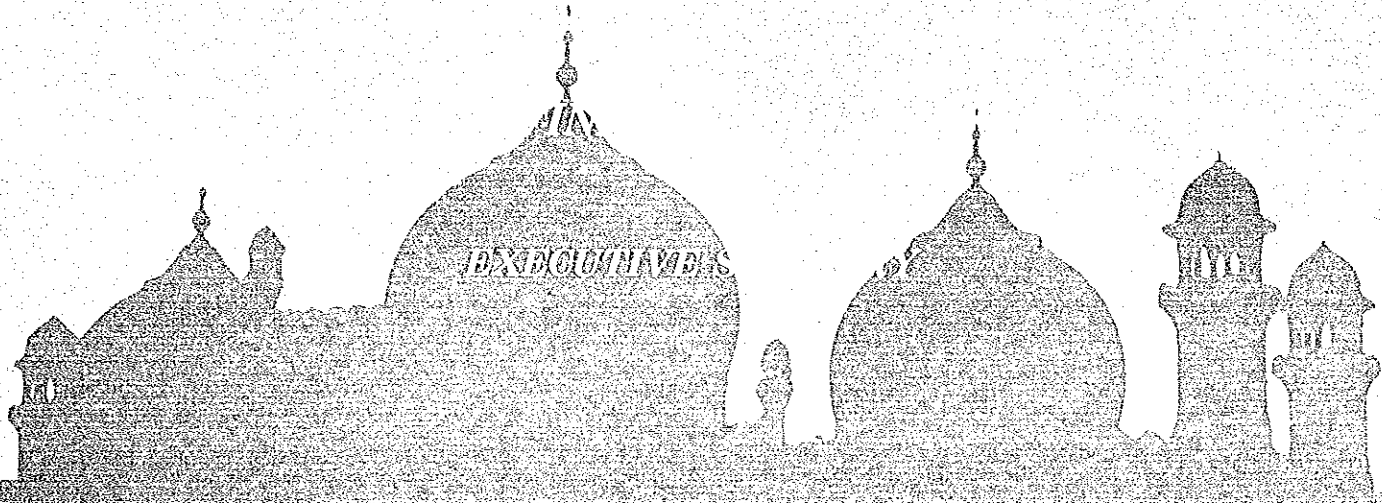


October 1991

Japan International Cooperation Agency

Islamic Republic of Pakistan

COMPREHENSIVE STUDY ON TRANSPORTATION SYSTEM IN LAHORE

FINAL REPORT

EXECUTIVE SUMMARY

October 1991

Japan International Cooperation Agency

P R E F A C E

In response to a request from the Government of the Islamic Republic of Pakistan, the Japanese Government decided to conduct the Comprehensive Study on Transportation System in Lahore and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Pakistan a study team headed by Mr. Osamu Ohtsu, ALMEC Co., Ltd., three times between July, 1990 and September, 1991.

The team held a series of discussions with the officials concerned of the Government of Pakistan, and conducted various field surveys at the study area.

After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Islamic Republic of Pakistan for their close cooperation extended to the team.

October 1991

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

EXECUTIVE SUMMARY

Table of Contents

0. Outline of the Study

1) Study Objectives and Study Area

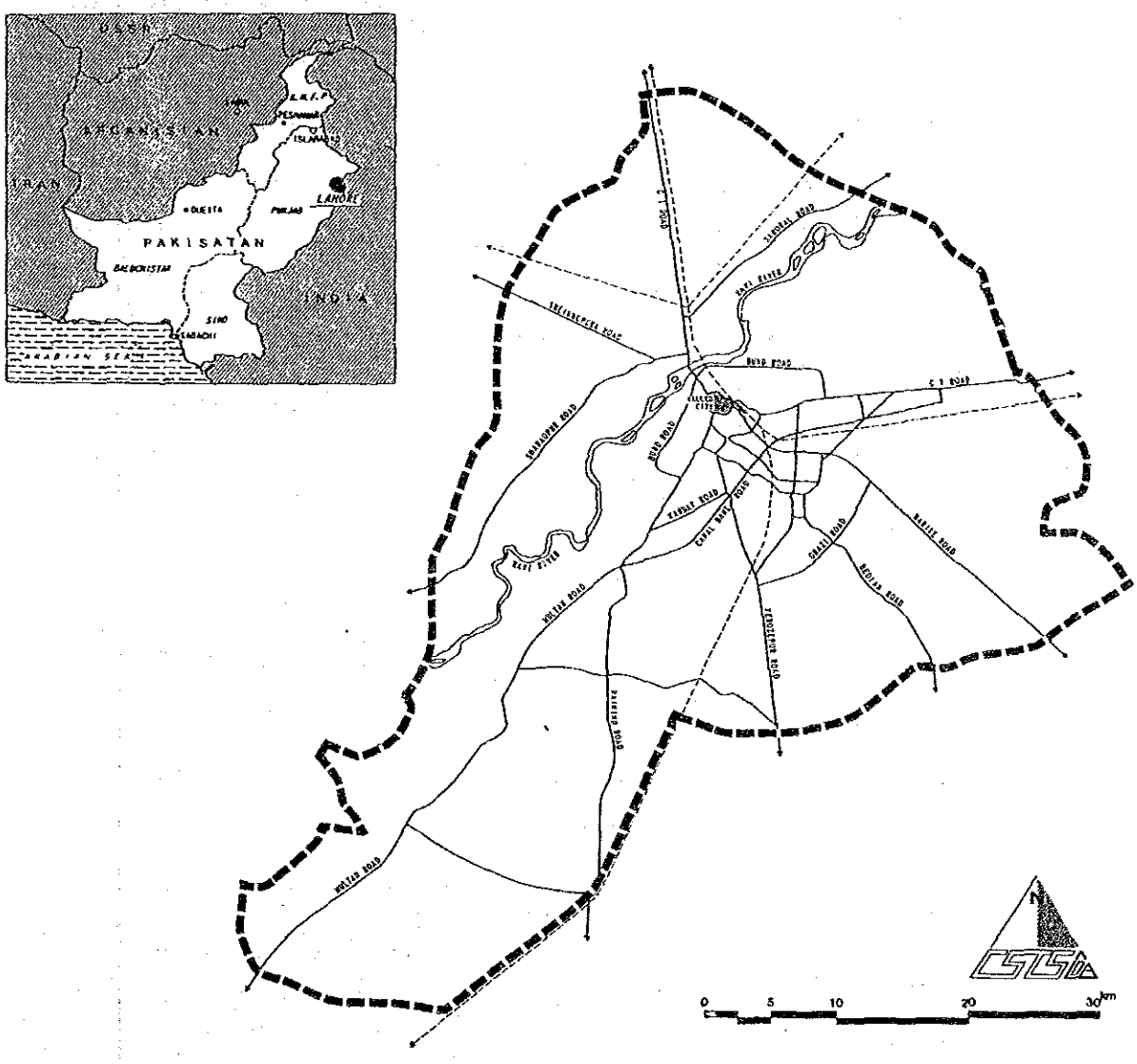
The study was commenced from July 1990, in accordance with the Scope of Work agreed upon by both Governments of Pakistan and Japan in October 1989.

The main objectives of the study are:

- To formulate a Master Plan to solve urban transportation problems in Lahore Metropolitan Area toward the target year of 2010, with intermediate output at the year 2000, and
- To conduct a Feasibility Study on selected mass transit system and any other selected project.

The study area covers the Lahore Metropolitan Area, approximately 2,250 sq.km, as shown in the figure:

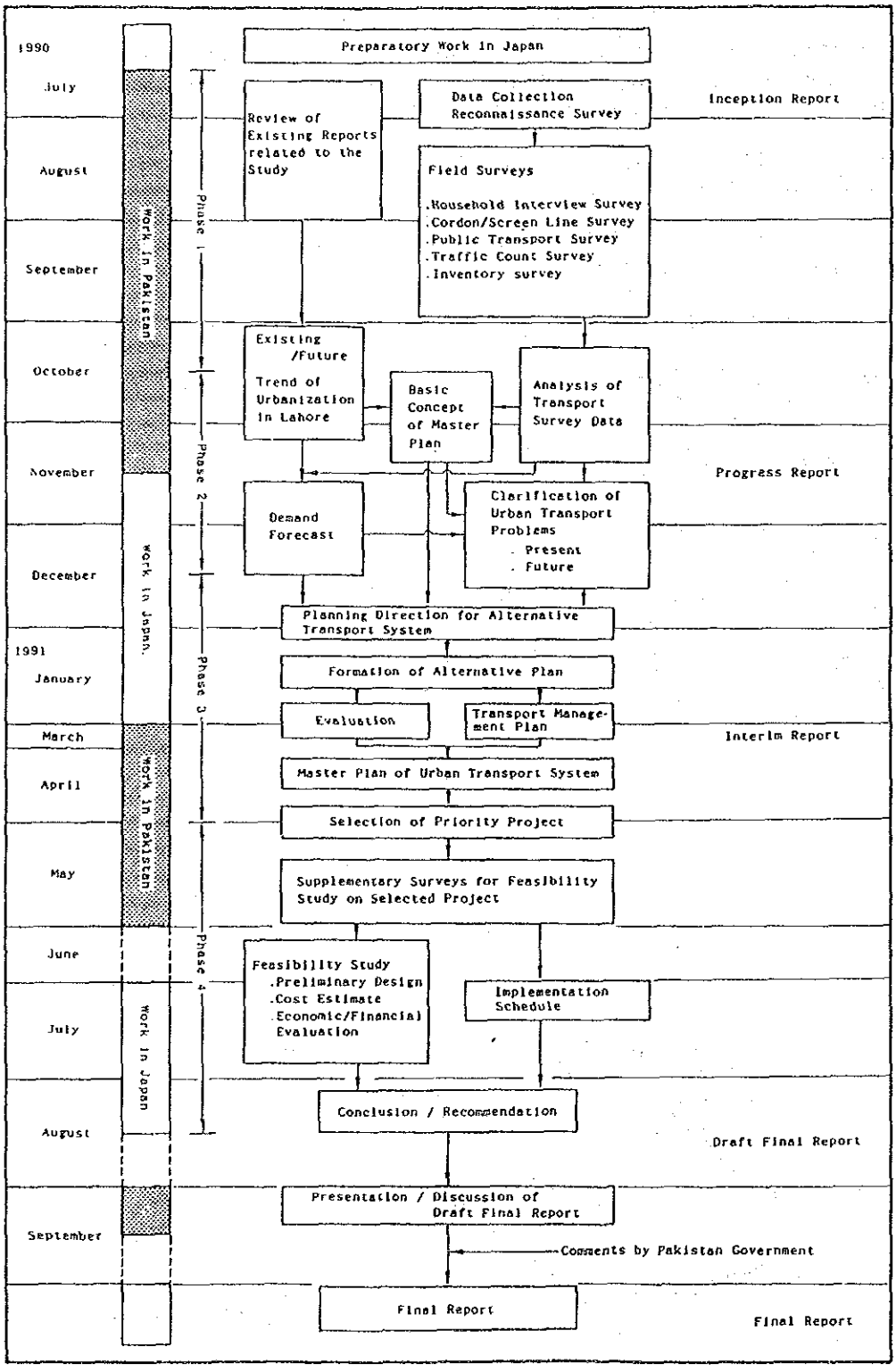
Figure 0.1 Study Area (Lahore Metropolitan Area)



2) General Work Flow of the Study

The study was carried out both in Pakistan and Japan for 15 months, July 1990 to October 1991, in accordance with the general flow-chart of the study as shown in Figure 0.2.

Figure 0.2 General Work Flow of the Study



3) Study Organization

The study was carried out by the JICA Study Team in close cooperation with the counterparts in Lahore Development Authority(LDA), and under the supervision of JICA Advisory Committee. Each member is listed in tables below:

Table 0.1 JICA Study Team Members

Assignment	Name
1. Team Leader	Mr. Osamu OHTSU
2. Transport/City Planning	Mr. Masato KOTOH
3. Transport Survey/Analysis	Mr. Hideaki ITABASHI
4. Transport Survey (1)	Mr. Yoichi ENOKIDO
5. Transport Survey (2)	Mr. Ken KUMAZAWA
6. Demand Forecast	Mr. Naoashi OKAMURA
7. Public Transport Planning	Mr. Teruhiko HORIE
8. Traffic Management	Mr. James M. McBRIDE
9. Transport Facility Planning	Mr. Masanao KOYAMA
10. Facility Design/Cost Estimate	Mr. Hiroshi YAJIMA
11. Economic/Financial Analysis	Mr. Daihachiro KAMIMURA

Table 0.2 JICA Advisory Committee Members

Assignment	Name	
Chairman	Dr. Shigeru Morichi	Professor, Tokyo Institute of Technology
Member (Road Transport)	Mr. Kazuhisa Fujisaki	Ministry of Construction (- March 1991)
Member(City Planning/ Demand Forecast)	Mr. Mizuo Kishita	Japan Regional Development/ Ministry of Construction
Member (Public Transport)	Mr. Yosuke Wakabayashi	Ministry of Transport (- March 1991)
Member (Public Transport)	Mr. Tetsuya Uzawa	Ministry of Transport (April 1991 -)

Table 0.3 LDA Counterparts

Name	
1. Mr. Khushal Khan	Cheif Traffic Engineer, TEPA-LDA
2. Mr. Masud Ahmad Qazi	Director Study, TEPA-LDA
3. Mr. Mohammad Sarwar Rana	Deputy Director Eco/Study, TEPA-LDA

1. Present Condition of Lahore Metropolitan Area

1) Population Trends

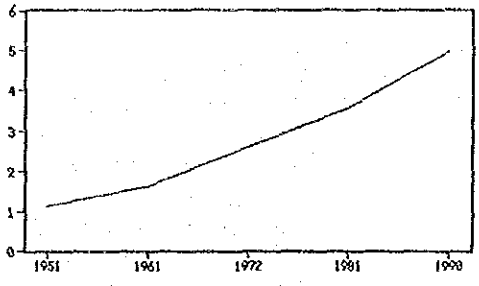
The population of the Lahore district is estimated as 5.0 million in 1990, while its 1951 population was 1.1 million. It has increased over fourfold these four decades and its share in Punjab Province has also increased, from 5.5% in '51 to 8.1% in '90.

Table 1.1 Population Trend, Punjab / Lahore District

YEARS	PUNJAB		LAHORE	
	POPULATION (000)	POP. DENSITY (PERSON/km²)	POPULATION (000)	POP. DENSITY (PERSON/km²)
1951	20,541	100	1,135	640
1961	25,464	124	1,626	918
1972	37,607	183	2,588	1,460
1981	47,294	230	3,545	2,001
1990	60,898	297	4,955	2,796

SOURCE: DENSITY CALCULATED FROM '1981 POPULATION CENSUS OF PAKISTAN' DATA

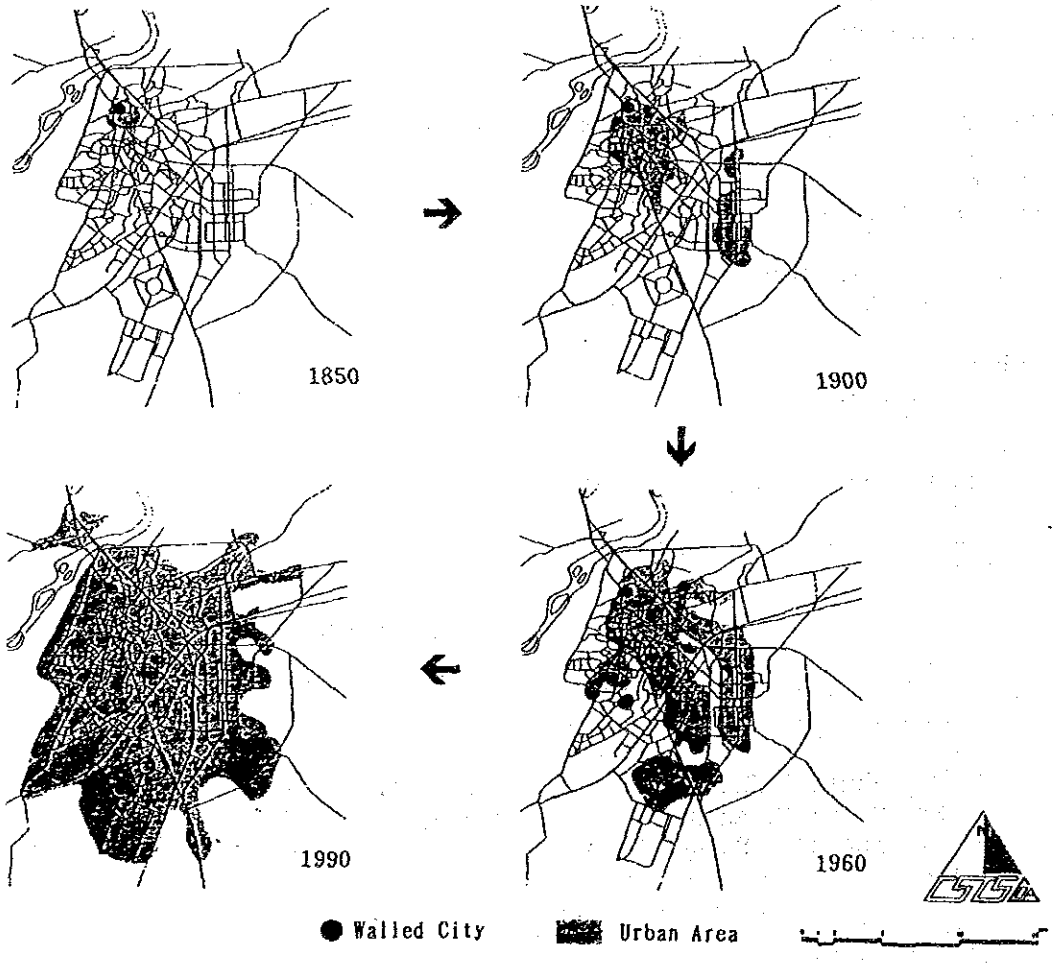
Figure 1.1 Population Trend of Lahore Dist.



2) Urban Growth of the LMA

Lahore developed from the Walled City which originated in Mogul Era, and its urbanized area has been expanding toward southeast and southwest.

Figure 1.2 Trend of Urbanization in Lahore



3) Present Land Use

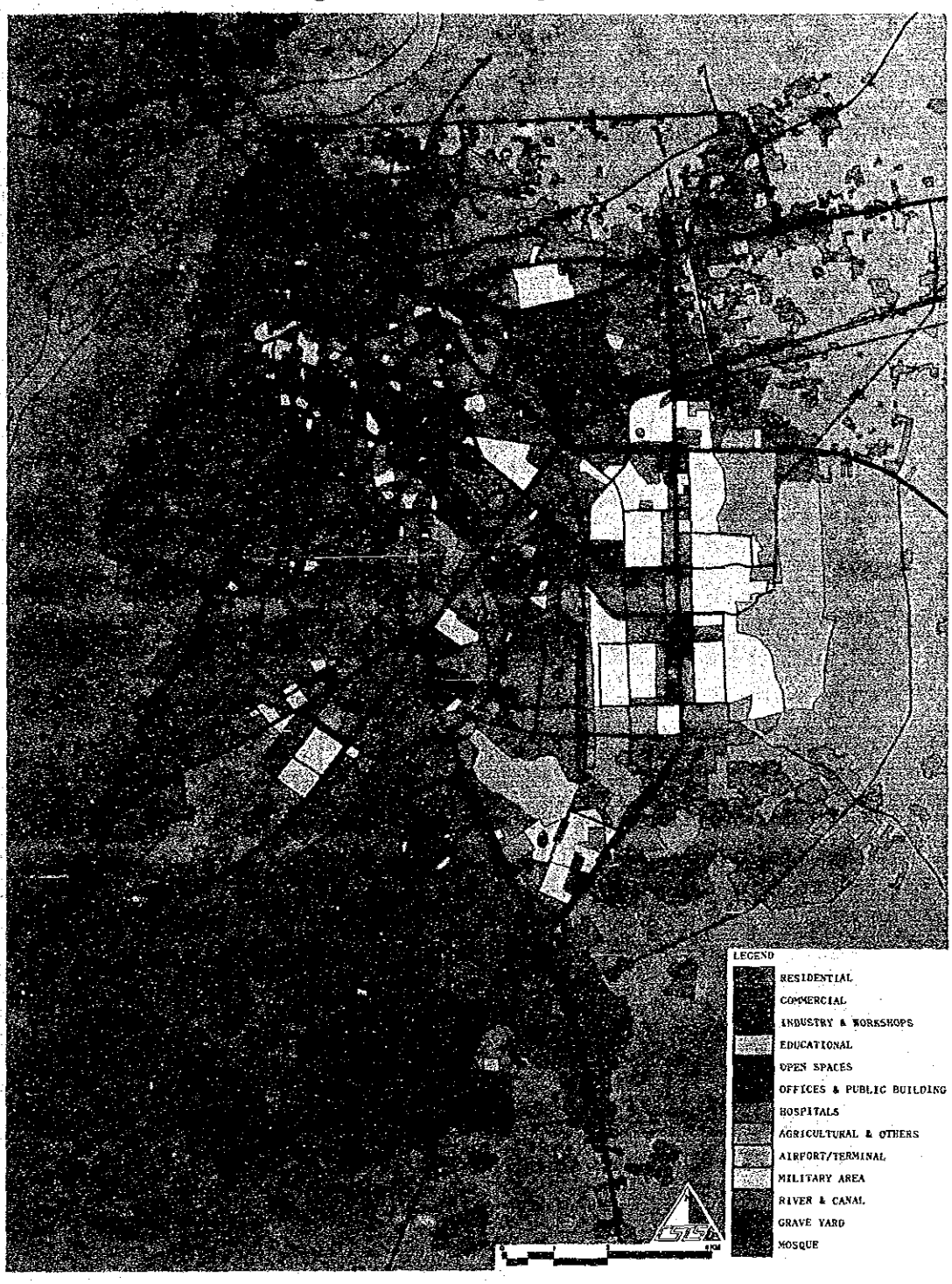
The existing land use in LMA is illustrated in Figure 1.3.

Commercial/Business Area: Walled City & its vicinity, the area along the Mall and other arterial roads

Residential Area: Traditional houses in/around Walled City, mixed with agricultural use between G.T. Rd. and Bund Rd., and Well-planned housing areas in Main Gulberg, Model Town, etc.

Industrial Area: Large factories along suburban trunk roads

Figure 1.3 Existing Land Use



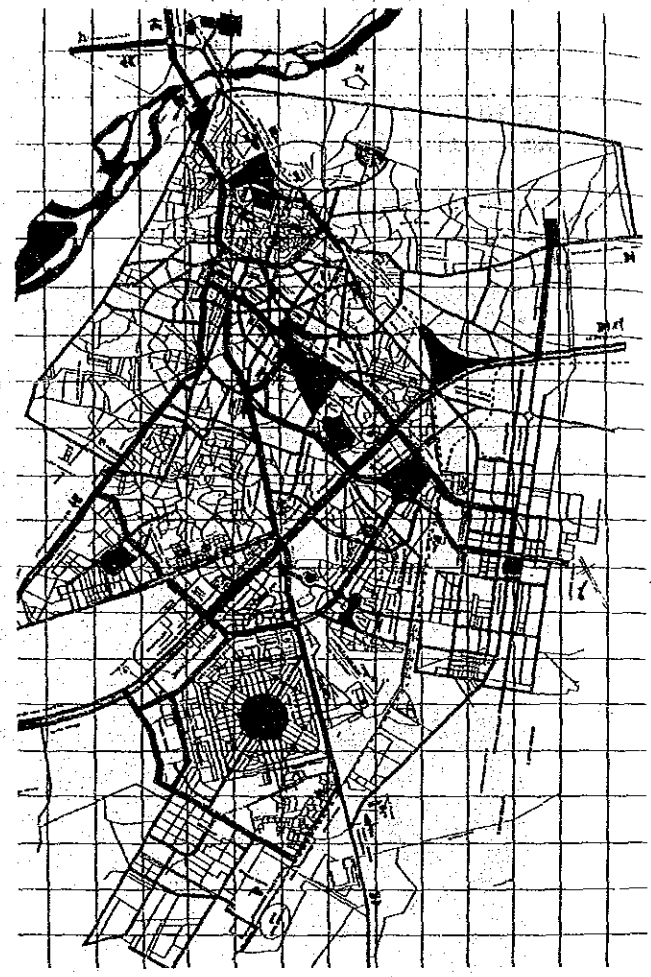
4) Major Facilities and Greenery

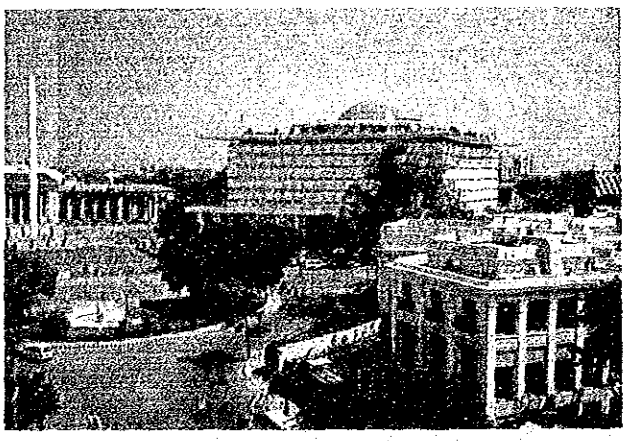
There are many large-scale public facilities, such as mosque, tomb, university, stadium, park, museum and government buildings in Lahore, because of its functions as the regional center of Province and religious heart with historical importance. Especially Badshahi Mosque, Punjab University, Iqbal Park and Lahore City Station are famous, historic and in largest-scale in Pakistan.

Lahore is also famous for its richness of greenery such as garden, road-side trees and green along UBD canal.

The carefully consideration is necessary to preserve those environments, when transport infrastructures will be implemented in future.

Figure 1.4 Major Facilities





Assembly Hall/WAPDA House

The Mall Road

5) Trip Characteristics by Person Trip Survey

The 'Person Trip Survey' was conducted in the study, in order to analyze the general transport features by LMA residents and to obtain the fundamental data for traffic demand forecast / transport master plan. The survey consists of followings:

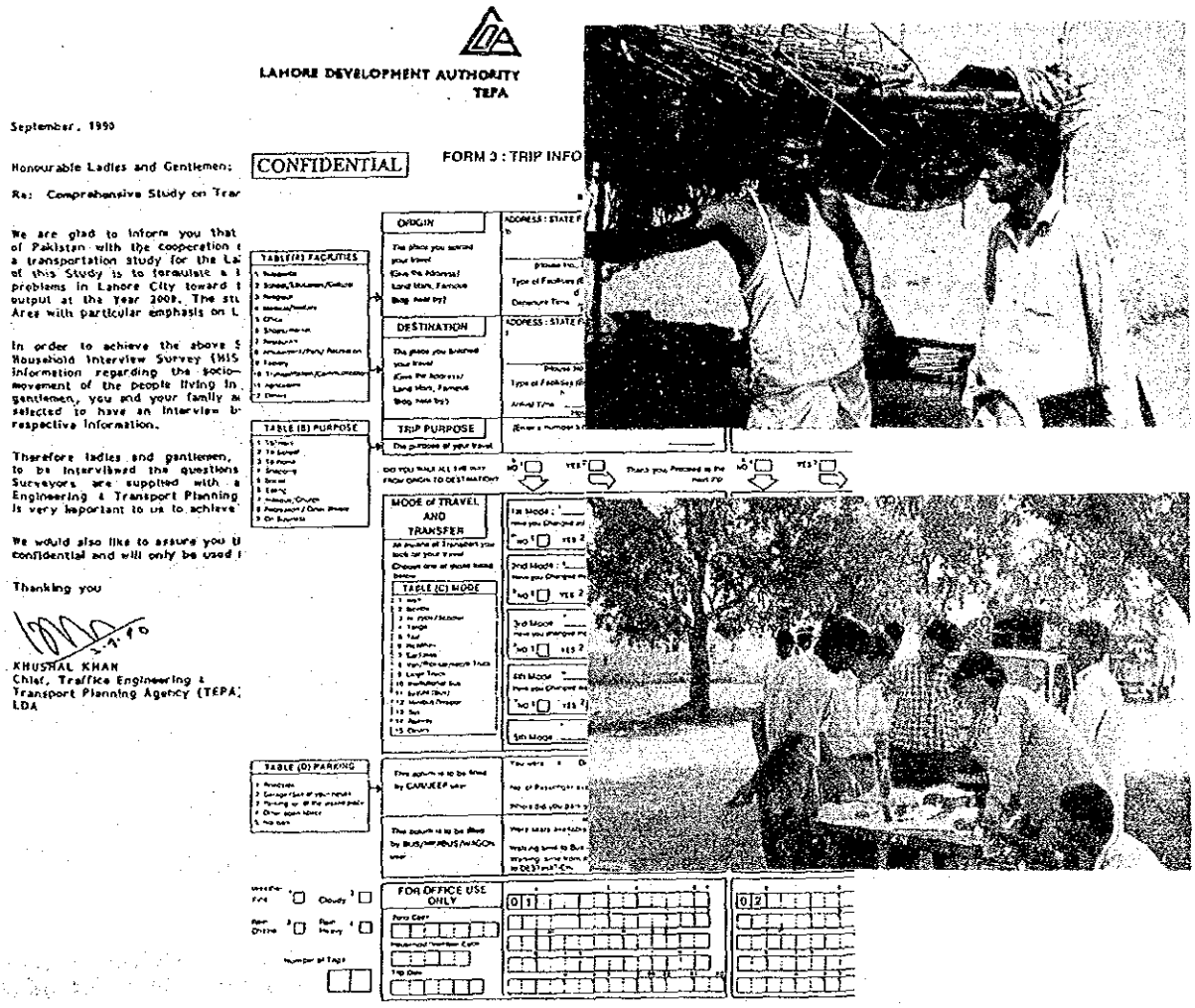
(1) Household Interview Survey : 12 thousand households were randomly chosen, and interviewed about characteristics of family/household members and all the trips traveled in a normal week day.

(2) Cordon Line Survey : Interview to drivers / traffic count were carried out at road-sides across the border of LMA. Railway passengers were also interviewed at railway station.

(3) Screen Line Survey : At 36 survey points across the three screen lines, traffic count survey was conducted. Load factor(average number of pass. per vehicle) was also surveyed.

(4) Public Transport Users Survey : Bus passengers were interviewed at major bus terminals.

Figure 1.5 Survey Sheet of HIS



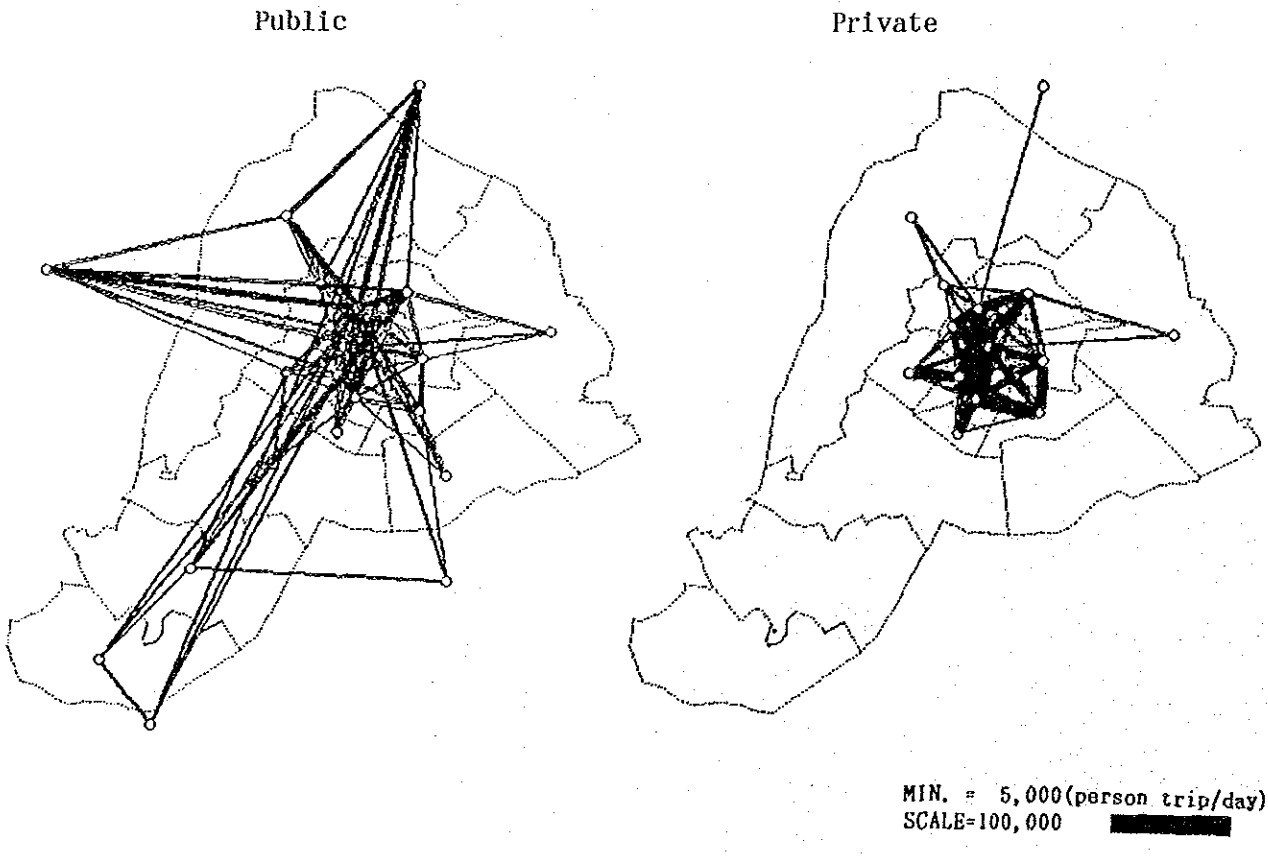
The total number of person trips in LMA is estimated at 10,249thousand by HIS, of which 95% is traveled within LMA. 428thousand trips are external trips and only 21thousand through LMA.

Table 1.2 Summary of Person Trips, 1990

Classification of Major Person Trip Flow	Number of Daily Trips	Percent
Internal Person Trips	9800000	95.6
- by LMA Residents	9706000	94.7
- by Non-Residents of LMA	94000	0.9
External Person Trips	428000	4.2
- by LMA Residents	73000	0.7
- by Non-Residents of LMA	355000	3.5
Through Person Trips	21000	0.2
- by LMA Residents	-	0.0
- by Non-Residents of LMA	21000	0.2
Total - All Person Trips	10249000	100.0

Source: CSTS Person Trip Survey, 1990

Figure 1.6 Person Trip Flow



Regarding the trip purpose composition, 45% of total trips (excl. walk) are 'to home', 20% 'to work', 18% 'private', 14% 'to school' and 'on business' is very few. The mode composition varies by trip purpose, as shown in Figure 1.8.

Figure 1.7 Trip Purpose Composition

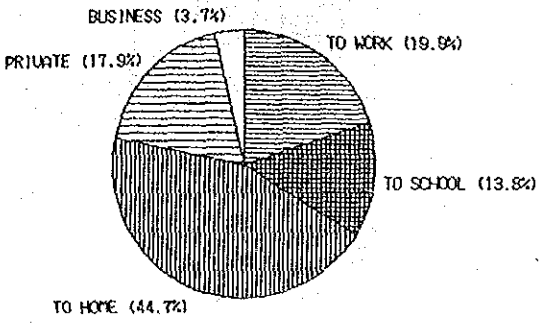
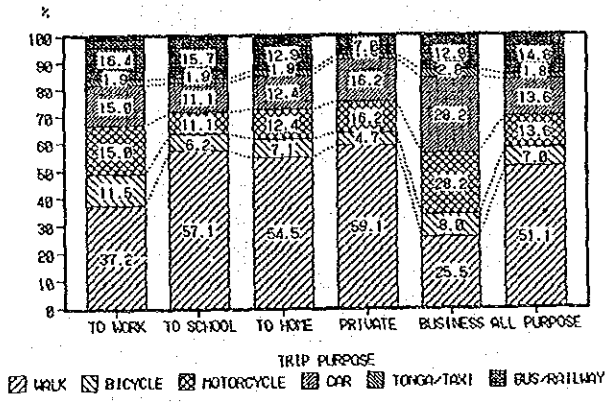
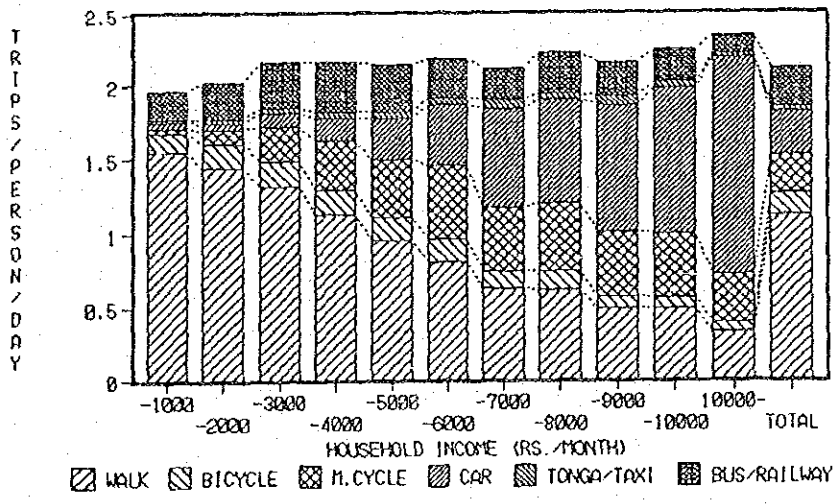


Figure 1.8 Trip Mode Composition



Source : CSTS Household Interview Survey, 1990
Notes : Trips made by LMA residents
Car includes car/jeep, van/pick-up/micro-truck and large truck for private use.
Tonga and taxi include rickshaw.

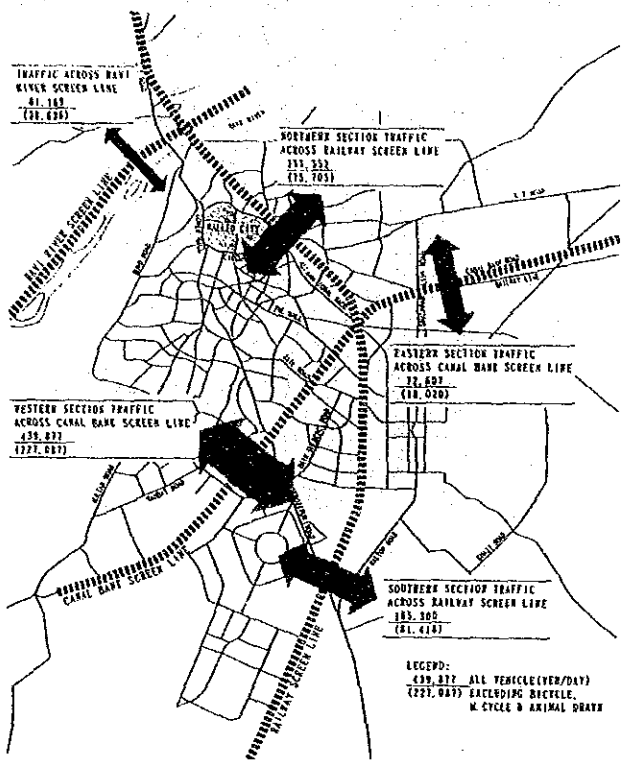
Figure 1.9 Trip Generation Rate(by Mode) by Household Income Level



The result of screen line survey is summarized in Figure 1.10.

The volume at canal screen is 512 thousand, at railway 443 thousand and at Ravi river 81 thousand, respectively. Over half of the volume is by bicycle, motorcycle & animal-drawn, except at canal screen.

Figure 1.10 Traffic at Screen Line

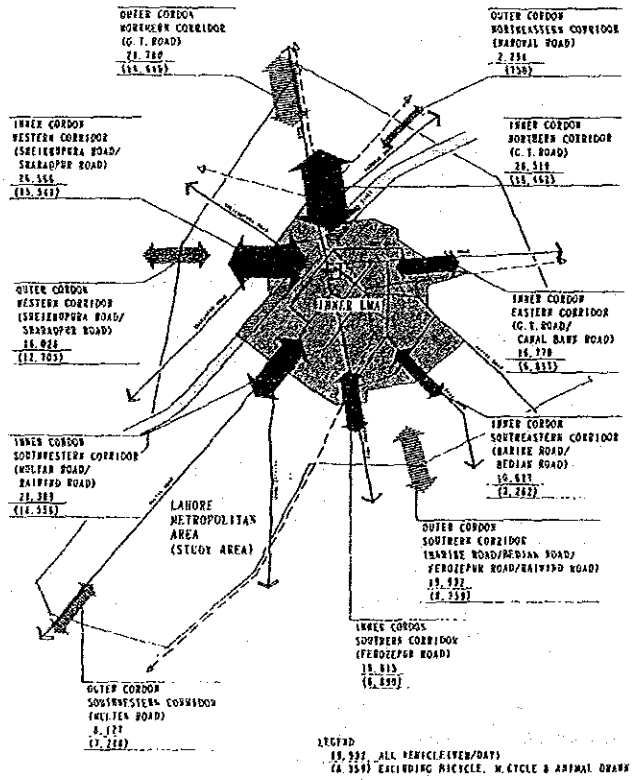


While, the traffic volume across cordon-lines are observed:

68,000 veh/day : outer cordon-line
121,000 veh/day : inner cordon-line

The heaviest volume is observed at northern corridor along G.T. Rd.

Figure 1.11 Traffic at Cordon-line



6) Road Network and Traffic

The radial arterial roads centered to Walled City are relatively well-developed in LMA, because of its historical urban growth. However, there are insufficient circumferential roads except the Circular Rd., and it is necessary to complete the functional road-network configulation with adequate circumferential roads.

The traffic volume at major section counts for over 100thousand veh/day, at Ferozepur Rd., Multan Rd., the Mall, etc.
Since there are high percentage share of non-motorized vehicles at most of sections, such as animal, animal-cart, bicycle, all the roads in LMA are really congested even with the smaller traffic volume.

Figure 1.12 Road Network

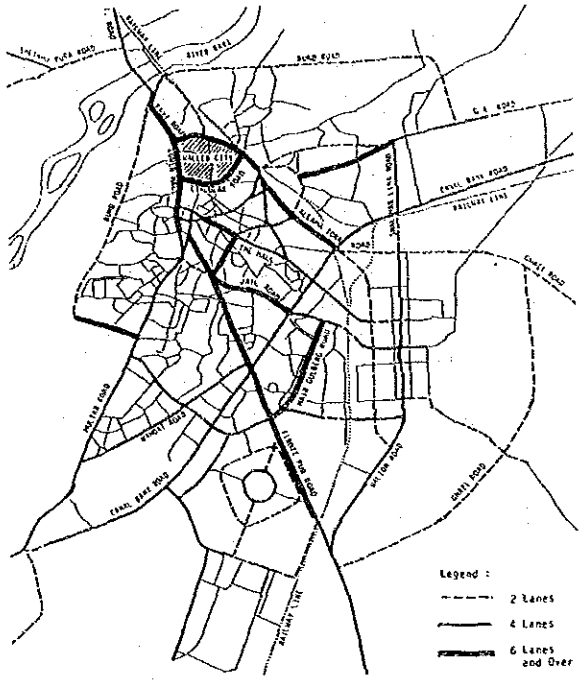
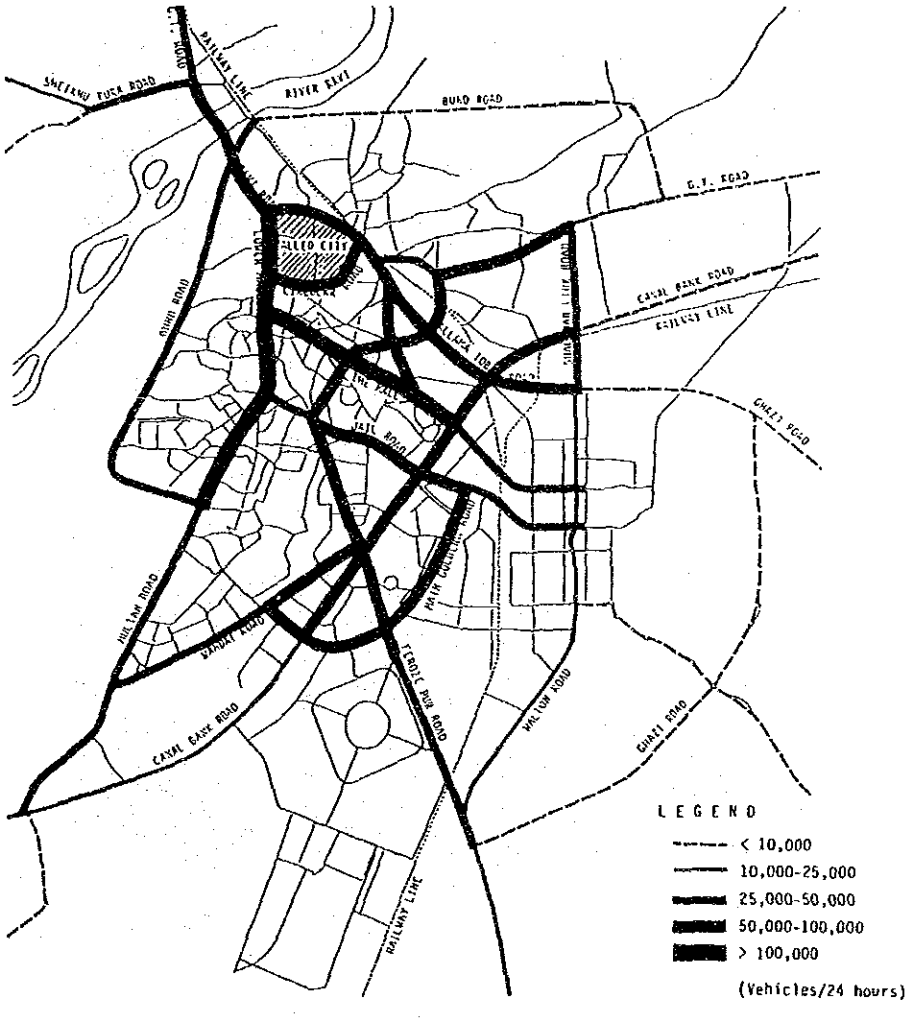


Figure 1.13 Traffic Volume at Major Road Sections

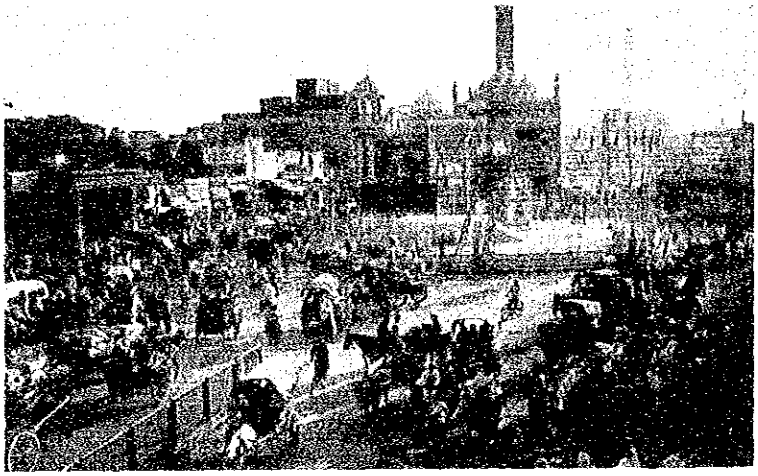


There are a number of roundabout intersections in LMA. Some were constructed before World War II and are located at main intersections, occupying relatively large space. When roundabouts provide greenery spot, monument, pond, etc. which contribute to the scenery of the city, however, increasing traffic demand has exceeded the capacity at many roundabout intersections.

Among other intersections, some are with inadequate engineering design/signal control reducing the traffic capacity.

Traffic volumes at major intersections in LMA are in the range of 5,000 to 13,000 PCU/peak hr. Those with motorized traffic more than 9,000 PCU/hr are Qartaba Chowk, Jail/Canal Rds, Chouburji Chowk, Ferozepur/Canal Rds, Kalma Chowk and the Mall/Canal Rd.

They are located in major public transport corridors.



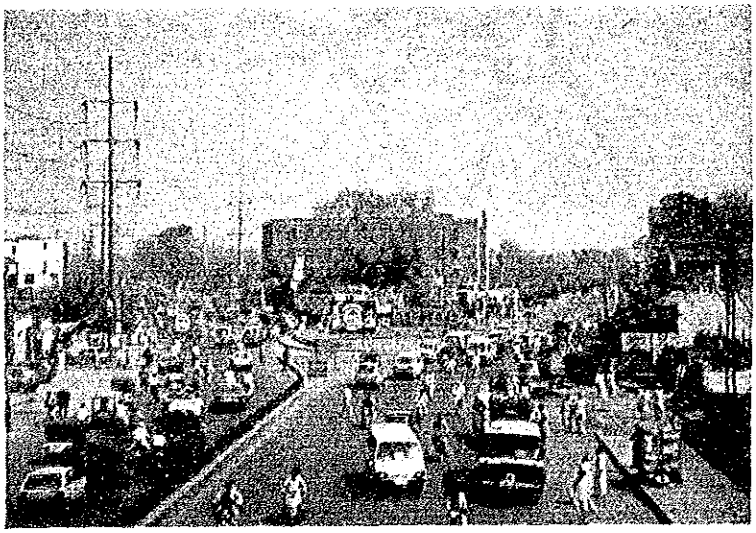
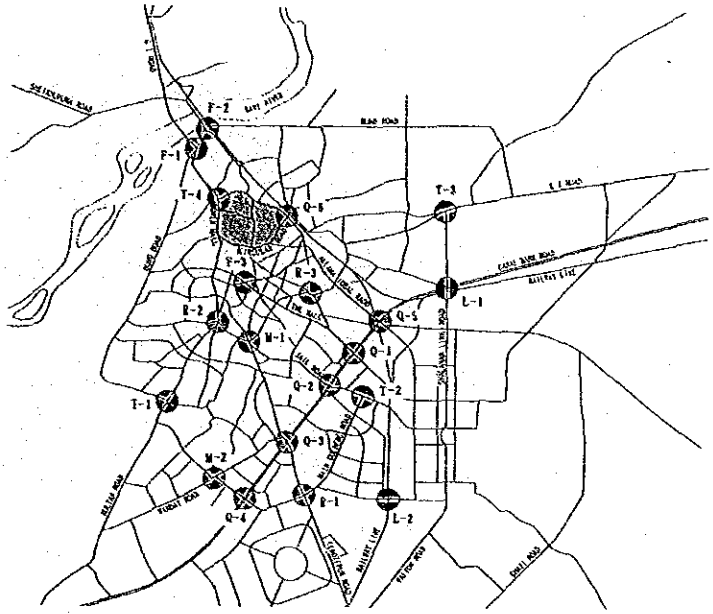


Figure 1.14 Classified Types of Intersections



Type of Intersection

Type	Name of Intersection	Location
T-Leg	·Yatim Khana	T-1
	·Fawala Chowk	T-2
	·GT Road/Shalimar Link Rd	T-3
	·Ravi Road/Circular Rd	T-4
4-Leg	·GT Road/Bund Road	F-1
	·Old Ravi Bridge	F-2
	·The Mall/Mcleod Road	F-3
Multi- Leg	·Muzang Chungi	M-1
	·Nabdat Rd/Allama Iqbal Rd	M-2
Roundabout	·Kalma Chowk	R-1
	·Chouburji	R-2
	·Shimla Hill	R-3
Quasi-roundabout	·The Mall/Canal Bank Rd	Q-1
	·Jail Rd/Canal Bank Rd	Q-2
	·Ferozepur Rd/Canal Bank Rd	Q-3
	·Campus Rd/Canal Bank Rd	Q-4
	·Allama Iqbal Rd/Canal Bank Rd	Q-5
	·Eikmoria	Q-6
Level Crossing	·Shalimar Link Rd/Railway	L-1
	·Park Road/Railway	L-2

7) Road Encroachment

It is quite common, not only in Lahore but also other urban areas in Pakistan and Asian countries, the economic activities expand on the road space in the mixture of vehicle traffic.

Activities other than traffic are shops, street vendors, storage, parking, buses waiting for passengers, animal feeding and so on. They are unauthorized and illegal.

At those sections, the right of way is occupied by non-traffic activities and the road space for traffic is reduced substantially.

Major sections encroached in LMA are described in Figure 1.15.

Figure 1.15 Location of Major Road Encroachment

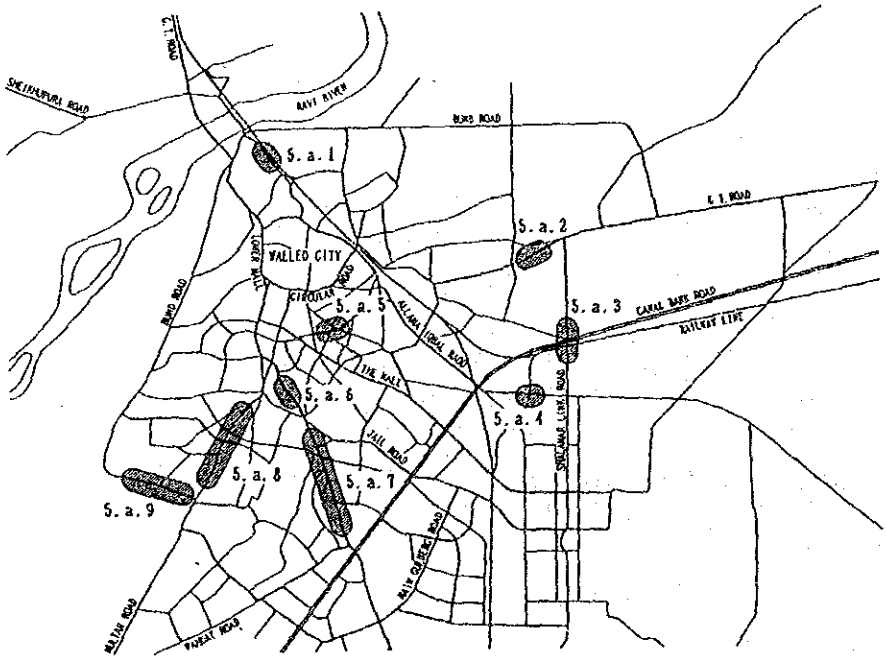
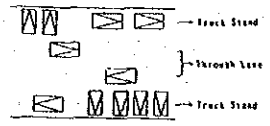
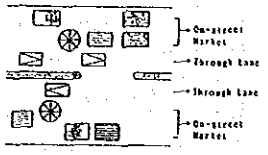


Figure 1.16 Types of Road Encroachment

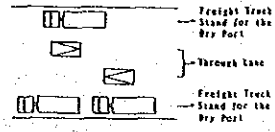
No. : 5.a.1
Name of Road: G.T.Road
Section: Old Ravi Bridge - Bdami Bagh Bus Stand
No. of Lanes: 2 → 4
Function: Access to the Badami Bagh Intercity Bus Terminal
Type of Encroachment: Truck Stand



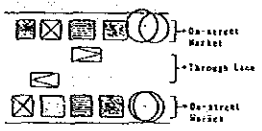
No. : 5.a.2
Name of Road: G.T.Road
Section: UET - Shalimar Link Road
No. of Lanes: 2 → 6~8
Type of Encroachment: On-street Market



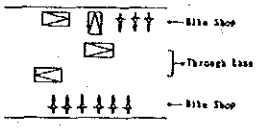
No. : 5.a.3
Name of Road: Shalimar Link Road
Section: Allama Iqbal Road - Canal Bank Road
No. of Lanes: 2 → 2
Function: Access Road Between North and South in the Eastern Part of the City
Type of Encroachment: Freight Track Stand



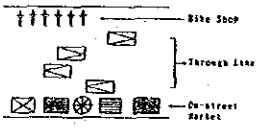
No. : 5.a.4
Name of Road: Allama Iqbal Road
Section: Canal Bank Road - Shalimar Link Road
No. of Lanes: 2 → 6
Type of Encroachment: On-street Market



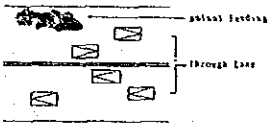
No. : 5.a.5
Name of Road: Mcleod Road
Section: The Mall - Railway Station Area
No. of Lanes: 2 → 4
Type of Encroachment: Bike Shop



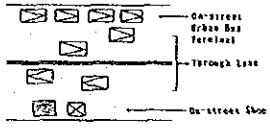
No. : 5.a.6
Name of Road: Lytton Road
Section: Muzang Chungi - Anarkali
No. of Lanes: 4 → 6
Type of Encroachment: Bike Shop and On-street Market



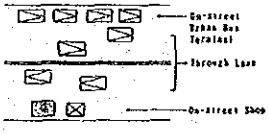
No. : 5.a.7
Name of Road: Ferozepur Road
Section: Muzang Chungi - Canal Bank Road
No. of Lanes: 6~8 → 10
Type of Encroachment: On-street Market, Animal Feeding



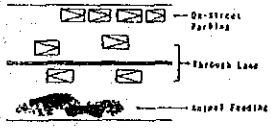
No. : 5.a.8(1)
Name of Road: Multan Road
Section: Choubruji - Bund Road
No. of Lanes: 4 → 6
Type of Encroachment: On-street Shop, On-street Bus Terminal



No. : 5.a.8(2)
Name of Road: Multan Road
Section: Choubruji - Bund Road
No. of Lanes: 4 → 6
Type of Encroachment: On-street Shop, On-street Bus Terminal



No. : 5.a.9
Name of Road: Bund Road
Section: Yatim Khana - New Bridge
No. of Lanes: 6 → 8
Type of Encroachment: On-street Parking, Animal Feeding



8) Public Transport

Public transport modes served in LMA are roughly divided into two:

-Individual : Tonga, Rickshaw, Taxi
-Public : Bus, Railway

Buses are further classified into operated by public (PRTC) and by private under licenses from RTA/PTA. Private buses have various types of vehicles; standard bus, medium size (Mazda), mini-bus (Hiace, Ford) and Suzuki.

Mini-buses with its capacity of approximately 20 passengers plays an important role in LMA. Currently, about 60% of the public transport users are served by mini-bus.

Inter-city transport is served not only by air and railway but also by various types of buses; standard / medium buses and flying coach. Their central terminals are located at Badami Bagh and G.T.S. at the heart of LMA.

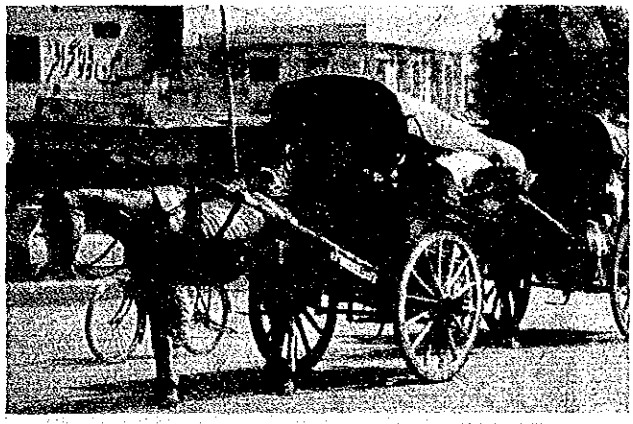
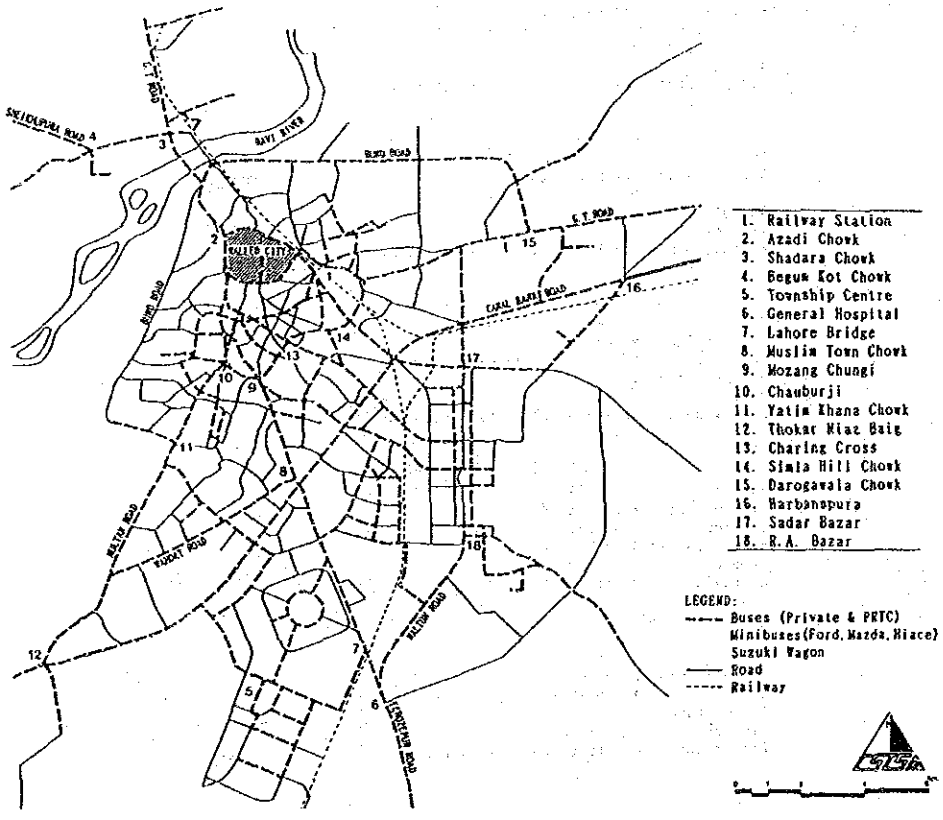
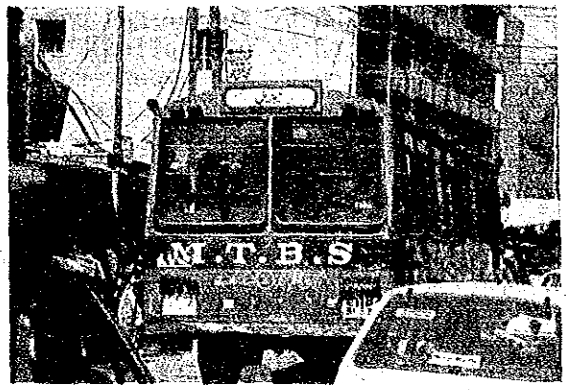


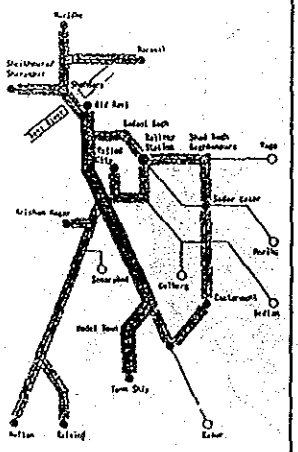
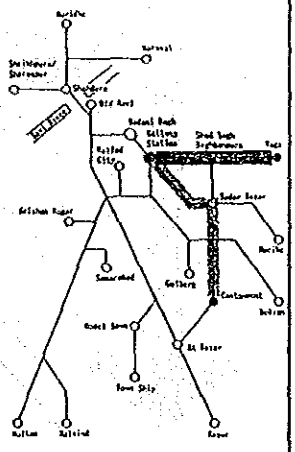
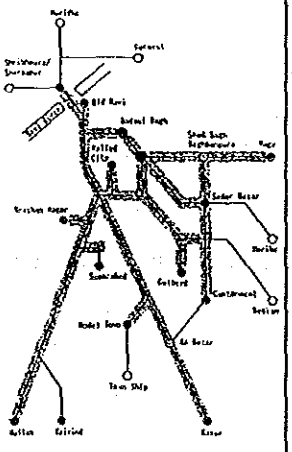
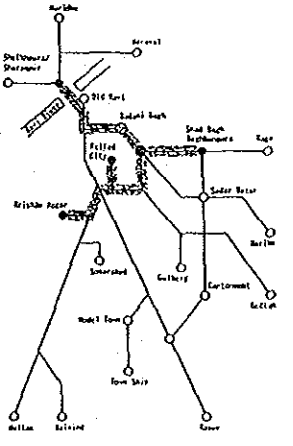
Figure 1.17 Bus Routes and Railway



Bus route structure of urban service is classified by vehicle type as shown in the following figure.

PRTC buses cover the almost whole areas westbound from railway and private standard buses serve within the eastern area. Mini-buses, rapidly increasing in LMA, also cover the entire LMA with their shorter routes and frequent services. Suzuki has the routes within the limited central area.



PRTC	Private Bus	Minibus	Suzuki
.Routes emanate from the Ferozepur Corridor mostly. .The average lenth of the routes is the largest in the four types in LMA.	.Routes cover the east and the south-east area of LMA where PRTC routes cannot extend.	.Routes from the periphery of Walled City and from the Railway Station Area. .Route lengths are not large as PRTC or Private Bus, But the number of the service routes is the largest and cover most of the public service network. .Currently, about 60% of the public transport users are served by minibus.	.Routes are among Walled city, Krishan Nager, & Shad Bagh. .Penetrate in narrow streets of those densely located areas. .Although not authorized, some of this type serve as feeder service in the developed housing areas, such as Model Town, Township, Iqbal Town, etc.
•No. of Routes = 33 •Average Route Length = 23.5 km •Daily Trips = 770 •Daily No. of Seats = 53,900	•No. of Routes = 12 •Average Route Length = 23.0 km •Daily Trips = 1,368 •Daily No. of Seats = 68,400	•No. of Routes = 50 •Average Route Length = 17.0 km •Daily Trips = 8,456 •Daily No. of Seats = 169,120	•No. of Routes = 4 •Average Route Length = 11.0 km •Daily Trips = 869 •Daily No. of Seats = 8,690
			

2. Future Urban Growth and Increasing Traffic Demand

1) Socioeconomic Framework

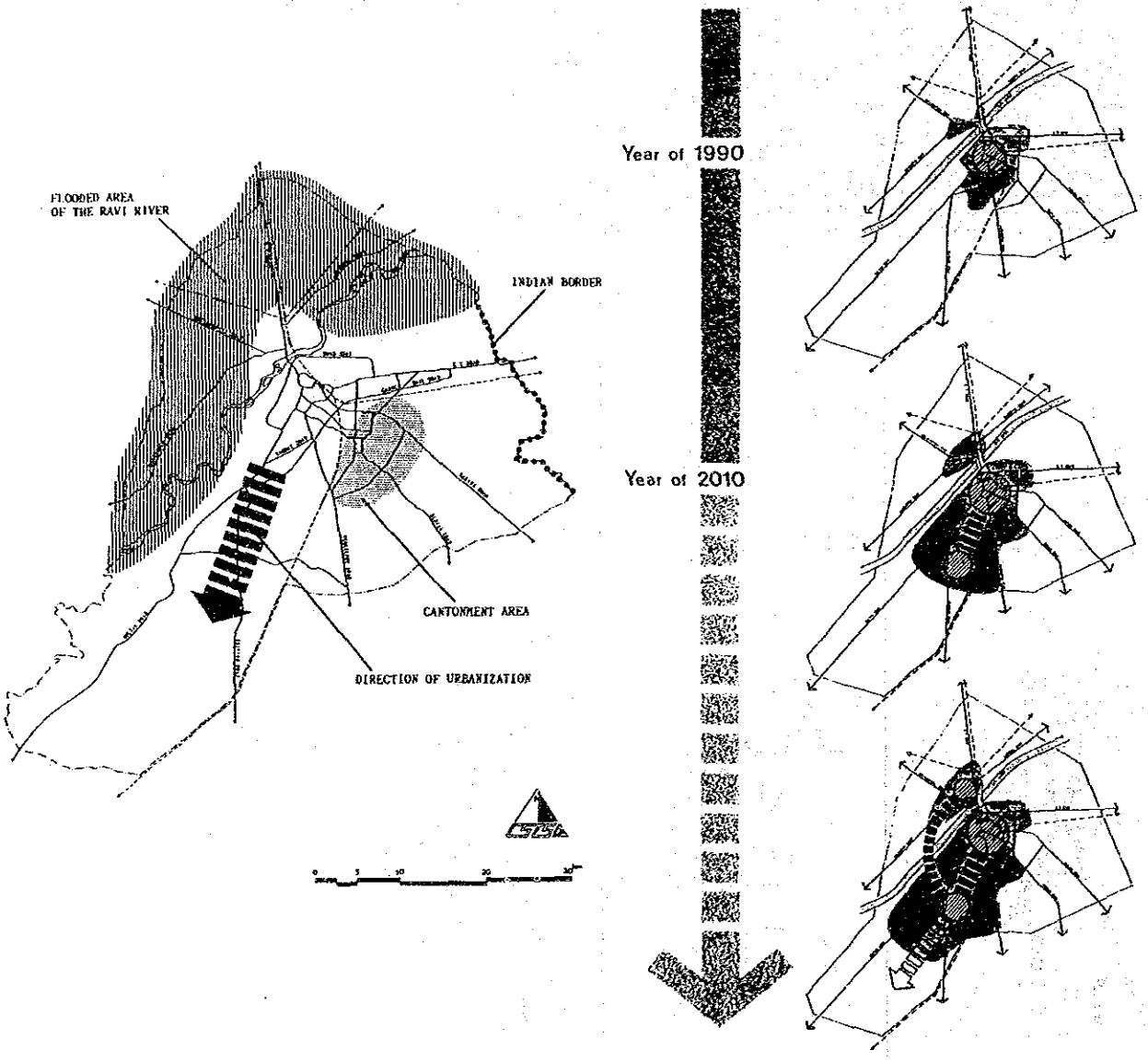
Various socioeconomic indicators, as essential information for demand forecast and transport planning, were estimated based on the authorized development plans. They are:

- Total population in 2000 & 2010,
- Population by gender and age-grope,
- Population by occupation,
- Population by employment sector,
- GNP & per capita GNP, etc.

2) Direction of Future Urbanization

Future urban growth of LMA was supposed as follows, taking into consideration both historical trend and geographical constraint of urbanization.

Figure 2.1 Direction of Urbanization in Future



3) Demographic Framework by Area

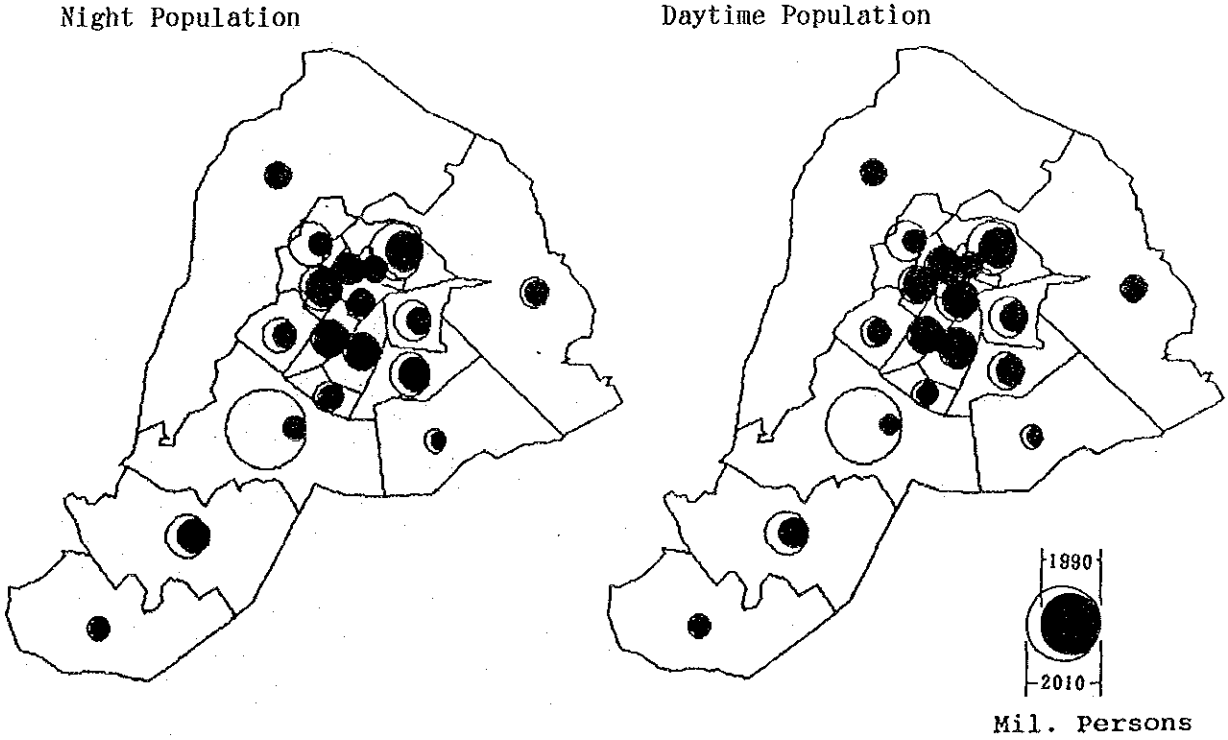
Breakdown of the previously estimated socioeconomic framework into each zone was carried out, considering the supposed land use pattern and present features of zone.

Population at night (No. of residents) and population in daytime are basic demographic data and summarized, with comparison between in 1990 and 2010.

Table 2.1 Daytime and Night Population by Zone, 1990/2010

ZONE		1990			2010				
NO.	NAME	POPULATION IN DAYTIME	POPULATION AT NIGHT	DAY/NIGHT RATE	POPULATION IN DAYTIME	POPULATION AT NIGHT	DAY/NIGHT RATE	DAY POP 2010/1990	NIGHT POP 2010/1990
1	WALLED CITY	434034	355515	1.22	516954	329690	1.57	1.19	0.93
2	GOVERNMENT HOUSE	532068	243959	2.18	748599	252511	2.97	1.41	1.04
3	IQBAL TOWN/NEW CAMPUS	421841	402357	1.05	536862	481410	1.12	1.27	1.20
4	SHAD BAGH	262360	274813	0.95	280436	275210	1.06	1.11	1.00
5	KRISHAN NAGAR	390519	495474	0.79	518790	654280	0.79	1.33	1.32
6	NIAZ BEG	182121	218758	0.87	357155	409452	0.87	1.96	1.86
7	BAGHBANPURA	606825	643328	0.94	1061589	1136240	0.93	1.75	1.77
8	SHAHDARA	181341	196150	0.92	584788	728673	0.80	3.22	3.71
9	MAIN GULBERG/MODEL TOWN	455831	397300	1.15	568314	483053	1.18	1.25	1.22
10	TOWNSHIP	172932	214465	0.81	283828	340250	0.83	1.64	1.59
11	CANTONMENT-NORTH	318317	292956	1.09	640880	631817	1.01	2.01	2.16
12	CANTONMENT-SOUTH	334223	431925	0.77	537582	678556	0.79	1.61	1.57
13	WAGHA	200477	226266	0.88	291981	298798	0.98	1.46	1.32
14	MOTA SINGHWALA	86159	124948	0.78	179011	208600	0.86	1.82	1.67
15	BHOPATTIAN(SOUTHERN SUB-CORE)	156888	186175	0.84	2094889	2341273	0.89	13.35	12.58
16	BHAIPHERU	138361	148611	0.93	211482	196248	1.08	1.53	1.32
17	SHEIKHUPURA	190304	202791	0.94	283862	267796	1.06	1.49	1.32
18	WAHGA/RAIWIND	343734	373545	0.92	691920	685285	1.01	2.01	1.83
TOTAL		5430336	5430336	1.00	10400242	10400242	1.00	1.92	1.92

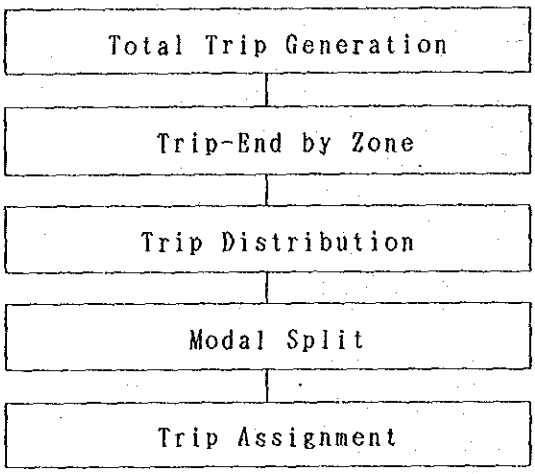
Figure 2.2 Distribution of Population, 1990/2010



4) Future Traffic Demand

Future Traffic Demand, in terms of person trips, was estimated in accordance with the following procedure.

Figure 2.3 General Flow of Demand Forecast



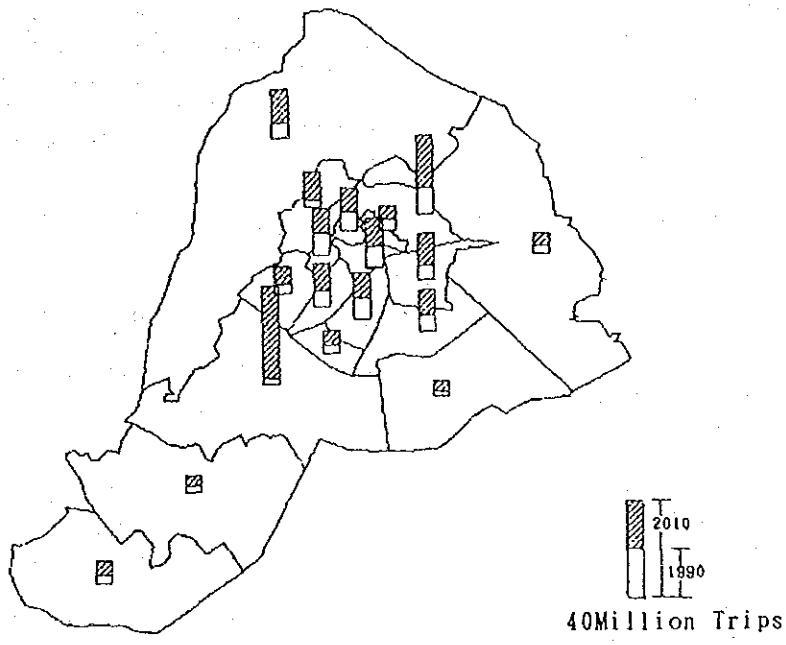
The population in 2010 is estimated at almost double of 1990, and number of trips is to be over double in accordance with the change of population structure and progress of motorization.

Table 2.2 Summary of Traffic Demand Forecast

Indicator	1990	2010	2010/1990
a) Total population ('000)	5,430	10,400	1.92
b) Population, 5 yr. & above	4,580	8,875	1.94
c) GNP per capita (Rs. in 1990)	7,590	13,900	1.83
d) Car-usable household (%)			
2-Wheels	77.5	91.0	1.17
4-Wheels	22.0	56.0	2.54
e) Total No. of trips			
All modes ('000)	10,249	20,234	1.97
Motorized	5,128	11,244	2.19
Private	3,280	7,269	2.22
Public	1,848	3,975	2.15

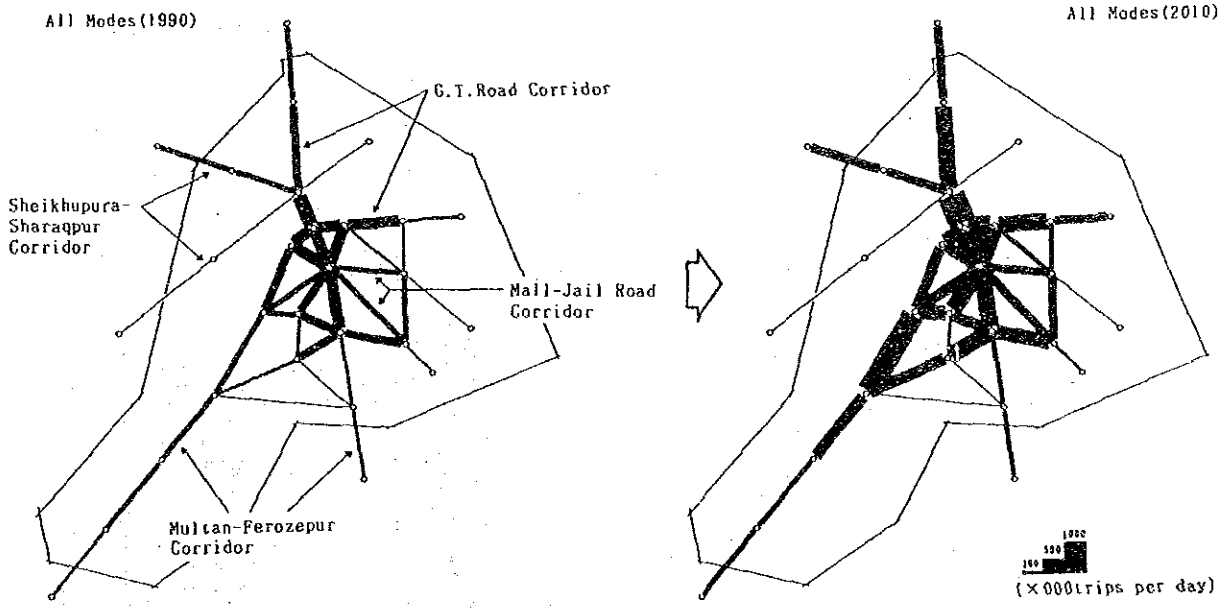
The trip generation/attraction has close correlations with population and potential of urban activities in zone. The large trip generation/attraction is observed in zones of Govt. house and Shahdara in 1990, existing business / commercial center in LMA, and in addition Bhopattian zone is estimated to have huge amount of traffic demand in 2010 as the developments progress.

Figure 2.4 Trip Generation by Zone, 1990/2010



The estimated trip O-D distribution shows the increase of traffic flow between the existing urban center and newly developed southern sub-center, in addition to the present heavy demands between the center and north/east.

Figure 2.5 Traffic Demand on Simplified Network



3. Master Plan Study

1) Summary of the Transport Problems in LMA

Present transport problems in LMA are seemed not so serious except for some areas and peark hours. This is partially due to the relatively wide road space and low mobility of women in comparison with other country. However, it is expected that the population in 2010 will be approximately double of the present (over 10 million) and traffic demand will exceed the double, and therefore it is now necessary to establish the comprehensive transport system to cope with future traffic demand. To establish the overall transport master plan with long-term prospects including on-going issues is one of the key factors for successful urban development in LMA.

2) Planning Policy and Approach

Considering the existing transport conditions and expected future traffic demand, the planning policy for the master plan is settled as follows:

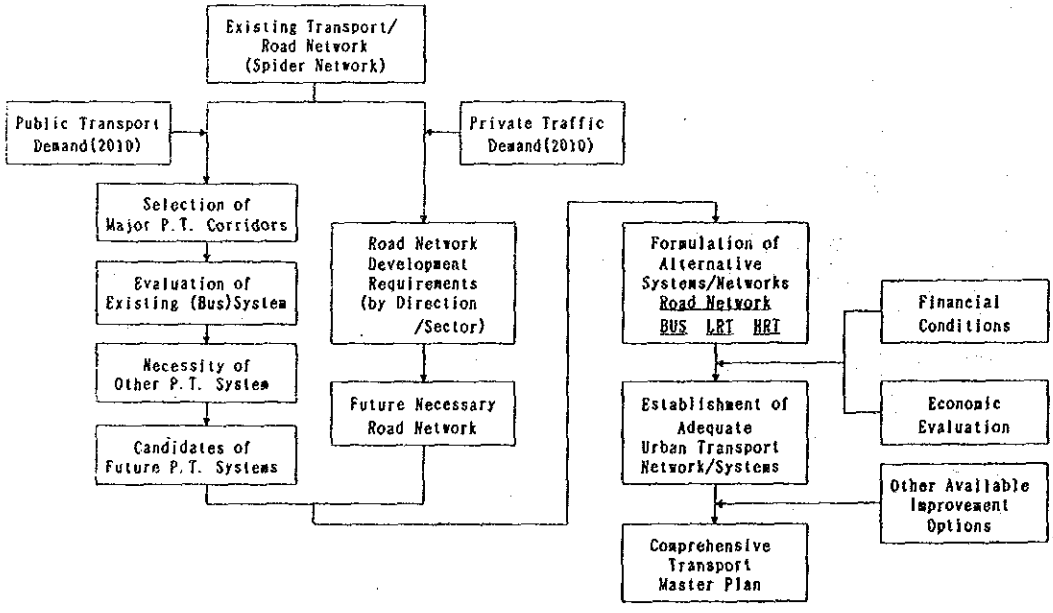
- Comprehensive transport system that could not only cope with the traffic demand in future but also maintain the individuality of LMA as the capital in Punjab;
- Preservation of urban amenities in Lahore;
- Establishment of functional road network system, with radial and circumferential roads, to meet the future road traffic demand;
- Introduction of more effective public transport system with higher capacity for the increasing public transport demand; and,
- Consideration on the significant features, high percentage share of 2-wheel vehicles and the very wide variety of transport modes.

In addition, followings are considered especially for short-term planning:

- Effective use of the existing transport facilities;
- Improvement of existing bus service; and,
- Efficient traffic management measures.

Planning approach for the transport master plan is summarized in Figure 3.1.

Figure 3.1 Planning Approach for Establishment of the Master Plan



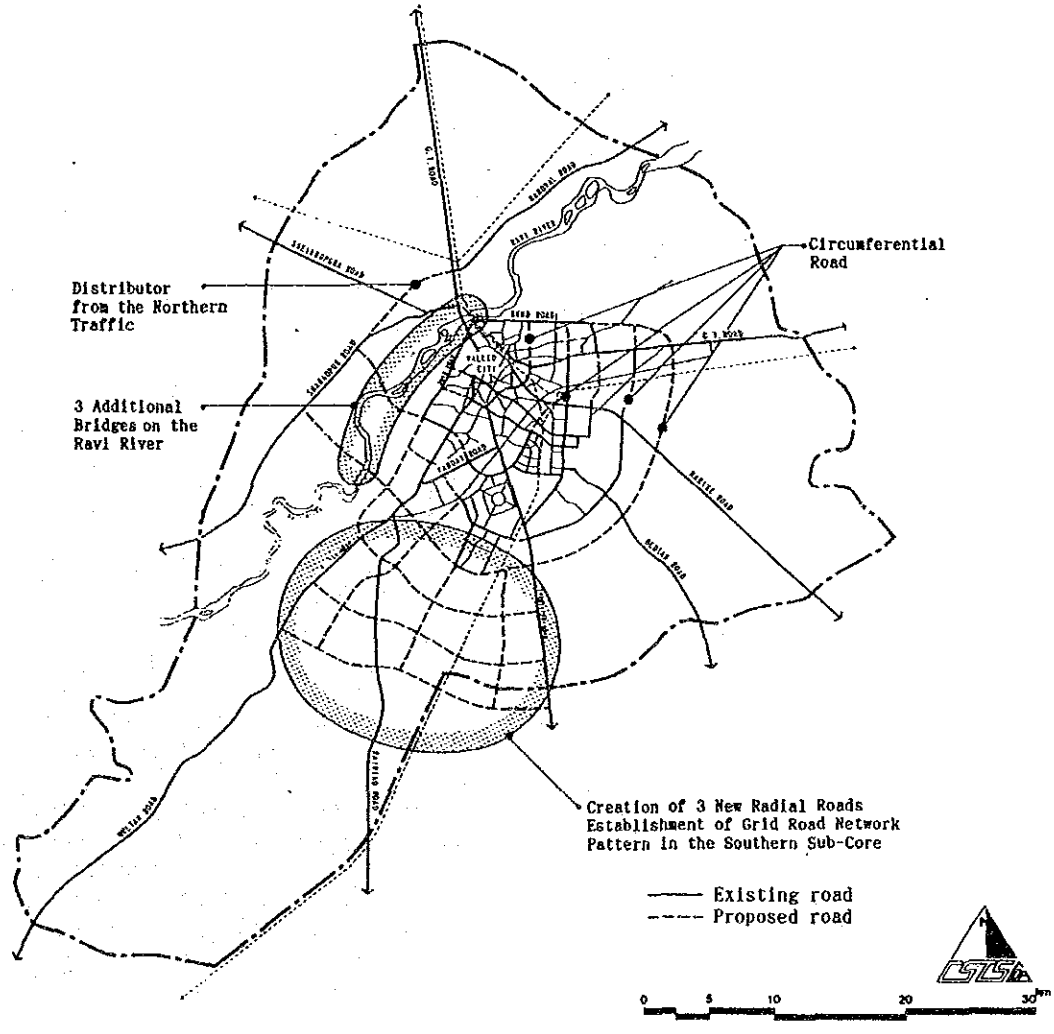
3) Road Network Improvement

For the future road network improvement, the required number of trunk roads by direction was examined by comparing future assigned traffic demand with the existing road network capacity, as shown in Table 3.1. The future road network with radial and circumferential roads was proposed as shown in Figure 3.2, considering the existing road network, future urbanization and the basic road network conceptual pattern.

Table 3.1 Required Number of Roads by Direction

Screen/Section	A.Traffic Demand in 2010 (000 puc/day)	B.Existing Road Capacity (000 puc/day)	A - B	Required Additional NO. of Road (4-lane Road)
Canal Bank	598	432	166	4
Railway	518	488	30	1
Ravi River	172	72	100	3
Southern Section-1	307	216	91	2
Southern Section-2	209	108	101	3

Figure 3.2 Poposed Road Network to the Future Traffic Demand

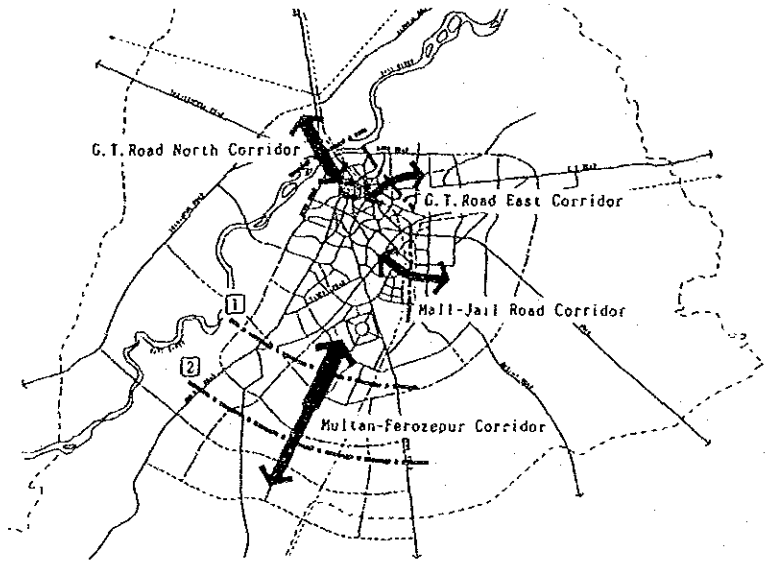


4) Public Transport System Improvement

In examining the assignment of future public transport demand on the proposed road network, 5 major public transport corridors are found as shown in Figure 3.3. It is suggested that the corridor between Multan and Ferozepur Roads has the heaviest public transport demand in the future among these corridors.

Figure 3.3 Estimated Demand on Public Transport Corridors, 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

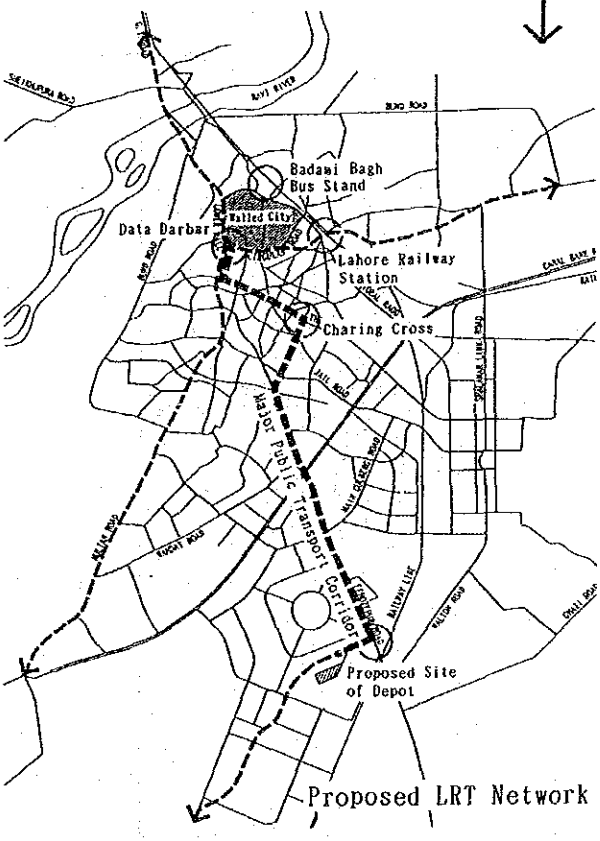


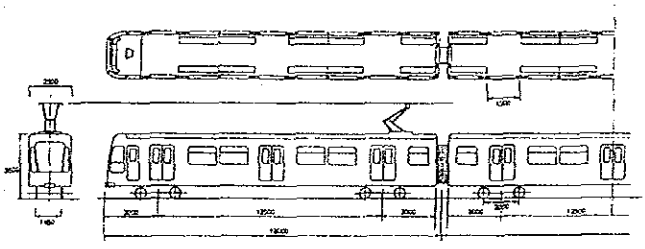
To cope with the expected future public transport demand, it is necessary to discuss the various countermeasures of public transport system for increasing its capacity.
Comparing the characteristics of various public transport system/facility, result of the assessment on the possibility of the future public transport system/facility introduction to LMA is summarized in Table 3.2. The following system/facility were selected for the mass transit study in LMA.

(1) To cope with the expected increase of public transport demand, LRT and busway were selected as the alternative trunk system along major public transport corridors.
(2) HRT system, with a minor improvement of the existing Pakistan Railway, were also examined as the supplemental urban public transport system.
(3) Other improvements of existing system/facility, such as restructuring bus routes and introduction new type of fleet, should be introduced as the basic countermeasures, because they could be introduced with lower cost and as immediate action.

Table 3.2 Assessment of Possible Public Transport System in LMA

	Items	Introduction of New System/Facility						Improvement of Existing System/Facility			
		Guided Transit System				Bussy System		Improvement of P.T. 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	Separate 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: 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 system except uses conventional buses	Improvement of P.T. for urban transit without interruption of intercity service and with small cost				
Assessment of Possibility to Lahore	To Introduce Low cost System/Facility	C	C	AA	A	A	A	AA	B	AA	B	AA
	Easy Operation	A	A	A	A	A	B	A	-	-	B	B
	Easy Maintenance	B	B	AA	B	B	A	A	-	-	A	AA
	Less Impact to the Urban Environment	AA	AA	C	A	B	B	A	AA	AA	A	A
	Effective Use of Existing System/Facility	C	C	C	C	C	B	AA	A	AA	B	AA
	Overall	Good for urban environment but high cost. B	Good for urban environment but high cost. B	Low cost but seriously affect to road traffic. A	Need examination. AA	Relatively low cost but needs new type of buses. A	Need examination. AA	Need examination. AA	Need examination. AA	Need examination. AA	Need examination. AA	Need examination. AA





Proposed Railcar of LRT

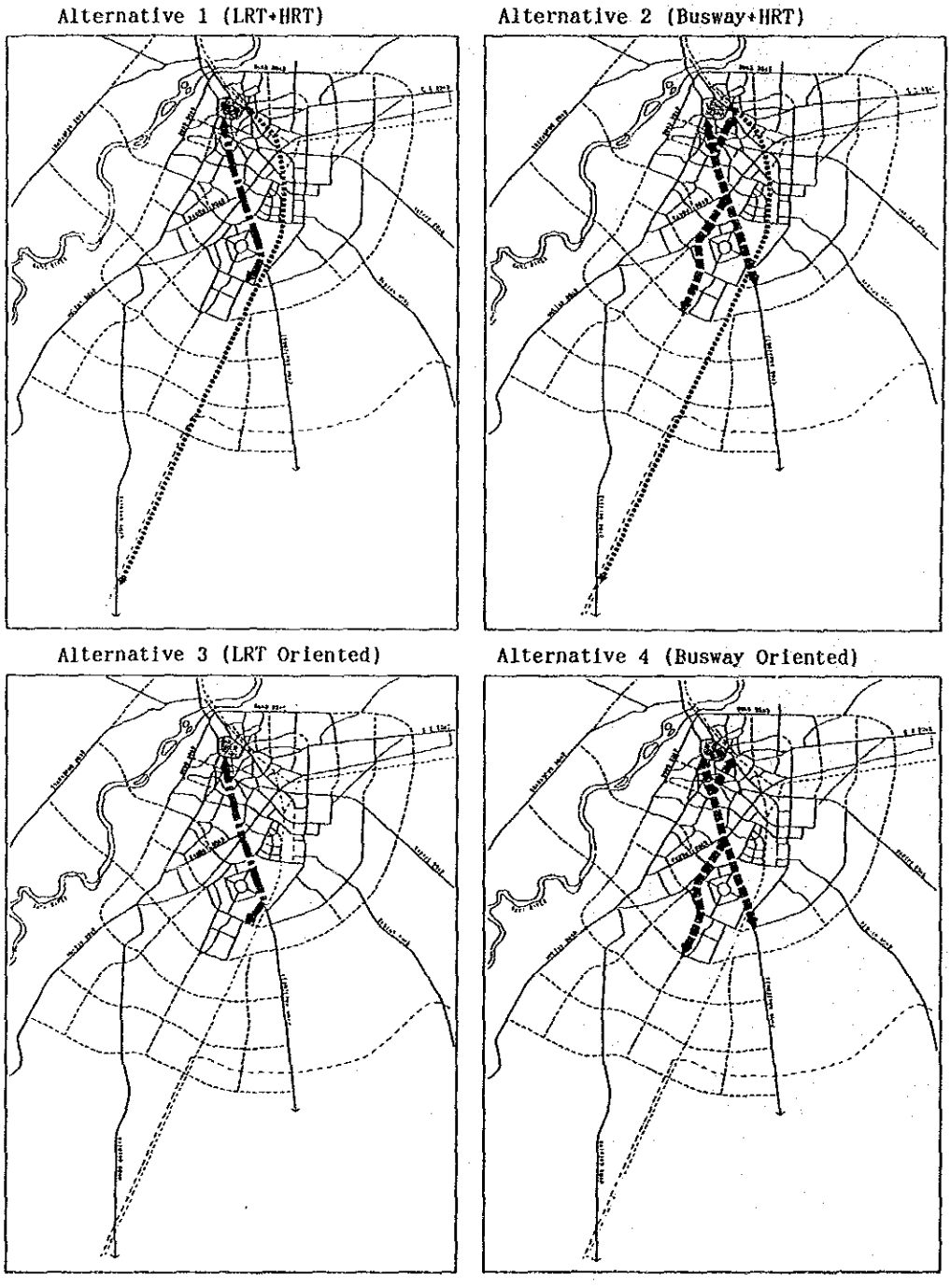
5) Evaluation of Public Transport Alternatives

Based on the future road network previously examined, following considerations were made to set up the public transport alternatives for evaluation;

- LRT / Busway stystem play a main role of public transport,
- HRT as a supplemental system,
- the planned road network is the basic component of all alternatives.

Four (4) alternatives, i.e., 'LRT' or 'Busway', plus with 'HRT' or without 'HRT' are proposed for the assessment of future mass transit system in 2010.

Figure 3.5 Alternative Packages of Public Transport System



From the assessment among four (4) public transport alternatives, the plan of "LRT + HRT" was recommended as the most benefitial public transport system for LMA, in collaboration with the proposed road network, for the 2010 master plan of LMA.

Table 3.3 Overall Evaluation of Public Transport Alternatives

Items	LRT + HRT (Case 1)	Busway + HRT (Case 2)	LRT Only (Case 3)	Busway Only (Case 4)
System	LRT = 12.5km HRT = 40km	Busway = 30km HRT = 40km	LRT = 12.5km	Busway = 30km
Daily Passenger	302,000	278,000	245,000	214,000
Economic Evaluation				
B/C Ratio	1.68	1.46	1.54	1.36
NPV (Rs. Million)	3,306	2,206	2,520	1,657
EIRR(%)	17.60	15.92	16.48	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

6) Master Plan

The comprehensive transportation plan for the year 2010 was formulated. The Master Plan consists of a package of various transport systems and traffic management schemes. Basic considerations for the master plan are;

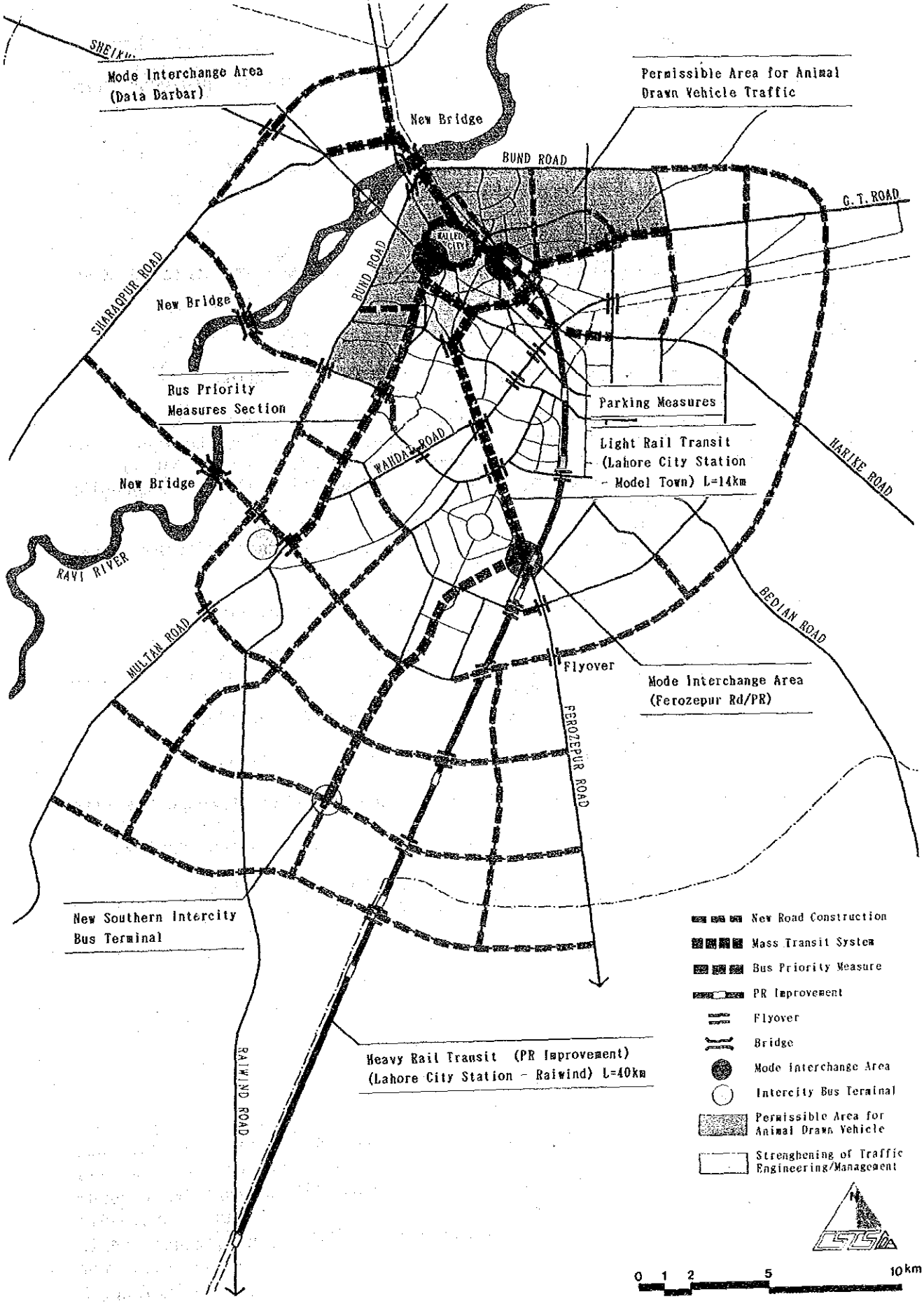
(1) Although traffic problems in LMA are not so serious, the population and traffic demand in 2010 are expected to increase more than double of the present, and traffic situation will deteriorate. While, the construction of transport infrastructure needs great amounts of budgets and time. Therefore, it is now necessary to establish the plan to introduce adequate measures of transport system in order to cope with the expected future demand.
(2) Considering the total project cost, financial constraints and other factors, it is necessary to set up adequate phasing of each component to maximize the benefits of the master plan in intermediate stages.

The Master Plan for the year 2010, which needs the total cost of 20 billion Rupees, consists of the components as shown in Table 3.4 and Figure 3.6.

Table 3.4 Major Components of the 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 3.6 Proposed Master Plan



7) Staging Program

Considering the following factors, the staging of various projects were planned.

- Total project cost
- Financial constraints of the Government of Punjab and LDA
- Progress of urban development to the south
- Traffic condition foreseeable by stage
- Transport network configuration

The three phases are proposed: short-term(1992-95), medium-term(1996-2000) and long-term(2001-2010).

Planning directions of each phase are as follows:

(1) Short-term projects : Total project cost = Rs. 25 billion

- Rehabilitation of deteriorated sections of trunk roads
- Effective and immediate traffic management actions for the inner area (Segregation between motorized and non-motorized vehicles, etc.)
- Improvement current bus system, i.e., introduction of higher capacity bus fleet
- New bridge construction across the Ravi river
- Expansion of the trunk road network to the southern developing area (Construction of part of the Ring Road)

(2) Medium-term projects : Total project cost = Rs. 65 billion

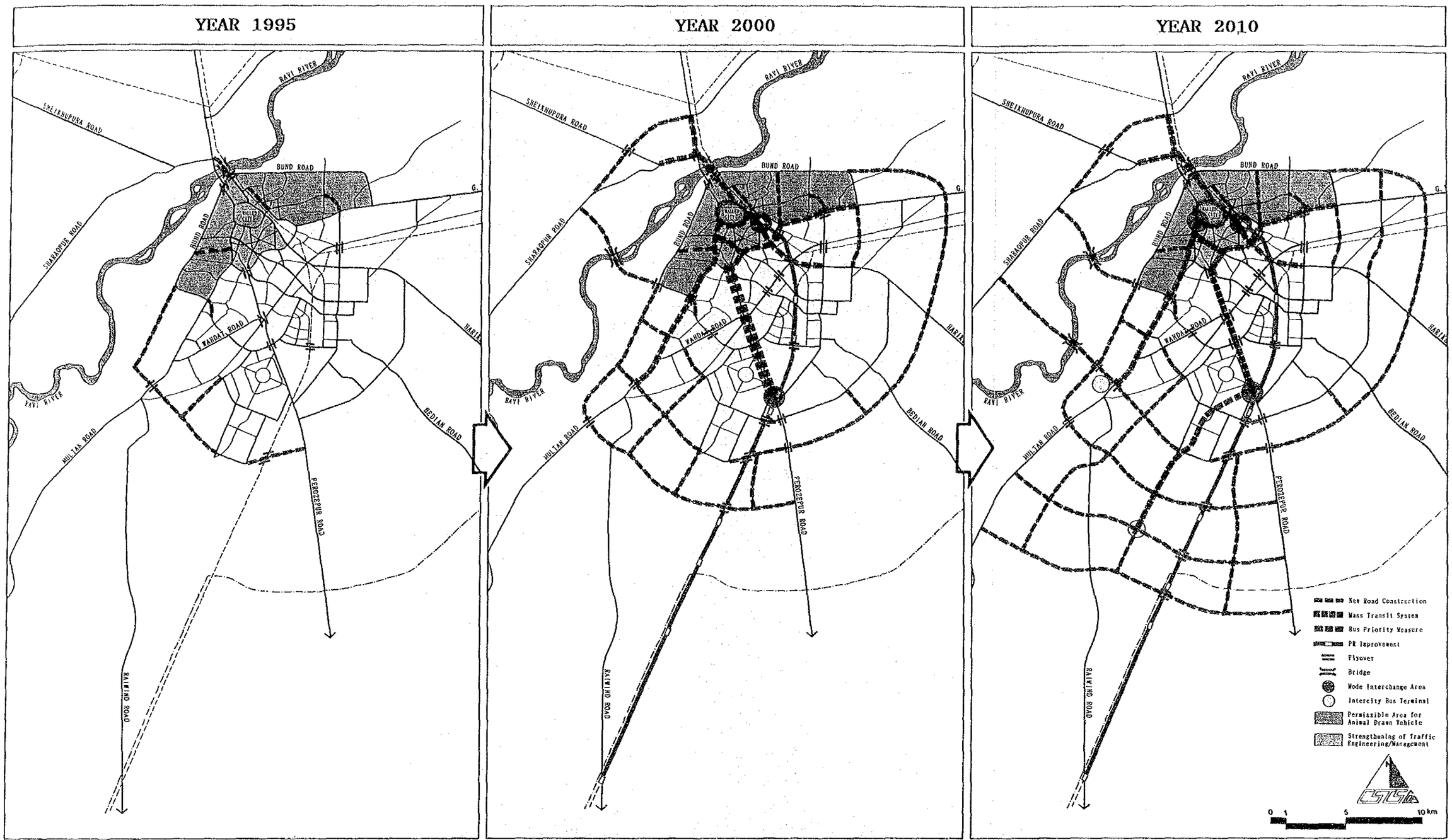
- Improvement of Pakistan Railway as an urban transport system
- Establishment of road network system in the southern development area (Completion of the Ring Road)
- Bus priority measures along the public transport corridors

(3) Long-term measures : Total project cost = Rs. 110 billion

- Introduction of effective and higher capacity public transport system as the first stage
- Creation of mode interchange areas to link the existing system and the new transport system
- Completion of radial/circumferential road network system
- Highly effective traffic management measures

These are summarized in Figure 3.7.

Figure 3.7 Staging Program



- 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.

8) Priority Projects for Feasibility Study

Priority projects for feasibility study are selected based on the following criteria:

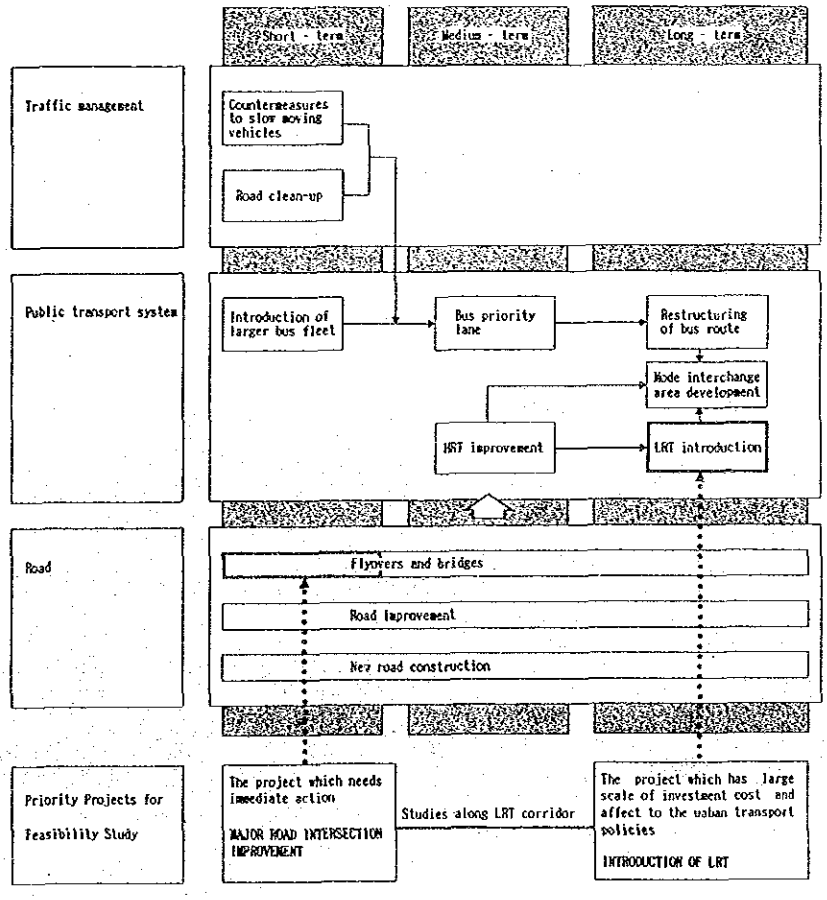
(1) The project which needs immediate implementation:
The project which needs immediate actions and provide effective mitigation to the current traffic problems is selected. They are the candidates in the concrete:
- a new bridge construction over the Ravi River,
- the connection a missing link in Krishan Nagar and Shad Bagh, and
- construction of flyovers along major transport corridors.

After careful evaluation and discussion with agencies concerned, the improvement of three (3) problematic intersections along Ferozepur Rd has been selected as the project which needs immediate action.

(2) The project which require a large-scale investment and preparatory studies before implementation, and is also expected to have a great impact on urban transport policies:
The introduction of the LRT, even if a long-term project, has the largest scale of investment cost among the various projects in this master plan study. However, the introduction of LRT must be to provide drastic impacts among the public transport system in LMA.

These both two projects, the intersection improvement and the introduction of the LRT, are located along Ferozepur Road, the heaviest public transport corridor in LMA.

Figure 3.8 Priority Projects Selection for Feasibility Study



4. Improvement of Major Road Intersections

There are various types of road intersections in Lahore. Some of these intersections cause traffic jams due to the geometric pattern and/or a large volume of inflow traffic into the intersection. The problematic intersections and its counter-measures were proposed by the analysis of existing ('90) traffic flow among the major 12 intersections in Lahore. As a result of the analysis, the intersections along Ferozepur Road ; Qartaba Chowk, Canal Rd. and Kalma Chowk , are determined to need an immediate improvemnt for grade-separated intersection. The present conditions, the improvement plan and feasibility of each intersection are summarized in Figure 4.1, and Figures 4.2, 4.3 and 4.4, respectively.

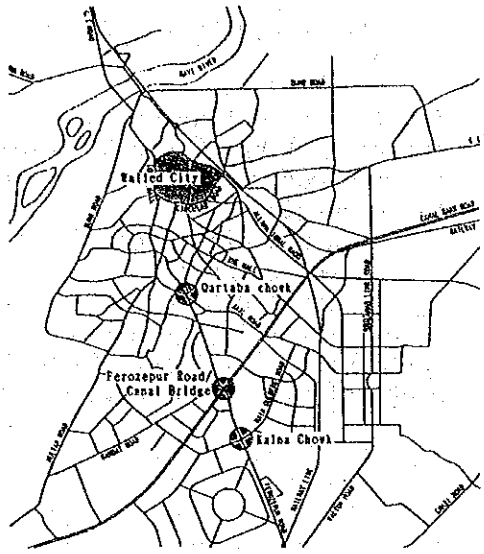
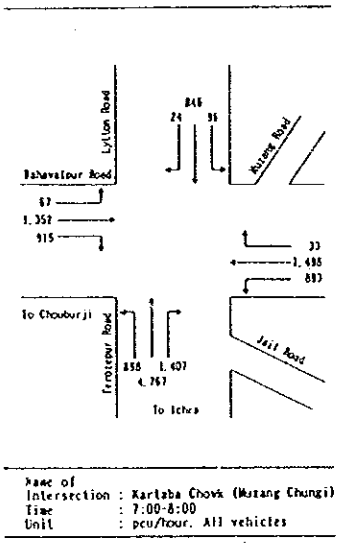
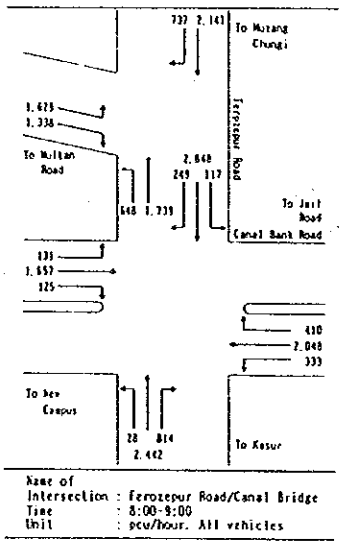
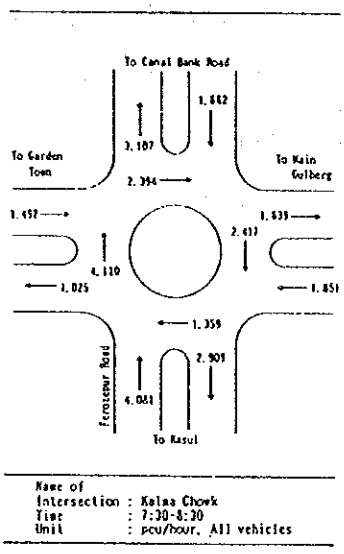


Figure 4.1 Present Conditions of the Studied Intersections







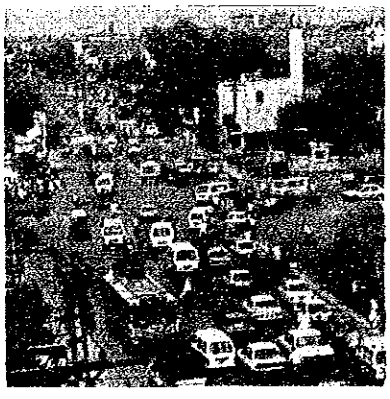
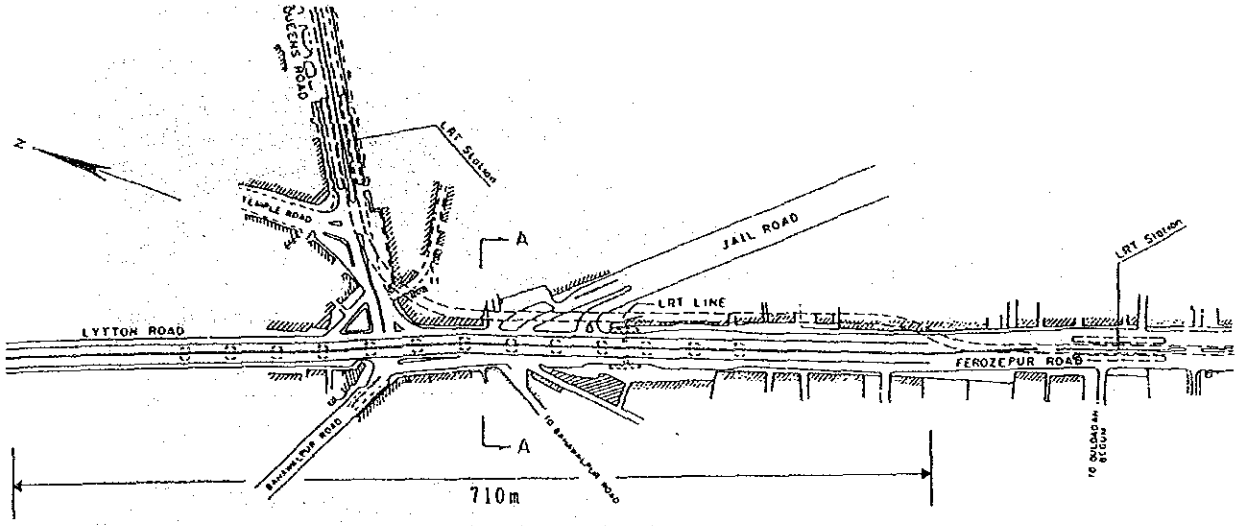
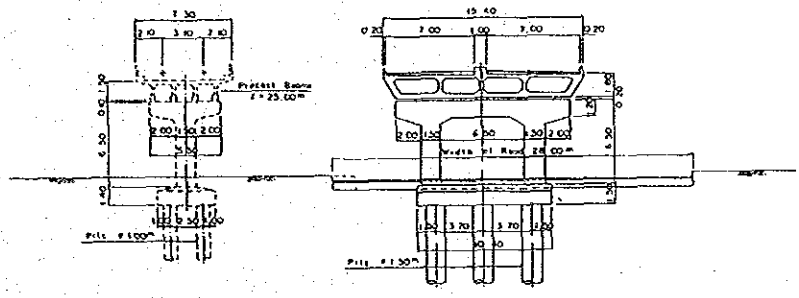


Figure 4.2 Improvement Plan at Qartaba Chowk



SECTION A – A



Traffic volume (pcu/hour)	Traffic change at flyover		Economic evaluation	Const. cost (Mil. Rs.)
Total =12,300	Under F/O Before= 64,300 After = 48,800	On F/O After = 32,300	B/C ratio=2.527 NPV=101.035(Mil. Rs.) EIRR=27.358%	103.4

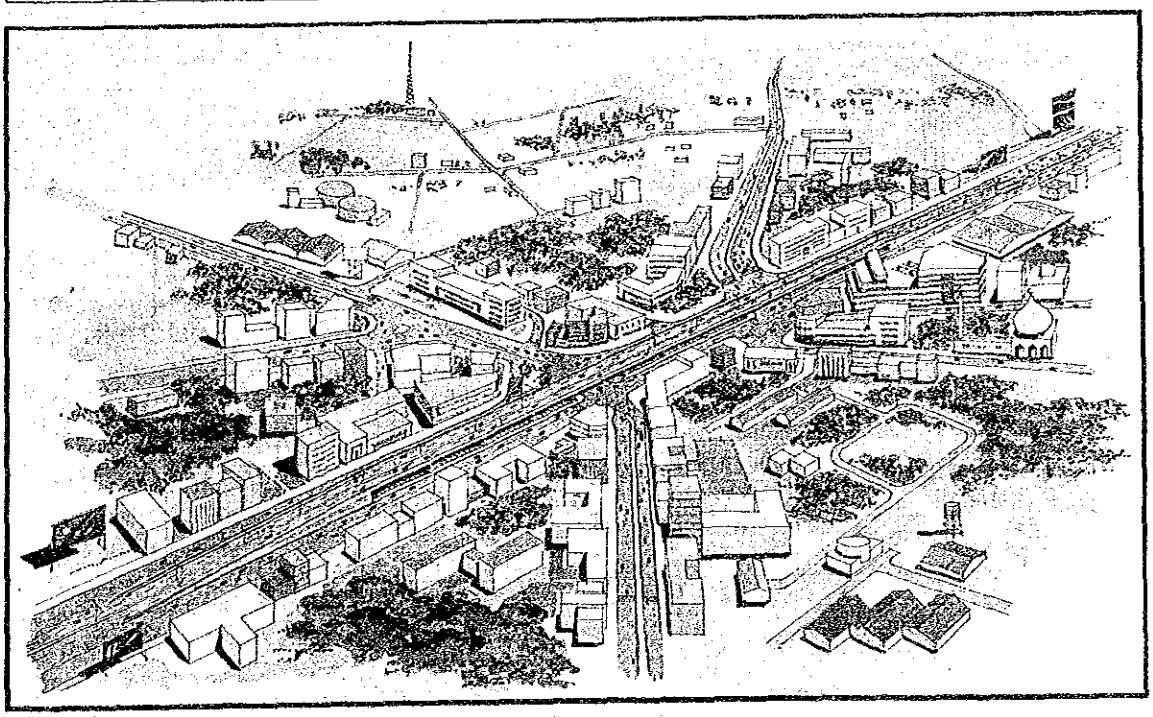
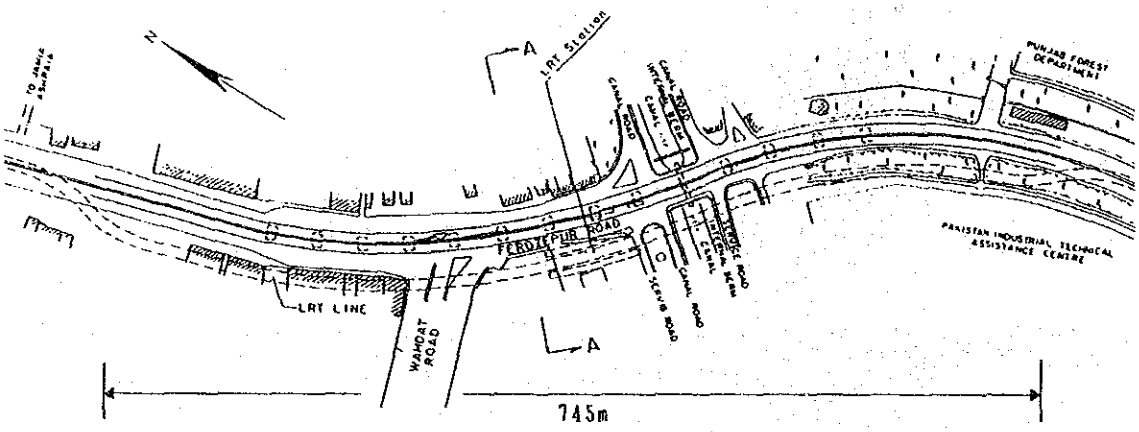
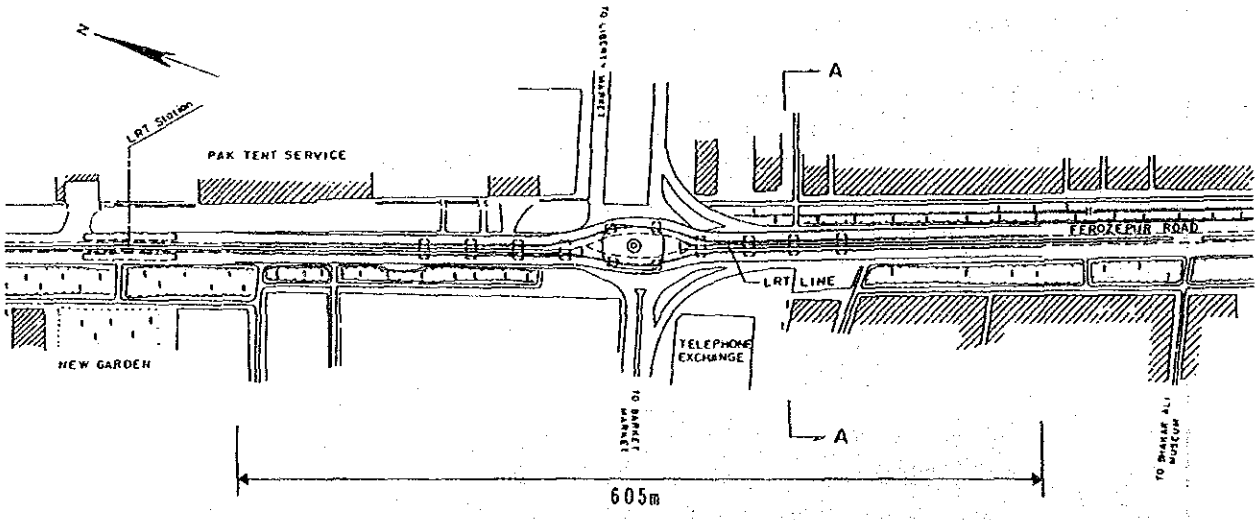


Figure 4.3 Improvement Plan at Canal Intersection



Traffic volume (pcu/hour)	Traffic change at flyover		Economic evaluation	Const. cost (Mil. Rs.)
Ferozepur Rd/Canal Bridge Total =11,100 Ferozepur Rd/Wahdat Rd Total = 7,900	Under F/O Before= 93,700 After = 58,500	On F/O After = 37,100	B/C ratio=5.027 NPV=287,047 (Mil. Rs.) EIRR=49.290%	111.4

Figure 4.4 Improvement Plan at Kalma Chowk



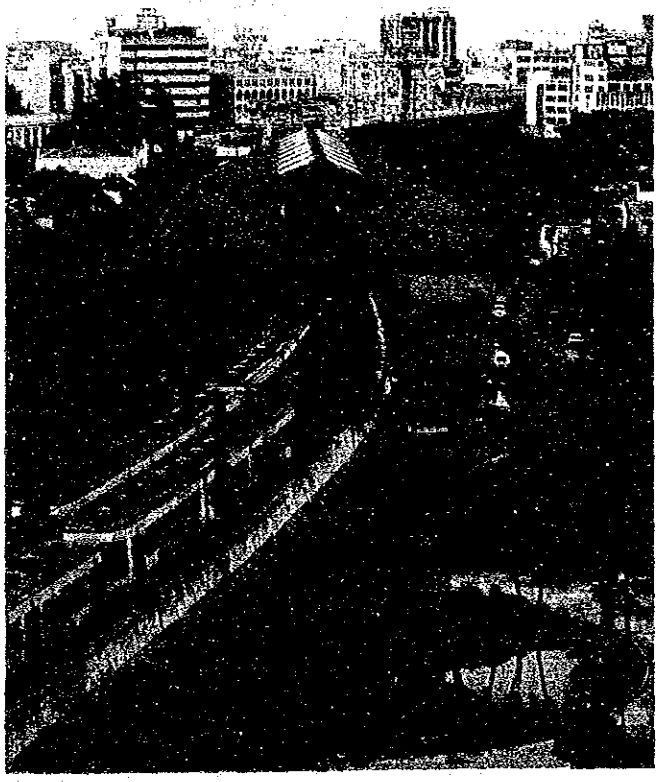
Traffic volume (pcu/hour)	Traffic change at flyover		Economic evaluation	Const. cost (Mil. Rs.)
Total = 9,600	Under F/O Before=106,600 After = 61,400	On F/O After = 48,500	B/C ratio=2.05 NPV=56.208 (Mil. Rs.) EIRR=22.876%	83.5

5. Introduction of Light Rail Transit(LRT) System

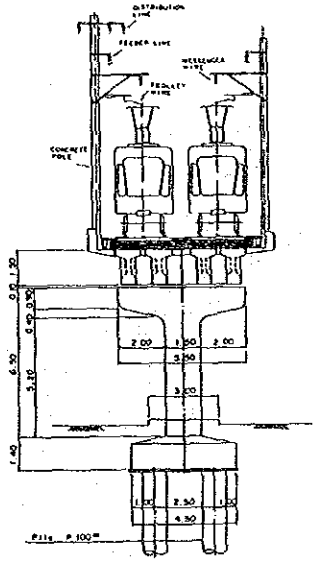
1) Outline of the LRT System

To cope with the future public transport demand in LMA, the LRT which has more comfort and higher capacity/speed than the current bus service is planned from Data Darber to Model Town South, where the heaviest public transport corridor in LMA. The proposed LRT is the medium-capacity of mass transit system with elevated track structure and its rolling stocks/capacity are lighter and smaller than the ordinary heavy rail transit. This system is also effective for the limited urban space. Currently, LRT is operated in Manila, the Philippines with 300 thousand daily passengers, and in the planning stage in Bangkok, Thailand. The current LRT in Manila and the outline of the proposed system in LMA are shown in Figure 5.1.

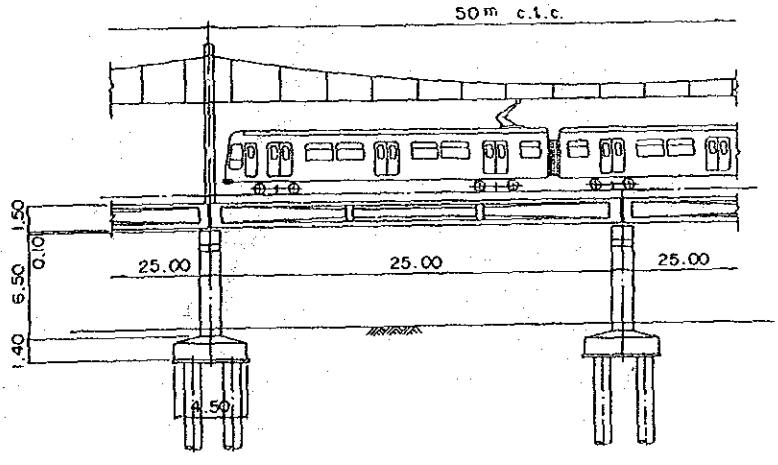
Figure 5.1 The LRT in Manila and Outline of Proposed System



CROSS SECTION



SIDE VIEW OF SIMPLE CATENARY



Route Section : Data Darbar
- Model Town South
Route Length : 12.5 km
Stations: 16 Stns & 2 Terminals
Railcar :Track gauge = 1,435 mm
Minimum radius = 100 m
Scheduled speed = 30 km/hr
Minimum headway = 2 min.
Train length = 52 m
Pass. capacity = 600

2) Route

The future extension of LRT route will run along the major public transport corridors with X-shaped configuration, such as Ferozepur, Multan and G.T. Road (north and east), as shown in Figure 5.2. Considering the future possible extension, passenger demand, distribution of major urban facilities and greenery, and enough width of road space, the proposed route of LRT is determined. The LRT, in the first phase in 2010, will run from Data Darbar to Model Town South with the length of 12.5 kms and 18 stations, as shown in Figure 5.3.

Figure 5.2 Future Extension of LRT Route

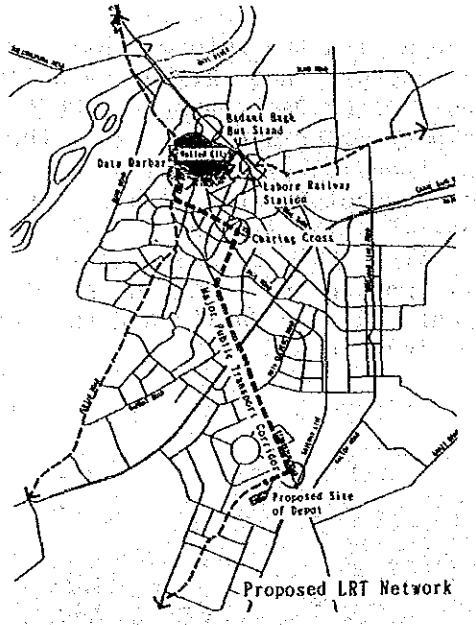
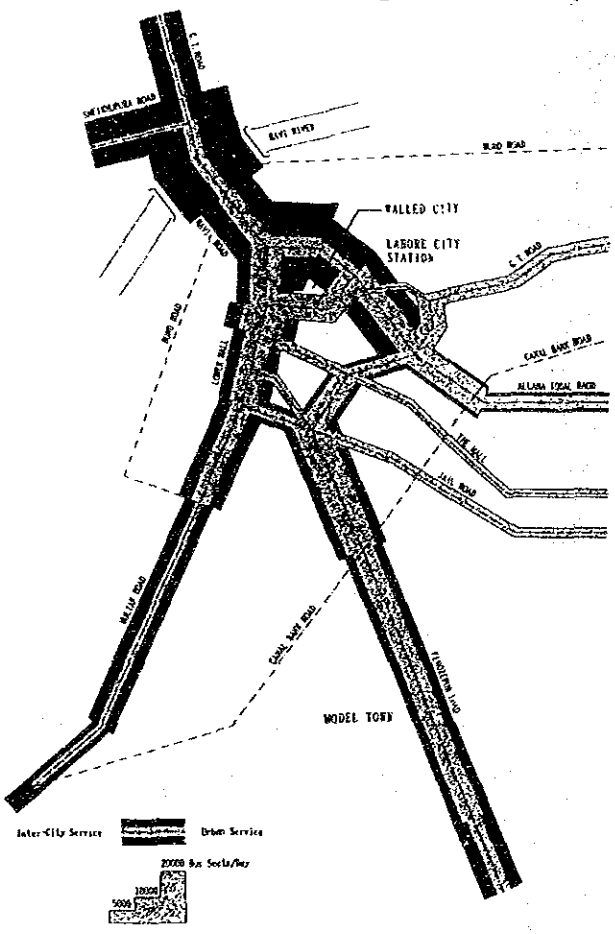
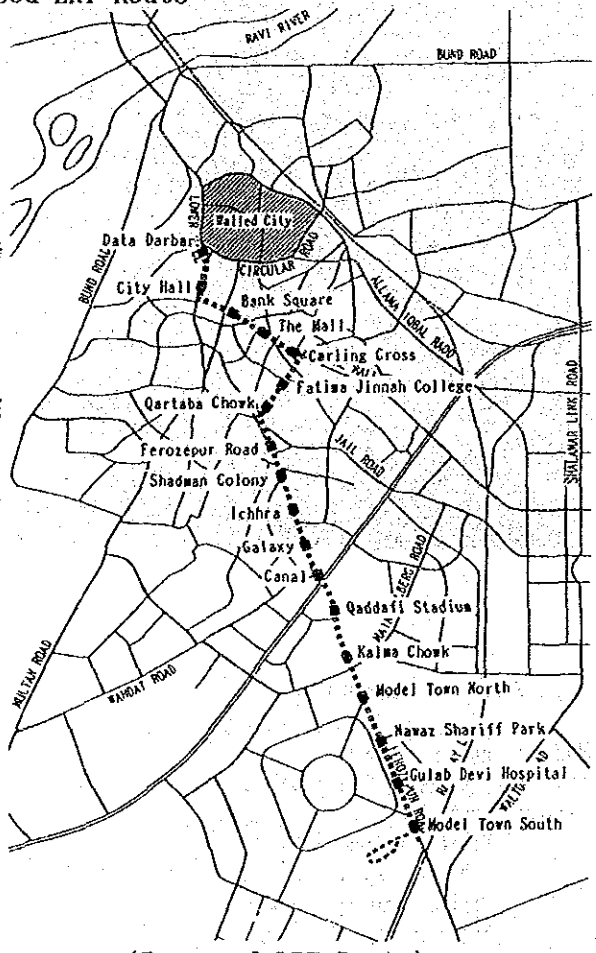


Figure 5.3 Proposed LRT Route



(Present Public Transport Corridor)

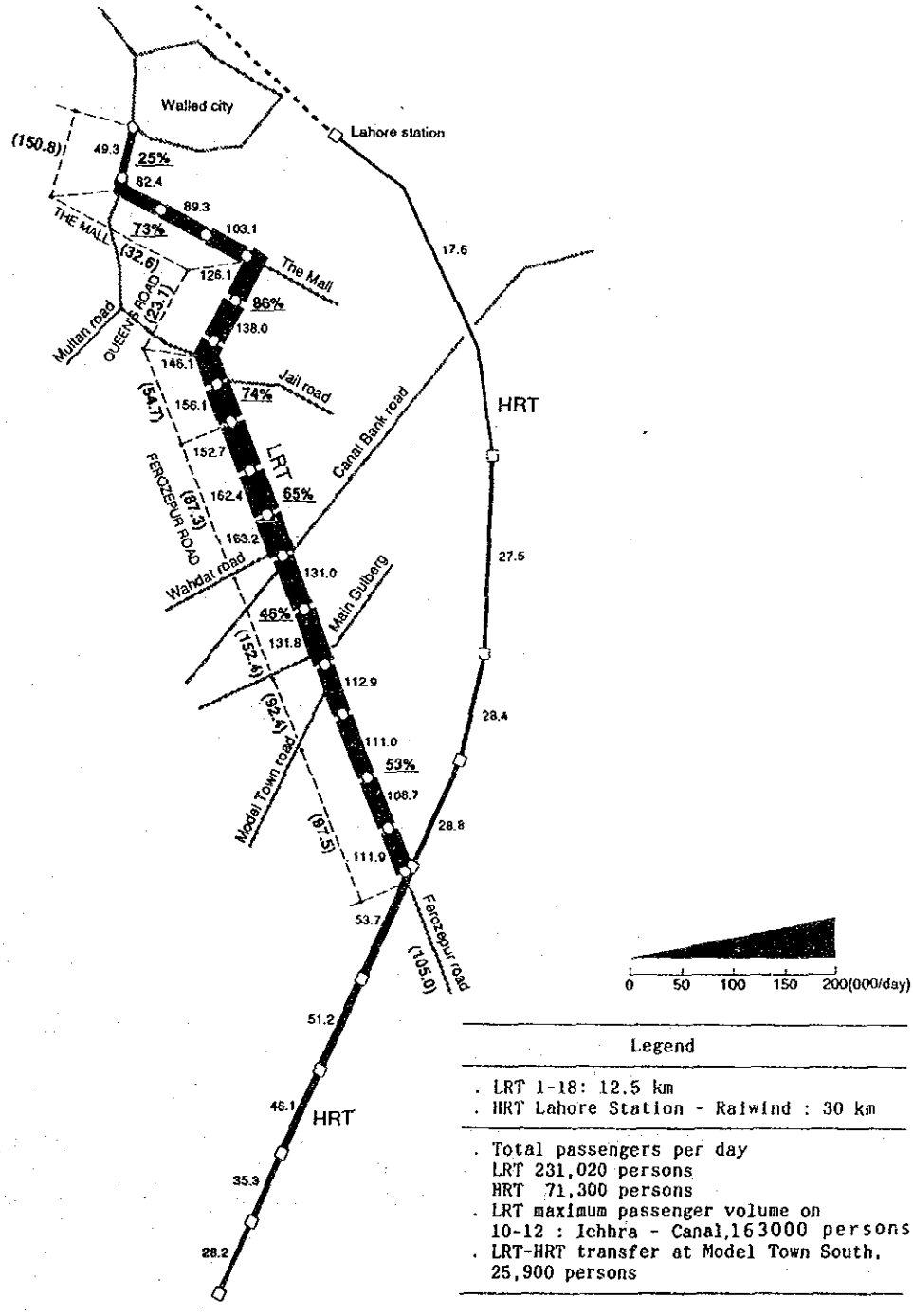


(Proposed LRT Route)

3) Demand Estimate

Demand for LRT was estimated from the proposed system, transport network and 2010 public OD table. As a result of the traffic assignment in 2010, the total daily passengers using LRT are 231 thousand and the maximum volume of 163 thousand passengers (both directions) is found at the mid-section of the route, as shown in Figure 5.4. The modal choice model between buses and LRT/HRT was examined based on the public transport user's characteristics and the example of other countries. The Logit Model explained by the time and cost between two modes are practically applied.

Figure 5.4 Estimated LRT passengers in 2010



4) Construction Cost

Based on the examples of other countries and the similar projects of transport sector in Pakistan, the construction cost of LRT is estimated as in Table 5.1. Total financial cost at 1990 price is approximately 60 billion Rupees and its breakdown into foreign and local costs is Rs. 16 billion and Rs. 44 billion, respectively.

Table 5.1 Construction Cost of LRT

Local Costs	:	4,340.77
Foreign costs	:	1,624.07
Total		5,964.84
		(Unit: Million Rs.)
Total length in km	:	12.50
Cost per km	:	477.19

5) Economic and Financial Assessment

Economic and financial assessments were examined based on the estiamted demand and cost, comparing 'with LRT' case and 'without' case.

The premises for the analysis of the economic assessment are as follows;
- Economic benefits consist of VOC savings and TTC savings;
- Economic cost consists of construction cost, additional investment cost and annual operation and maintenance cost; and,
- Evaluation term of 30 years after introduction of LRT (2010).

As the results, the economic internal rate of return (EIRR) of 19.23% and benefit-cost ratio of 1.77 were calculated, and these figures could be concluded that the project was economically feasible.

While, the following assumptions are for the financial assessment.
- The fare of LRT is Rs. 5 per ride (Rs. 2 higher than the average bus fare);
- Total number of daily passengers is 231 thousand in the first year of operation, with the annual increase rate of 3.0%.

The financial internal rate of return (FIRR) was calculated at 2.50%. This result indicates quite difficult aspects of financial management of LRT project itself.

There are two alternatives which would increase the FIRR; the one by increase of revenew with a higher fare / others, and the other by reduction of the replayment of initial construction cost.

Since higher revenue by higher fare would have a risk of less passengers, other measures to obtain more income should be found, such as by-developments related to the LRT.

While, the sensitivity analysis for assessing the FIRR by introducing the investment with low/non interest, was examined, and the result indicated that 75% subsidy to the initial cost seemed to realize a profitable operation of the LRT.

6) Development of Mode Interchange Areas

The strengthening of mode interchange areas is an effective countermeasures to urban public transport problems, because it makes convenient transfer to the public transport users, reduces road traffic volume and creates new urban business/commercial core around the area. The conceptual plans of Data Darbar and Model Town South, the terminal stations of both ends of proposed LRT, are shown in Figure 5.5.
In planning the Data Darbar mode interchange area, a harmouny between the historical Walled City and the new type of public transport mode was considered. On the other hand, in Model Town South, creation of a new type of urban center was planned by the large-scale commercial complex together with LRT/railway stations and bus terminal.

Figure 5.5 Conceptual Plan of Mode Interchange Area

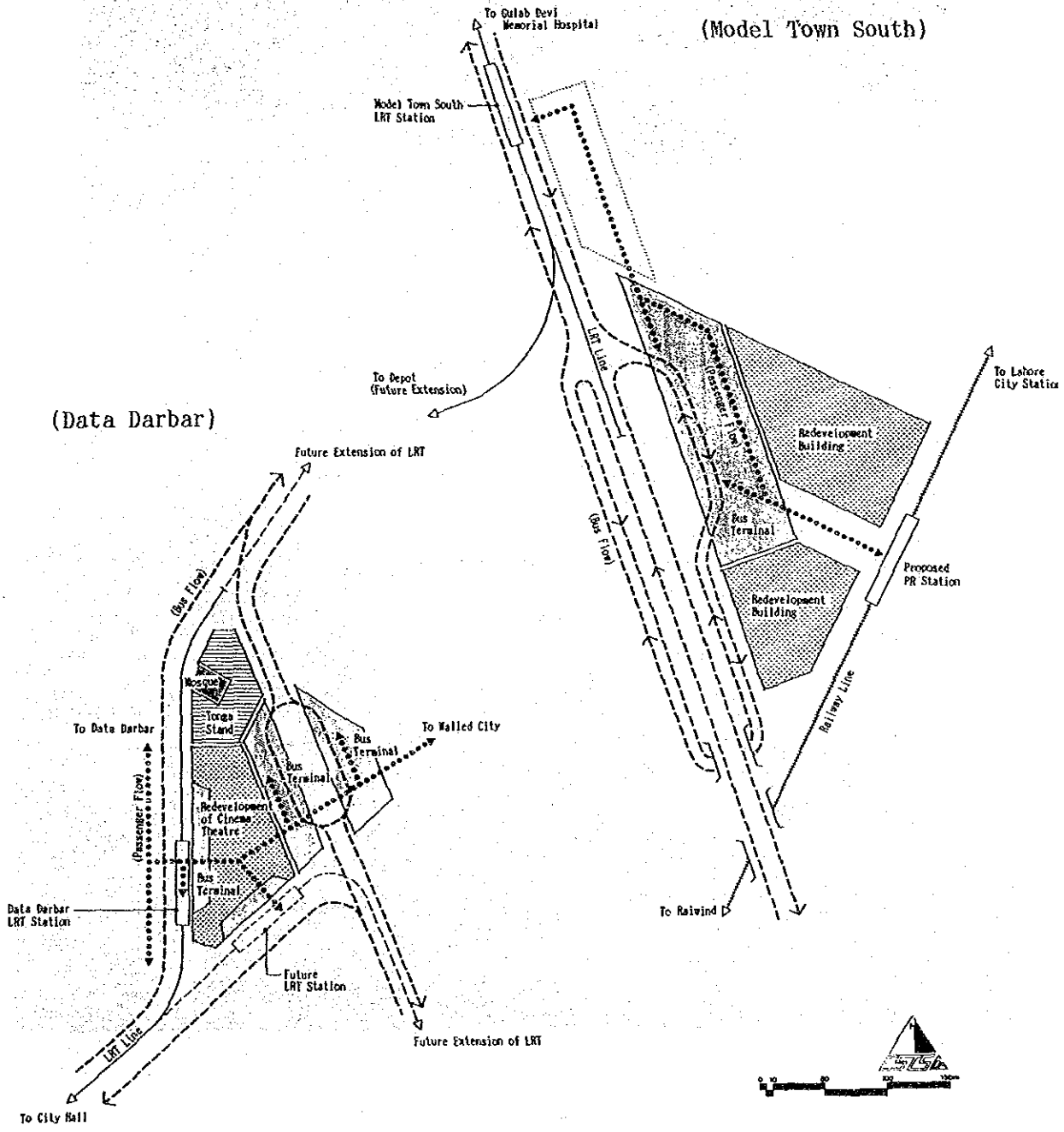
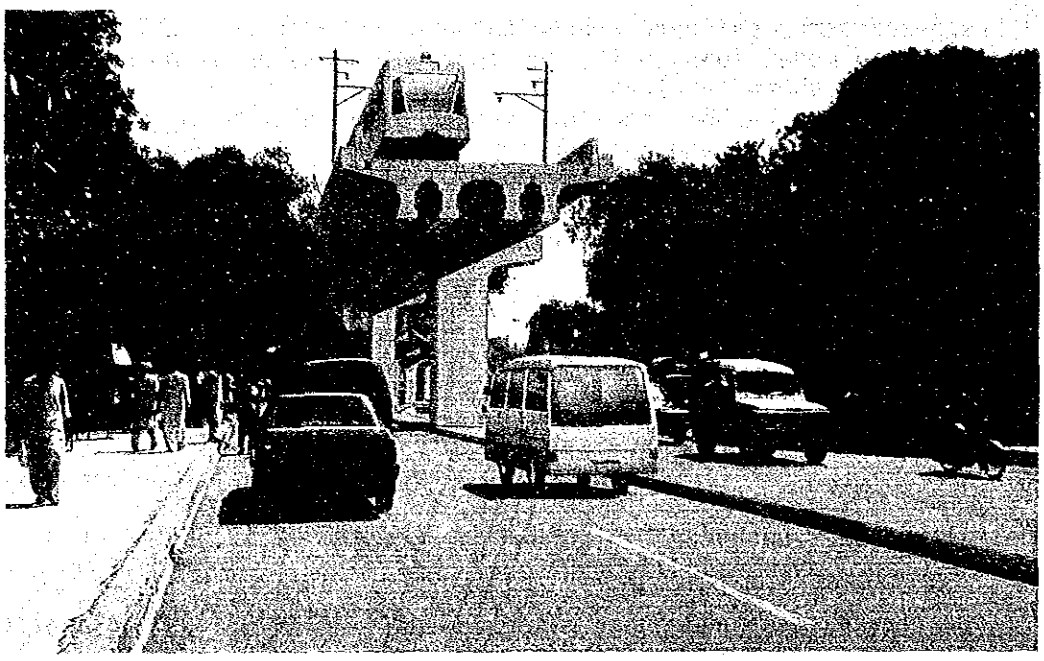
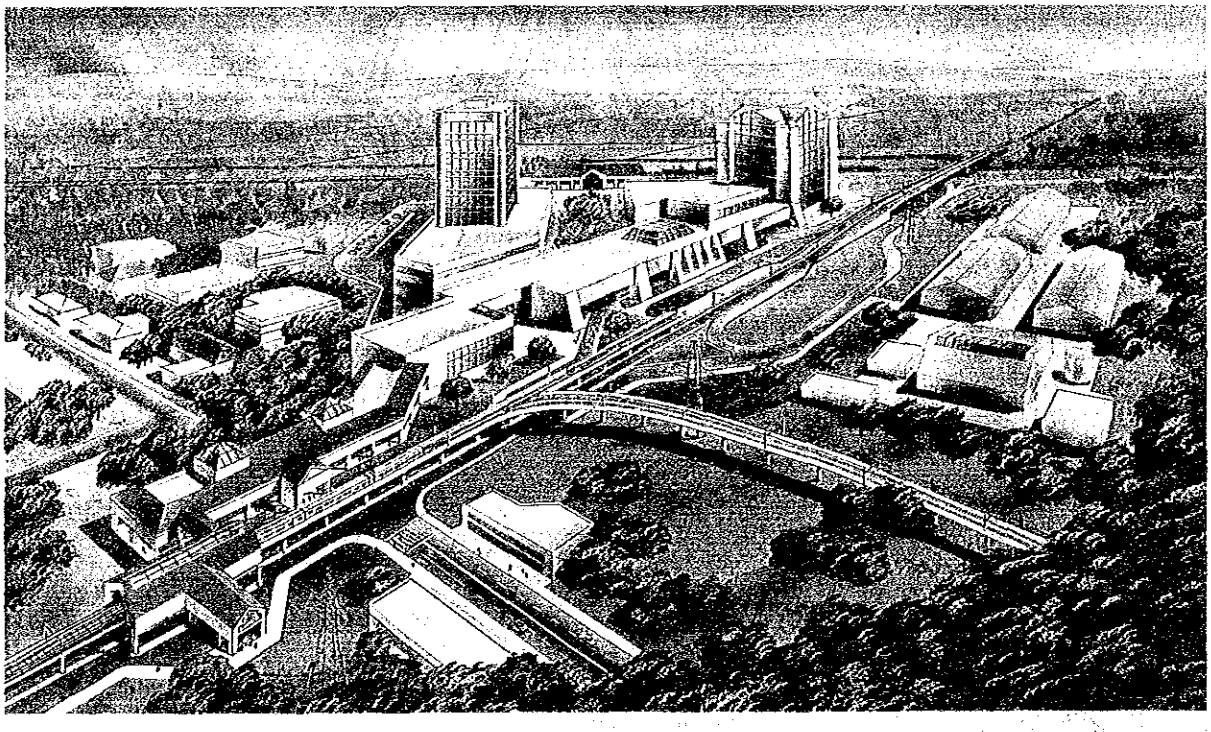


Figure 5.6 Perspective View of LRT and Mode Interchange Area

(LRT along the Mall)



(Model Town South Mode Interchange Area)



6. Additional Bridge Constructio across Ravi River

Current traffic on the existing "New Ravi Bridge" is 70,150 veh/day(both dir.), while its capacity is 48,000 veh/day. This shows that there is a critical traffic congestion on the bridge. Therefore, the construction of additional bridge is an eager project for immediate action. Considering the road network, current urbanization and related studies, etc., three alignment alternatives of the additional bridges are composed as shown in Figure 6.1. Judging from construction cost, estimated traffic volume and volume-capacity ratio and general impacts to the urban development/transport to LMA, comparison of the alternatives are resulted in Table 6.1. As a result, Alternative-1 is recommended because of the lowest construction cost with largest diverted traffic from the existing bridge. Alternative-2 and -3 can be proposed in the medium & long term development plan of LMA.

Figure 6.1 Alternatives of Additional Bridge

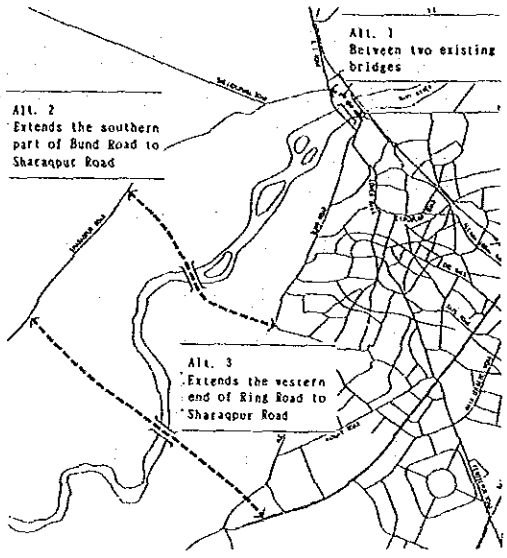


Table 6.1 Comparison of Bridge Alternatives

Alt.	Length of bridge and approaches(m)	Preliminary cost (Mill. Rs.)	Traffic volume on the existing and new bridges	Reduction of pcu*hour	Impact to the urbanization and urban transport	Overall evaluation
1	Bridge = 500 Appoaches =4,400	500	Existing=42,400 *(1.10) New =35,200 (0.92) Unit:pcu/day * Figures in parentheses are volume-capacity ratio	26,500 *Result of traffic assignment of Year1990 OD on the existing network vs. existing network + new bridge	The location of the additional bridge is close to the existing bridge. Traffic can be split over these bridges and a substantial reduction of traffic on the exis ting bridge will be realized. (77,500pcu/day→42,400) The reduction is modest on Ravi road and Lower Mall. The additional bridge will contribute to the urban and traffic growth following the existing pattern. Diversion traffic will be largest among the alternatives.	Length of bridge is the shortest, no specific problems in the construction and the least cost plan among the alternatives. Diversion traffic from the existing bridge is the largest. The location is suitable to the existing traditional urban activities and transport cores. *The lowest construction cost with largest diversion traffic from the existing bridge.
2	Bridge = 550 Appoaches =6,300	540	Existing=66,300 (1.73) New =11,500 (0.30)	20,200	Reduction of traffic on the existing bridge will be less then the above Alt.1. But reduction of traffic on Ravi road and Lower Mall will be more than the above Alt.1. Multan road in the central area will benefit from the reduction of heavy vehicles. The location is close to the designated new urban development area and will support the development.	Diversion traffic is less than the above Alt.1. Construction cost is higher than the above Alt.1. *Can be integrated in the long run development plan of LMA because it is closer to the new urban development area in the southern LMA.
3	Bridge = 600 Appoaches =8,400	810	Existing=68,200 (1.78) New = 9,500 (0.25)	38,000	Reduction of traffic on the existing bridge will be smaller than the above Alt. 2. But reduction on Ravi Rd.-Lower Mall will be larger than the above Alt.1. Through traffic of heavy vehicles will benefit mostly with this location. Diverted traffic will be smallest among the alternatives.	Diversion will be the smallest of the 3 alternatives. Construction cost is the largest because of the longest bridge and approaches. Long trips of through-traffic will divert to this newly located bridge. *If through traffic increases much more than the urban activity development of Lahore. This will be the most effective among the alternatives.

7. Pakistan Railway Improvement for Urban Transport

The network of Pakistan Railway (PR) in LMA is stretched radially from Lahore Station to south, north and east directions, and the line alignment has enough advantage for urban passenger traffic. However, PR is now contributing mostly to nationwide inter-city transport. In order to utilize the PR for urban transport in LMA, it is recommended that the electric railcar trains are introduced to operate on the existing electrified double track section between Lahore Station and Raiwind with the length of 40 km for the urban commuter service, as shown in Figure 7.1. The outline of the system is summarized in Table 7.1 and the estimated urban passengers by PR is approximately 70 thousand persons/day in 2010.

Table 7.1 Outline of PR Improvement for Urban Transport

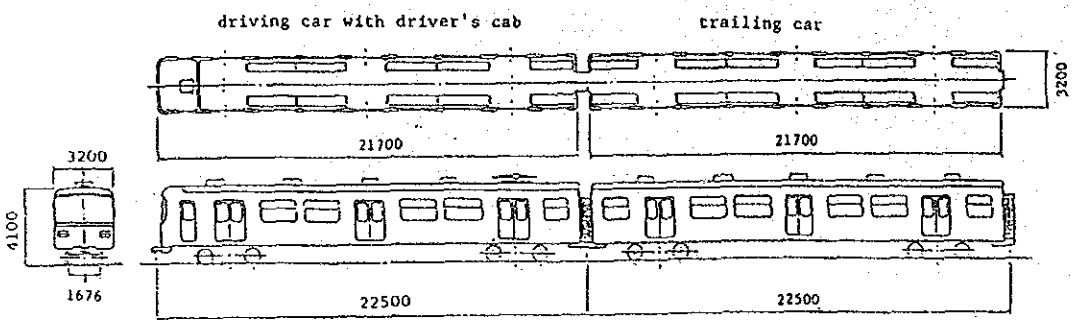


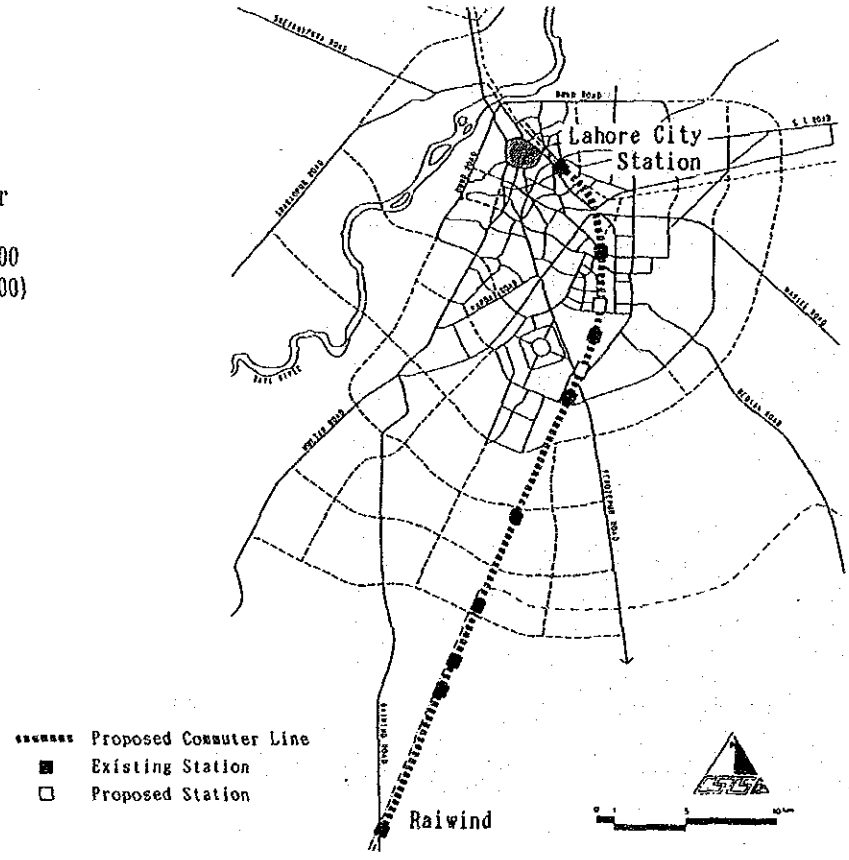
Figure 7.1 Proposed Commuter Line

Route Section : Lahore Station
- Raiwind
Route Length : 40.0 km

No. of Stations : 11 (2 new st.)

Railcar : Maximum speed = 100 km/hr
Train length = 135 m
Passenger Capacity = 1,200
(in peak hour = 1,500)
Headway = 12 min.

Cost : Rs. 3,260 million



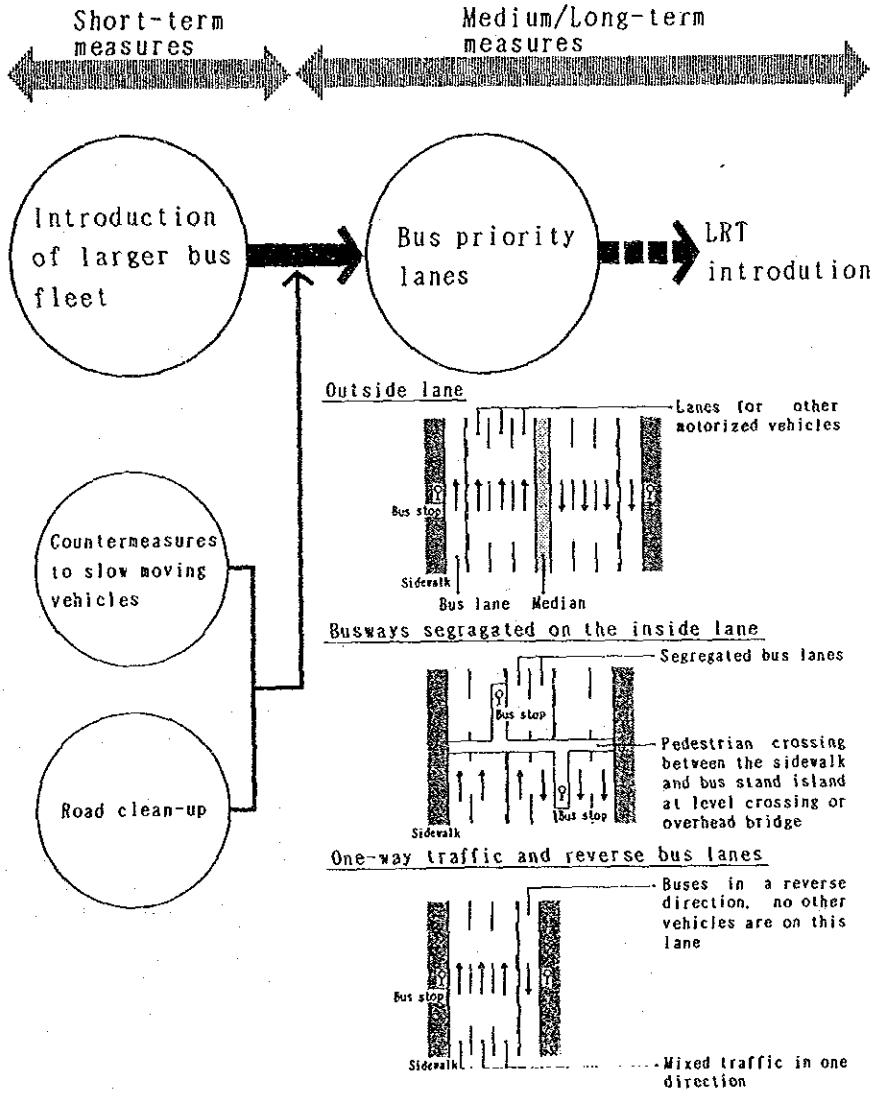
8. Bus Service Improvement

Current problems of urban bus service in LMA are summarized in two points; the financial deficit of PRTC and increasing illegal operation of mini-bus by private sector. Moreover, slow vehicular movement and road encroachment also cause traffic friction and deterioration of bus service.
On the other hand, the LRT is proposed in the future as more effective public transport system than the current bus services. This project, though, needs long duration for completion.

Therefore, the bus service improvement before the introduction of LRT is studied as an immediate action. Scenario of the bus service improvement measures is illustrated in Figure 8.1 and below:

- The road clean-up and the segregated system between motorized and non-motorized vehicles should be implemented as the short-term measures.
- The higher capacity bus fleet should be introduced before introduction of bus priority measures.
- Bus priority lanes shown in the figure are introduced after the completion of the above mentioned measures.

Figure 8.1 Bus Service Improvement Measures



9. Other Studies

1) Traffic Safety

One of the reasons of the traffic congestion in LMA is the bad manners of automobile drivers, and this becomes the primary cause of traffic accidents and generates the traffic jams. It is important that the countermeasures for the traffic problems are not only the improvement of transport system/facilities but also the traffic safety program including modification of automobile drivers' behavior. As the measures for the traffic safety program, followings are proposed: the improvement of geometric design of roads, traffic safety campaign, strengthening of mobility and institution of traffic police, and continuous data collection and analysis of traffic accidents.

2) Parking

Parking conditions in the city center are serious due to the increase in private cars. This is especially evident in the Anarkali area and along the Mall. To cope with the increasing parking demand in the city, LDA is now planning to construct the multi-story parking along the Mall in cooperation with the private sectors. This is one of the effective countermeasures to the serious parking problems. However, it is estimated that the parking demand in 2010 is approximately 2.5 times of current figure. The countermeasures to this increasing parking demand in the city are not only construction of parking facilities but the introduction of some parking control, including in-flow traffic control.

3) Land Reservation for Future Infrastructure Development

In connection with the implementation of the transport infrastructure projects, it is recommended to reserve necessary land space prior to any decision. It would be financially and socially favorable for the TEPA/LDA or any other organization to conduct the urban development projects to secure necessary land area, before the implementation of any projects. To avoid inflation of the land prices is one of the reasons, as those projects will be implemented several years later. Another reason is to avoid social conflict in the course of project implementation.

4) Environmental Considerations

The urban environments receive various impacts by the implementation of development projects such as roads, flyovers, LRT and related works. Measures to preserve or protect the environments should be taken into consideration, and actions for the mitigation of negative impacts should be performed prior to the project implementation. Environmental considerations necessary for the construction of the flyovers and the LRT projects are discussed below:

- When the projects are authorized by the Government, the area should be declared for future land acquisition.
- Physical separation of the area from the outlying community by a "green buffer" should be considered.
- Greenery and historical assets should be preserved.
- During the construction period, a method should be adopted to minimize inconvenience to people and the disturbance of normal traffic.
- Structures should be designed to be aesthetically harmonious with their surroundings.

10. Recommendations

1) Comprehensive Transport Master Plan

The proposed master plan in this study, coping with the future traffic demand in the year 2010, consists of:

- 200 kms road construction in total, with 3 additional bridges across Ravi river, 26 flyovers at major road intersections,
- 12.5 kms long LRT construction,
- 40 kms PR improvement with electric railcar introduction, etc.

The traffic condition in LMA, which is suggested to be in the worth situation without those projects, can be improved to a great extent in 2010. For example, the average travel speed within the inner LMA keeps a level of 20 km/hr, the average congestion degree reaches below 1.0 in total LMA and 1.2 even in the inner LMA, comparing to 1.3 and 1.7 in 'Do-nothing' case, respectively.

Table 10.1 Effects of Master Plan on Traffic Condition

	Travel speed (km/hr)		Congestion degree	
	Inner LMA	total LMA	Inner LMA	total LMA
Present Condition(1990)	28.24	33.10	0.86	0.22
Do-nothing (2010)	11.47	18.06	1.74	1.32
with Projects	19.94	30.11	1.24	0.89

The total necessary investment cost of all the proposed projects in the master plan is estimated at 20 billion Rupees in 1990 price. For the smooth implementation of these project, the following considerations should be taken. It is important to secure the financial sources and the adequate coordination among the agencies concerned to various projects, in accordance with the staging program. Moreover, necessary institutions should be established to reserve/acquisit the area for these infrastructures, since the land acquisition would be more difficult in future especially in the developing southern part in LMA.

2) Improvement of Major Intersections

The construction of flyovers at three intersections along Ferozepur Road, Qartaba Chowk, Canal-Ferozepur and Kalma Chowk, indicates a reasonable feasibility, and the immediate implementation is expected. The following points should be carefully taken into consideration in the further stage.

- Adequate design and structure, coping with the future expected LRT system.
- Preservation of environments around the intersection and reduction of worsening traffic condition during its construction period.

3) Introduction of LRT System

The necessity and adequateness of LRT introduction in future has been examined and further detailed studies are also necessary in the next stage.

- The practical organization for construction and operation/management of new public transport system, making reference to the preliminary idea proposed in the study.

- The measures to better financial feasibility, reducing the debt of initial investment and increasing the revenue without less passengers.

- The availability of terminal development from various viewpoints in order to increase user's convenience and LRT's operational benefit.

- The possible collection system, from private sector to public, of the developed benefit along the route after LRT introduction.

4) Others

The additional Ravi bridge construction is concluded as necessary in short-term stage, and the final decision would be done after the full scale feasibility study, together with the Ring Road construction, which is going to be carried out by TEPA.

The bus service improvement measures are also important to be implemented urgently, judging from the essential policy of effective use of the existing systems/facilities, and actual improvement program should be discussed with PRTC and other concerned agencies in accordance with proposed scenario.