7.4 Public Transport System Improvement

7.4.1 Public Transport Corridor

Based on the traffic assignment of public transport demand on the proposed road network, public transport corridors can be found in Figure 7.4.1 and as follows.

In spite of the urbanized area expands toward the south, the strong public transport demand remain between the city center and outskirts of the city. The followings are the future public transport corridors.

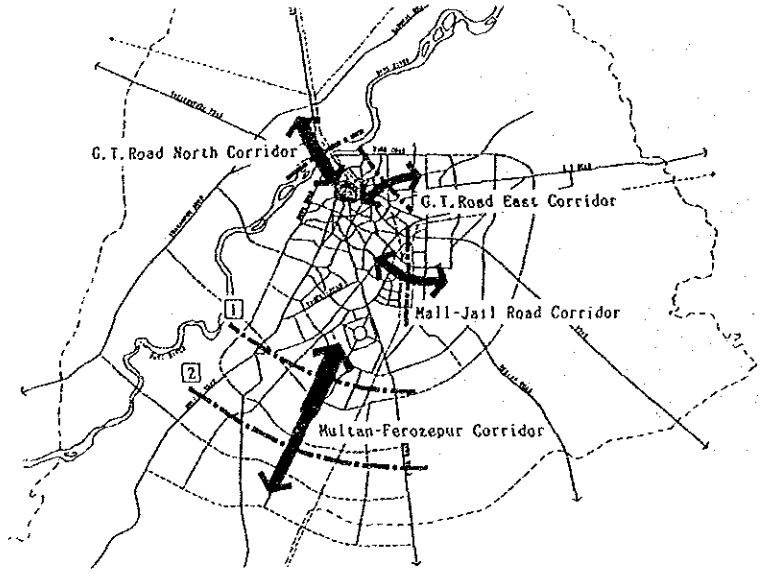
- G.T. Road north corridor connects between city center and northern area across the Ravi River
- G.T. road east corridor connects between city center and Shad Bagh
- Allama Iqbal - Jail Road corridor connects between city center and Cantonment
- Multan-Ferozepur Road corridor connects between city center and southern sub-core

Estimated demand in 1990 and 2010 on those corridors are as follows. Two corridors have a substantially heavy demand in 2010 ; G.T. Road north and Multan-Ferozepur Road corridors.

Table 7.4.1 Estimated Demand on Public Transport Corridor, 1990/2010

Corridor	Demand (000 trips/day)		Increase Rate 2010/1990
	1990	2010	
G.T. Road North	327	596	1.82
G.T. Road East	250	386	1.54
Allama Iqbal-Jail Road	184	331	1.80
Multan-Ferozepur Road 1	301	781	2.59
Multan-Ferozepur Road 2	226	670	2.96

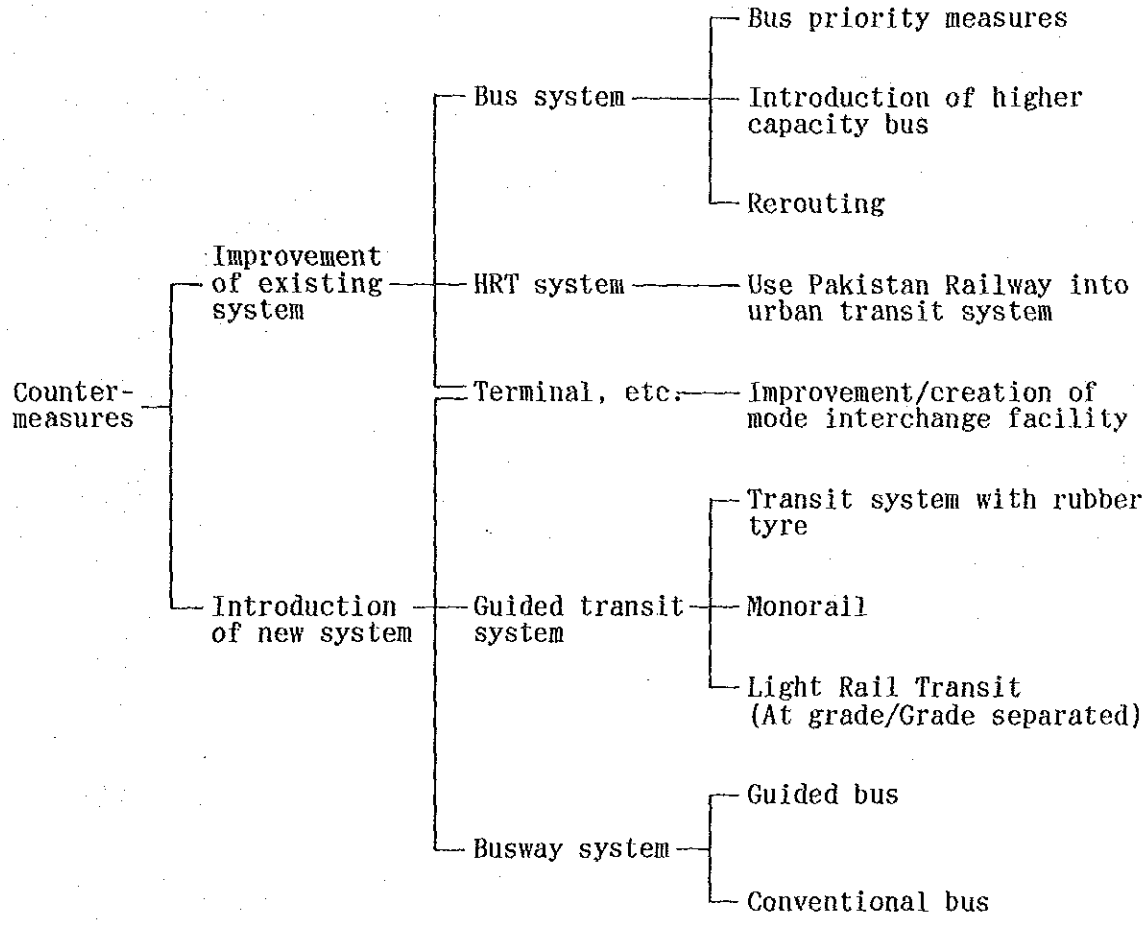
Figure 7.4.1 Public Transport Corridors in 2010



7.4.2 Countermeasures for Future Demand

To cope with the expected future public transport demand, it is necessary to discuss the various countermeasures for the improvement of public transport system. Generally, these are divided into following categories.

Figure 7.4.2 Countermeasures for Public Transport System Improvement



Based on the various characteristics of these systems/facilities, the assessment of possibility for introduction of the future public transport system/facility in Lahore is summarized in Table 7.4.2. Factors of assessment are as follows:

- To introduce the system/facility with lower cost
- To introduce the system/facility with easier operation
- To introduce the system/facility with easier maintenance system
- To introduce the system/facility with less impact to the urban environment
- Effective use of existing system/facility
- To introduce the system/facility to accommodate the improved existing system/facility

Table 7.4.2 Assessment of Possible System to Improve the Public Transport Conditions in LMA

Items		Introduction of New System/Facility						Improvement of Existing System/Facility			
		Guided Transit System				Busway System		Improvement of P.R. for Urban Transit	Creation/Improvement of Mode Interchange Area	Restructuring of Bus Route	Introduction of Higher Capacity Bus	Bus Priority Measures
		Transit System with Rubber Tyre	Monorail (Straddle Type)	LRT At Grade	LRT Grade Separated	Guided Bus	Conventional Bus					
General Characteristics	Passenger Capacity (Pass./Hr)	5,000-14,000	5,000-40,000	3,000-10,000	5,000-30,000	6,000-20,000	6,000-20,000	10,000-60,000	Creation/improvement of mode interchange area such as bus-rail, rail-rail and bus-bus to smooth transfer of passengers	Need restructuring of bus routes along the new transit corridor to avoid traffic jams	Introduction of higher capacity bus to reduce the number of buses along main public transport corridors	Separete buses from the other traffic to improve the existing bus service along main public transport corridors and multi-lane road
	Car Size in Meter [Unit Capacity]	8×2.4 [75]	14.1×3 [100]	30×2.5 [200]	30×2.5 [200]	9.5×2.5 [80]	9.5×2.5 [80]	20×3 [200]				
	Scheduled Speed [Min. Headway]	25 [1.5]	25 [2.0]	15 [1.0]	30 [2.0]	30 [1.0]	25 [1.0]	50 [2.0]				
	Approx. Construction Cost (Mil. Rs./Km)	550	600	100	410	230	175	65				
	Environmental Impact *1: Noise	AA	AA	C	A	A	A	C				
	Air Pollution	AA	AA	AA	AA	C	C	AA				
	Visual Environment	B	B	A	B	B	B	B				
	Obstruction for Road Traffic	AA	AA	C	AA	A	A	B				
	Adoption to the Areas/Cities and Other Characteristics	Mainly use for feeder service of mass transit Small capacity and high frequency	For the small and medium-size cities Mainly use for feeder service of mass transit	Use for short distance trips in the CBD of small and medium-size cities	Meet higher demand than other guided transit	Dual modes operation: high speed and easy operation on the grade separated section and feeder service with low speed at-grade section	Same as the guided bus sistem except uses conventional buses	Improvement of P.R. for urban transit without interruption of intercity seivice and with small cost				
Assessment of Possibility to Lahore	To Introduce Low Cost System/Facility *1	C	C	AA	A	A	A	AA	B	AA	B	AA
	Easy Operation *1	A	A	A	A	A	B	A	-	-	B	B
	Easy Maintenance *1	B	B	AA	B	B	A	A	-	-	A	AA
	Less Impact to the Urban Environment *1	AA	AA	C	A	B	B	A	AA	AA	A	A
	Effective Use of Existing System/Facility *1	C	C	C	C	C	B	AA	A	AA	B	AA
	Overall	Good for urban environment but high cost	Good for urban environment but high cost	Low cost but seriousely affect to road traffic	Need examination	Relatively low cost but needs new type of buses	Need examination	Need examination	Need examination	Need examination	Need examination	Need examination
	*2	B	B	A	AA	A	AA	AA	AA	AA	AA	AA

*1 AA:Excellent A:Good B: Fair C:Bad
*2 AA:Possible A:Relatively possible B: Fair

From these assessment, the following systems/facilities are selected for the public transport study in LMA.

(1) To cope with the expected increase of public transport demand, LRT and busway are selected for the trunk system along major public transport corridors.

(2) HRT system, the improvement of the existing Pakistan Railway for urban transport, is also examined for the supplemental public transport system.

(3) Other improvements of the existing systems/facilities such as restructuring of bus routes should be introduced for the basic countermeasures of public transport in LMA, because they can be introduced with lower cost and immediate action.

Based on those assessment and analysis of future public transport corridors and strategic areas for public transport system, countermeasures of corridors/areas are summarized in Table 7.4.3.

Table 7.4.3 Plans for Four Corridors and Two Areas (1)

Corridor	Particulars	Public Transport Demand	Plans to be Developed
South (Multan-Ferozepur)	Large demand is forecast between the existing central area and the developing area in the south, which travels on this southern corridor	•At the screen line south of Johole town year : ps trips 1990 226,000 2010 670,000 •At the screen line south of township 1990 301,000 2010 781,000	•Buses with larger capacity should be encouraged. •Priority reserved lanes of buses should be maintained on roads of Multan Ferozepur, and others including new radial roads. •Demand will be larger, when roads are closer to the central area of Lahore. New transport system should be developed to meet those larger demand. - LRT or Exclusive busways - PR's existing line facility may be used for the urban shuttle service within the context of not deteriorating its inter-city service.
North (Ravi River crossing)	All traffic to the north, Rawalpindi, Sheikhupura, and Shahdra concentrate on the Ravi Bridge of the dual two lane bridge	•At the screen line of Ravi River Bridge year : ps trips 1990 301,000 2010 781,000	•New bridge(s) are necessary to meet the increasing demand - One bridge very close to the existing Ravi Bridge since the flows on this Bridge to Badami Bagh and other core areas seems to increase continuously. Reserved lanes for buses are required. - A new bridge at the southern end of Bund Road will be necessary since it may serve through-traffic to/from Multan Rd. and the southern part of LMA. •Buses with larger capacity should be encouraged.
East (Shad Bagh-Wagah)	Development of Shadbagh district will receive much population and employment. But spatial extension is limited by the border at Wagah.	•At the screen line of the railway lines year : ps trips 1990 250,000 2010 386,000	•Improvement of the eastward G T Road, Shalimar Ring Road, Bridges over the railways are necessary. •Bus reserved lanes and other priority actions are required. •Buses with larger capacity should be encouraged.
Southeast (Cantonment)	Corridors between the central area and Cantonment, Airport, etc. Mall, Jail Road, and other multilane roads serve this corridors.	•At the screen line of the railway lines year : ps trips 1990 184,000 2010 331,000	•Main roads are crossing the railway lines and link the central area and Cantonment. It is found they are not coming yet to the maximum saturated level. Bus reserved lanes and priority measures will meet the growth of public transport demand.

Table 7.4.3 Plans for Four Corridors and Two Areas (2)

Area	Particulars	Public Transport Demand	Plans to be Developed
Inner Area	Institutional/Business Center in Lahore not only in 1990 but also in 2010	Generated/Attracted P.T. Demand year : ps trips 1990 812,000 2010 1,312,000	Combination of traffic managements for buses such as bus priority measures and introduction of higher capacity buss are effective to this area due to the limit of spatial conditions.
Southern Sub-Core	Future rapid urban growth is expected due to the decentralization of the city center to this area	year : ps trips 1990 78,000 2010 991,000	It is possible to introduce the overall public transport measures such as new transit system with complete its feeder service a along the proposed road network.

Based on Table 7.4.3, the basic system/facility of public transport is planned as follows:

(1) Larger capacity bus will be introduced in the future because current situation of bus fleet in which majority is Hiace-typed minibuses will causes serious traffic jams along public transport corridors.

(2) For the improvement of public transport service, introduction of bus priority lanes should be considered to the bus corridors which have high frequency of bus traffic and multi-lane roads.

(3) Restructuring of bus routes along the new transit corridor should be studied and in the case of the introduction of rail transit, it is necessary to provide the feeder service of this system and create mode interchange areas.

(4) Introduction of new bus routes along proposed roads is necessary to consider the bus service area and size of public transport demand.

(5) The southern corridor which has high demand of public transport should consider the introduction of new transit system such as LRT and/or busway.

(6) Pakistan Railways which has a route along southern public transport corridor should be improve for supplemental urban transit because of the low construction cost.

7.4.3 Outline of Candidate Systems

Outline of selected public transport systems such as LRT and busway and improvement of Pakistan Railways, is summarized below.

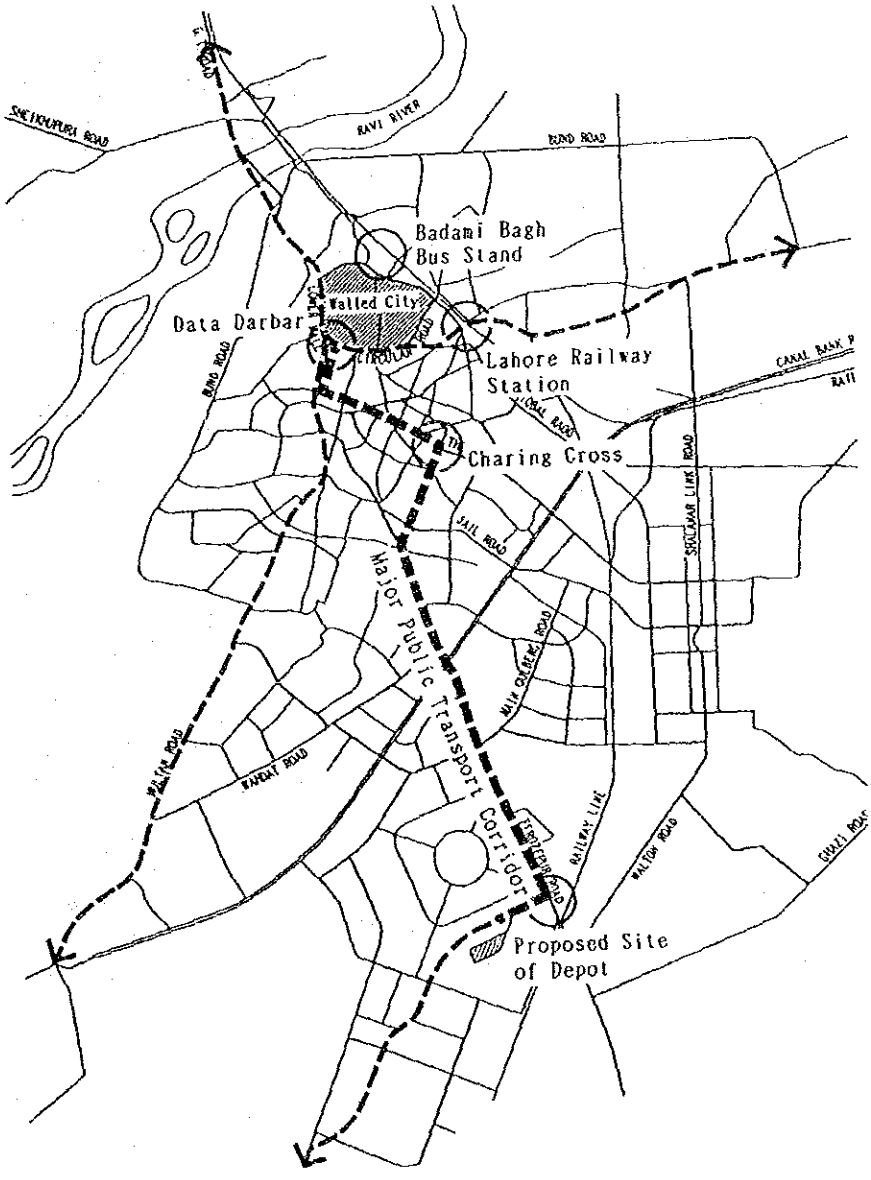
(1) Light Rail Transit(LRT) System

a) Route

Based on the evaluation of the following factors of alternative routes, the selected LRT routes are shown in Figure 7.4.3 and considerations taken into account are as follows:

- Future development along the LRT corridor,
- Expected demand along the LRT corridor,
- Existing conditions of urban facility along the LRT corridor,
- Ease of transfer to/from other modes of transport, and
- Economical cost of construction.

Figure 7.4.3 LRT Basic Routes with Future Extension



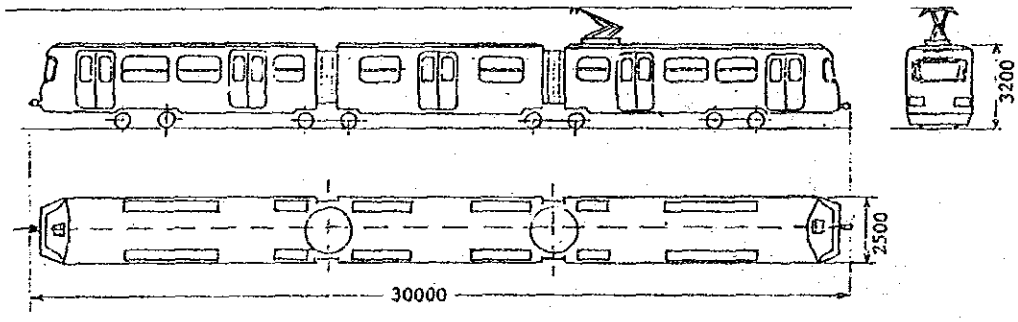
b) Design Standard

The general view of the proposed electric railcar is shown in Figure 7.4.4, while the design standard is as follows:

Table 7.4.4 Specification of Proposed LRT System

Alignment	
Track gauge:	1,435 mm
Maximum gradient:	
- for mainline	3 %
- for connecting line with car depot	4 %
Minimum radius of curve:	
- for mainline	75 m
- for entrance to the depot	50 m
Rolling Stock	
Type: Electric railcar unit with articulated three bodies	
Maximum speed, fully loaded:	80 km/h
Maximum acceleration, fully loaded:	3.8 km/h/sec
Average service braking, fully loaded:	4.2 km/h/sec
Emergency braking, fully loaded:	5.1 km/h/sec
Dimensions: (see Figure 7.4.4)	
Total length	30 m
Width	2.5 m
Height (rail to roof)	3.2 m
Empty weight:	40 ton
Passenger capacity:	
Seating	68
Standing	132
Total	200

Figure 7.4.4 Proposed Railcar of LRT



c) Train Operation Program

The proposed train operation program of the LRT in the year 2010 is as follows:

Train formation:	2 articulated units (4 cars)
Minimum train headway:	2 minutes
Scheduled speed	30 km/hr
Number of railcar units required:	80 units

(2) Busway

To cope with the expected future increase of public transport demand and to improve the public transport service, a busway system, which has exclusive elevated bus routes and dual modes, i.e., express bus and feeder service, should be examined. The system is briefly explained as follows:

a. Express and air-conditioned bus should be operated along the elevated and exclusive bus route for high speed and luxurious bus service.

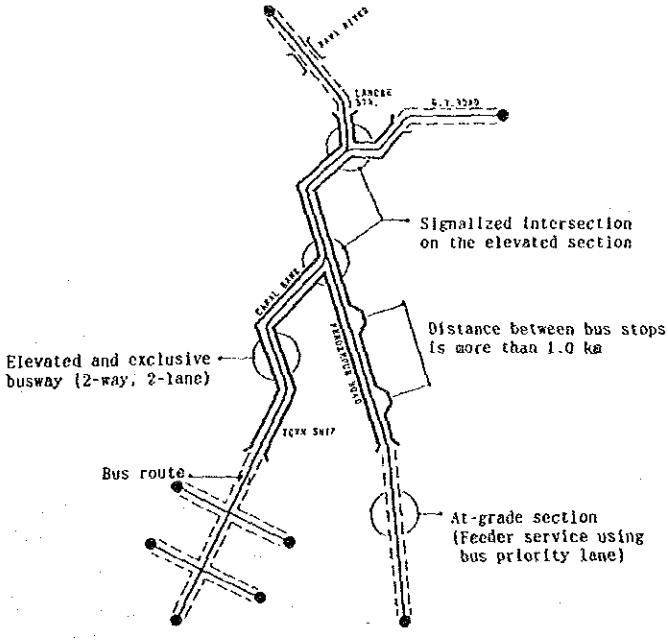
b. To keep a flexible operational characteristics and high operational speed, this system would have dual modes; namely, the express service along the elevated bus routes in the congested urbanized area and the feeder service using at-grade bus priority lane in the suburban area.

c. The busway would have a width for 2-way and 2-lane due to the spatial limitation in the urbanized area and to minimize construction cost.

d. The distance between bus stops on the busway should be planned at least 1.0 km to keep the high operational speed.

e. The alignment of busway routes would cover main public transport corridors such as Ferozepur Road. This is shown in Figure 7.4.5.

Figure 7.4.5 Concept and Alignment of the Busway



(3) Improvement of Pakistan Railways

In order to utilize Pakistan Railways for the urban transportation in LMA, it is recommended that electric railcar trains be operated on the existing electrified double track section in LMA, as shown in Figure 7.4.6. The train operation program is purposed as follows:

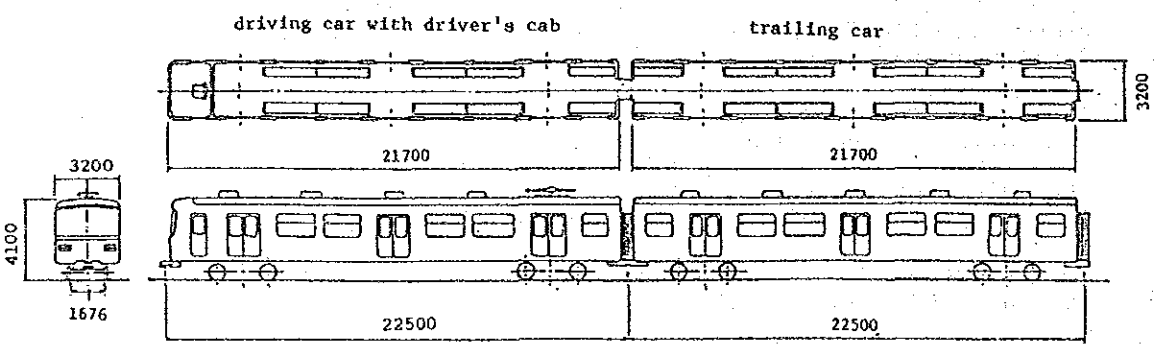
a) Operating Line: Route length 40 km
Number of stations 11 (with 2 new Stations)

b) Electric Railcar (1 unit consists of a driving car and a trailing car)

Power source AC 25kV
Maximum speed 100 km/hr

The general view of the proposed electric railcars is shown in Figure 7.4.6.

Figure 7.4.6 General View of Proposed Railcar



c) Train formation (consists of 2 articulated units or six railcars):

Passenger capacity/trains:
Standard 1,200
in rush hour 1,560
(load factor) 130 %

Total length of a train: 135 m

d) Train Operation Method: Trains stop at every station, but operation of rapid service trains, which stop only at main stations, is possible. Minimum train headway is 12 minutes. The traffic capacity during rush hour is estimated at 7,800 passenger/hour.

The facilities to be constructed or reconstructed in order to operate the proposed electric railcar trains are as follows:

(a) Station: The new shunting track shall be constructed at Jia Bagga

(b) Track: No additional rehabilitation is necessary.

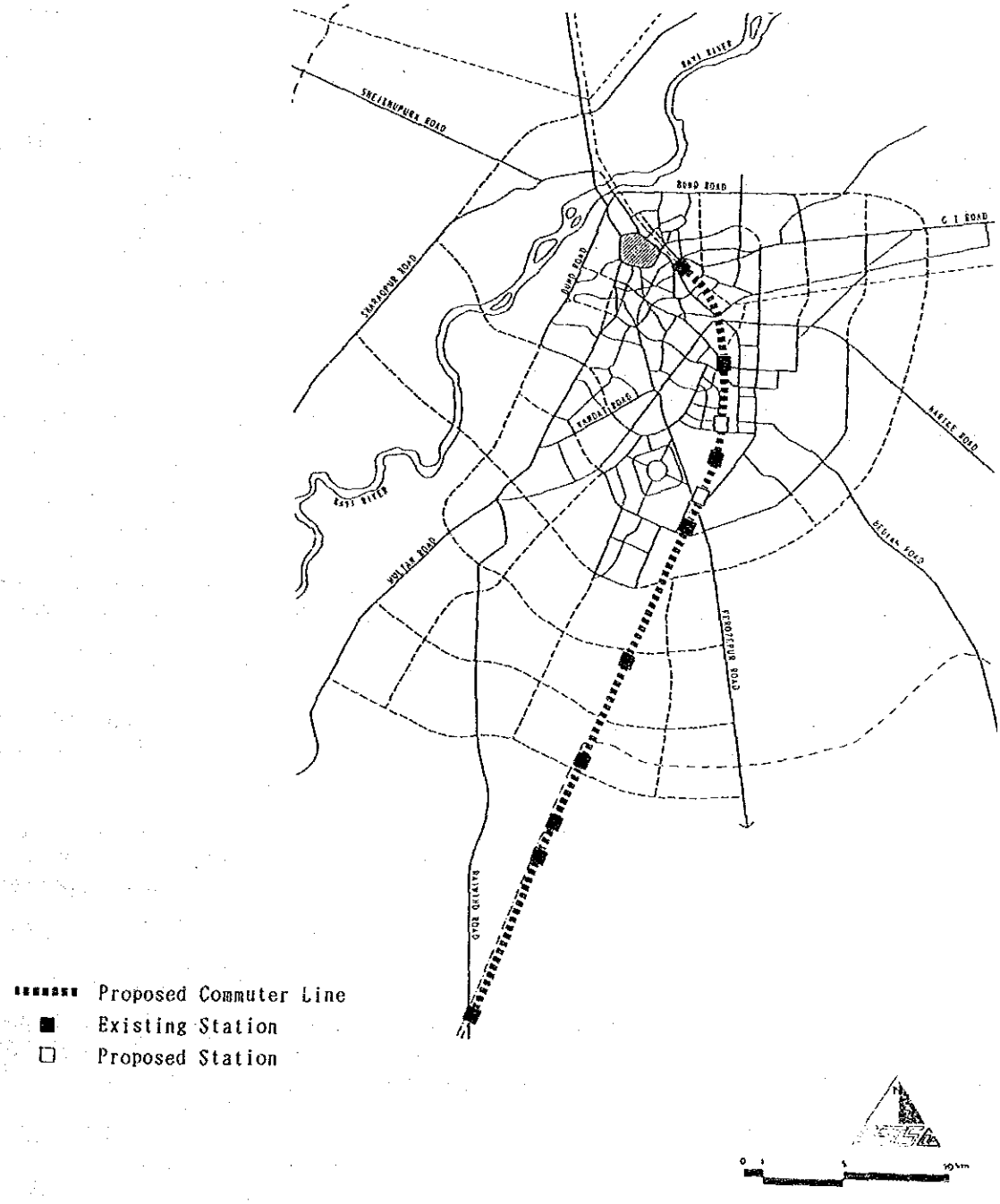
(c) Signalling and telecommunication system: The existing U style instrument (tokenless block system) will be used, but introduction of automatic signalling system in future is recommended.

(d) Electric power facility: some additional capacity of substation and distributing network is required.

(e) Electric railcar: The number of electric railcars to be purchased total 48: 24 driving cars, 24 trailing cars

(f) Car depot: New car depot to stable and maintain the electric railcars will be constructed in Jia Bagga area.

Figure 7.4.7 Proposed Section for PR Improvement



7.5 OTHER PLANNING OPTIONS

The functional other planning options for transport masterplan such as traffic management and transport terminal planning are effective to faciliate the road and public transport system in Lahore.

The planning directions of the these options are as follows:

(1) Traffic management is effective in the urbanized area where has the limit of preparation the right of way for the proposed transport system/facilities and the transport demand will increase in the future.

(2) Existing intercity bus terminals are located in Badami Bagh and GTS bus stand. However, it is necessary to study the location, size and access of these intercity bus terminals to meet the expected future increase of the transport demand.

7.5.1 Traffic Management

The numerous ongoing and planned projects of traffic management is carried out by TEPA to improve the current traffic problems. Nevertheless, it is necessary to study that the more drastic traffic management measures will be introduced considering the future transport demand. From the analysis of the existing and future transport conditions, two areas i.e., inner area and southern sub-core are necessary the consider the introdution of the traffic management.

(1) Inner area

Considering the traffic management aspects, this area is divided into three as described below:

- The total inner area should be strengthened the overall traffic management such as one way system because of the limit of the enough space for introduction of the new transport systems/facilities. And the clearance of road right of way along the primery and secondary roads is one of the most important issue for the better transport circumstances in LMA.

- The area between the Walled City and the Mall should be considered parking control due to the expected future increase of parking demand and the limit of the facility.

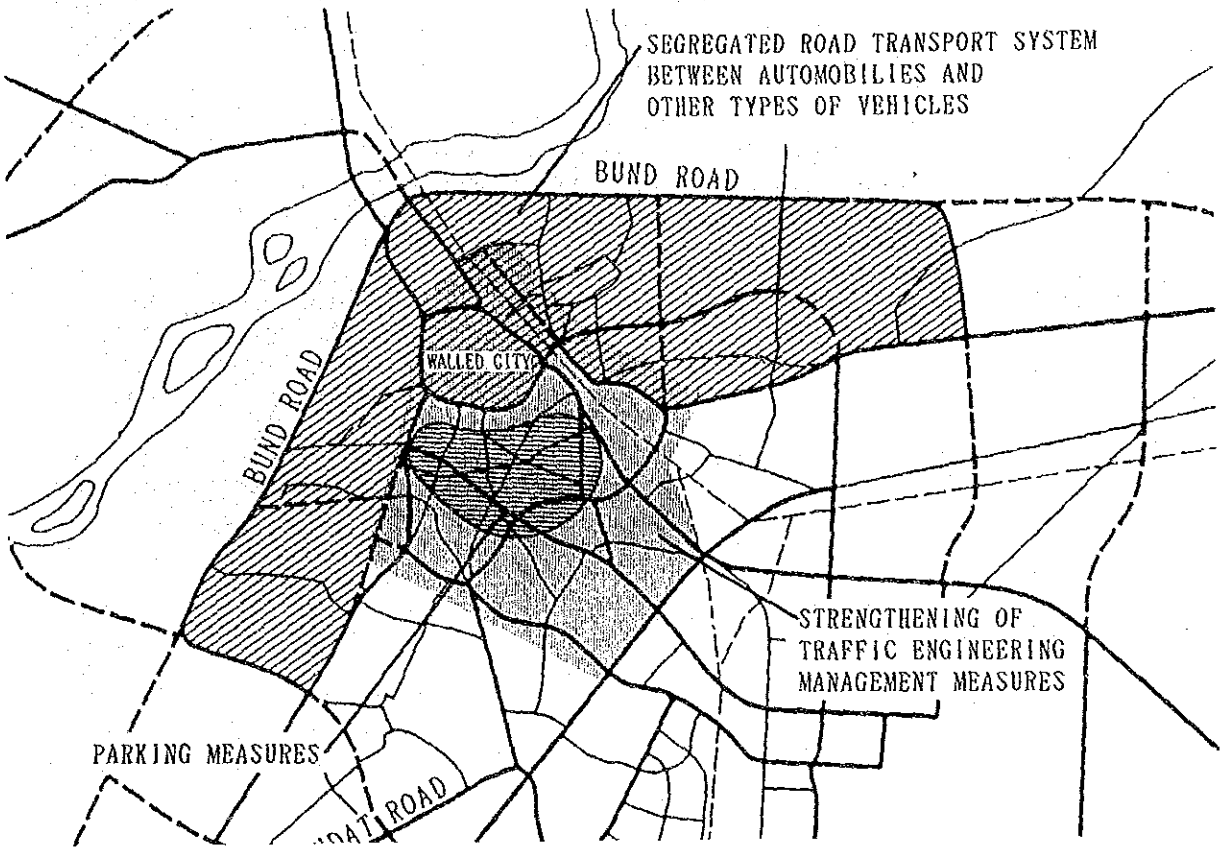
- The Walled City and its sorrounding area should be considered the segregated traffic system between motorized and non-motorized vehivles such as Tongas and other animal drawn vehicles to improve the expected future traffic jams.

(2) Southern sub-core

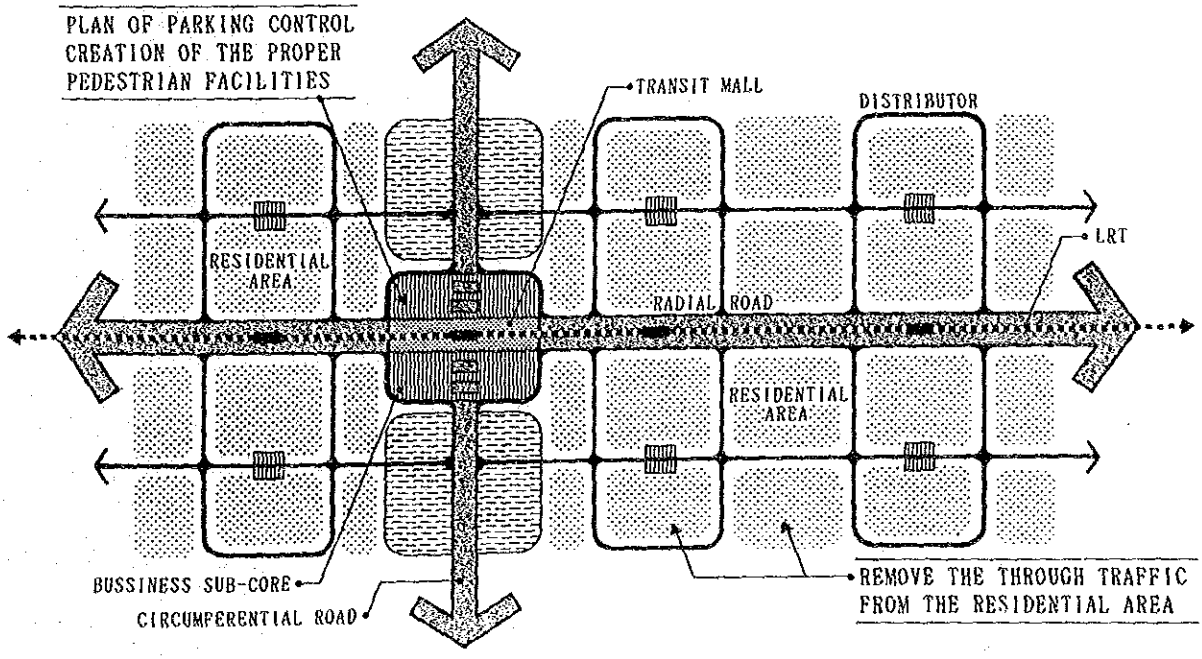
To faciliate the better transport circumstances in the well-planned development area, traffic management program should be introduced together with the development scheme as shown in Figure 7.5.1.

Figure 7.5.1 Traffic Management for the Inner Area and Southern Sub-Core

Inner Area



Southern Sub-Core



7.5.2 Mode Interchange Area Development

The development of mode interchange area such as transit stations and bus terminals is one of the most effective measures to increase the public transpot users. It is expected to introduce not only bus system improvement but also the introduction of LRT and HRT improvement.

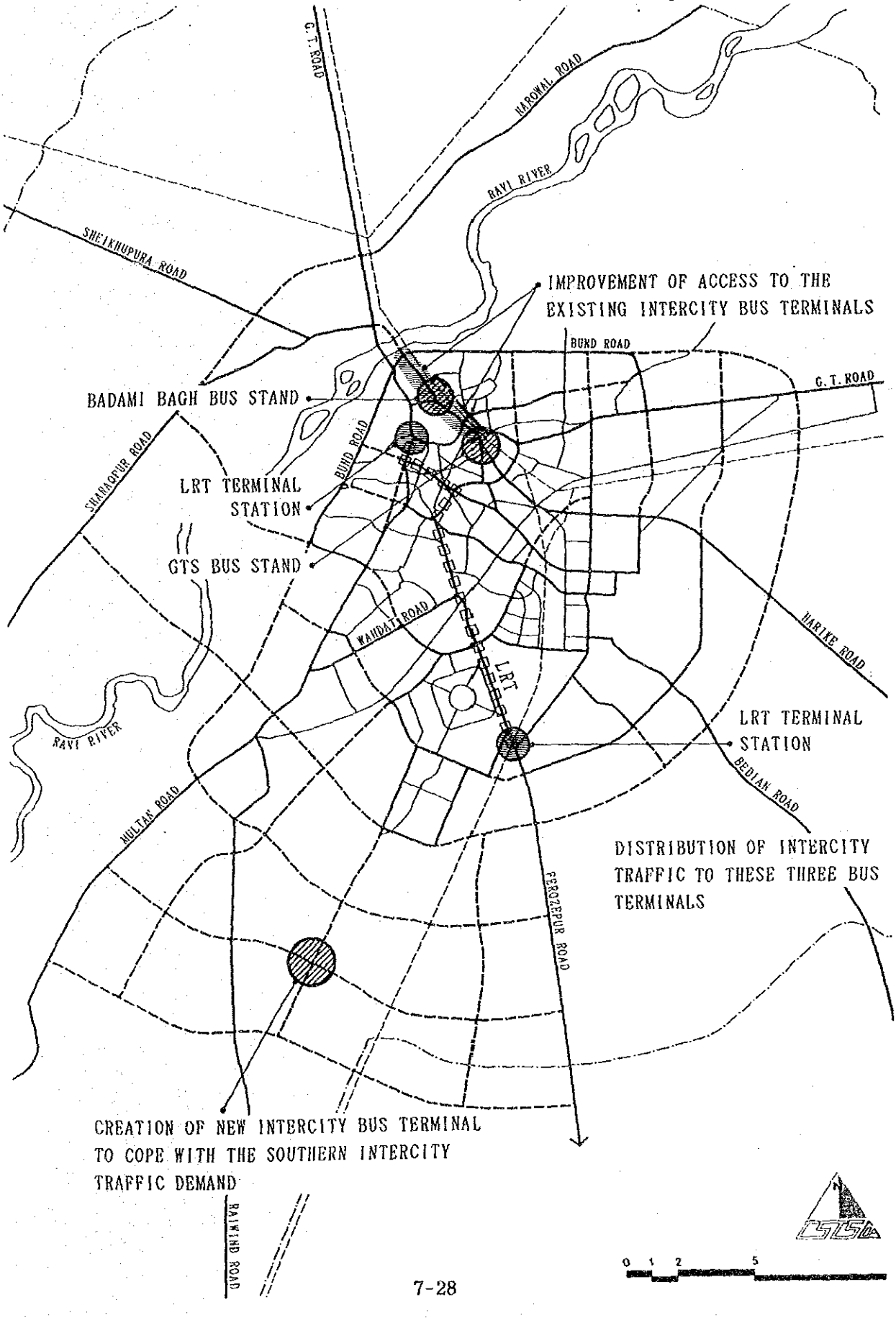
(1) LRT Station is new type of transport system. The station facilities of this system is to possible to create not only the better transfer facilities between other public transpot modes but also the new urban core in the vicinity developed together with the commercial complex.

(2) Though the location and size of the existing intercity bus terminals, Badami Bagh and GTS bus stands, are sufficient, the inadepuate access is the serious problems in these area to cope with the future traffic demand. Therefore, improvement of the access of these intercity bus terminals is important to effective use of the existing facilities.

For the southern development ares, it is necessary to create the new intercity bus terminal to cope with the expected demand of intercity traffic to this area.

The adequate share of directional intercity traffic by these three terminals i.e., Badami Bagh, GTS bus stand and new southern bus terminal is efficient to distribute the expected increase of intercity traffic demand.

Figure 7.5.2 Mode Interchange Area Development



CHAPTER 8. TRANSPORT FACILITIES AND COST ESTIMATE

CHAPTER 8 TRANSPORT FACILITIES AND COST ESTIMATE

To solve urban traffic congestion in Lahore, construction of new roads, improvement of roads, upgrading of Pakistan Railway, introduction of Light Rail Transit System and Busway System, etc. are discussed in this Chapter with the engineering basis of the study including the design standard of road and cost estimate.

The cost estimates of the projects identified in this study is made on the basis of the data available from various implementing agencies and relevant study reports.

8.1 Roads and Road Facilities

8.1.1 Design Standards of Road

The existing roads in Pakistan had not been developed by the one fixed standard. Since the urban areas have been and will continue to expand significantly, that development should be associated with proper design standards.

Several studies for preparing the design standard of road have been conducted in Pakistan, which are:

- Highway Design manual, NHB 1983
- A Policy on Geometric Design of Highway and Streets, AASHTO 1984
- The National Transport Plan in Pakistan, JICA 1988

It was confirmed that the selected four categories of road currently used was reasonable road classifications in terms of cross sectional width for systematic development of road transportation in Lahore. They are shown in Table 8.1.1 and Figure 8.1.1.

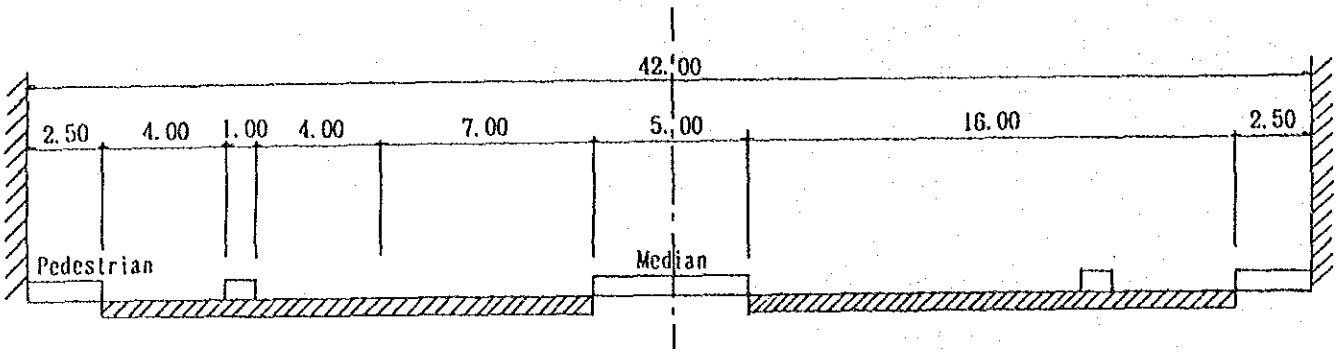
Although roads in Lahore with various types of cross sectional width had been built, constructing new roads and improving the existing roads shall be classified road network into above categories according to traffic volume. The geometric design standard for this project is prepared based on AASHTO in reference with Japanese Standard(refer to Table 8.1.2).

Table 8.1.1 Each Category for Road Planning

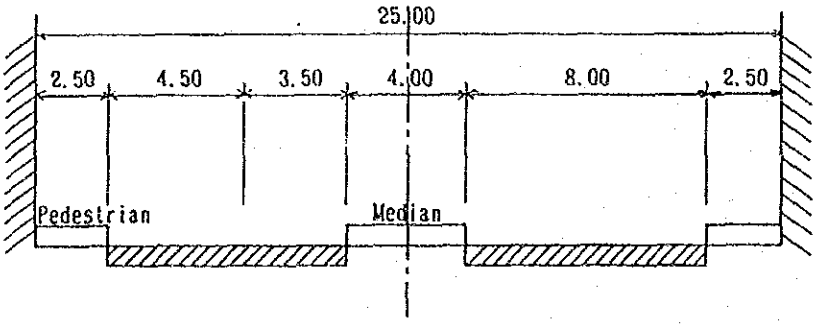
Classification	Design Speed (km/hr)	Planning Guideline (Traffic)		Typical Cross Section (m)		
		A.D.T. (Veh/day)	Level of Service (V/C)	R.O.W.	Formation Width	CarriageWay Width
6 - lanes	60	72,000	D (0.85)	4[illegible].00	4[illegible].00	17.5 × 2
4 - lanes (Urban)	60	48,000	D (0.85)	25.00	25.00	8.00× 2
4 - lanes (Suburban)	110	68,000	D (0.85)	40.00	29.20	7.30× 2
2 - lanes	60	12,000	D (0.85)	15.00	15.00	9.00

Figure 8.1.1 Typical Road Section (in meters)

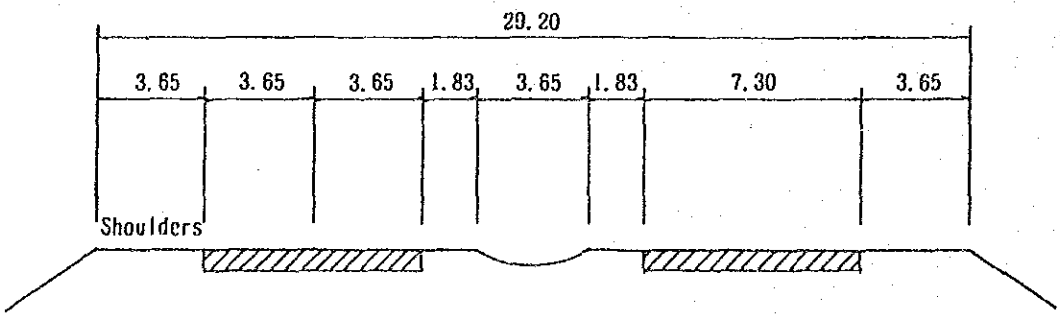
6-LANES



4-LANES (Urban road)



4-LANES (Suburban road)



2-LANES

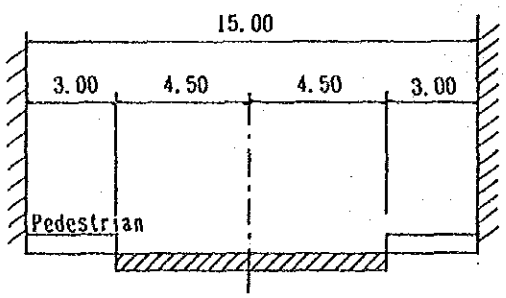


Table 8.1.2 Comparison of Standard Design

ITEM	UNIT	AASHTO	JAPAN
Design Speed	km/h	50	
Clearance	m	4.5	4.5
Minimum Curve Radius	m	80	80
Maximum Superelevation	%	8	10
Transition Curve	m	43	40
Sight Distance	m	61	55
Maximum Gradient	%	8	9
Minimum vertical Curve Length	m	21	40
Minimum Radius of Vertical Curve (Crest)	-	12	8
Minimum Radius of Vertical Curve (Sag)	-	8	7

8.1.2 Pavement

The pavement design is based on the relationship between performance, structural thickness, the traffic loadings, and natural soil condition. However, the following thickness of each course is considered to be standard for each road classification.

Figure 8.1.2 Pavement for 6 and 4 lanes (Thickness in cm)

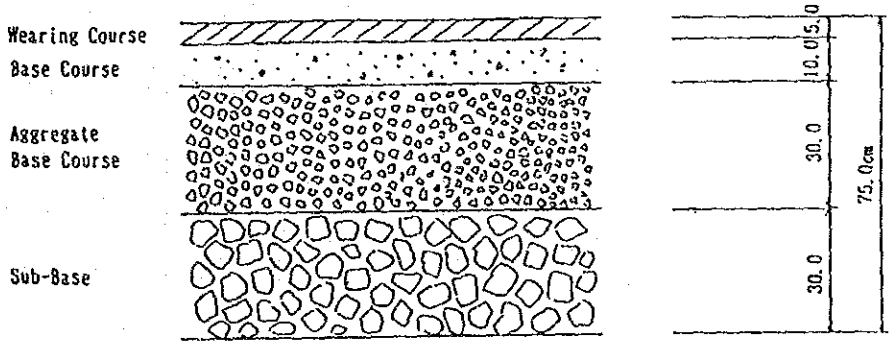
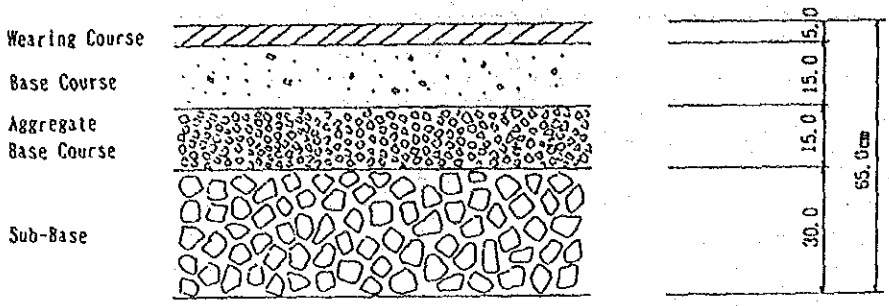


Figure 8.1.3 Pavement for 2 lanes (Thickness in cm)



8.1.3 Bridge across Ravi River

From the viewpoint of minimizing construction cost, local construction conditions and future maintenance, post-tensioned concrete T-shaped girder bridge, which is the same design as the existing one across Ravi River, is most desirable. Side elevation and cross section of the bridge is shown in Figure 8.1.4 and 8.1.5.

Figure 8.1.4 Side Elevation

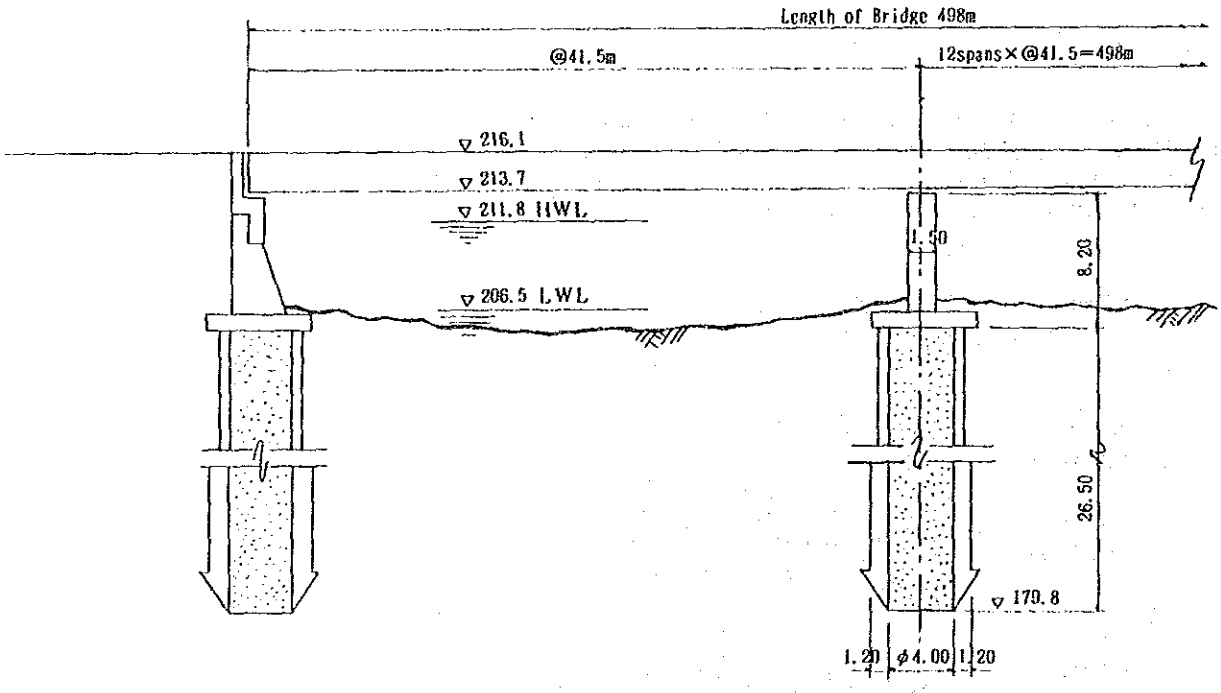
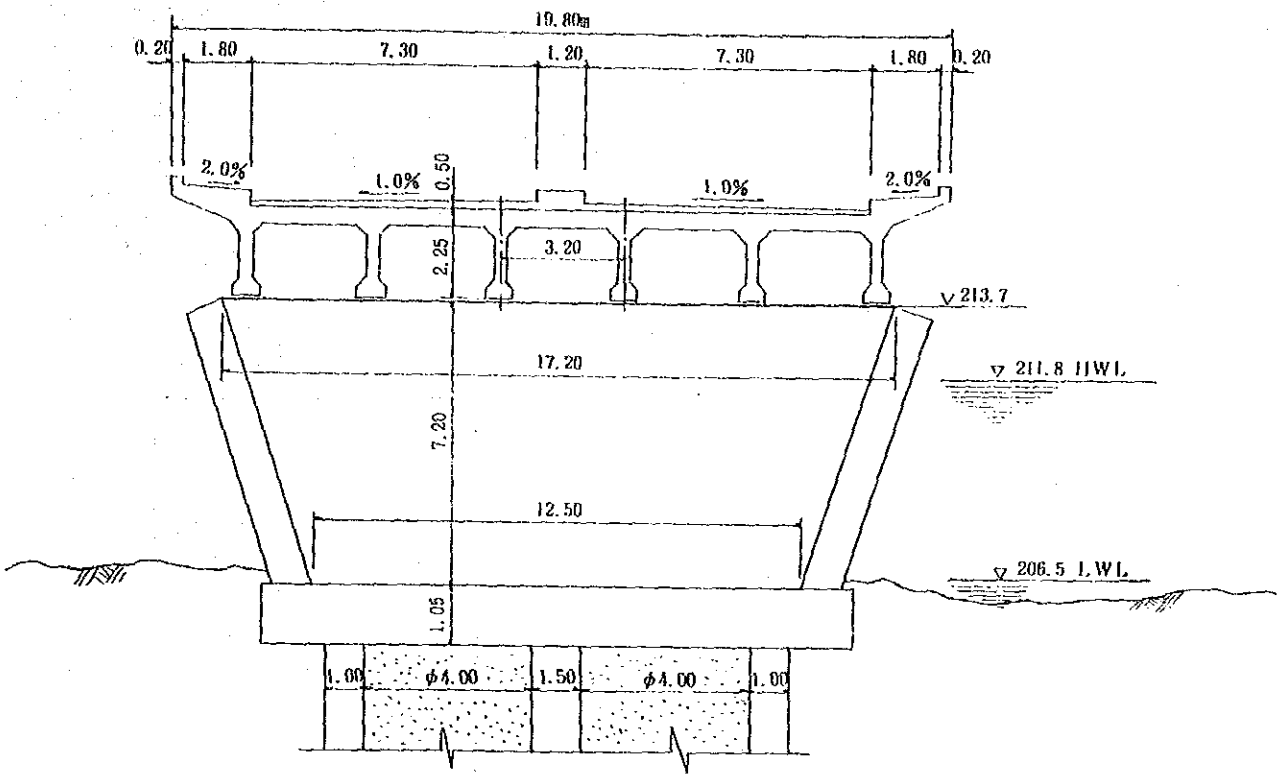


Figure 8.1.5 Cross Section



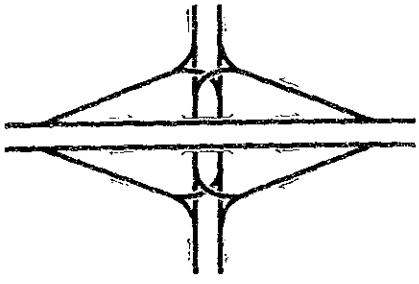
8.1.4 Interchange and Flyover

1) Interchange

There are many types of interchange for road intersection such as diamond type, trumpet type, clover leaf type, etc. After examination of various types of them, Study Team selected the diamond type of interchange in suburbs of Lahore due to the following reasons.

1) Construction cost will be minimized.
2) Space for land acquisition is small.
3) Only one elevated structure is required. (Several elevated structures are required for other types)

Figure 8.1.6 Diamond type of Interchange



2) Flyover

There are two types of flyovers. One is built above road and the other is built above railway. Flyover shall be designed to keep the clearance of 4.70 m for road and 6.25 m for railway.

Figure 8.1.7 Flyover for Road (Intersection with right angle)

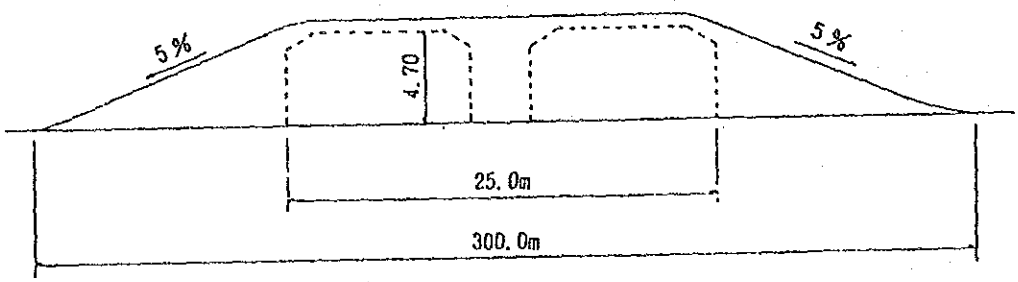
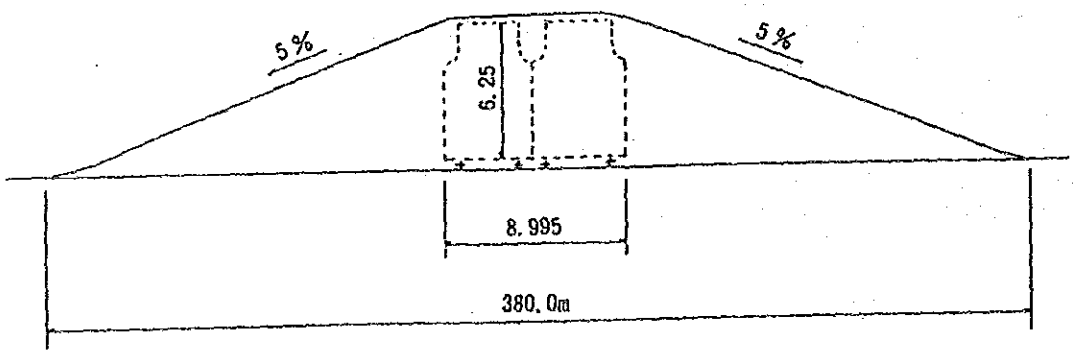


Figure 8.1.8 Flyover for Railway (Intersection with right angle)



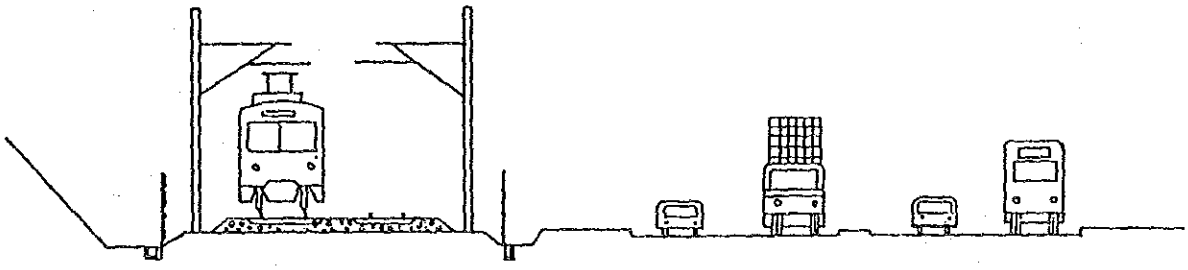
8.2 Alternative Public Transport Systems

8.2.1 Heavy Rail Transit System (HRT)

Pakistan Railways is operated as an intercity transportation at present. To utilized it into an urban transport system in Lahore, upgrading of the existing system is required between Lahore St. and Raiwind St. as follows.

- Improvement of power facilities
- Introduction of new electric cars
- Construction of yards and shops
- Improvement of track alignment at Raiwind St.

Figure 8.2.1 Heavy Rail Transit System



8.2.2 Light Rail Transit System (LRT)

LRT can be operated on a sharply curved track and it is available for occupying smaller Right of Way than heavy rail system. The transport capacity is 8,000 to 25,000 person/hour/one direction. Not so as to increase traffic congestion, LRT must be planned to build on elevated structures along road.

Figure 8.2.2 Light Rail Transit System on Elevated Structures

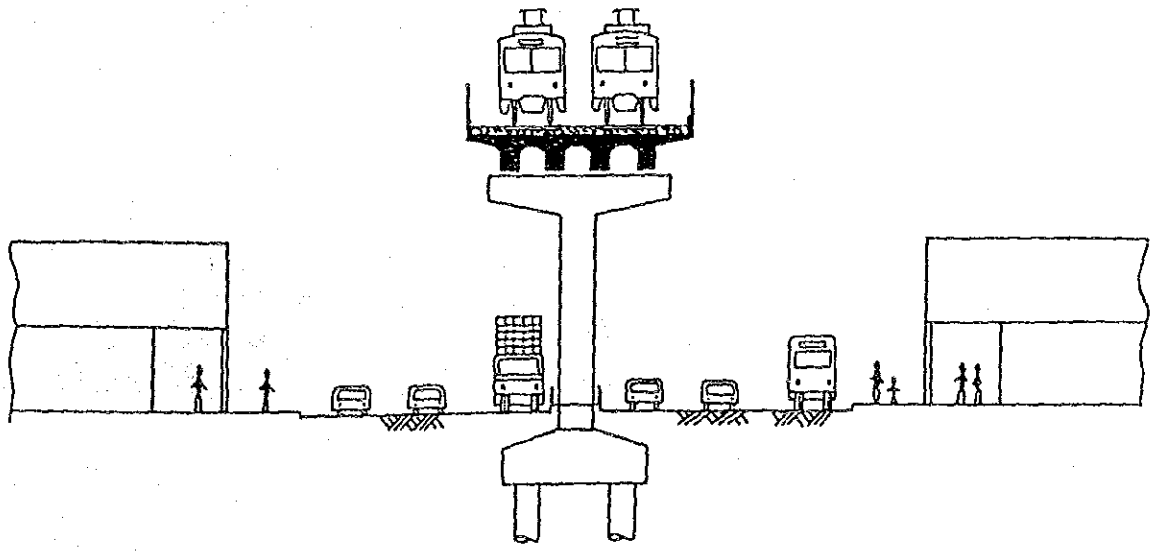
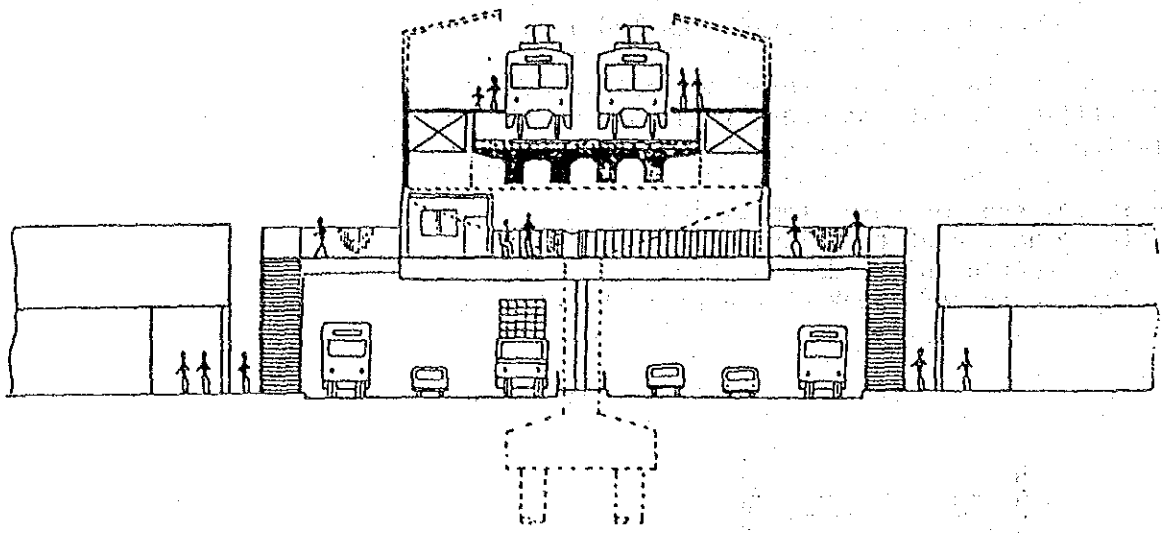


Figure 8.2.3 Light Rail Transit System at Elevated Station



8.2.3 Busway System

Busways will be located in the median of existing roadways, either at grade or elevated. Buses run on exclusive right of way, except with busways the vehicles can also freely use any of the other streets on the same trip before and after using the busway. Stations are sited at locations spaced about 1 Km apart. At the station, 3 lanes are desirable with passing lane at the center. The center lane will be used alternatively one - way direction according to traffic volume.

Figure 8.2.4 Busway System at Grade

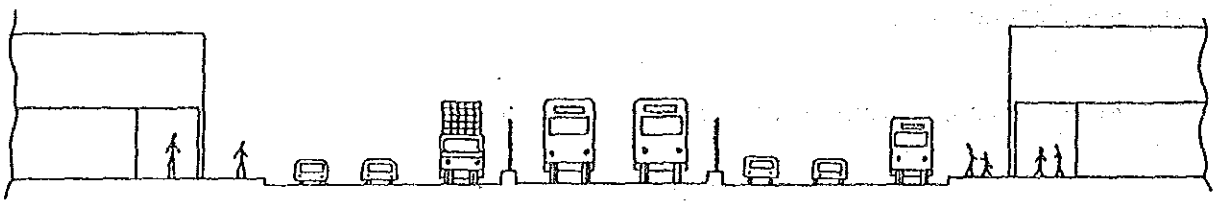


Figure 8.2.5 Busway System at Grade Station

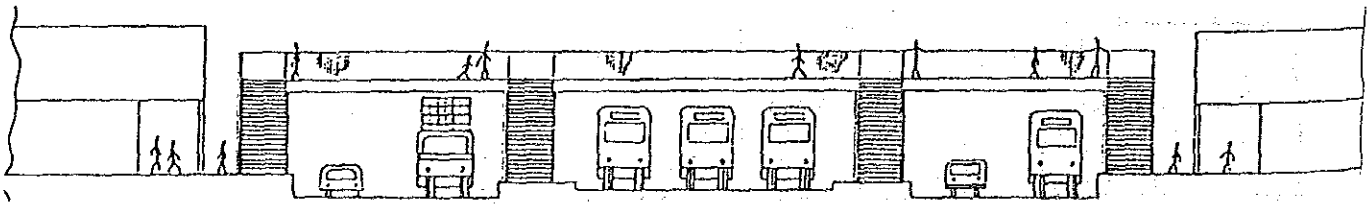


Figure 8.2.6 Busway System on Elevated Structures

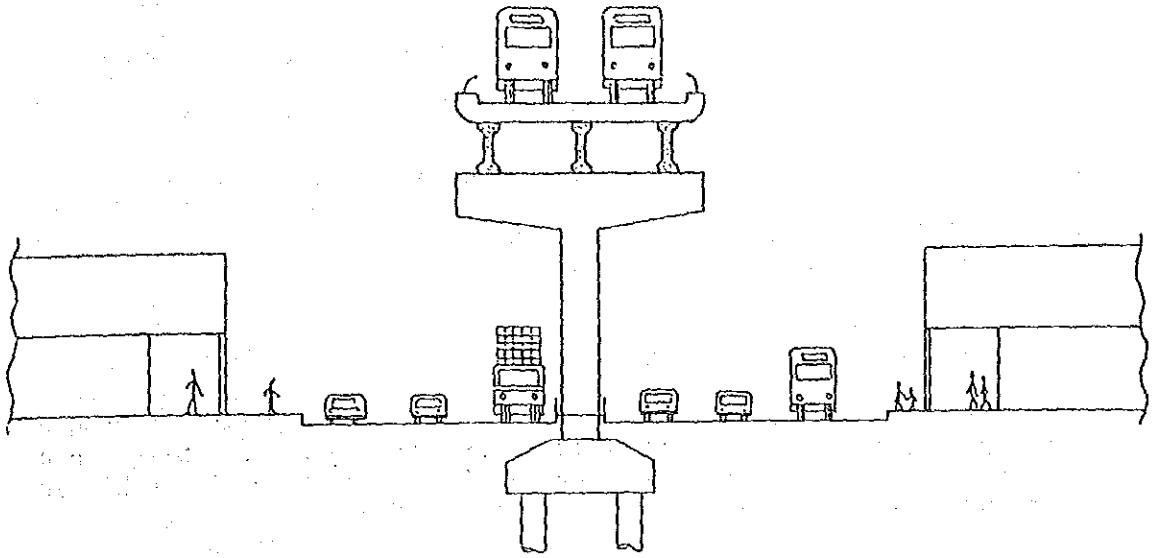
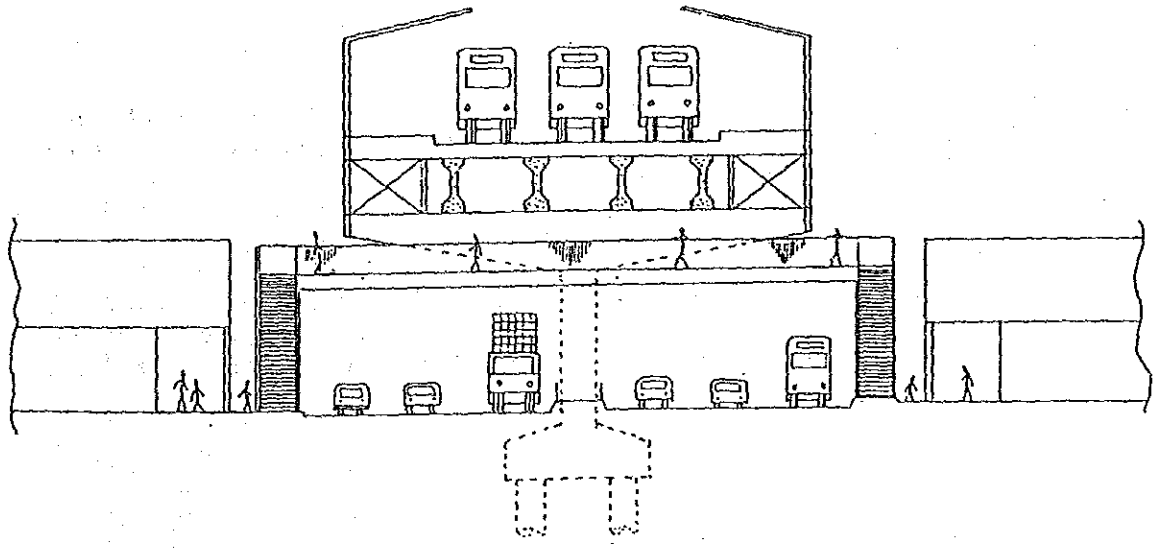


Figure 8.2.7 Busway System on Elevated Station



8.3 Cost Estimate

For the purpose of economic and financial analysis, project cost is estimated on the basis of the following:

1) Construction cost
2) Engineering cost including detailed design and supervision
3) Physical contingency
4) Land acquisition and compensation costs
5) All costs are estimated at 1990 price

8.3.1 Components of project cost

The unit price of each construction item is estimated by the economic conditions prevailing at the end of 1990, and the cost is split into foreign currency and local currency portions both indicated in Pakistan Rupees Exchange rate is : US$ 1.0= Rs. 21.70= 132 Yen.

1) Foreign currency

- Wages of foreign personnel
- Imported materials and machineries (CIF price)
- Overhead and profit of foreign firms

2) Local currency

- Wages of local personnel
- Local materials
- Overhead and profit of local firms
- Managing and maintenance cost of equipment.

3) Tax and duties

Tax and duties comprises of custom duty, sales tax, import surcharge, Iqra surcharge, income tax and Octroi. The rate of custom duty and sales tax differ from equipment to equipment.

4) Economic and financial costs

The project costs are estimated both in terms of economic and financial costs. The economic cost is estimated by subtracting all transfer costs such as custom duty, sales taxes, import surcharge, etc. from financial cost.

8.3.2 Unit cost

1) Labour cost

The daily rates of labour includes basic wages, fringe benefits, social charges, bonus, etc.

Skilled labour	Rs. 120 per day
Semi-skilled labour	Rs. 80 per day
Unskilled labour	Rs. 60 per day

2) Material cost

Table 8.3.1 Unit Cost of Major Materials

Materials	Unit	Unit Cost (Rs.)
Cement	bag	94.17
Steel mild	ton	14,600
Steel high yield	ton	14,700
Prestressing cable	ton	25,706
Binding wire	kg	20
Bitumen (60/70 grade)	ton	6,500
Cut back Asphalt	ton	8,441
Sand	c.m	50
Crushed aggregate	c.m	90
Fuel Petrol	Litre	9
Diesel	Litre	4.20

3) Machine cost

Table 8.3.2 Unit Cost of Major Equipment

Equipment name	C.I.F. (Rs.)
Bulldozer Model D85A-21B	4,245,000
Wheel loader Model WA 420-1	3,320,000
Hydraulic excavator Back Hoe 0.3m^3	1,557,000
Hydraulic excavator Back Hoe 0.7m^3	2,580,000
Dump track 20 ton	5,026,000
Cargo track 11 ton with crane	2,109,000
Portable compressor 150 HP	684,000
Portable compressor 200 HP	834,000
Crawler crane Model DH 30	2,908,000
Truck crane hydraulic 25 ton	3,251,000
Scraper Model 621	5,387,000
Vibratory roller Model W1002D	1,293,000
Asphalt distributor Model ND 60	1,046,000
Generator 100 KVA	385,000
Generator 200 KVA	625,000

4) Unit Construction cost

Table 8.3.3 Unit Construction Cost

(Rupees)

ITEM	Unit	Foreign Cost	Custom & Taxes	Local Cost	Financial Cost	Economic Cost
Clearing and grubbing including compaction	sq.m	1.60	2.00	4.40	8.00	6.00
Excavate & remove common material	cu.m	6.00	7.50	16.50	30.00	22.50
Excavate & remove Semi Rock	cu.m	18.40	23.00	50.60	92.00	69.00
Excavate & remove Rock	cu.m	25.80	32.25	70.95	129.00	96.75
Structural excavation	cu.m	9.00	11.25	24.75	45.00	33.75
Granular backfill	cu.m	43.40	54.25	119.35	217.00	162.75
Common backfill	cu.m	13.20	16.50	36.30	66.00	49.50
Formation of embankment from roadway excavation in common material	cu.m	10.40	13.00	28.60	52.00	39.00
Ditto with rock & semi rock	cu.m	11.60	14.50	31.90	58.00	43.50
Formation of embankment from borrow excavation 5 km lead	cu.m	9.80	12.25	26.95	49.00	36.75
Granular subbase	cu.m	65.00	81.25	178.75	325.00	243.75
Aggregate base	cu.m	76.60	95.75	210.65	383.00	287.25
Asphaltic base course	cu.m	316.00	395.00	869.00	1580.00	1185.00
Asphaltic concrete for wearing course	cu.m	380.60	475.75	1046.65	1903.00	1427.25
Prime coat	sq.m	3.60	4.50	9.90	18.00	13.50
Prestressed Concrete	cu.m	550.60	688.25	1514.15	2753.00	2064.75
Structural Concrete	cu.m	364.00	455.00	1001.00	1820.00	1365.00
Lean concrete	cu.m	276.40	345.50	760.10	1382.00	1036.50
Reinforcement Grade 40	T	4393.80	5492.25	12082.95	21969.00	16476.75
Reinforcement Grade 60	T	4421.00	5526.25	12157.75	22105.00	16578.75
Prestress cable and installation accessories	T	6929.80	8662.25	19056.95	34649.00	25986.75
Riprap	cu.m	86.60	108.25	238.15	433.00	324.75

8.4 Project Cost

The estimated construction cost at the end of 1990 price for each project is summarised separately in Table 8.4.1 to Table 8.4.5. It is estimated that land acquisition and compensation costs will be included only for private land and not for public land. Table 8.4.6 shows the whole project cost for this Master Plan.

Table 8.4.1 Project Cost for Road

Unit = '000 Rupees / km

Description		Economic Cost	Financial Cost
Road 6 - lanes Carriageway 17.50 m × 2	local cost	41,100	49,600
	foreign cost	7,200	7,200
	total	48,300	56,800
Urban Road 4 - lanes Carriageway 8.00 m × 2	local cost	33,500	38,300
	foreign cost	4,000	4,000
	total	37,500	42,300
Suburban Road 4 - lanes Carriageway 7.30 m × 2	local cost	33,400	38,200
	foreign cost	4,000	4,000
	total	37,400	42,200
Road 2 - lanes Carriageway 9.00 m	local cost	21,400	24,700
	foreign cost	2,800	2,800
	total	24,200	27,500
Road Improvement 2 lanes into 4 lanes	local cost	24,900	28,400
	foreign cost	2,900	2,900
	total	27,800	31,300
Road Improvement 2 lanes into 6 lanes	local cost	23,400	28,400
	foreign cost	4,200	4,200
	total	27,600	32,600

Table 8.4.2 Project Cost for Road

Unit = '000 Rupees each

Description		Economic Cost	Financial Cost
Interchange 4 - lanes (diamond type)	local cost	70,600	80,600
	foreign cost	8,400	8,400
	total	79,000	89,000
Flyover 2 - lanes (above road)	local cost	25,400	29,400
	foreign cost	3,400	3,400
	total	28,800	32,800
Flyover 2 - lanes (above railway)	local cost	32,200	37,200
	foreign cost	4,300	4,300
	total	36,500	41,500
Ravi Bridge 4 - lanes (span with 500m long)	local cost	80,900	92,400
	foreign cost	9,700	9,700
	total	90,600	102,100

Table 8.4.3 Project Cost for HRT

Unit : million Rupees per km

Description		Economic Cost	Financial Cost
Heavy Rail Transit (Upgrade of existing	Local cost	26.5	44.1
	Foreign cost	21.1	21.1
Pakistan Railway)	Total	47.6	65.2

Table 8.4.4 Project Cost for LRT

Unit : million Rupees per km

Description		Economic Cost	Financial Cost
Light Rail Transit on elevated structures	Local cost	196.8	296.9
	Foreign cost	113.1	113.1
	Total	309.9	410.0

Table 8.4.5 Project Cost for Busway

Unit : million Rupees per km

Description		Economic Cost	Financial Cost
Busway at grade	Local cost	28.9	44.5
	Foreign cost	12.9	12.9
	Total	41.8	57.4
Busway on elevated structures	Local cost	95.9	141.6
	Foreign cost	38.5	38.5
	Total	134.4	180.1

Table 8.4.6 Summary of Project Cost

Unit : million Rupees

Description	Unit Cost		Unit	Quantity	Economic Cost	Financial Cost
	Economic	Financial				
(1) Rood Project						
- Road - 6 lanes	48.3	56.8	km	9.200	444	523
- Urban Road 4 lanes	37.5	42.3	〃	99.150	3,718	4,194
- Suburban Road 4 lanes	37.4	42.2	〃	80.300	3,003	3,389
- Road - 2 lanes	24.2	27.5	〃	18.250	442	502
- Road Improvemen 2 into 4 lanes	27.8	31.3	〃	62.750	1,744	1,964
- Road Improvement 2 into 6 lanes	27.6	32.6	〃	6.450	178	210
- Interchange	79.0	89.0	each	1	79	89
- Flyover (above road)	28.8	32.8	〃	7	202	230
- Flyover (above railway)	36.5	41.5	〃	6	219	249
- Ravi Bridge	90.6	102.1	〃	3	272	306
			Sub - total		10,301	11,656
(2) Transit System Project						
- Heavy Rail Transit (HRT)	47.6	65.2	km	30.000	1,428	1,956
- Light Rail Transit (LRT)	309.9	410.0	〃	15.000	4,649	6,150
- Busway at grade	41.9	57.4	〃	18.700	784	1,073
- Busway on elevated struc.	134.4	180.1	〃	30.650	4,119	5,520

CHAPTER 9. EVALUATION OF ALTERNATIVE PLANS

CHAPTER 9 EVALUATION OF ALTERNATIVE PLANS

9.1 Evaluation Method

9.1.1 General

In this chapter, an economic evaluation between the proposed alternative plans in the master plan study is carried out. Alternative plans are shown in four types of the mass transit service combinations as discussed in Chapter 7. The road development plan to be completed by 2010 is incorporated in each alternative. It means the case without the project in this economic evaluation is the road network of 1990. The comparison is conducted among the four alternative mass transit service plans shown below.

Alt.-1. LRT & HRT
Alt.-2. Busways & HRT
Alt.-3. LRT only
Alt.-4. Busways only

The most economically viable plan shall be an essential part of the overall transport master plan for LMA in the coming 20 years or 30 years.

The economic benefits measured here are savings in vehicle operating costs (VOC) and savings in travel time costs (TTC) of passengers. Alternative plans will reduce congestion of road traffic, which will result in less VOC of vehicles on roads and less travel time for users of the new mass transit as well as persons on buses and private vehicles.

The economic costs is composed of construction costs of roads, civil work and structures, rolling stock, depot/workshop and daily operation and maintenance (O & M) costs.

9.1.2 Premises

Those alternatives are evaluated on the assumptions as follows:

1. Road construction (including improvement of existing roads) will be implemented during the year 1991 to 2010. Investment costs will be distributed equally among these twenty (20) years.

2. Each alternative mass transit plan will be implemented during the year 2006 to 2010. Investment costs will be distributed equally among these five (5) years.

3. Evaluation term of 50 years from the commencement of the road construction, including benefits over the 30 years after the completion of each alternative public transport plan.

4. In case of calculating benefits from the implementation of road construction, which is derived from VOCs and TTCs, some amount is anticipated after 5 years of commencement of construction. In this evaluation, one sixteenth of benefits of the first year (i.e. 2011) is

added up each year during the years from 1996 to 2010.

5. Costs and benefits are shown at the 1990 constant prices in economic terms.

6. For the economic evaluation, benefits of the first year (i.e. 2011) are assumed to increase by 3 percent per annum during the evaluation term, according to the estimated total traffic demand growth.

7. Calculated results are shown by the benefit-cost ratio (B/C Ratio: using a discount rate of 12 %), the net present value (NPV: using a discount rate of 12 %), and the economic internal rate of return (EIRR).

9.2 Alternative Plans

A comprehensive transport system, comprising both road transport and rail transit systems, is necessary to cope with future urban transport demand in LMA, as discussed in Chapter 7. A comparison of each alternative public transport system is also conducted in the same chapter, and in this section the formulation of alternative packaged plans is considered and evaluated.

9.2.1 Alternative Four Packaged Plans

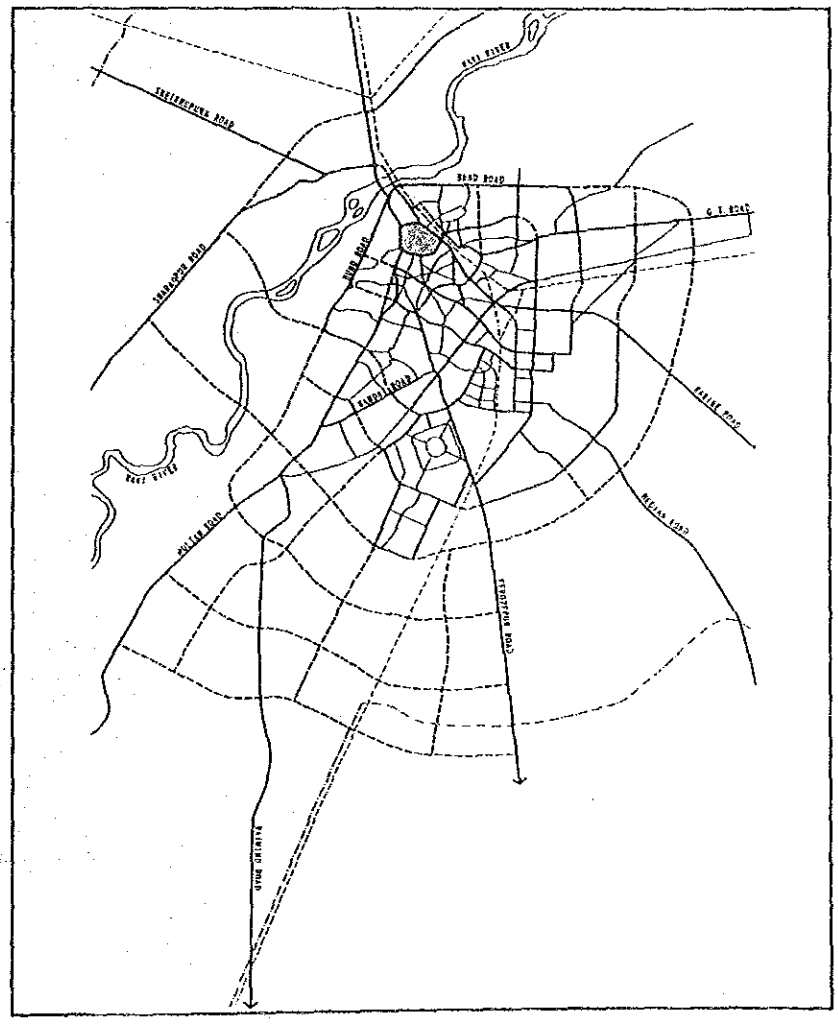
(1) Components for Alternatives

Based on the examination in Chapter 7, the major transport system components which comprise the transport master plan of LMA in the year 2010 are as follows.

1) Road Network

Road network consists of basic radial/circumferential pattern, resulting in 65 km of the existing road improvement and 200 km of new construction, with intersection improvement and bridge construction.

Figure 9.2.1 Proposed Road Network

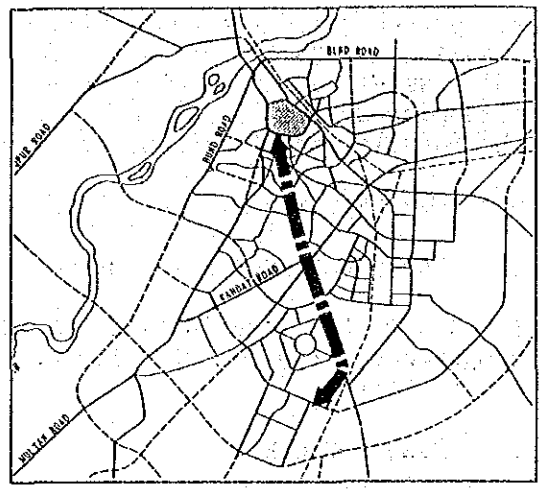


2) Public transport system

a) LRT System

The core system of public transport for its major corridors, with extension possibility towards south, north and east in future

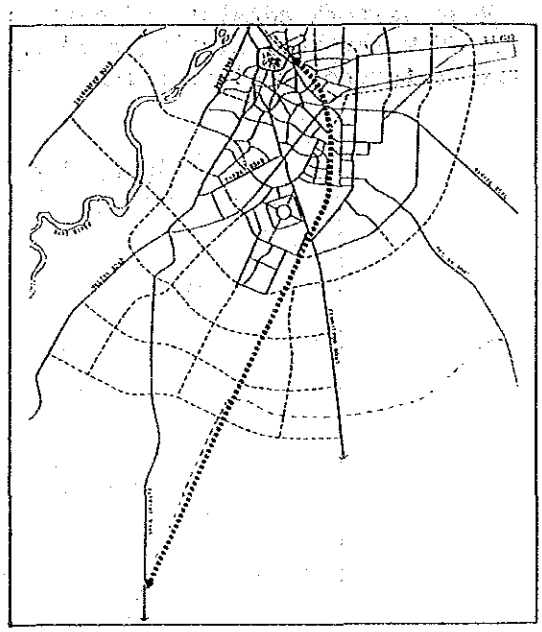
Length: approx. 13km
(in 1st stage)



b) HRT Improvement

As a supplemental system, introduction of electric railcars between Lahore City St. to Raiwind St., using existing PR facilities as much as possible

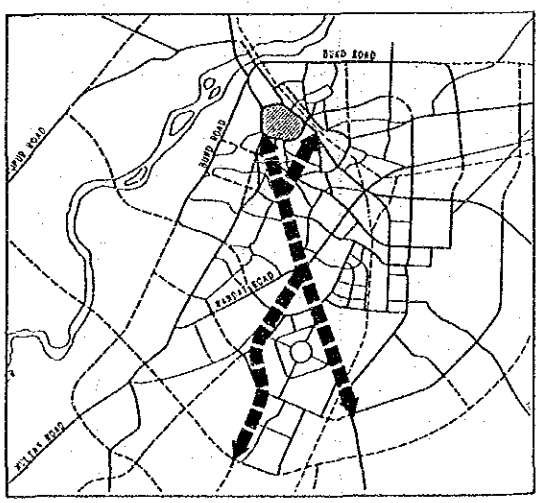
Length: approx. 40km



c) Busway

Grade-separated bus exclusive ways, along major public transport corridors with possible R.O.W

Length: approx. 30km



(2) Alternative Packages

Factors considered for the alternative packages are as follows:

1) Existing conditions of urbanization and transport system in LMA

2) Characteristics of transport demand

3) Suitability and realization of introduction of transport system

4) Possible investment size

5) High effectiveness and cost performance of mixture of the different systems

Based on the above, the procedure in drawing up the alternative packages is shown as follows:

1) The planned road network is the basic component for all alternatives.

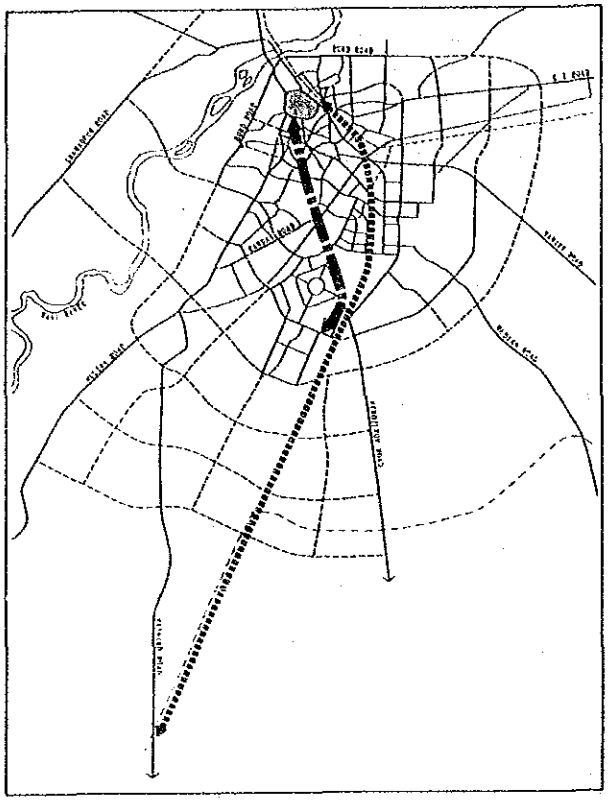
2) The LRT and the busway, which form the core of public transport, are the main factors of the alternatives.

3) It is considered that HRT is the supplemental system of public transport due to its limited capacity.

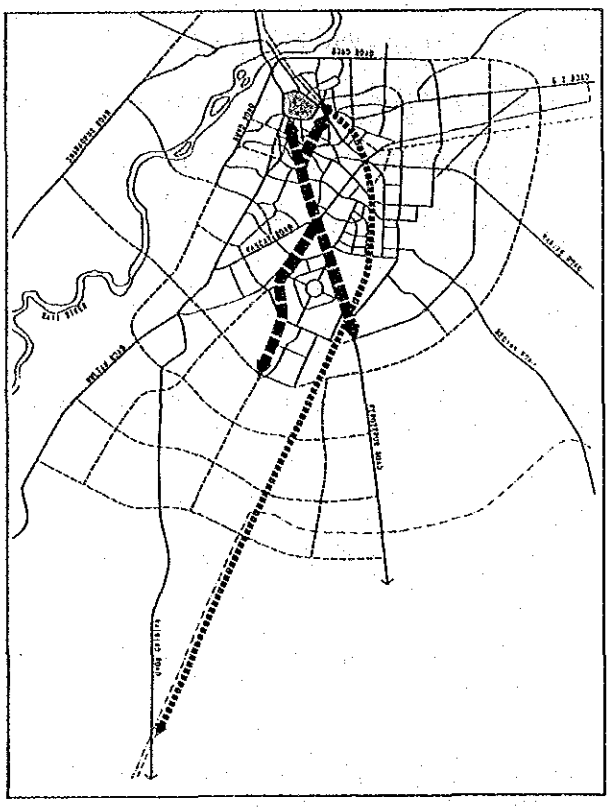
Therefore, four (4) alternatives, i.e., 'LRT' or 'Busway', plus 'with HRT' or 'without HRT' are proposed for the alternative study of transport master plan in 2010, as shown in Figure 9.2.2.

Figure 9.2.2 Alternative Packaged Plans

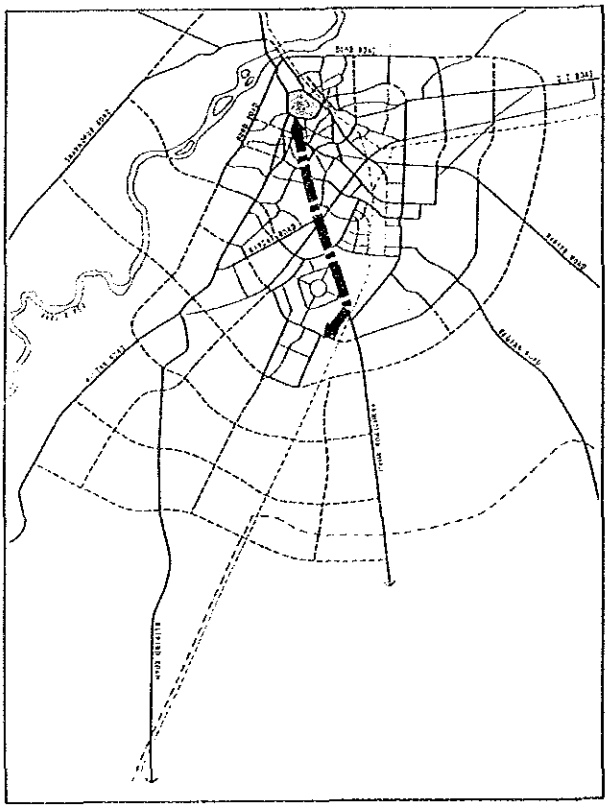
Alternative 1 (LRT+HRT)



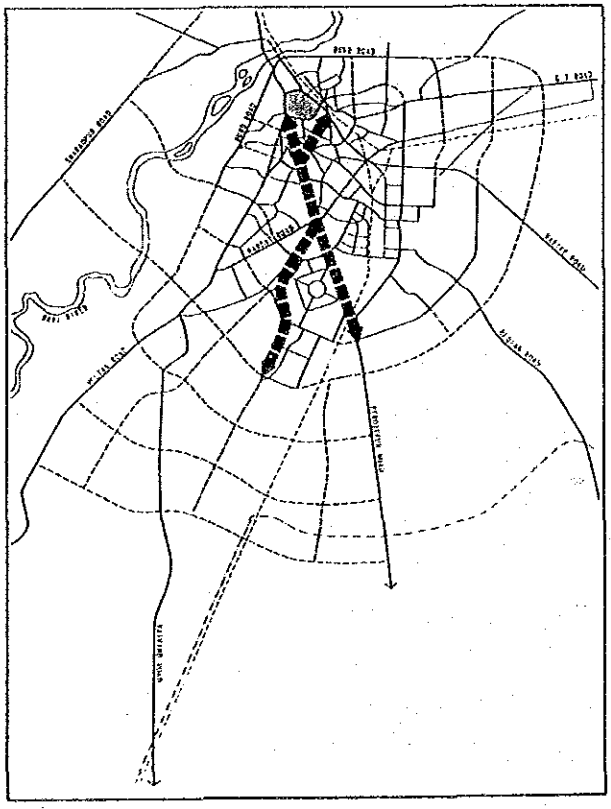
Alternative 2 (Busway+HRT)



Alternative 3 (LRT Oriented)



Alternative 4 (Busway Oriented)



9.2.2 Cost

The necessary cost for construction of each four alternative packaged plan is estimated as discussed in Chapter 8, and the results are summarized in Tables 9.2.1 to 9.2.4.

Table 9.2.1 Total Project Cost (Alternative 1 : LRT + HRT)

Unit : million Rupees

Description	Unit Cost		Unit	Quantity	Economic Cost	Financial Cost
	Economic	Financial				
Road - 6 lanes	48.3	56.8	km	9,200	444	523
Urban Road 4 lanes	37.5	42.3	"	99,150	3,718	4,194
Suburban Road 4 lanes	37.4	42.2	"	80,300	3,003	3,389
Road - 2 lanes	24.2	27.5	"	18,250	442	502
Road Improvement 2 into 4 lanes	27.8	31.3	"	62,750	1,744	1,964
Road Improvement 2 into 6 lanes	27.6	32.6	"	6,450	178	210
Interchange	79.0	89.0	each	1	79	89
Flyover (above road)	28.8	32.8	"	7	202	230
Flyover (above railway)	36.5	41.5	"	6	219	249
Ravi Bridge	90.6	102.1	"	3	272	306
Light Rail Transit	309.9	410.0	km	15,000	4,649	6,150
Heavy Rail Transit	47.6	65.2	"	30,000	1,428	1,956
Total Project Cost					16,378	19,762

Table 9.2.2 Total Project Cost (Alternative 2 : Busway + HRT)

Unit : million Rs.

Description	Unit Cost		Unit	Quantity	Economic Cost	Financial Cost
	Economic	Financial				
Road - 6 lanes	48.3	56.8	km	9.200	444	523
Urban Road 4 lanes	37.5	42.3	"	99.150	3,718	4,194
Suburban Road 4 lanes	37.4	42.2	"	80.300	3,003	3,389
Road - 2 lanes	24.2	27.5	"	18.250	442	502
Road Improvement 2 into 4 lanes	27.8	31.3	"	62.750	1,744	1,964
Road Improvement 2 into 6 lanes	27.6	32.6	"	6.450	178	210
Interchange	79.0	89.0	each	1	79	89
Flyover (above road)	28.8	32.8	"	7	202	230
Flyover (above railway)	36.5	41.5	"	6	219	249
Ravi Bridge	90.6	102.1	"	3	272	306
Busway at grade	41.9	57.4	km	18.700	784	1,073
Busway on elevated struc.	134.4	180.1	"	30.650	4,119	5,520
Heavy Rail Transit	47.6	65.2	"	30.000	1,428	1,956
Totale Project Cost					16,632	20,205

Table 9.2.3 Total Project Cost (Alt. 3: LRT)

Unit : million Rs.

Description	Unit Cost		Unit	Quantity	Economic Cost	Financial Cost
	Economic	Financial				
Road - 6 lanes	48.3	56.8	km	9.200	444	523
Urban Road 4 lanes	37.5	42.3	"	99.150	3,718	4,194
Suburban Road 4 lanes	37.4	42.2	"	80.300	3,003	3,389
Road - 2 lanes	24.2	27.5	"	18.250	442	502
Road Improvement 2 into 4 lanes	27.8	31.3	"	62.750	1,744	1,964
Road Improvement 2 into 6 lanes	27.6	32.6	"	6.450	178	210
Interchange	79.0	89.0	each	1	79	89
Flyover (above road)	28.8	32.8	"	7	202	230
Flyover (above railway)	36.5	41.5	"	6	219	249
Ravi Bridge	90.6	102.1	"	3	272	306
Light Rail Transit	309.9	410.0	km	15.000	4,649	6,150
Totale Project Cost					14,950	17,806

Table 9.2.4 Total Project Cost (Alt. 4: Busway)

Unit : million Rs.

Description	Unit Cost		Unit	Quantity	Economic Cost	Financial Cost
	Economic	Financial				
Road - 6 lanes	48.3	56.8	km	9.200	444	523
Urban Road 4 lanes	37.5	42.3	"	99.150	3,718	4,194
Suburban Road 4 lanes	37.4	42.2	"	80.300	3,003	3,389
Road - 2 lanes	24.2	27.5	"	18.250	442	502
Road Improvement 2 into 4 lanes	27.8	31.3	"	62.750	1,744	1,964
Road Improvement 2 into 6 lanes	27.6	32.6	"	6.450	178	210
Interchange	79.0	89.0	each	1	79	89
Flyover (above road)	28.8	32.8	"	7	202	230
Flyover (above railway)	36.5	41.5	"	6	219	249
Ravi Bridge	90.6	102.1	"	3	272	306
Busway at grade	41.9	57.4	km	18.700	784	1,073
Busway on elevated struc.	134.4	180.1	"	30.650	4,119	5,520
Totale Project Cost					15,204	18,249

9.3 Economic Evaluation

9.3.1 Introduction

The costs for every alternative are;

- initial investments for construction of such facilities as roads and bridges, light rail transit system (LRT), heavy rail transit system (HRT) and/or busways
- annual operation and maintenance (O/M) cost, and
- additional investments; if any, during the project life of 30 years.

On the other hand, benefits from each alternative package can be considered as follows;

- savings in vehicle operating cost (VOC) on roads
- savings in travel time cost (TTC) of passengers on roads as well as on the new transit

Other items and other intangible benefits such as increase of urban amenity, environmental improvement and effective utilization of existing facilities and reduction in traffic accidents are not quantified.

9.3.2 Benefits

(1) Vehicle Operating Cost (VOC)

VOC was estimated by road project studies conducted recently in Pakistan. They are reviewed and updated here. Duty and tax components are excluded and figures are shown in economic cost. Appendix Tables 9.3.1 through 9.3.8 discuss the detail of VOC.

(2) Traffic Volume, Average Speed and Share by Vehicle Type

1) Traffic Volume

Traffic volumes assigned in each case, "Road improvement only" and other four alternative cases, were estimated in Chapter 7 and are summarized in Table 9.3.1.

The average vehicle operating speed is also estimated as shown in Table 9.3.2.

In these tables, "Private" includes motorcycle, car, taxi/rickshaw, and trucks, while "Public" includes mini-bus and bus.

Table 9.3.1. Estimated Traffic Demands by Alternative

(per day)

		Do Nothing	LRT+HRT	Busway+HRT	LRT only	Busway only
Total	Pass.km	148,504,933	149,419,590	148,634,343	148,667,903	148,586,108
	Pass.hr	7,904,990	7,811,241	7,830,012	7,860,253	7,853,850
Private	Pass.km	102,030,683	102,030,683	102,030,683	102,030,683	102,030,683
	Pass.hr	5,207,086	5,207,086	5,207,086	5,207,086	5,207,683
Public Total	Pass.km	46,474,250	47,388,907	46,603,660	46,637,220	46,555,425
	Pass.hr	2,697,904	2,604,155	2,622,926	2,653,167	2,646,764
Bus Total	Pass.km	46,474,250	43,602,318	42,673,951	44,414,671	43,958,227
	Pass.hr	2,697,904	2,493,386	2,484,092	2,579,082	2,542,876
LRT	Pass.km	-	1,934,743	-	2,222,549	-
	Pass.hr	-	64,491	-	74,085	-
HRT	Pass.km	-	1,851,846	1,219,394	-	-
	Pass.hr	-	46,296	30,485	-	-
Busway	Pass.km	-	-	2,710,315	-	2,597,198
	Pass.hr	-	-	108,412	-	103,888

Table 9.3.2 Average Vehicle Operating Speed

		Do Nothing	LRT+HRT	Busway+HRT	LRT only	Busway only
Private		19.59	19.59	19.59	19.59	19.59
Public	Bus	17.23	17.49	17.18	17.22	17.29
	LRT	-	30.00	-	30.00	-
	HRT	-	40.00	40.00	-	-
	Busway	-	-	25.00	-	25.00

2) Conversion Factors from Passenger to Vehicle

Based on the results of the Screen Line Survey conducted in October 1990, shares of traffic volume by vehicle type and average number of passengers were obtained, and from these figures the average number of passengers in "Private" mode and "Public" is calculated as 2.07 and 19.50 persons per vehicle, respectively. (Table 9.3.3)

The total vehicle operating kilometerages by mode are obtained, applying the above results to the pass.-km in Table 9.3.1, as shown in Table 9.3.4.

Table 9.3.3. Vehicle Composition and Average No. of Passengers

		Private Vehicle				Public Transport		Total
		Motor Cycle	Auto Rickshaw	Car*	Truck	Mini Bus	Bus**	
Screen Line A		169,221	22,633	194,148	4,846	18,557	4,170	413,575
Screen Line B		141,660	22,084	109,081	8,374	13,275	2,192	296,666
Screen Line C		17,440	2,447	18,907	5,723	7,162	4,095	55,774
Total	No. of Veh.	328,321	47,164	322,136	18,943	38,994	10,457	766,015
	(%)	(42.86)	(6.16)	(42.05)	(2.47)	(5.09)	(1.36)	(100.00)
Average No. of Pass.		1.5	2.0	2.6	3.0	14.0	40.0	—

* including SUZUKI
** including institutional buses
*** Screen lines are in Figure 3.3.3

Table 9.3.4 Total Vehicle-km

(vehicle-km/day)

		Do Nothing	LRT+HRT	Busway+HRT	LRT only	Busway only
Private		49,290,185	49,290,185	49,290,185	49,290,185	49,290,185
Public	Bus	2,383,295	2,236,016	2,188,408	2,277,675	2,254,268
	Busway	-	-	67,758	-	64,930

3) VOC of Each Cases

The average VOCs of each alternative case (in Rupees per 1,000 km) are calculated from both "Operating Speed" derived in Table 9.3.2 and "VOC" in Appendix 9.3.8. and are tabulated in Table 9.3.5.

Table 9.3.5 Average VOCs of Each Alternative Case

		Operating Speed(km/hr)	Motor Cycle	Auto Rickshaw	Car	Truck	Average VOC
Private Vehicle	Unimproved Rd. Cond.	19.59	433.02	1,813,84	4,560.57	5,258.66	2,506.75
	Improved Rd. Cond.	19.59	398.36	1,683.94	4,090.90	4,898.83	2,261.69

Plan	Public Transport		Operating Speed(km/h)	Mini Bus	Bus	Average VOC(Rs./1000km)
0	Do Nothing Case	Unimproved Rd. Cond.	17.23	3,116.79	5,092.49	3,533.47
1	Alternative Projects	Improved Rd. Cond.	17.49	2,942.34	4,788.89	3,331.78
2			17.18	2,979.29	4,840.48	3,371.81
3			17.22	2,974.52	4,833.31	3,366.54
4			17.29	2,966.18	4,820.75	3,357.31
2		Busway	25.00	—	3,376.23	3,376.23

(3) Savings in VOC in the First Year

The total VOCs of each case are calculated both with vehicle-km given in Table 9.3.4 and average VOC in Table 9.3.5. Table 9.3.6 shows the results.

The differences of total VOCs, between "Do Nothing" case and each alternative case, are defined as the "Savings in VOC" by implementation of each alternative projects.

As the result of annual total savings in VOC, figures in Table 9.3.7 can be compared.

Table 9.3.6 Comparison of VOC by Case (Rs./day)

		Do Nothing	LRT+HRT	BUSWAY+HRT	LRT Only	BUSWAY Only
Total		131,979.47	118,929.03	119,086.79	119.147.0	119,266.62
Private		123,558.17	111,479.12	111,479.12	111,479.12	111,479.12
PUBLIC	Sub Total	8,421.30	7,449.91	7,607.67	7,667.88	7,787.50
	Buses	8,421.30	7,449.91	7,378.90	7,667.88	7,568.28
	Busway	-	-	228.77	-	219.22

Table 9.3.7 Savings in VOC by Alternative Case (mil.Rs./year)

	LRT+HRT	Busway+HRT	LRT Only	Busway Only
Private*	2,204.43	2,204.43	2,204.43	2,204.43
Public	354.56	296.97	275.00	231.34
Total	2,558.99	2,501.40	2,479.43	2,435.77

* half the figure of annual Savings in VOC calculated from Table 9.3.6.

As is clear in the table, "LRT+HRT" case shows the largest benefits, while "Busway Only" case shows the smallest.

(4) Savings in Travel Time Costs (TTC)

TTC was estimated in Appendix Table 9.3.6., while total travel time is assigned as shown in Table 9.3.1.

Differences of travel time of each alternative plan with "Do Nothing" case in "Public" mode is shown in Table 9.3.8. Using the vehicle composition and average number of passengers as shown in Table 9.3.3, average travel time cost per passenger-hour is calculated to be 4.9154 Rupees for the "Public" mode. (Rs. 10.6381 for the "Private" mode)

Table 9.3.8 Difference of Travel Time by Alternative Plans (passenger-hour)

LRT+HRT	BUSWAY+HRT	LRT only	Busway only
204,518	105,400	118,822	51,140

Daily savings in TTC of "Public" mode by each alternative plan is estimated as shown in Table 9.3.9.

Table 9.3.9 Daily Savings in TTC (Public)

(Rs./day)

	LRT+HRT	BUSWAY+HRT	LRT Only	BUSWAY Only
Savings in TTC	1,005,287.8	518,083.2	584,057.7	251,373.6
Percentage to total public TTC of "Do Nothing" Case	7.58	3.91	4.40	1.90

Although there is no difference of travel time between "Do Nothing" case and alternative cases in Table 9.3.1 due to system of traffic distraction, at least half the percentage of savings in TTC can be anticipated in "Private" mode with the improved conditions of road network.

Thus, the total savings in TTC by each alternative plan is estimated as shown in Table 9.3.10.

Table 9.3.10 Savings in TTC by Alternative Plans

(mil. Rupees/year)

	LRT+HRT	BUSWAY+HRT	LRT Only	BUSWAY Only
Private	766.29	394.87	444.81	191.67
Public	366.93	189.10	213.18	91.75
Total	1,133.22	583.97	657.99	283.42

9.3.3 Project Costs

The costs of each alternative plan consist of initial investment and operation/maintenance cost during the evaluation period.

As the each project cost was estimated in the previous chapter, the detailed breakdown for years during the evaluation period is summarized in Appendix Table 9.3.9(1) to (4), together with benefits estimated.

9.3.4 Economic Evaluation

From the both results of benefit and cost flows in the previous sections, indicators of economic evaluation for comparison of four alternative project packages, such as B/C ratio, NPV and EIRR, are calculated as in Table 9.3.11.

Every alternative seems to be economically feasible with more than 15 percent of EIRR. Considering that the cost flows are simplified, especially the initial investments equally divided in 20 years for road construction and 5 years for each alternative plan, these resultant figures should be regarded as crudely estimated indicators for a mutual comparison among the alternatives.

In this regard, "LRT oriented" case is always favourable from any factors than "Busway oriented" case. Among two "LRT oriented" cases, "LRT+HRT" case shows higher B/C ratio, larger NPV and higher EIRR than "LRT Only" case.

Though "LRT+HRT" case is the most favourable from the economic evaluation view-point, the best alternative in the economic terms may not be always the best choice considering other physical, social and economical conditions of the LMA. Thus, the recommendation in this stage is to suggest that the "LRT oriented" alternative plans are considered as the priority projects for the Feasibility Study to be conducted in the coming next stage.

Table 9.3.11 Results of Economic Evaluation

Indicator	LRT+HRT	BUSWAY+HRT	LRT Only	BUSWAY Only
Net Present Value (NPV)	(Rs.in mil) 3,306.11	(Rs.in mil) 2,206.03	(Rs.in mil) 2,519.88	(Rs.in mil) 1,656.55
B/C Ratio	1.68	1.46	1.54	1.36
Economic Internal Rate of Return (EIRR)	17.60%	15.92%	16.48%	15.27%

9.4 Overall Evaluation

Based on the economic evaluation and other factors, overall evaluation of transport alternatives was conducted and its result is summarized in Table 9.4.1.

The factors for the evaluation are as follows:

(1) Economic evaluation such as B/C ratio, NPV (net present value) and EIRR (economic internal rate of return)

(2) Easiness of maintenance and operation of the system

(3) Impact to the urban environment

(4) Impact to the land use and effectiveness of development along the transport corridor

(5) Impact to the road and road network

(6) Flexibility to the increase of transport demand

(7) Revitalization of the existing system/facility

As a conclusion, the "LRT + HRT" alternative is recommended to be the major public transport system as well as the road network system in the master plan for the LMA because of the following reasons.

- Creation of new urban amenity
- Introduction of well-planned land use and effectiveness of development along transport corridor
- Improvement of the existing system/facility

Table 9.4.1 Overall Evaluation of Transport Alternatives

Items	LRT + MRT (Case 1)	Busway + MRT (Case 2)	LRT Only (Case 3)	Busway Only (Case 4)
System	LRT = 12.5km MRT = 40km	Busway = 30km MRT = 40km	LRT = 12.5km	Busway = 30km
Daily Passenger	302,000	278,000	245,000	214,000
Economic Evaluation B/C Ratio NPV (Rs. Million) EIRR(%)	1.68 3,306 17.60	1.46 2,206 15.92	1.54 2,520 16.48	1.36 1,657 15.27
	AA	B	A	B
Easiness of Maintenance and Operation of the System	Two different rail transport systems	Conventioanl systems	New rail transport system	Easy operation because of conventional bus
	B	A	A	AA
Impact to the Urban Environment	Introduction of attractive new landmark in Lahore Less impact to the environment	Impact to environment because of exhaust gas from bus	Introduction of attractive new landmark in Lahore Less impact to the environment	Impact to environment because of exhaust gas of bus
	AA	B	A	B
Impact to the Land Use and Effectiveness to Development along the Transport Corridor	Developmental land use along LRT because of the wide influenced area by rail transit Effective development along LRT corridor, especially near the LRT stations		Effective development along LRT corridor, especially near the LRT stations	
	AA	B	A	B
Impact to the Road and Road Network		Less impact to the road traffic due to the max. pass. carried by this system		
	A	AA	B	B
Flexibility to the Increase of Transport Demand	Necessary improvement of access to stations		Necessary improvement of access to stations	Easier construction of facility than LRT
	B	A	B	AA
Revitalization of the Existing System/Facility	Revitalization of PR	Revitalization of PR		
	AA	AA	B	B
Overall Evaluation	Recommendable system(1) because of the creation of new urban amenity, development of land use and improvement of existing system/facility		Recommendable system(2)	
	AA	B	A	B

(Note) AA: Excellent, A: Good, B: Fair

9.5 FINANCIAL CONSIDERATIONS

Before conducting economic analysis, available fund for improving and upgrading roads and highways in the LMA, as one of the constraint factors, is examined.

This fund is of the nature of investment for roads and highways in the LMA, even if any projects proposed and analyzed in this master plan is not realized. It is to indicate how much fund will be anticipated during the term from 1991 to 2010, and to compare with the costs estimated in the master plan.

As it is so, it must be noted that the figure indicated here is not the maximum fund available for the implementation of any projects proposed in the master plan. It also excludes recurrent costs of maintenance and administration.

9.5.1 Trends of Public Investment for Roads and Highways

(1) Trends of Development Expenditure by the Federal Government

1. Development expenditure by the Federal Government increased with average annual growth rate of 7.79% from 1984/85 to 1988/89 in current prices.

2. Sectorial allocation for 'Transport and Communications' is around 15 per-cent of the total development expenditure.

3. Within the transport and communications sector, roads and highways receives an average of 18 percent of the sectorial allocation. Or, roads and highways receives an average of 2.5 percent of the total development expenditure.

(2) Trends of Development Expenditure by Provincial Governments

1. Development expenditure by Provincial Government shows a higher average annual growth rate of 16.13 percent from 1984/85 to 1988/89. Its ratio to that of the Federal Government increased from 26.1 percent in 1984/85 to 35.2 percent in 1988/89. With this rate of growth, it is anticipated that the development expenditure by Provincial Government will exceed that by the Federal Government in a near future.

2. Sectorial allocation for Transport and Communications is around 10 percent of the total development expenditure.

3. Breakdown figure of the roads and highways is not available. It is assumed by studying the share in Federal Budget, that allocation for roads and highways in the transport and communications sector is also around 25 percent. Or, roads and highways are estimated to be receiving a little over 2.5 per cent of total development expenditure of Provincial Government.

Table 9.5.1 Trends of Development Expenditure by the Public Sector

(In current prices)

			Amount (mil.Rs.) and Share (%)*						Average (%) Annual Growth Rate	Average Share(%)
			1984/85	1985/86	1986/87	1987/88	1988/89	1989/90		
Federal Government	Amount (mil. Rs.)	Total Development Expenditure	25,989 27,025	29,796 28,771	34,500 32,176	33,630 35,040	37,591 36,482	43,167 n.a.	10.68 7.79	-
		Transport and Com. Sector	4,525 4,659	4,882 4,788	4,942 4,924	4,512 3,725	6,138 5,678	6,813 n.a.	8.53 5.07	-
		Roads and Highways	675 714	893 786	696 632	1,000 486	977 980	1,163 n.a.	11.49 8.24	-
	Share (%)	Transport and Com. Sector to Total Dev't Expenditure	18.4 17.2	16.4 16.6	14.3 15.3	13.4 10.6	16.3 15.6	15.8 n.a.	-	15.6 15.1
		Roads and Highways to Total Dev't Ex.	2.6 2.6	3.0 2.7	2.0 2.0	3.0 2.8	2.6 2.7	2.7 n.a.	-	2.65 2.56
		to Transport & Com. Sector	14.9 15.3	18.3 16.4	14.1 12.8	22.2 26.5	15.9 17.3	17.1 n.a.	-	17.1 17.7
Provincial Govt's	Amount (mil. Rs.)	Total Development Expenditure	7,300 7,057	9,602 9,512	12,500 11,965	14,500 14,800	12,833 12,833	12,833 n.a.	11.94 16.13	-
		Transport and Com. Sector	885 883	898 1.070	979 899	1,117 1,335	1,467 1,383	1,788 n.a.	15.10 11.87	-
	Share (%)	Transport and Com. Sector to Total Dev't Expenditure	12.1 12.5	9.4 11.2	7.8 7.5	7.7 9.0	11.4 10.8	13.9 n.a	-	13.4 10.2

Source : Planning Commission, Min. of Planning and Development and Min. of Finance and Economic Affairs, and the Study Team

Note/ up : projected
down : actual

9.5.2 Estimation of Development Expenditure for Roads and Highways in Pakistan

(1) Estimation of Total Development Expenditure by the Public Sector

1. Federal Government

By applying the average annual growth rate of 7.79%, total development expenditure of the Federal Government is estimated to be;

in 1991 : Rs. 45,700 mil.

2000 : Rs. 89,700 mil.

2010 : Rs.190,000 mil.

2. Provincial Government

By applying the average annual growth rate of 16.13%, total development expenditure of Provincial Government is estimated.

in 1991 : Rs. 20,100 mil.

2000 : Rs. 77,200 mil.

2010 : Rs.344,400 mil.

(2) Estimation of Development Expenditure for Transport and Communications Sector

1. Federal Government

By applying the share of 15.1% to the total development expenditure and the average annual growth rate of 5.07%, following figures are estimated.

	1991	2000	2010
			(Rs. in mil.)
(1)by share	6,900	13,500	28,700
(2)by growth rate	6,600	10,300	16,900
(mid.figure	6,750	11,900	22,800)

2. Provincial Governments

By applying the share of 10.2% to the total development expenditure and the average annual growth rate of 11.87%, following figures are estimated.

	1991	2000	2010
			(Rs. in mil.)
(1)by share	2,050	7,870	35,130
(2)by growth rate	1,940	5,310	16,310
(mid. figure	2,000	6,950	25,720)

(3) Estimation of Development Expenditure for Roads and Highways

1. Federal Government

By applying the shares of 2.56% and 17.7% to total development expenditure and transport and communications sector, and the average annual growth rate of 8.24%, following figures are estimated.

	1991	2000	2010
			(Rs. in mil.)
(1)by share to total develop. expenditure	1,170	2,300	4,860
(2)by share to Transport Sector	1,190	2,110	4,040
(3)by growth-rate	1,240	2,530	5,590

2. Provincial Government

By applying the shares of 2.55% and 25% to the total development expenditure and transport sector, following figures are estimated.

	1991	2000	2010
			(Rs. in mil.)
by share (1)	510	1,970	8,780
by share (2)	500	1,740	6,430

9.5.3 Estimation of Development Expenditure for Roads and Highways in the LMA

(1) Population Estimation

Future population of Pakistan, Punjab Province and Lahore Metropolitan Area (LMA) is estimated as shown in Table 9.5.2.

Table 9.5.2 Population Estimated

		1951	1961	1972	1981	1990 estimate	2000 estimate	2010 estimate
Pakistan		33,740	42,880	65,309	84,254	108,695	144,200	191,400
Punjab State	Population	20,541	25,464	37,607	47,284	60,898	80,700	106,800
	Share to Pakistan (%)	60.9	59.4	57.6	56.1	56.0	56.0	55.8
LMA	Population	1,135	1,626	2,748	3,748	3,854	5,430	7,800
	Share to Pakistan (%)	3.36	3.79	4.21	4.57	5.00	5.41	5.59
	Share to Punjab (%)	5.53	6.89	7.36	8.15	8.92	9.67	10.02

Source : Pakistan Statistical Yearbook (1986), Economic Survey 1990 and Study Team

(2) Estimation of Development Expenditure for Roads and Highways in the LMA

1. Federal Government

Assuming that the development expenditure for roads and highways by the Federal Government is allocated at a share twice of the population share of LMA in the country, following figures are estimated.

		1991	2000	2010
Share of Population of the LMA (%)		5.04	5.41	5.59
Development Expenditure for Roads and Highways by the Federal Gov't (Rs. in mil.)	(1)	1,170	2,300	4,860
	(2)	1,190	2,110	4,040
	(3)	1,240	2,530	5,590
Development Expenditure for Roads and Highways in LMA by the Federal Government (Rs. in mil.)	(1)	118	248	554
	(2)	120	228	452
	(3)	125	274	625

2. Provincial Government

According to an example concerning irrigation investment, Punjab Province had been receiving shares of 75% in 1984 and 70% in 1989 to the total allocation. It is anticipated that the share of Punjab Province will decrease gradually to 68% in 1991, 60% in 2000 and 52% in 2010.

On the other hand, the allocation share of LMA within Punjab Province will increase to 20% in 1991, 25% in 2000 and 30% in 2010.

Thus, the development expenditure for Roads and Highways by Punjab Provincial Government is estimated as follows.

		1991	2000	2010
Development Expenditure for Roads and Highways by Provincial Governments				(Rs. in mil.)
	(a)	510	1,970	8,780
	(b)	500	1,740	6,430
Share of Punjab Province (%)		68	60	52
Development Expenditure for Roads and Highways by Punjab Province (Rs. in mil.)	(a)	347	1,182	4,566
	(b)	340	1,044	3,344
				(%)
Share of LMA to Punjab Prov.		20	25	30
				(Rs. in mil.)
Development Expenditure for Roads and Highways in LMA	(a)	69	296	1,370
	(b)	68	261	1,003

(a) high case, (b) low case

3. Total Available Fund for Roads and Highways by the Public Sector

Eventually, available fund for roads and highways by the public sector in the LMA is estimated as follows:

(Rs. in mil.)

		1991	2000	2010
by Federal Gov't	"High" case	125	274	625
	"Low" case	118	228	452
by Prov. Gov't	"High" case	69	296	1,370
	"Low" case	68	261	1,003
Total	"High" case	194	570	1,995
	"Low" case	184	489	1,455

9.5.4 Available Fund by the Public Sector (at 1990 constant price)

As those figures estimated in 9.5.3 are based on current prices, they need be converted into 1990 constant prices adopting GNP deflator.

In 1988/89, GNP deflator shows 170.30 comparing with the base year (1980/81). The annual average inflation rate derived from the figure is 6.88 percent.

With the GNP deflator, total available fund by the public sector for roads and highways in the LMA at 1990 constant price are estimated as shown in Table 9.5.3.

Table 9.5.3 Estimated Available Fund

(Rs. in mil.)

	Case	1991	2000	2010
by Federal Gov't	High	117.0	140.9	165.2
	Low	110.4	117.2	119.5
by Provincial Gov't	High	64.6	152.2	362.1
	Low	63.6	134.2	265.1
Total	High	181.6	293.1	527.3
	Low	174.0	251.4	384.6
Cumulative Total (1991 - 2010)	High			6,382.0
	Low			5,261.4

* Figures at 1990 constant price

It is estimated through a trend extrapolation that, a size of 5.3 billion Rupees to 6.4 billion Rupees (at 1990 constant price) will be allocated for the development of roads and highways in the LMA during 1991 to 2010. However the estimate is far below the approximated cost of the Master Plan in Chapter 7. Approximately four times larger amount is necessary. Fund sources should be explored in various directions to implement a continued development projects.

CHAPTER 10. MASTER PLAN AND PROPOSED PROJECTS

CHAPTER 10 MASTER PLAN AND PROPOSED PROJECTS

10.1 Master Plan for the Year 2010

Following the studies conducted in the previous stages, a comprehensive transportation plan for the year 2010 and future is formulated as the Master Plan.

The Master Plan consists of a package of various transport systems and traffic management schemes, both for short-term and long-term action measures. Basic considerations of the transport masterplan is as follows:

(1) At present, the traffic problems are not so serious, except for some areas. However, the population of LMA is expected to increase to about 10 million, which is double that of the present figure. Therefore, it would be necessary to introduce adequate measures of transport system/facility in order to cope with the expected increase in population.

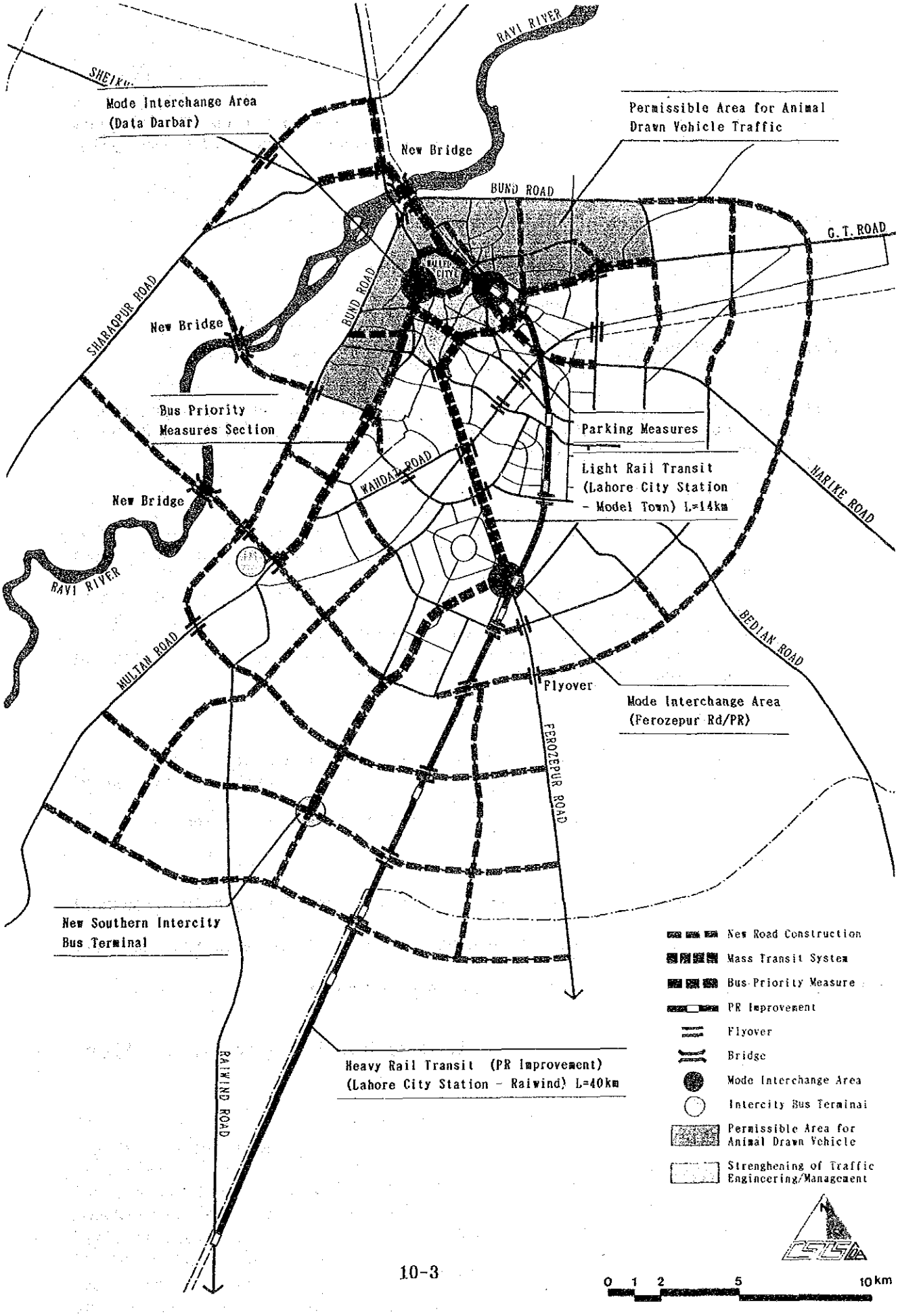
(2) Considering the total project cost, financial constraints and other factors, it is necessary to set up the adequate staging of various projects to maximize the benefits of 2010 master plan.

The Master Plan for the year 2010 which has total project cost of 20 billion Rupees is summarized in Table 10.1.1 and Figure 10.1.1.

Table 10.1.1. Major Components of Master Plan

1. Improvement and construction of roads
   1) Improvement of existing roads: 70 km
      - widening
      - cross-section restructuring
      - surface treatment
   2) New construction of roads: 200 km
2. Intersection improvement: 26 intersections
   1) Signaling
   2) Flyover
      - road vs. road
      - road vs. railway
3. New bridge construction: 3 bridges across the Ravi River
4. Improvement and expansion of current bus system
   1) Provision of bigger bus fleet
   2) Revision of bus fare
   3) Introduction of priority lane: 52 km (5 sections)
   4) Improvement of bus routes and schedule
5. Improvement of existing MRT: 40 km
6. Introduction of LRT system: 12.5 km
7. Development of mode interchange areas
   1) Major LRT stations: 2 stations
   2) Intercity bus terminal (Southern)
8. Traffic management in the Inner Area
   1) Parking control
   2) Segregated system between motorized and non-motorized vehicles

Figure 10.1.1 Proposed Master Plan



10.2 Stage Programmes

Considering the following factors, it is necessary to set up the adequate staging of various projects to maximize the impact of the 2010 master plan:

(1) Total project cost

(2) Financial constraints of the Government of Punjab and LDA

(3) Progress of urban development to the south

(4) Traffic aspects

(5) Transport network configuration

Based on these factors, three stages are proposed such as short-term (1992-1995), medium-term (1996-2000) and long-term (2001-2010). Planning directions of each stage is as follows:

(1) Short-term measures:

- Improvement of deteriorated sections of trunk roads.
- Effective and immediate traffic management actions for the inner area. (Review of World Bank Study)
- Improvement of existing system, i.e., introduction of higher capacity buses.
- New Bridge construction across the Ravi River.
- Expansion of the trunk road network to the southern Development area (Construction of Part of Ring Road)

(2) Medium-term measures:

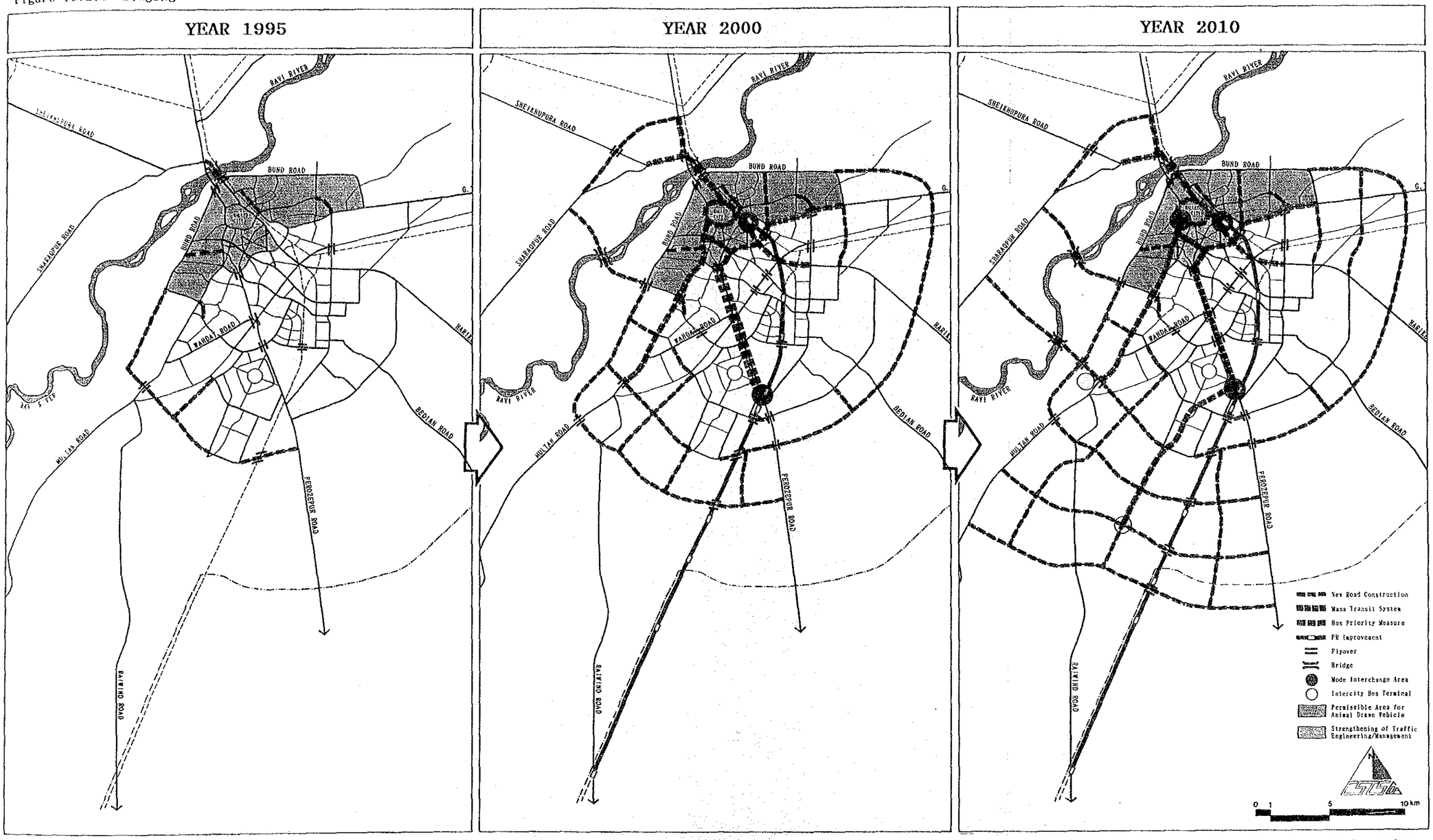
- Improvement of Pakistan Railway as a urban transport system.
- Establishment of road network system in the southern development area. (Completion of Ring Road)
- Bus priority measures along the public transport corridors.

(3) Long-term measures:

- Introduction of effective and higher capacity public transport system.
- Creation of a mode interchange area to link existing and new transport facilities.
- Highly effective traffic management measures.

These are summarized in Figure 10.2.1, Table 10.2.1, Figure 10.2.2, Figure 10.2.3 and Figure 10.2.4.

Figure 10.2.1 Staging



- Improvement of deteriorated sections of trunk roads.
- Effective and immediate traffic management actions for the inner area. (Review of World Bank Study)
- Improvement of current bus system, i.e., introduction of higher capacity buses.
- New bridge construction across the Ravi River.
- Expansion of the trunk road network to the southern development area. (Construction of part of Ring Road)

- Improvement of Pakistan Railway as a urban transport system.
- Establishment of road network system in the southern development area. (Completion of Ring Road)
- Bus priority measures along the public transport corridors.

- Introduction of Light Rail Transit along Major Public Transport Corridor.
- Creation of mode interchange areas to link existing and new transport facilities.
- Highly effective traffic management measures.

Table 10.2.1(1) Stage Programmes of Projects (1)

Improvement of Existing Roads

Code	Name of Road	Location	Length (km)	Short-term (1992-1995)	Medium-term (1996-2000)	Long-term (2001-2010)
RI-01	Bund Rd.	Shalimar Rd. - New Bridge(2→4)	1.15	○		
RI-02	Bund Rd.	New Bridge - Purana Sanda Rd. (2→4)	3.75	○		
RI-03	Bund Rd.	Darban Data - Ravi Rd. (2→4)	3.50	○		
RI-04	Bund Rd.	Ravi Rd. - Mahmud Bat(2→4)	9.00	○		
RI-05	G.T. Rd.	Bund Rd. - Badami Bagh(2→4)	1.35	○		
RI-06	G.T. Rd.	Badami Bagh - Lahore Station(2→4)	1.20	○		
RI-07	G.T. Rd.	Delhi Gate - Lahore Station(2→4)	2.10	○		
RI-08	C1	Bund Rd. - G.T. Rd. (2→4)	0.90		○	
RI-09	Shalimar Rd.	G.T. Rd. - Allama Iqbal Rd. (2→4)	1.05		○	
RI-10	Egerton Rd.	Durand Rd. - Koper Rd. (2→4)	0.60		○	
RI-11	Bahawalpur Rd.	Muzang Chungi - Multan Rd. (2→4)	1.20		○	
RI-12	Khawaja Farid Rd.	Multan Rd. - Bund Rd. (2→4)	2.90		○	
RI-13	Shalimar Link Rd.	C2 - Canal Bank Rd. (2→4)	0.75		○	
RI-14	Jail Rd.	Sarwar Rd. - Main Gulberg(2→4)	1.60		○	
RI-15	Maulana Fazal Hag Rd.	Wahdat Rd. - Multan Rd. (2→4)	1.60		○	
RI-16	Main Rd. in Green Town	R7 - Industrial Area in Township(2→4)	2.00	○		
RI-17	Sharaqpur Rd.	Sharaqpur Rd. - G.T. Rd. (2→4)	7.40		○	
RI-18	Sharaqpur Rd.	Sharaqpur Bypass - LMA Border(2→4)	17.50			○
RI-19	Abdali Rd.	Lower Mall - Purana Sanda Rd. (2→4)	1.40	○		
RI-20	S.M.A. Hai Rd.	Ganda Nala - WAPDA Town(2→4)	4.30			○
Total			65.25	25.45	18.00	21.80

New Construction of Roads

Code	Name of Road	Location	Length (km)	Short-term (1992-1995)	Medium-term (1996-2000)	Long-term (2001-2010)
RC-01	Ravi Rd.	Shahdara - Bund Rd. (4)	2.00	○		
RC-02	G.T. Rd. (Bypass)	Flyover - Lahore Station(4)	2.10	○		
RC-03	Bund Rd. Link Rd.-1	Bund Rd. - Sultanpura Rd. (4)	2.80	○		
RC-04	Misri Shah Link Rd.	G.T. Rd. - Misri Shah Rd. (2)	1.80	○		
RC-05	Bund Rd. Link Rd.-2	Bund Rd. - Purana Sanda Rd. (4)	1.00	○		
RC-06	Multan Rd. Bypass	The Mall - Multan Rd. (4)	2.00			○
RC-07	G.T. Rd. Link Rd.	G.T. Rd. - Ghazi Rd. (2)	5.05		○	
RC-08	G.T. Rd. Link Rd.	G.T. Rd. - C4(2)	2.00			○
RC-09	Canal Bank Link Rd.	Canal Bank Rd. - Ghazi Rd. (2)	3.40			○
RC-10	Ghazi Link Rd.	Ghazi Rd. - C4(4)	2.00		○	
RC-11	Ferozepur Link Rd.	Ferozepur Rd. - Peco Rd. (2)	1.50		○	
RC-12	C2	Multan Rd. - Maulana Fazal Haq Rd. (4)	1.60	○		
RC-13	C2	Wahdat Rd. - Allama Iqbal Rd. (4)	0.40	○		
RC-14	C2	Bund Rd. - Sharaqpur Rd. (4)	7.50		○	
RC-15	Multan Link Rd.	Multan Rd. - C5(4)	2.10		○	
RC-16	C4	Bund Rd. - Ferozepur Rd. (4)	27.85		○	
RC-17	C4	Ferozepur Rd. - C5(4)	13.20	○		
RC-18	C4	C5 - Sharaqpur Rd. (4)	8.00			○
RC-19	Sharaqpur Rd. Bypass	Sharaqpur Rd. - G.T. Rd. (4)	9.00		○	
RC-20	C5	Multan Rd. - Ferozepur Rd. (4)	15.70		○	
RC-21	C5(Multan Rd. Bypass)	Multan Rd. - Bund Rd. (4)	9.50	○		
RC-22	C6	Multan Rd. - Ferozepur Rd. (4)	19.60			○
RC-23	C7	Multan Rd. - Ferozepur Rd. (4)	22.30			○
RC-24	R6	C4 - C7(4)	10.20			○
RC-25	R7	C4 - C7(6)	9.20			○
RC-26	R8	Maulana Shaukat Ali Rd. - C7(4)	13.00			○
RC-27	New Campas Rd.	Canal Bank Rd. - Wahdat Rd. (4)	1.90		○	
RC-28	Ganda Nala Rd.	Peco Rd. - Ferozepur Rd. (6)	2.70			○
Total			199.4	34.40	72.60	92.40

Table 10.2.1(2) Stage Programmes of Projects (2)

New Construction of Bridges and Flyovers

Code	Name of Road	Location	Length (m)	Short-term (1992-1995)	Medium-term (1996-2000)	Long-term (2001-2010)
BR-01	G.T. Rd.	Between two existing bridges(4)	500	○		
BR-02	C2	C2 on the Ravi River(4)	540		○	
BR-03	C4	C4 on the Ravi River(4)	810			○
FO-01	G.T. Rd.	G.T. Rd. × Sheikhpura Rd. (4)	300		○	
FO-02	Bund Rd.	Bund Rd. × G.T.Rd. & R/W Line(4)	700	○		
FO-03	Ravi Rd.	Ravi Rd. × Bund Rd. (4)	300	○		
FO-04	G.T. Rd.	G.T. Rd. × C2(4)	300		○	
FO-05	Shalamar Rd.	Shalamar Rd. × R/W Line(4)	400		○	
FO-06	Shalimar Link Rd.	Shalimar Link Rd. × Canal & R/W Line(4)	600	○		
FO-07	The Mall	The Mall × Canal Bank Rd. (4)	300		○	
FO-08	Jail Rd.	Jail Rd. × Canal Bank Rd. (4)	300		○	
FO-09	Qartaba Chowk	Ferozepur Rd. × Lytton Rd. (4)	300	○		
FO-10	Ferozepur Rd.	Ferozepur Rd. × Canal & Wahdat Rd. (4)	750	○		
FO-11	Kalma Chowk	Ferozepur × Main Gulberg(6)	600	○		
FO-12	Ferozepur Rd.	Ferozepur Rd. × Ghazi Rd. (4)	300		○	
FO-13	Ferozepur Rd.	Ferozepur × C4(4)	300		○	
FO-14	Park Rd.	Park Rd. × R/W Line(4)	400	○		
FO-15	Peco Rd.	Peco Rd. × R/W Line(4)	400		○	
FO-16	C4	C4 × R/W Line(4)	400	○		
FO-17	C5	C5 × R/W Line(4)	400		○	
FO-18	C6	C6 × R/W Line(4)	400			○
FO-19	C7	C7 × R/W Line(4)	400			○
FO-20	Wahdat Rd.	Wahdat Rd. × Allama Iqbal Rd. (4)	300		○	
FO-21	Yatim Khana Chowk	Multan Rd. × Bund Rd. (4)	300		○	
FO-22	Multan Rd.	Multan Rd. × C4(4)	300	○		
FO-23	Bund Rd.	Bund Rd. × C5(4)	300		○	
FO-24	C5	C5 × C4(4)	300			○
FO-25	Multan Rd.	Multan Rd. × C5(4)	300		○	
FO-26	Sharaqpur Link Rd.	Sharaqpur Link Rd. × Sheikhpura Rd. (4)	300		○	
Total		3 bridges and 26 flyovers		1B/R+9F/O	1B/R+14F/O	1B/R+3F/O

Bus Priority Lanes

Code	Location	Length (km)	Short-term (1992-1995)	Medium-term (1996-2000)	Long-term (2001-2010)
BP-01	Lahore City Station - Badami Bagh - G.T.Rd. - Shahdara(4→6)	11.90		○	
BP-02	Badami Bagh - Lower Mall - Multan Rd. - Niaz Beg(4)	12.30		○	
BP-03	Aiwan Iqbal Complex - Shalimar Rd. - G.T. Rd. - crossing with Bund Rd. (4→6)	8.80		○	
BP-04	Lahore City Station - Allama Iqbal Rd. - Ghazi Rd. - Sadar Bazar(2→4)	5.70		○	
BP-05	Model Town South - Ganda Nala Rd. - S.M.A. Hai Rd. - crossing with C6(6)	13.20			○
Total		51.90		38.70	12.50

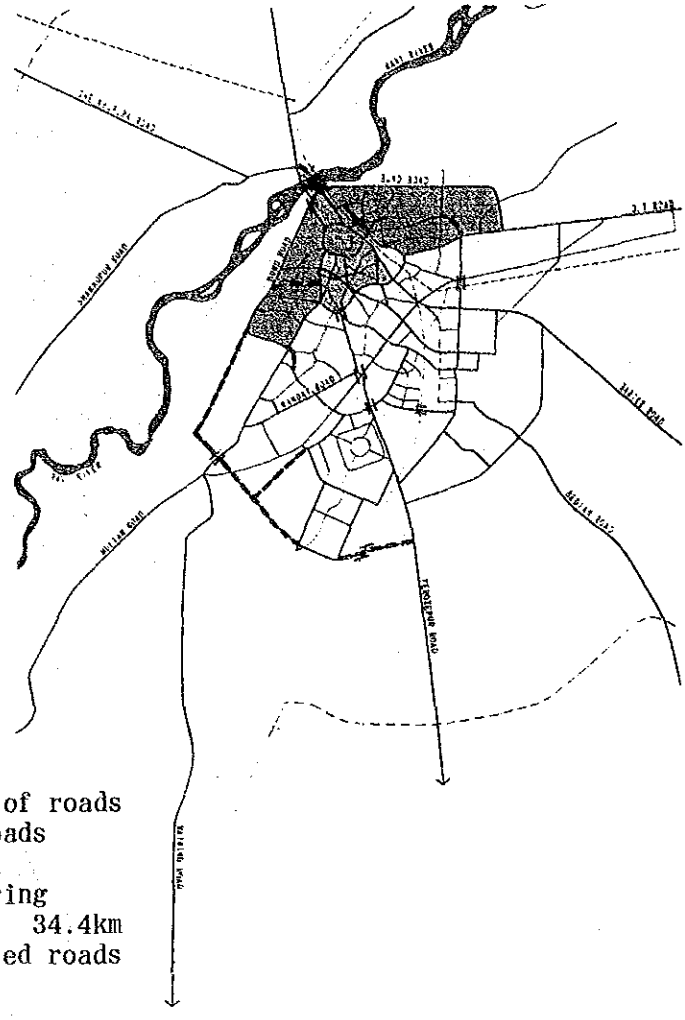
Rail Transit System

Code	System/Facility	Location	Length (km)	Short-term (1992-1995)	Medium-term (1996-2000)	Long-term (2001-2010)
LR-01	LRT	Data Darbar - Model Town South(18 sta.)	12.50			○
HR-01	HRT Improvement	Lahore St. - Raiwind(11 stations)	40.00		○	
			52.50		40.00	12.50

Mode Interchange Area

Code	Location	Area (ha)	Short-term (1992-1995)	Medium-term (1996-2000)	Long-term (2001-2010)
LS-01	Data Darbar	1.80			○
LS-02	Model Town South	3.70			○
		5.50			5.50

Figure 10.2.2 Major Components of Short-term Plan (1992-1995)



1) Improvement and construction of roads
   a) Improvement of Existing roads
      - Widening
      - Cross section restructuring
   b) New construction of roads: 34.4km
   c) Land acquisition of proposed roads

2) Intersection improvement: 9
   a) Signaling
   b) Flyover

3) New bridge construcion: 1 bridge over the Ravi river

4) Improvement and expansion of existing public transport system
   a) Provision of bigger fleet
   b) Improvement of bus routes and schedule
   c) Revision of bus fare

5) Traffic management in the Inner area
   a) Segregated traffic system betyween motorized and non-motorized vehicles
   b) Road clean-up along trunk roads
   c) Parking control measures

Total construction cost in short-term is approximately 25 billion Rs.

Figure 10.2.3 Major Components of Medium-term Plan (1996-2000)

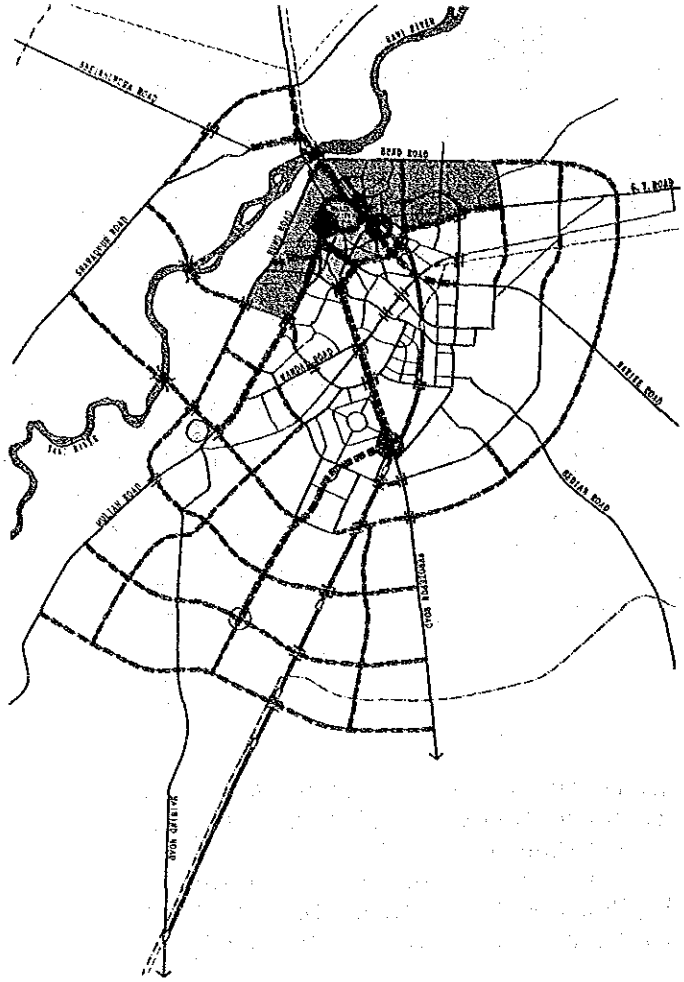
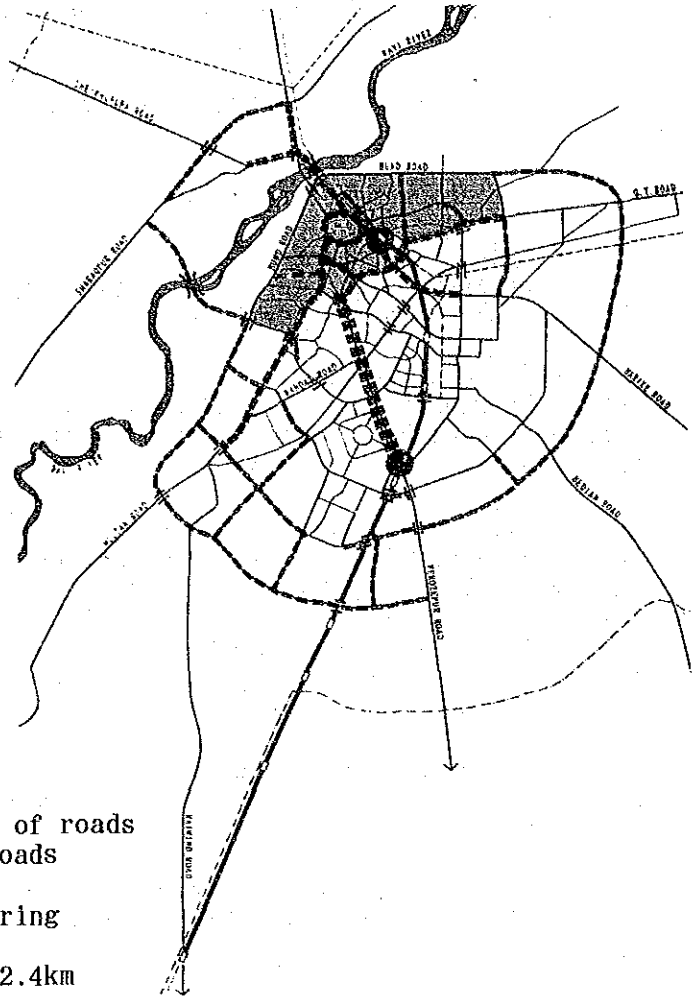


Figure 10.2.4 Major Components of Long-term Plan (2001-2010)



1) Improvement and construction of roads
   a) Improvement of existing roads
      - Widening
      - Cross section restructuring

2) Intersection improvement: 92.4km
   a) Signaling
   b) Flyover

3) New bridge construction: 1 bridge over the Ravi river

4) Improvement and expansion of existing public transport system
   a) Provision of bigger bus fleet
   b) Improvement of bus routes and schedule
   c) Introduction of bus priority measures
      - Median/curbside bus lane
      - Counterflow buslane along one-way roads

5) Introduction of LRT system: 12.5km

6) Development of mode interchange facilities
   a) LRT terminals (model Town South, Data Darbar)
   b) Intercity bus terminal (Southern)

7) Traffic management in the Inner area
   a) Parking control measures

Total construction cost in long-term is approximately 110 billion Rs.