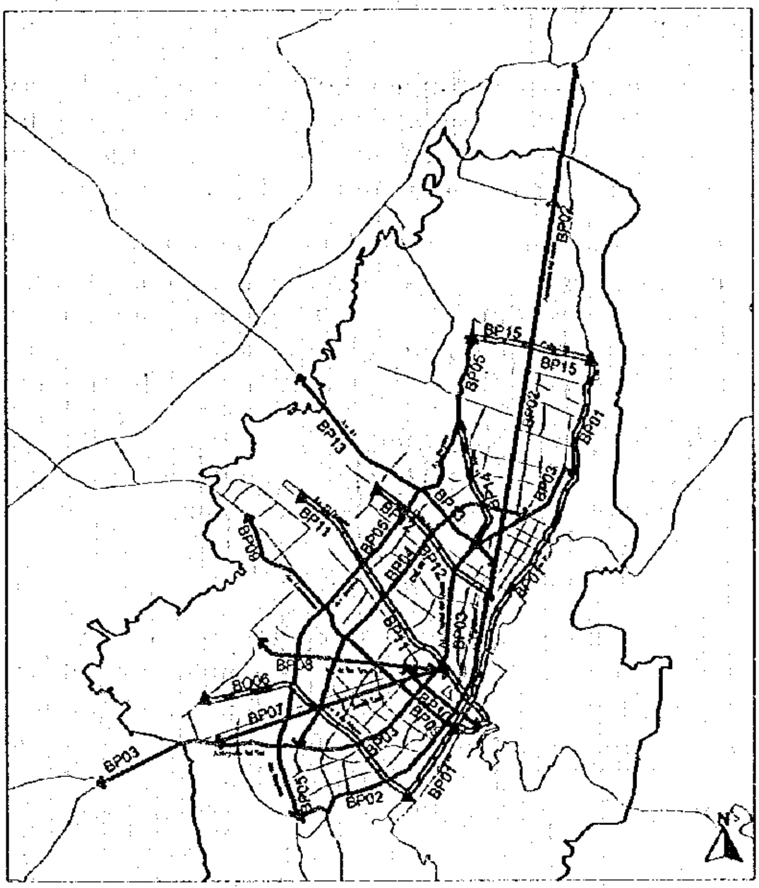


Figure 12.2-10 Trunk Bus Projects

Table 12.2-8 Estimated Cost of Trunk Bus Projects

Code No.	Project	Length (km) Type A	Length (km) Type B	Project Cost (million US$) Type A	Project Cost (million US$) Type B
BP01	Cra.7		21.4		1.7
BP02	Av. Caracas	37.5		2.3	
BP03	Av. Ciudad de Quito	28.8		2.9	
BP04	Cra. 68	15.9		1.6	
BP05	Av. Boyaca	24.5		2.5	
BP06	Calle 22s/Av. 1° de Mayo		11		0.9
BP07	Villa del Rio-Cundinamarca	9.5		25.8	
BP08	Av. las Americas	8.2		0.8	
BP09	Av. Centenario	13.4		1.3	
BP10	Av. Ciudad de Lima	4		0.4	
BP11	Autopista El Drado		13.4		1.1
BP12	Calle 68/Av. 68		6.6		0.5
BP13	Av. 78/Av. 81	10.3		1	
BP14	Av. Suba		5.4		0.4
BP15	Calle 170		4.9		0.4
Sub-Total		152.1	62.7	38.6	5
Total			214.8		43.6

12.2.2 New Tariff Policy

There are several approaches to determine a fare system for public service, such as "cost plus profit", "user's benefit" and " user's willingness to pay". It is not clear which one rules the present bus fare system in Bogota. However, it may be concluded that the present tariff level is not high enough to cover the full operating cost.

According to the STT's latest estimate of the bus operating cost, monthly cost of a regular-sized bus is 3.2 million pesos. On the other hand, monthly proceeds of a bus are in the range of 2.5 to 2.8 million pesos according to our interview survey of bus operators. Thus, proceeds are less than costs by 15 to 25%. This amount of deficit corresponds more or less to the depreciation cost and therefore, bus owners can hardly replace their fleet.

A macroscopic approach deducts an almost same results: Our estimate of public transport demand is about 8.3 million passengers a day. Provided that a passenger pays 250 pesos on average and assuming 22 working days a month, monthly total sales will be 45.7 billion pesos, earned by about 18,000 units. Thus, monthly sales per unit is 2.54 million pesos, which coincides with the interview data.

Several reasons for this situation are pointed out. (1) Daily operating distance has been reduced due to traffic congestion. (2) As the urban area expanded, passenger's trips became longer and as the result, sales per km became less. (3) The fare level has not been adjusted properly to inflation. (4) As the bus fleet became older, their operating rate became lower and the maintenance cost higher. In any case, the fare level should be kept in the reasonable range which can support the financially sound management of the public transport business.

In order to fill the gap between the current fare and the fare to be, and also to rationalize the fare system, the zone fare system is recommended, where the fare rises according to the passenger's trip length, not proportionally but discretely.

Figure 12.2-11 presents an example of zoning for the fare system. In the first stage, rather large zones are to be applied, dividing Bogota into four tariff zones. Suggested tariff rates are shown in Table 12.2-9, where the minimum fare is 250 pesos, lower than the current flat rate, for intra-zone trips, and an additional 50 pesos is charged every time a bus crosses zone boundaries. Thus, the highest fare is 400 pesos for trips between zone 1 and 4.

According to the person trip survey in 1995, daily passengers using public transport approximate eight million, excluding trips to and from outside Bogota City. Thus, total sales of the public transport business is estimated of 2,000 million pesos a day, assuming the average fare at 250 pesos/ride. Even under the condition of the suggested tariff system, total sales amount will be about 2,080 million pesos, almost same amount as under the current fare level.

After people become accustomed to the zone fare system, the second stage should be implemented, dividing the City into nine zones. Inside a zone, for instance, a flat rate of 200 pesos is applied, and 300 pesos to the adjacent zone. An additional 100 pesos are applied each time a passenger enters another zone.

Under this fare system, total daily sales is estimated to be 2,530 million pesos, which is larger than the current amount by 26.4 %. Passengers who have to pay more than 400 pesos are 32% of the total, while 21% need to pay only 200 pesos which is less than the current fare.

Table 12.2-9 Tariff Table under Zone Fare System
(pesos/ride at 1995 price)

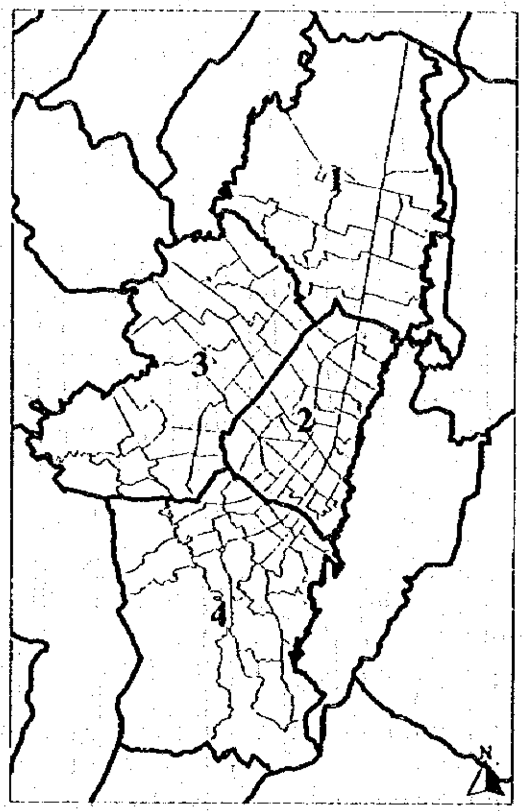
(1) Stage 1

from:to	1	2	3	4
1	250	300	350	400
2	300	250	300	300
3	250	300	250	300
4	400	300	300	250

(2) Stage 2

from:to	1	2	3	4	5	6	7	8	9
1	200	300	300	400	400	600	600	700	700
2	300	200	300	300	400	500	500	600	600
3	300	300	200	300	300	400	400	500	500
4	400	300	300	200	300	300	300	300	400
5	400	400	300	300	200	400	300	400	500
6	600	500	400	300	400	200	300	300	300
7	600	500	400	300	300	300	200	300	400
8	700	600	500	300	400	300	300	200	300
9	700	600	500	400	500	300	400	300	200

(1) Stage 1



(2) Stage 2

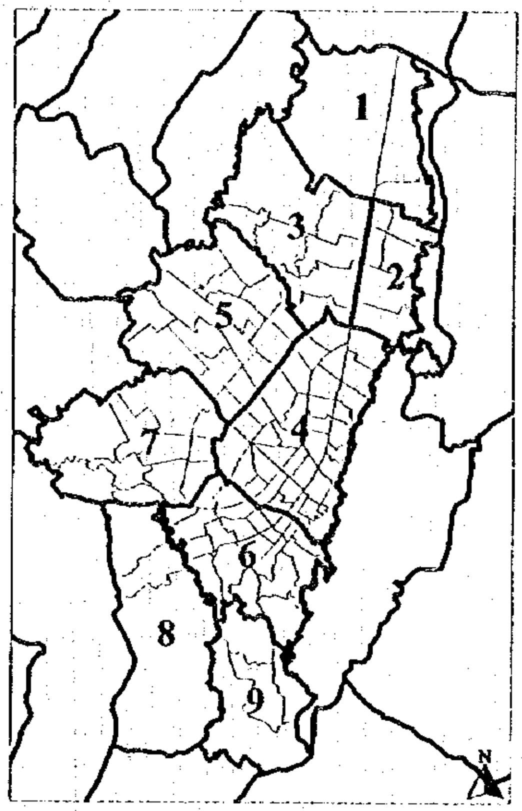


Figure 12.2-11 Zoning for Zone Fare System

12.2.3 Capacity-up and the Regional Integration of Public Transport Administration

(1) Reinforcement of the STT

Presently, public transport is administrated by the UTP (Public Transport Unit) of the STT, which consists of four divisions. Excluding division chiefs, there are only 15 professional staff and engineers working in those divisions. This number is apparently not sufficient to manage the wide area of public transport, especially to undertake the difficult tasks of the short-term plan, such as reorganization of bus companies and bus routes.

One of the most important functions of the UTP is to continuously monitor the demand-supply balance of public transport services and deal properly with applications for new bus routes or changing bus routes. Nevertheless, neither manpower nor information is sufficient for this task. Adequate budget allocation should be considered to assign professional staff, develop a database and introduce a computer system.

The UTP planned, for example, to carry out a survey of bus passengers getting on and off at each road link, but had to split the survey area into two parts and postpone one to the next year due to insufficient budget. This kind of data is inevitable to grasp the demand structure, and the budget for such a survey should not be insufficient.

For efficient administration, it is urgent to develop a public transport database which covers:

a) Public transport route database
b) Bus fleet database
c) Public transport operation database
d) Bus terminal database
e) Public transport operators database
f) Public transport operating cost database
g) Public transport accident and dispute database

At the same time, a software package should be developed for maintenance of the database and also for retrieval and analysis of the database information. The current staff of the SIG is only three engineers. In order to develop the database and the package and provide other divisions with the required information, at least three systems engineers and 5 to 10 operators will be needed. Then, the SIG should be strongly reinforced, in personnel and budget.

(2) Regional Integration of Public Transport Administration

The urbanization of Bogota has been expanding over the city boundary and more than 800,000 persons daily cross the boundary. Therefore, public transport service should be planned and administrated covering the area wider than the city of Bogota, at least, covering the Bogota Metropolitan Area, including 17 adjacent municipalities.

For this wider regional integration of public transport administration, establishment of a permanent coordinating committee is highly recommended. The committee should consist of representatives of the STT, the public transport divisions of each municipality, bus companies, bus owners and personnel experienced in public transport planning. The main function of the committee is to coordinate the interests of each group, pursuing the maximization of passengers' convenience and equality of business opportunity. Issues to be discussed in the committee, therefore, will be as follows.

a) Inter-municipal bus routes
b) Fleet allocation or the bus routes

c) Tariff system
d) Planning and financing of facility development for bus operation

This committee should be supported by a highly qualified group such as the SIG, which could produce the necessary information for the committee to make decision.

12.2.4 Structural Reform of Bus Operators Organization

At present, there are 66 bus companies in Bogota, of which, however, most companies do not own their bus fleet but only possess route franchises for a bus operation. Bus companies have the bus owners as their member (Socio) and allot the bus routes to them. Daily bus operation is done by bus owners themselves or drivers employed by the owners. This traditional system causes many problems in current public transport service.

Drivers are paid, for example, according to the sales, and thus they will try to get passengers, as many as possible, which tends to drive them to violate rules and regulations or to conduct an illegal operation. Bus companies always try to increase their franchises and as a result, the market of bus transport will become a fraction. Individual bus owners do not have enough capital to replace their fleet and thus, the bus fleet will be superannuated.

Two principles are recommended to improve the old-fashioned business structure.

a) Bus companies should be directly responsible for daily bus operation and financial management
b) Bus owners should equally get returns according the asset value of their vehicles

As the first step to realize the principles mentioned above, it is proposed to establish a "Bus Fleet Trust Company". The Company is basically a rent-a-bus company, being entrusted with vehicles by bus owners and renting them to bus operating companies. Instead of making individual contracts between bus owners and bus companies, the Trust Company will make a rental contract with bus companies. Bus companies pay a rental charge to the Trust Company and bus owners are paid by the Trust Company. All the operation work is undertaken by the bus companies and bus drivers and other operational staff are employed by the bus companies (Figure 12.2-12).

The Bus Fleet Trust Company should have the following functions:

a) To assess vehicles values
b) To be entrusted with vehicles by owners
c) To rent vehicles to bus operating companies
d) To collect bus rent and distribute it to owners
e) To inspect vehicles and recommend an adequate repair to owners
f) To make consulting service to owners on vehicle replacement

In the stage of establishment and early operation of the Trust Company, the local Government will need to join in planning, creating consensus among entities with interest, and investing as a share-holder, if necessary. In addition to those functions, the Trust Company should expand its roles to vehicle repair, and financing for vehicle replacement.

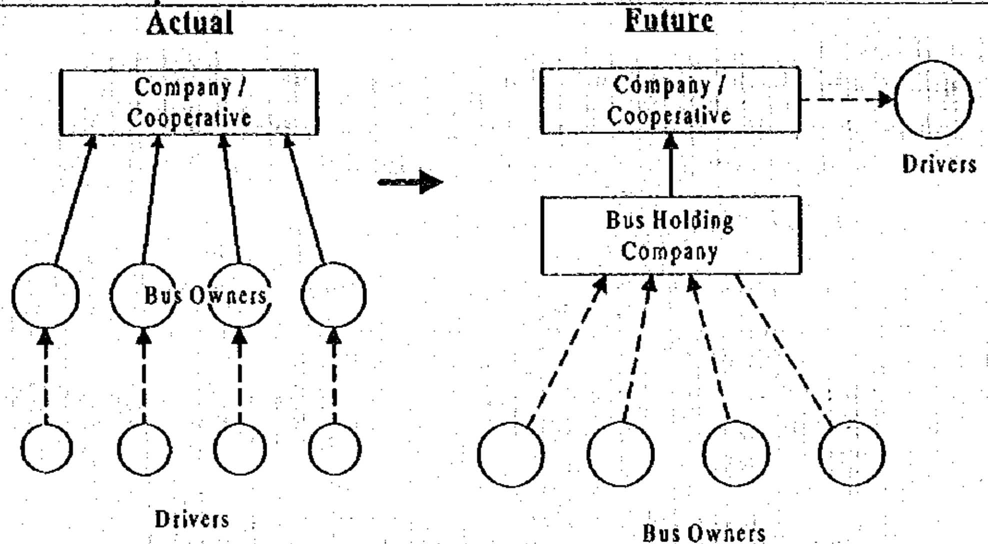


Figure 12.2-12 Structural Reform of the Bus Service Industry

12.2.5 Replacement of Bus Fleet

Buses are getting older year by year in Bogota. How to renew the superannuated fleet is one of the most important issues to be solved. The number of new public transport vehicles to be introduced up to the year 2020 will be enormous. Table 12.2-10 shows bus fleet required in the future.

Table 12.2-10 Bus Fleet Required in the Future

(1) In Case of Trend

Vehicle Type	1995	2000	2010	2020
Bus	10,980	12,062	14,556	17,566
Buceta	6,589	7,324	9,050	11,182
Collectivo	4,126	4,533	5,470	6,602
Total	21,695	23,919	29,076	35,350

(2) In case of Trunk/Feeder Bus System

Vehicle Type	1995	2000	2010	2020
Bus	10,980	9,990	12,812	14,200
Buceta	6,589	6,940	7,700	8,543
Collectivo	4,126	4,417	5,061	5,800
Total	21,695	21,347	25,573	28,543

Most bus owners in Bogota are small-scale owners with a few bus units and thus with small financial capacity. Moreover, bus business is currently not very profitable under the ongoing tariff system and the prevailing low operating rate. Thus, vehicle renewal is generally difficult in Bogota, which results in the superannuation of fleet. Introduction of the new tariff system and new bus service is urgent not only for its own benefit, but for financially sound management and bus fleet renewal.

12.3 Medium and Long Term Plan

12.3.1 Growth of Public Transport Demand

Transport demand will increase by two factors; increase of trips and prolongation of trip length. According to our forecast, trips by public transport will increase 1.35 times from 8.3 million in 1995, to 11.2 million in 2020. This growth is rather modest, comparing to 2.3 times of growth by private mode.

Present and future trip length distributions are compared in Figure 12.3-1. Average trip length is 9.2 km at present and will become longer up to 11.3 km, in 2020. Therefore, transport demand will increase 1.66 times (1.35 x 11.3/9.2) in terms of passenger-km.

Figure 12.3-2 shows present and future trip distribution in the form of desired lines. Main attracting zones will be the area of Centro to Chapinero, also in the future. On the other hand, generating zones will spread to the peripheral zones such as Suba, Engativa, Fontibon, Ciudad Kennedy and Bosa. This results in the prolongation of trip length.

Figure 12.3-3 presents the passenger flow assigned on the present network by all-or-nothing method, which shows a potential demand. As the capacity of each road section is assumed to be infinite, the flow pattern does not change in the future. On main arterial roads such as Autopista del Norte, Avenida Caracas, Avenida Ciudad de Quito, Avenida las Americas and Avenida Boyaca, some sections will have a daily demand over one million passengers. Actually, those roads cannot accommodate such a huge demand and so passengers will be forced to detour and be distributed to other roads with capacity. This information is very indicative for future network planning.

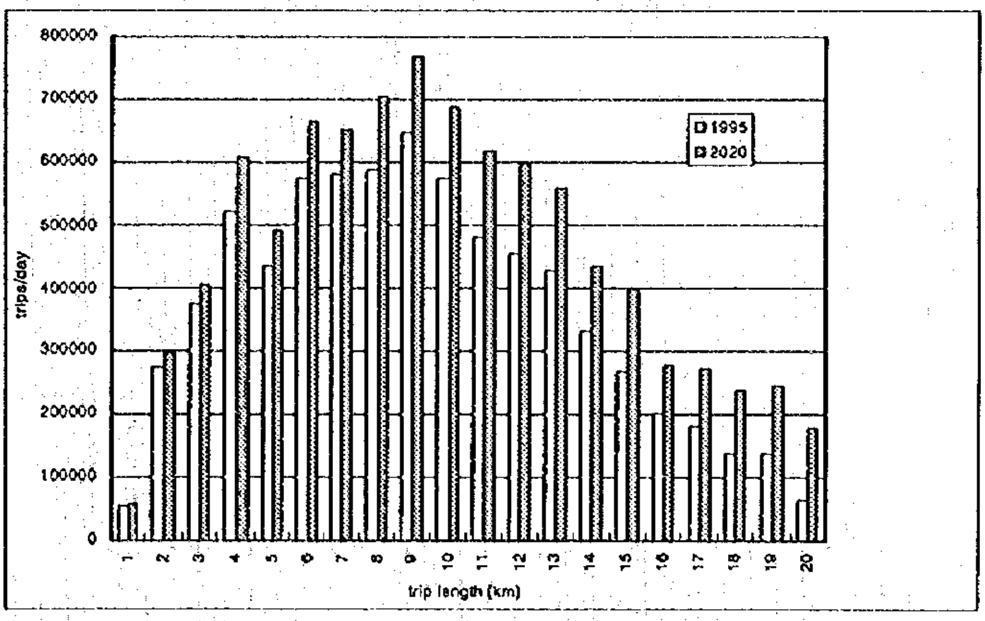


Figure 12.3-1 Distribution of Trip Length of Public Transport Passengers

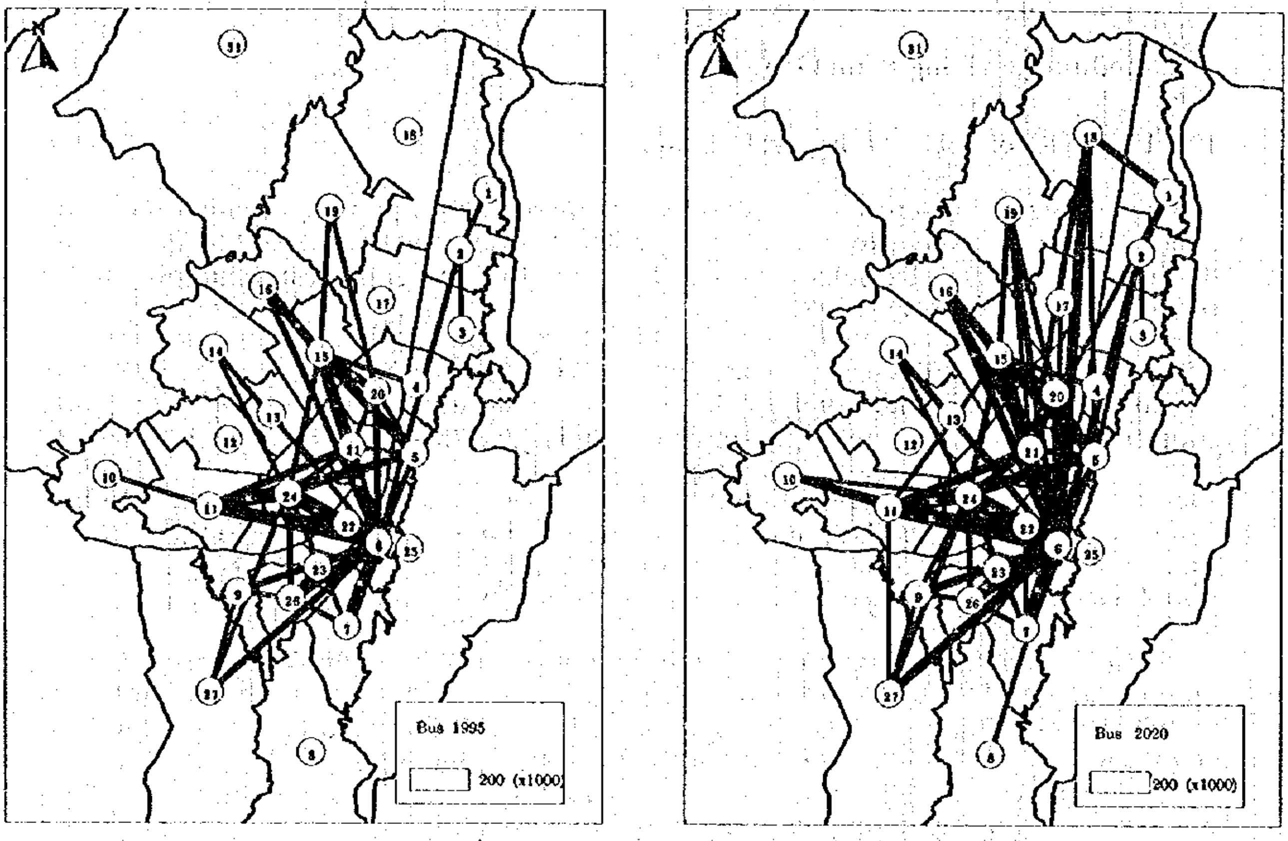
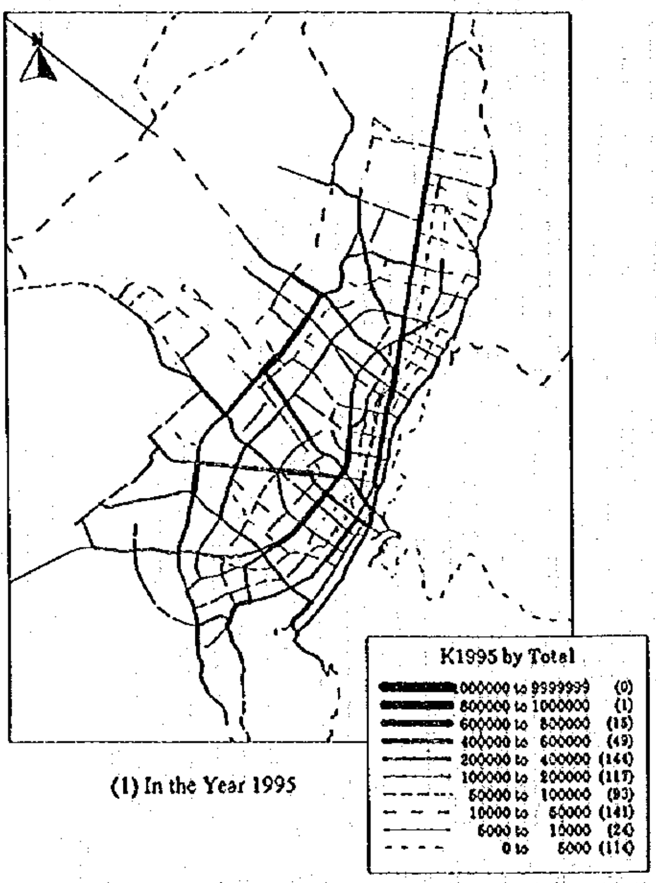
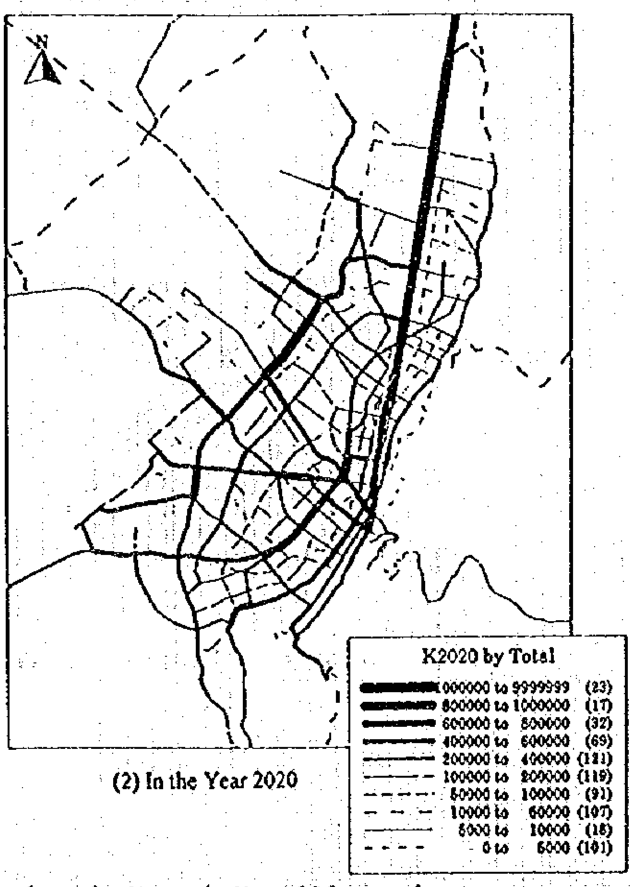


Figure 12.3-2 Desired Lines of Public Transport Vehicles (in PCU)



(1) In the Year 1995



(2) In the Year 2020

Figure 12.3-3 Public Transport Demand Assigned on the Present Road Network

12.3.2 Modal Comparison of Mass-Transit

Table 12.3-1 and Table 12.3-2 summarize the characteristics and attributes of various types of mass-transit now operated for urban transport in the world. Although many factors should be considered to select the most appropriate mode for Bogota, a monorail and a guideway bus system may not have enough capacity, in case demand exceeds 150,000 passengers a day.

Table 12.3-1 Characteristics of Mass-Transit

Attribute	Metrobus	Metro (HRT)	LRT	Monorail	Guideway Bus
1. Transport Capacity					
Car length (m)	18	16 - 20	14 - 30	10 - 15	7 - 8
Capacity / Car (pax)	180 - 250	140 - 200	100 - 250	80 - 100	40 - 70
Train composition(car)	-	4 - 10	2 - 4	2 - 6	4 - 6
Capacity / train	-	560-2000	200-1000	160-600	160-420
Max speed (Km / hour)	45	60 - 80	60 - 80	60 - 80	50 - 60
Design speed (km / hour)	18 - 25	30 - 40	18 - 40	18 - 40	20 - 30
Headway :peak (train/hr)	60	25 - 25	20 - 25	10 - 15	15 - 20
off-peak(train/hr)	10 - 20	5 - 10	5 - 10	5 - 10	4 - 6
Max capacity (pax/hr/direction)	15,000	50,000	25,000	9,000	8,400
2. Construction Cost (million US$/km)					
at grade	3	10	7	-	5
underground	-	130 - 260	100 - 200	-	-
elevated	-	50 - 80	40 - 60	40 - 60	30 - 60
Construction Cost/Pax/peak hour					
at grade (US$/km/pax/hr)	20	20	30	-	60
underground	-	260 - 520	400 - 800	-	-
elevated	-	100 - 160	160 - 240	440 - 890	360 - 710
3. Rolling Stock Cost					
Cars needed for peak hour (car)	60	250	100	90	120
Cost per Car(million US$)	30 - 40	120 - 170	100 - 150	100 - 170	50 - 70
Cost / Pax at peak hr(US$/km/pax/hr)	1200-1600	6000-8500	4000-6000	10000-7000	7100-10000
4. Operating Cost (million US$/km/year)	1.46	6.66	4.52	2.21	2.33
Cost / Pax at peak hr(US$/km/pax/hr)	10	13	14	25	28
5. Passengers necessary to cover the operating cost at $500 / ride(pax/km/day)	8,100	36,600	24,600	12,000	2,100

Note: Operating cost is estimated under a standard operation schedule.
Source: For Metrobus, Proposal for Metrobus Plan and for others, estimated based on actual data in Japan.

Table 12.3-2 Modal Characteristics of Mass-Transit

Criteria	Metrobus	Metro (HRT)	LRT	Monorail	Guideway Bus
Transport Capacity	◎	◎	○	●	●
Rapidity	●	◎	◎	○	●
Punctuality	●	◎	◎	◎	○
Construction Cost *	◎	○	○	●	●
Operating Cost *	○	○	◎	●	●
Flexibility of Alignment*	◎	●	●	○	○
Air Pollution	●	◎	◎	◎	◎
Energy Consumption	●	◎	○	○	○
Hindered by Road Traffic	●	◎	◎	◎	○

Note : ◎ Good, ○ Fair, ● Bad
* : per passenger

Heavy rail transit (HRT) is the most commonly developed mode in the large cities. It has the highest speed among others, and the largest capacity, possibly exceeding 50,000 passengers per hour per direction. Station are usually located with the intervals of about one kilometer in the urban area and 1.5 to 2.0 Km in the suburbs. Because of its high speed and frequent operation, it has to be completely segregated from a road and other transport facilities and then it is usually constructed in the city center at elevated or underground level. The underground section should be planned as short as possible because of its high cost and uncomfortable to pass through.

Light rail transit (LRT) adopts smaller and lighter rolling stock and other facilities and as the results, construction and operating cost are lower but the capacity is smaller, ranging 10,000 to 25,000 passengers per hour per direction. LRT is defined as a transit, (1) running is its own right of way in most sections, (2) on a dual railways, (3) driven with an electric motor and (4) having a capacity between those of HRT and buses. Its alignment is more flexible because of its smaller radius of curvature.

Monorail is a transit running on a single rail, guided and supported by the same rail girder. While it has the advantage of low cost and flexible alignment more than LRT, its capacity is limited to less than 10,000 passengers per hour. In addition , there are disadvantages such that the monorail cannot connect with other conventional railway system and that switching its junction points takes time due to its heavy and complicated structure.

Automated guideway transit (AGT) is developed with a combined technology of automobile, railway and computer control. It is a transit with rubber tire wheel running on a dual railway and operated with less noise and easily in a gradient sections. The capacity of its wagon widely ranges 20 to 70 passengers and AGT is suitable for the demand of 5,000 to 15,000 passengers per hour per direction. During peak time, its transport capacity can be raised by jointing more wagons and shortening headway and in the off-peak time, the demand-response operation is possible with its computer control system.

12.3.3 Mass-transit Network Plan

(1) Scenario for Public Transport Development

Considering traffic conditions in large cities of the world, it is apparent that construction of new roads can hardly catch up with the demand increase in the end. New roads constructed to mitigate traffic congestion would induce further urban development, invite new traffic demand and result in heavier congestion. And then, another new road would have to be planned again. This is almost Sisyphus' endless work.

As already stated, public transport demand will increase 1.66 times in terms of passenger-km by year 2020. Meantime, trips by private mode will increase 2.8 times. Moreover, this demand increase will not cease in 2020, but last forever as long as the city grows.

Private mode and public mode would scramble for limited transport space in the urban area. Logically, the public mode is superior to the private mode in respect to effective and economical use of urban space. Provided that average occupancy is 30 passengers for a bus and 1.5 passengers for a car and the PCU of a bus is 2.0, the bus is 10 times as effective as a car in the use of space (30/1.5/2.0). Rail transit is much superior in this respect.

In order to make effective use of limited transport space, private mode passengers should be shifted to a public mode. For this, public transport has to offer a better service in quality while the private mode is to be restricted to use. The trunk bus system proposed in the short-term plan is the first step for public transport improvement.

However, provided with two exclusive bus lanes like Avenida Caracas, trunk bus system has the capacity of 30,000 passengers per hour at most. When the demand exceeds this level, a rail transit will be needed. Nevertheless, to develop a rail transit network will require a huge amount of investment and almost impossible to realize in one generation.

Therefore, our proposal is to reform the trunk bus system to a mode like rail transit in more economical way, changing the exclusive bus lanes to exclusive busway. A bus running on the busway is called an express bus. The capacity of this system is about 43,000 passengers per hour. Trunk bus routes with demand over 30,000 passengers should be upgraded to busways one after another.

A time will come, sooner or later, when even the express bus system will no longer cope with the demand. By that stage, a railway system should be introduced. This is the proposed evolution scenario for public transport development in Bogota (Figure 12.3-4, Figure 13.3-5).

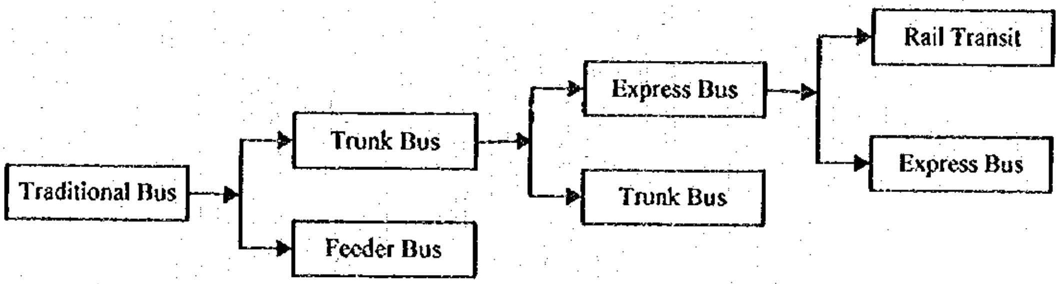


Figure 12.3-4 Scenario of Public Transport Development

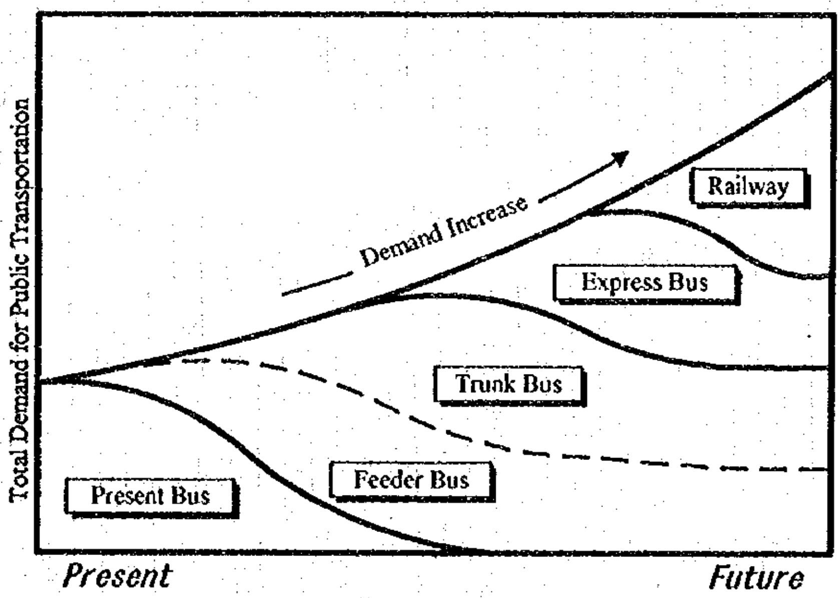


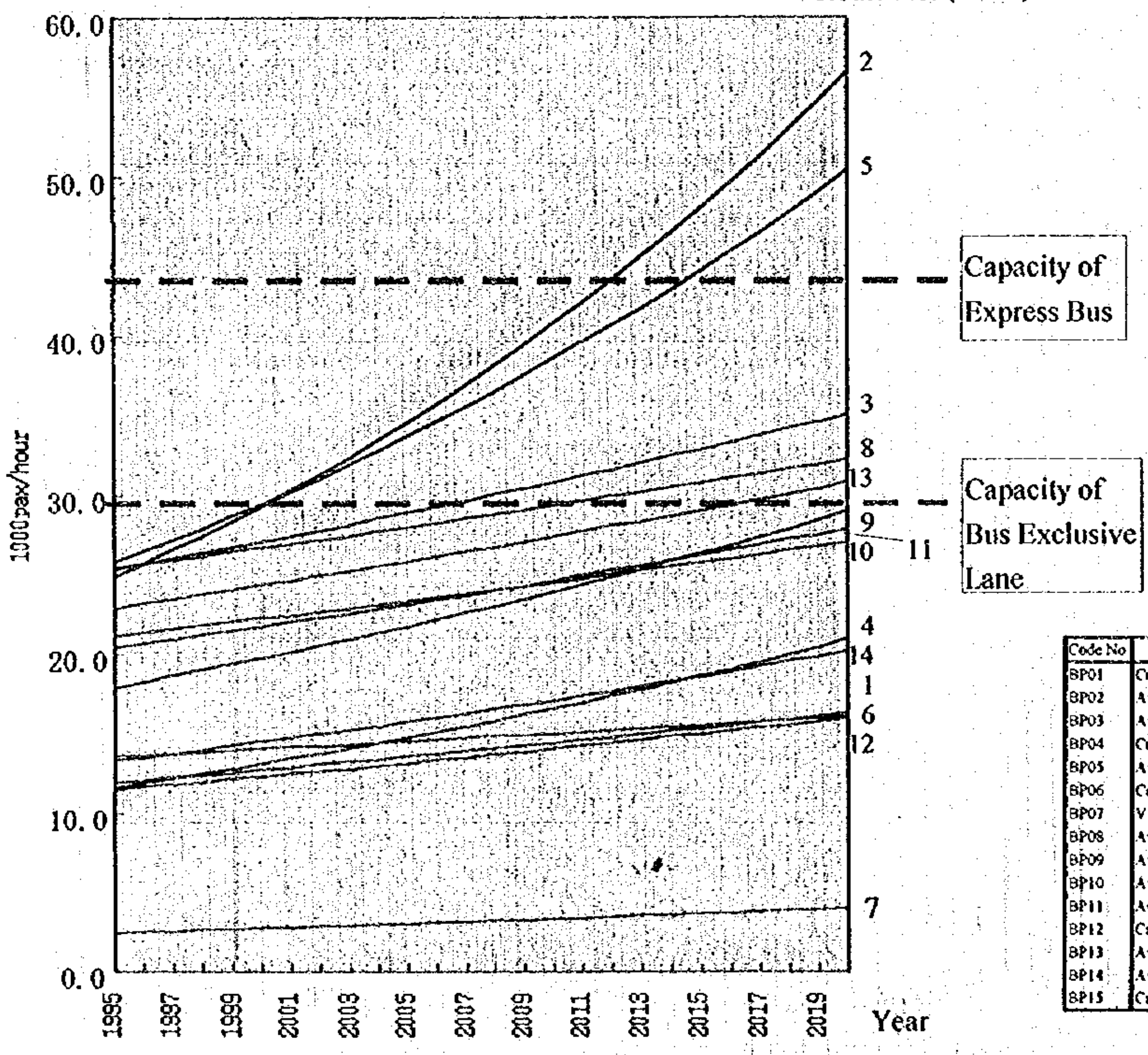
Figure 12.3-5 Schematic Chart of Public Transport Evolution in Bogota

(2) Mass-Transit Network

Mass-Transit is defined in this study as transit with a larger capacity than that of the trunk bus, which requires its own infrastructure. Mass-Transits which meet these conditions are an express bus and a rail transit. Assuming that all the trunk bus projects are constructed in the coming five years, that is, by the year 2001, a demand analysis of the trunk bus projects proposed as the short-term proposal is made, in order to identify the routes with demand larger than the capacity of the trunk bus system, to be converted to the mass-transit system.

For this purpose, the transport demand for each trunk bus route is estimated by assigning the OD trips in 1995 and 2020 on the trunk bus network. The number of passengers representing a route is calculated as the average of three links; a link with maximum passengers and two links both sides of the links. Figure 12.3-6 is illustrated in this way.

Current traffic on the exclusive bus lanes of Avenida Caracas is considered to almost reach the maximum level and is about 500 to 600 buses per lane per one peak hour. Two lanes are provided for exclusive use in one direction and average occupancy during peak hour is about 30 passengers per vehicle. Thus, the capacity of two bus lanes is estimated to be 30,000 passengers (500 x 2 x 30) in one direction.



Code No	Project
BP01	Cra 7
BP02	Av. Caracas
BP03	Av. Ciudad de Quito
BP04	Cra 68
BP05	Av. Boyaca
BP06	Calle 22s/Av. 1° de Mayo
BP07	Villa del Rio-Cundinamarca
BP08	Av. las Americas
BP09	Av. Centenario
BP10	Av. Ciudad de Lima
BP11	Autopista El Drado
BP12	Calle 68/Av. 68
BP13	Av. 78/Av. 81
BP14	Av. Suba
BP15	Calle 170

Figure 12.3-6 Demand Growth of Trunk Buses by Route (Passenger/hour/direction)

Although no route would be over saturated at present, passengers on Avenida Caracas and Avenida Boyaca will exceed the level of 30,000 passengers per hour within a couple of years. By the year 2020, three more routes will have demand over capacity; Avenida Ciudad de Quito, Avenida de Las Americas and Avenida 78/Avenida 81. Therefore, these routes or some other routes which can mitigate the congestion on these roads should be planned to be upgraded to express bus routes.

As explained later, the planned capacity of the express bus system is about 43,000 passengers and the two routes of Avenida Caracas and Avenida Boyaca will have a demand over this figure in the period of 2010 to 2015.

Based on demand as well as current traffic, road conditions, network balance, etc., a Long Term mass-transit network is composed, consisting of three routes. However, this network does not include Avenida Boyaca, because the total extension of a network is limited for the purpose of that alternative comparison in Chapter 10. On the other hand, the demand analysis shows, Avenida Boyaca has the second-highest potential demand second to Avenida Caracas. All three alternatives other than the selected Alternative A include the route on Avenida Boyaca as a component. Therefore, Avenida Boyaca is added to the mass-transit network selected in Chapter 10 as the Master Plan Network. Another modification is Avenida Centenario, one of the east-west routes. By a re-alignment project of the west railway line which is parallel to Avenida Centenario, its right of way will became available in the future. Then, the land of the west line is used instead of Avenida Centenario. In addition, this route is connected with the Avenida78/Avenida81 route by Avenida.7ª route in the selected network. However, both routes are to be constructed and operated independently, eliminating the Avenida 7ª section, mainly because of environmental issues. Consequently, the modifications made on the Alternative A in Chapter 10 are the following three points:

a) Addition of Avenida Boyaca route
b) Change of Avenida Centenario route to the west railway line
c) Elimination of the Avenida 7a route

The Master Plan mass-transit network is shown in Figure 12.3-7, where the network is divided into eight project sections. Each project cost is estimated as shown in Table 12.3-3.

The cost in the table does not include the bus fleet cost but only the cost for road facilities to segregate bus lanes, grade separation at intersections and expansion of bus stops. However, the cost of BX02 which passes the right of way of the north railway line include road construction cost. Some cost breakdown of railway projects (FP01+FP02) is shown in Table 12.3-4 as the cost of route No. 5.

Table 12.3-3 Estimated Cost of Mass-Transit Projects

No.	Route	Km	Project Cost (million US$)
BX01	Av. Caracas - Av. 27 - South Line	19.0	9.9
BX02	Av. Caracas - North Line	9.2	112.8
BX03	Av. Boyaca	18.4	5.8
BX04	Av. Boyaca - Parque el Tunal	5.0	0.5
BX05	Av. 79 / Av. 81	15.0	5.5
BX06	Av. Lima - West Line	15.8	83.5
FP01	Line No.1 (Norte-Quito-Sur)	32.0	2,275.0
FP02	Extension of line No.1 to Chia	8.0	201.2
Total		122.4	2,694.2

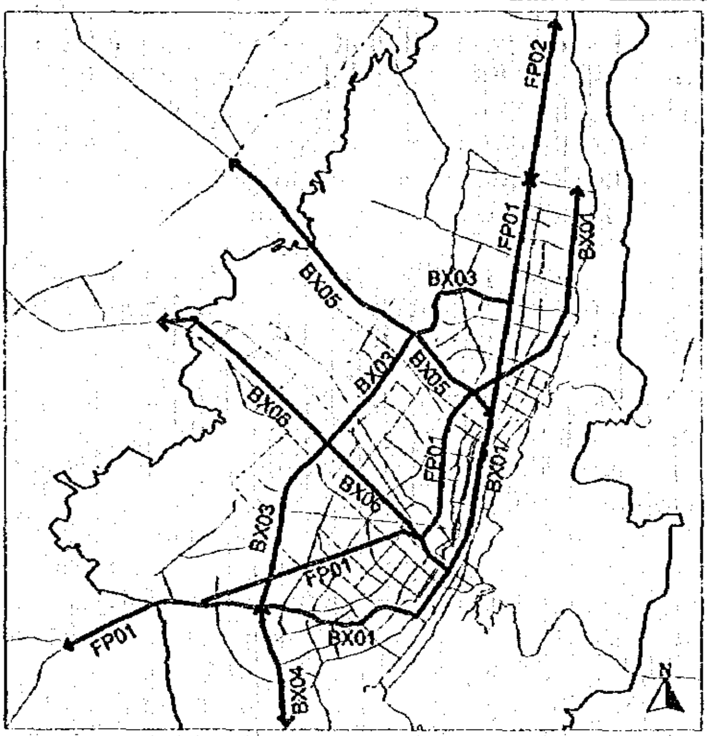


Figure 12.3-7 Mass-Transit Network Plan

12.3.4 Rail-Transit System

Although two routes of Avenida Caracas and Avenida Boyaca are apparently superior to others as to demand, priority setting is tried on 6 lines of 8 projects shown in Figure 13.2-7 from more comprehensive viewpoints. However, the Colombian Government is now conducting another comprehensive study on railway transit project called "Integrated System of Mass-Transit (SITM)", scheduled for July 1995 to June 1996. Therefore, only a guideline will be given in this Master Plan Study as a detailed plan is expected to emerge from the SITM study.

Demand, cost and evaluation of other aspects on six routes are summarized in Table 12.3-4.

The alignment and physical conditions of each alternative line are considered as described below. Construction costs of them shown in Table 12.3-4 are estimated also based on these consideration.

1) Alternative Line No.1 (L=42.0 Km)

   a) Starting at Capila, the line runs on the center median of Autopista del Norte at the ground level, down the intersection with Avenida Ciudad de Quito (L=16.0 Km). After Calle 170, it may need to excavate two meter deep to under-pass five pedestrian bridges.
   b) Along Avenida Caracas, it goes underground southward and turning to the right at Avenida 27 following Autopista del Sur toward south-west and after the intersection with Avenida Boyaca, it comes up to the ground level (L=18.5 Km). In this section, it needs to go deep enough to cross three rivers.
   c) After Carrera 72S, it takes the route using the right of way of the south railway, down to Soacha at the elevated level (L=7.5 Km). For the final 4 Km it can be at the ground level.

2) Alternative Line No.2 (L=30.0 Km)

a) Starting at Calle 170, it takes the route using the right of way of the north railway and the following Avenida Ciudad de Quito down to the intersection with Calle 63 (L=13.0 Km). Before reaching Avenida Caracas, the line needs to be elevated to cross six major roads. Three existing fly-over bridges along Avenida Caracas may need modification.

b) Under the center median of Avenida Ciudad de Quito, the line goes underground to the south and turns to the south following the south railway After Calle 13, it comes up to the ground level (L=5.0 Km). In this section, special attention should be paid to plan how to pass through the foundation of Calle 63, 53 and 45 and Autopista el Dorado and Avenida de las Americas.

c) Along the South railway, it goes at the ground level down the Avenida 1o de Mayo (L=3.5 Km). In this section, the line needs to cross two rivers and three arterial roads by bridges.

d) Before reaching Avenida Boyaca, it goes underground again and takes the route under the center median of Avenida Boyaca. After crossing Autopista del Sur, it comes to the ground level (L=4.0 Km). Afterwards, it runs at the elevated level over the center median of Avenida Boyaca, down to the end point of Sotavento (L=4.5 Km).

3) Alternative Line No.3 (L=18.0 Km)

a) The line starts at Siberia and takes the route toward Bogota on the center median of Autopista Medellin. After crossing the Bogota river, it needs to be elevated due to many crossing with arterial roads (L=13.5 Km).

b) Entering Avenida 81, it goes underground below the center median of Avenida 81. Turning to the south at Carrera 7, it takes the route following Carrera 7 and turns to the west at the intersection with Avenida Ciudad de Lima. Afterwards, taking the route under the west railway and comes to the ground level at Calle 42 (L=13.0 Km).

c) It goes westward at the elevated level, down to Avenida Boyaca and then it runs at the ground level, to the end point of Avenida Centenario, via Fontibon (L=12.5 km).

4) Alternative Line No.4 (L=18.0 Km)

a) Starting at Autopista del Norte, it takes the route at the elevated level over the center median of Avenida 127, down to Avenida 81 (L=5.0 Km)

b) Using the center median of Avenida Boyaca, it goes southward at the ground level, down to the south railway (L=13.0Km)

5) Alternative Line No.5 (L=40.0 Km)

This route is a combination of Line No. 1 and Line No.2. After Avenida Boyaca it goes to the end at the ground level, via Bosa.

6) Alternative Line No.6 (L=39.0 Km)

This line is a combination of a part of Line No. 1 and a part of Line NO.4.

In general, route 1 is highly evaluated among others, except project cost. As this route passes one of the busiest areas, it must have a long underground section and its negative impact during construction period will be the highest..

Route 2 is ranked medium in most evaluation items. Route 3 has relatively low demand and it can be considered premature to construct rail-transit, even in the year 2020. Route

4 by itself will also have small demand as the access to the central area is not good; nevertheless Avenida Boyaca has a large potential flow of passengers.

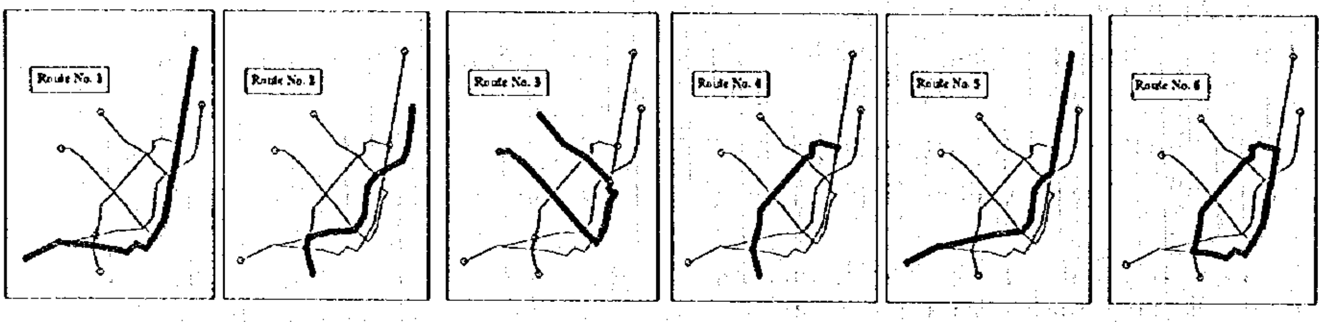
Route 5 is a mixed plan of route 1 and 2, detouring around the busy area of route 1 to save the construction cost, taking its route to Avenida Ciudad de Quito and the discontinued south railway line. Project cost of this route is about 70% of the cost of route 1 while it has the same volume of demand as route 1. Route 6 is a ring railway connecting Avenida Boyaca and Avenida Caracas. This route will have the largest demand of all, but cost is also highest due to the underground section on Avenida Caracas.

Although all the railway routes should be constructed in the long run, route 5 is recommendable as the first line from comprehensive viewpoints. Concerning routes 5, detailed demand is shown in Figure 12.3-8. On the section from Avenida 127 to Avenida Boyaca, one hundred thousand passengers can be expected in the year 2020. This figure should be understood as the maximum demand because the fare of rail-transit is assumed to be the same as the present bus fare and the transfer time cost is neglected in this analysis.

Construction period of a railway should be as short as possible from the economic and financial points of view. The route No.5 should be divided into two phases instead of constructing 40km at once. Construction of each section will take four to six years.

Table 12.3-4 Preliminary Evaluation of Mass-Transit Routes

Item	Mass Transit Route					
	1	2	3	4	5	6
Total Extention (km)	42	30	39	18	40	39
Demand in the year 2020						
Passenger(pax/day)	381,000	339,000	346,000	229,000	381,000	484,000
Passenger-km	3,447,000	2,026,000	2,266,000	1,594,000	3,367,000	3,525,000
Average passenger/km	82,071	67,533	58,103	88,556	84,175	89,523
Construction Cost (million US$)						
Construction Cost	3,219	1,907	2,652	767	2,243	3,526
Rolling Stock	200	152	200	112	200	200
Land Cost	3	4	28	14	34	18
Total Cost	3,422	2,063	2,880	893	2,477	3,744
Cost/km	81.5	68.8	73.8	49.6	61.9	96.0
Evaluation(A:good, B:Fair, C:bad)						
Demand	A	B	C	B	A	A
Project Cost	C	B	B	A	A	C
Easy Construction	C	A	B	A	A	C
Land acquisition for yard	A	B	A	B	A	B
Accessibility to Centro/CBD	A	B	A	C	B	A
Removal of squatters	A	B	C	A	B	A



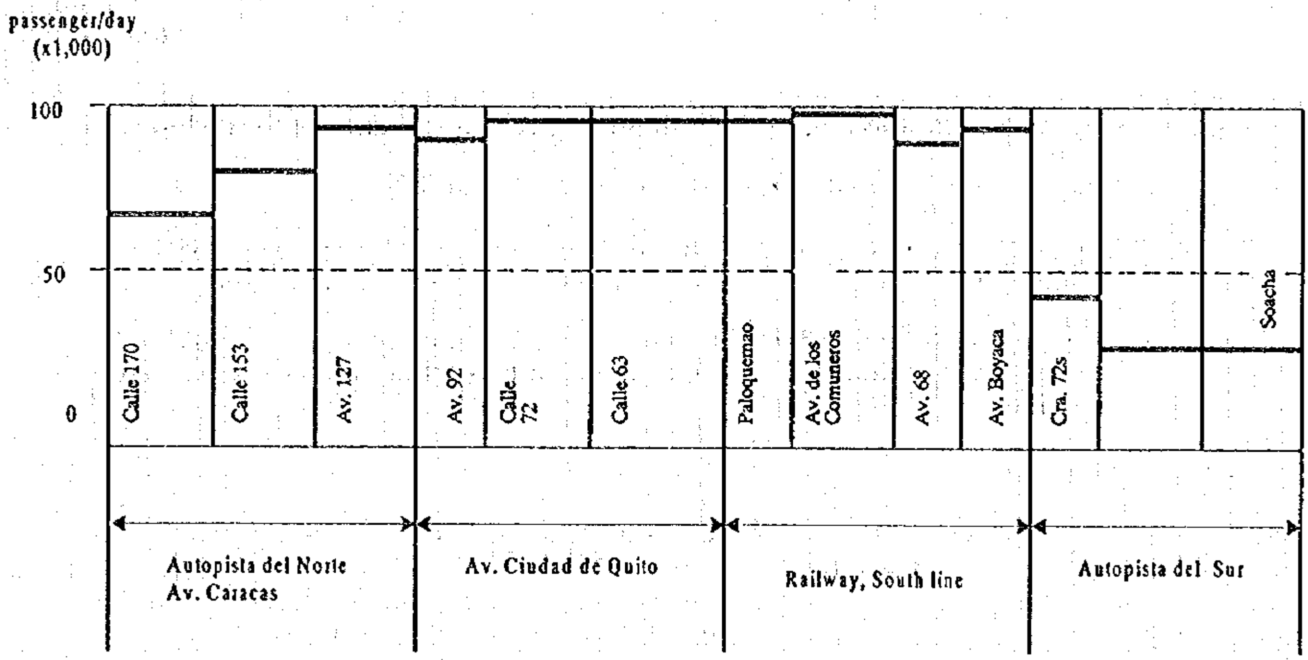


Figure 12.3-8 Daily Passenger Flow of Proposed Urban Railway Line (FP01) in 2020

Beyond the year 2020, other routes are to be converted from busway to railway one by one. As the railway network expands, the operation system should be changed in order to provide passengers with best service. Figure 12.3-9 illustrates one example of changing operation:

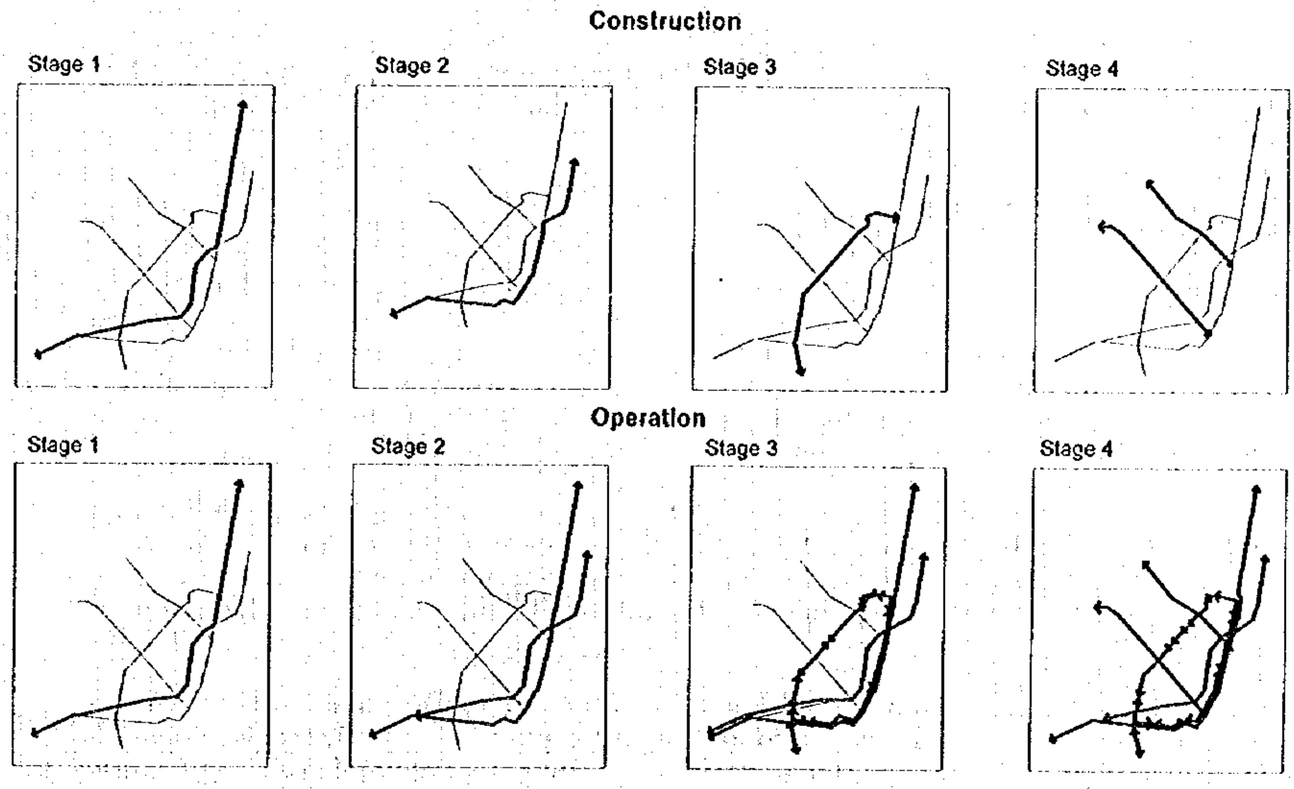


Figure 12.3-9 Expansion of Railway Network and Change in Operation System