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# THE FEASIBILITY STUDY ON THE TRANSPORT INFRASTRUCTURE DEVELOPMENT PROJECT IN CALCUTTA FINAL REPORT VOLUME III TECHNICAL REPORT

SEPTEMBER 1992

JAPAN INTERNATIONAL COOPERATION AGENCY



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THE TRANSPORT INFRASTRUCTURE  
DEVELOPMENT PROJECT IN CALCUTTA  
FINAL REPORT VOLUME III  
TECHNICAL REPORT**

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## PREFACE

In response to a request from the Government of India, the Government of Japan decided to conduct a feasibility study on The Transport Infrastructure Development Project in Calcutta and entrusted the study to the Japan International Cooperation Agency (JICA).


JICA sent to India a study team headed by Dr. Juro Kodera, Yachiyo Engineering Co., Ltd., two times between September, 1991 and September, 1992.

The team held discussions with the officials concerned of the Government of India, and conducted 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 India for their close cooperation extended to the team.

September, 1992



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Kensuke Yanagiya  
President  
Japan International Cooperation Agency





**THE FEASIBILITY STUDY  
ON  
THE TRANSPORT INFRASTRUCTURE DEVELOPMENT PROJECT  
IN  
CALCUTTA**

**FINAL REPORT**

**VOLUME III : TECHNICAL REPORT**

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CHAPTER 1  
RESULT OF TRAFFIC SURVEYS



## CHAPTER 1 RESULTS OF TRAFFIC SURVEYS

### 1.1 Survey Methodology

#### 1.1.1 Collation and Review of Available Data

The following relevant data was provided by the Counterpart Team;

- (1) The 1971 screen-line road-side traffic count data from the "TRAFFIC STUDY FOR PROPOSED RAPID TRANSIT SYSTEM AND SUBURBAN DISPERSAL LINE IN CALCUTTA" issued by "TRAFFIC AND TRANSPORTATION DIVISION, CALCUTTA METROPOLITAN PLANNING ORGANIZATION"
- (2) The 1981 road-side traffic count data by "RECORDED CLASSIFIED TRAFFIC VOLUMES ON CALCUTTA ROADS 1978" issued by "TRANSPORTATION AND PLANNING DIRECTORATE TRANSPORT DEPARTMENT GOVERNMENT OF WEST BENGAL MAY, 1985"
- (3) The 1991 road-side traffic count data surveyed between 1986 and 1991 by the Transport Department, Government of West Bengal
- (4) Major road data including number of lanes made by the Transport Department, Government of West Bengal
- (5) Origin-Destination data of 1964 from "DATA SUPPLEMENT FOR TRAFFIC AND TRANSPORTATION PLAN CALCUTTA METROPOLITAN DISTRICT, 1966-1986" studied by "CALCUTTA METROPOLITAN PLANNING ORGANISATION"
- (6) Origin-Destination data of 1976 from "DATA SUPPLEMENT FOR TRAFFIC AND TRANSPORTATION PLAN CALCUTTA METROPOLITAN DISTRICT, 1966-1986" estimated by "CALCUTTA METROPOLITAN PLANNING ORGANISATION"

The traffic count data was utilized to estimate future demand in this Study, and the major road data was used to create road network data for traffic distribution. However the Origin-Destination data was not utilized in this Survey, because the data was too old to be employed in the present assignment. The Study Team carried out the following traffic surveys to understand the present traffic conditions in Calcutta.

- Traffic Volume Surveys
- Road-side Origin-Destination Survey on Howrah

Bridge

- Travel Speed Survey
- Parking Survey
  - Parking Interview Survey
  - Parking Licence Plate Survey
  - Parking Capacity Survey(Parking Volume Count)

1.1.2 Field Surveys

(1) Traffic Volume Surveys

The traffic volume count was carried out by directional traffic volume count during the period of November 18 to 28, 1991 excluding holidays. Vehicle were counted by classification survey locations placed at 16 intersections plus Howrah Bridge (see Fig. T-1.1.1). At the Howrah Bridge, the counting was carried out for 24 hours, and for the other 16 locations the survey duration was 12 hours from 8:00 in the morning to 20:00 in the evening. The Survey was implemented as follows;

- a. Time Duration at periodic intervals(every 15 minutes)
  - 24 hours for Howrah Bridge
  - 12 hours for the 16 intersections
  
- b. Vehicle classification
  - Fast Vehicle
    - Passenger car/Jeep
    - Taxi
    - Truck
    - Mini Truck
    - Bus
    - Mini/Midi Bus
    - Motor Cycle/Scooter/Moped
    - Tram
    - Other motorized vehicle
  - Slow Vehicle(Non-motorized vehicle)
    - Cycle
    - Cycle Rickshaw/Hand Rickshaw
    - Animal-drawn/Hand Cart
    - Wheelbarrow
    - Other non-motorized vehicle



(2) Road side Origin-Destination Survey

The Origin-Destination survey (hereinafter referred to as the O-D survey) method between Calcutta and Howrah was by driver interview and was carried out continuously for 24 hours on November 27, 1991. The Survey was implemented as follows;

- a. The survey was conducted at the bridge approach on the Calcutta side at all the necessary locations to survey the traffic crossing the Howrah Bridge, as shown in Figure 4.1.2.
- b. Both directional traffic flows were surveyed.
- c. Survey duration was 24 hours
- d. Target sampling ratio was more than 15% of traffic volume with the sampled vehicles representing all vehicle classification.
- e. Vehicle classification employed were as follows;
  - Passenger car/Jeep
  - Taxi
  - Truck
  - Mini Truck
  - Bus
  - Mini/Midi Bus
  - Motorcycle/Scooter/Moped
  - Auto Rickshaw/Vans
  - Tram

For vehicle classifications of Bus, Mini/Midi Bus and Tram driver interview. The O-D survey for these classifications covered recording was not conducted the origin and destination zone by the Route number and the number of passenger by occupancy rank only.

- f. Interview items were as follows;
  - Origin
  - Destination
  - Purpose
    - To Work
    - Business
    - To School

- Private (Shopping, etc.)
- To Home
- Number of Passengers include driver
- Vehicle classification
- Sampling Time

(3) Travel Speed Survey

The travel speed survey was carried out on the 7 routes shown in Fig. T-1.1.3 between November 18 and 28, 1991 excluding holidays. In order to collect information on the commuting time, the survey was carried out during the morning and evening peak hours. The survey routes were as follows;

- Route Number 1
  - Deshpran Sasmal Road
  - S.P.Mukherjee Road
  - A.T.Mukherjee Road
  - J.L.Nehru Road
  - Chittaranjan Avenue  
(hereinafter referred to as C.R. Avenue)
  - J.M.Avenue
  - Bhupen Bose Road
  - R.G.Kar Road
  - Raja Manindra Road
- Route Number 2
  - Diamond Harbour Road
  - Acharya Jagadish Chandra Bose Road  
(hereinafter referred to as A.J.C.Bose Road)
  - Acharya Profullya Chandra Roy Road  
(hereinafter referred to as A.P.C.Roy Road)
  - Bidhan Sarani North
  - B.T.Road
- Route Number 3
  - Gariahat Road
  - Syed Amir Ali Avenue
  - Park Street
- Route Number 4
  - Howrah Bridge
  - Mahatma Gandhi Road  
(hereinafter referred to as M.G. Road)
- Route Number 5
  - Lenin Sarani
  - Convent Lane
- Route Number 6

- Najrul Islam Avenue
- Manicktala Main Road
- Vivekananda Road
- Route Number 7
- Circus Avenue

(4) Parking Survey

a. Parking Interview Survey

The parking interview survey method was by driver interview. Survey was carried out on the 8 road sections shown in Fig.T-1.1.4 between November 18 and 28, 1991 for morning and evening peak hours. The survey locations were as follows;

- Esplanade Row
- Red Cross Place
- Koila Ghat Street
- B.B.D. Bag North
- India Exchange Place
- Rabindra Sarani
- B.B.D. Bag East
- N.S. Road

b. Parking Licence Plate Survey

The parking licence plate survey method was by patrol and recording of licence plate numbers at every 15 minutes intervals. Survey was carried out on the 13 road sections shown in Fig.T-1.1.4 between November 18 and 28, 1991 for 12 hours from 8:00 in the morning to 20:00 in the evening. The survey locations were as follows;

- Esplanade Row
- Red Cross Place
- Koila Ghat Street
- B.B.D. Bag North
- India Exchange Place
- Rabindra Sarani
- B.B.D. Bag East
- N.S. Road
- Waterloo Street
- British India Street
- R.N. Mukherjee Road
- Church Lane
- Lyons Range

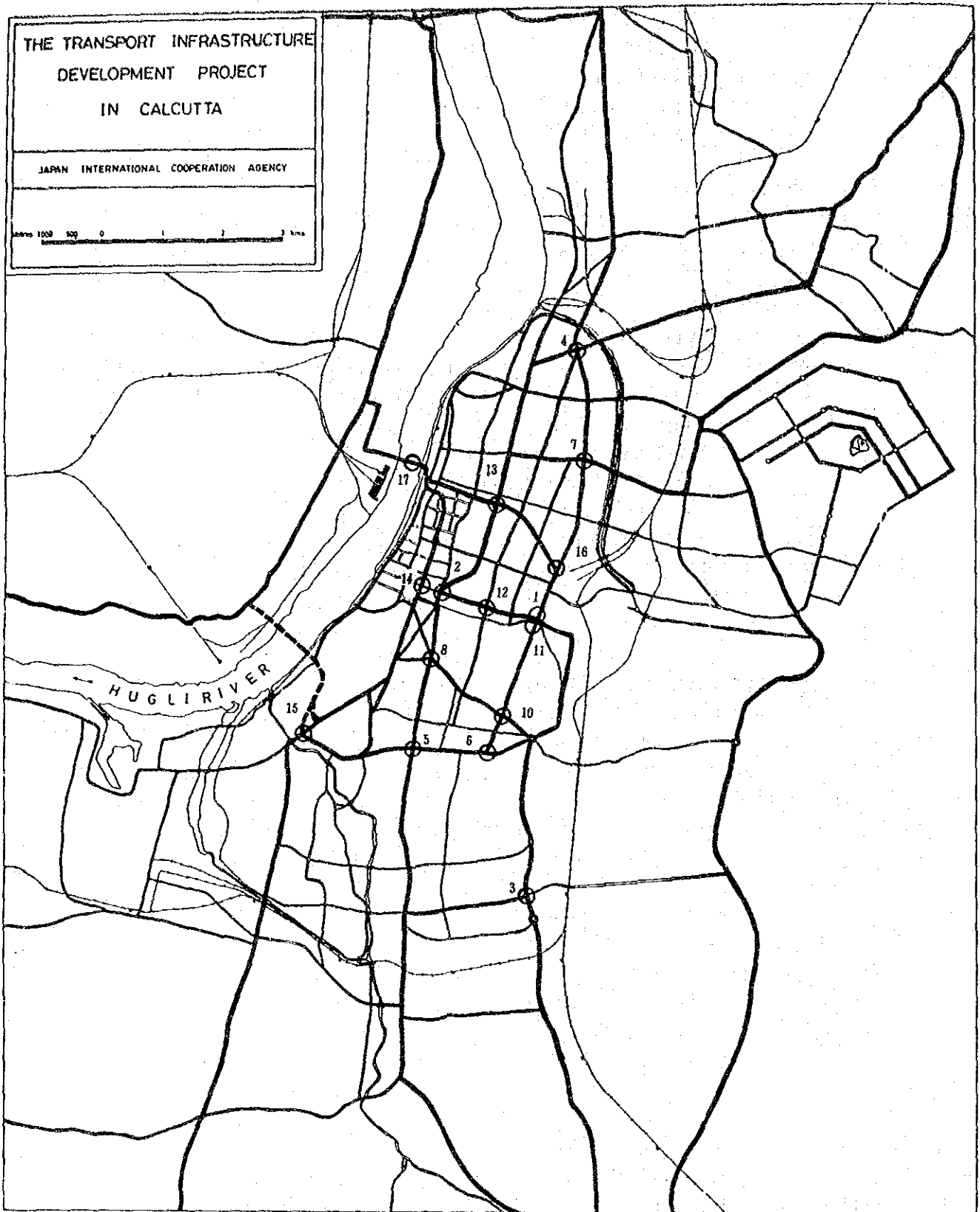


Figure T-1.1.1 Location of Traffic Volume Count

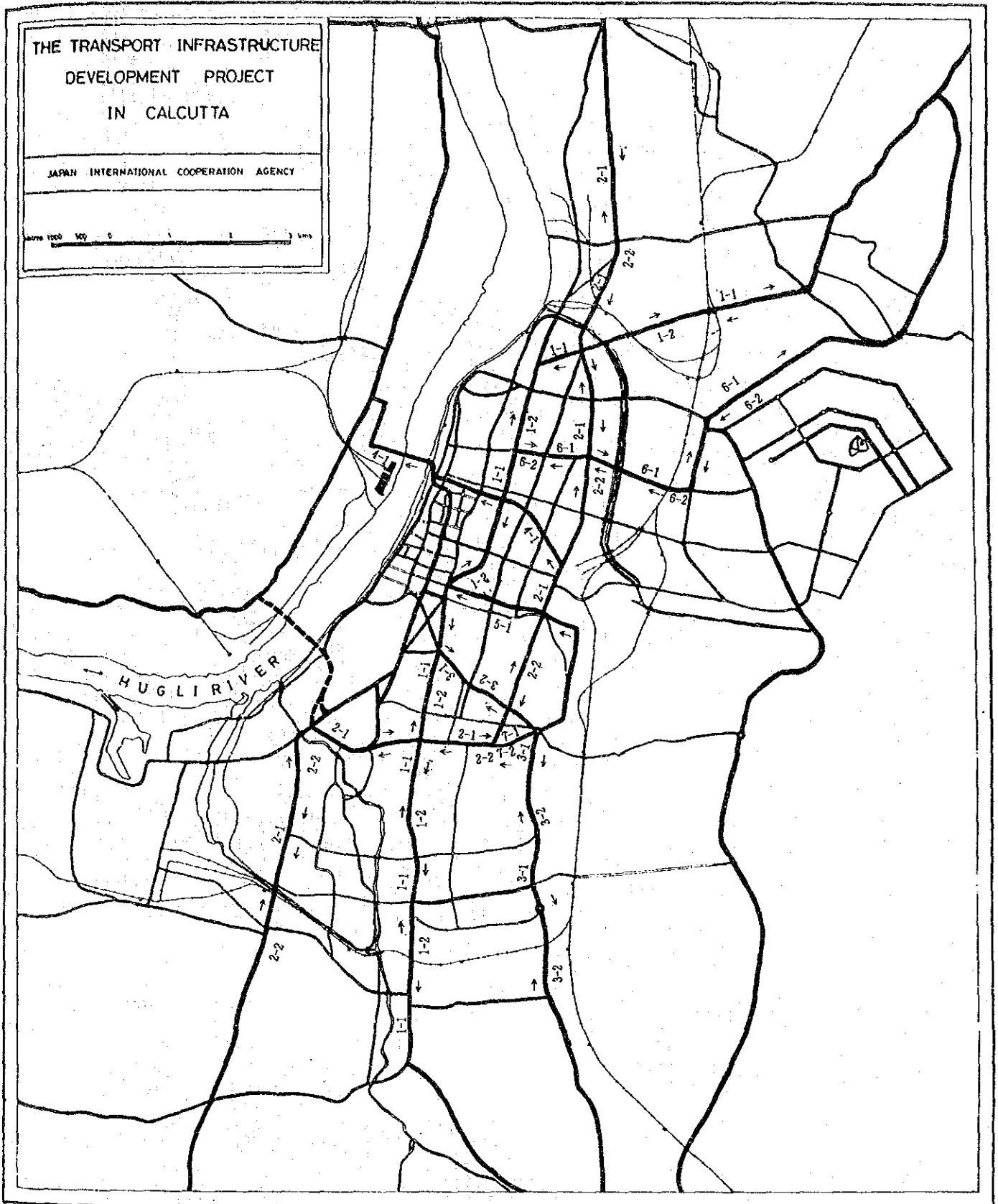
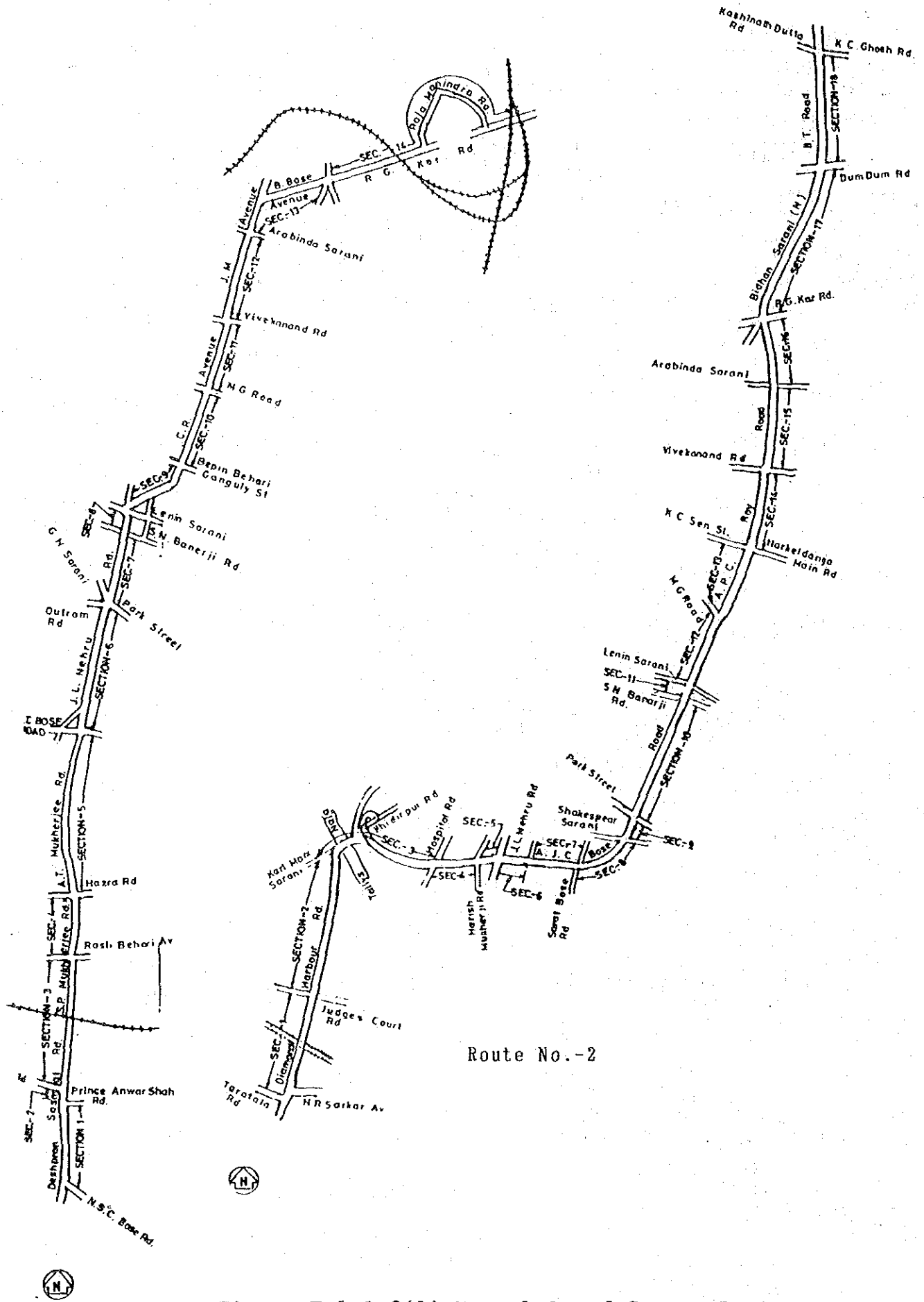
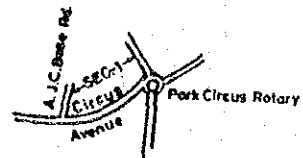


Figure T-1.1.2 Location of Travel Time Survey

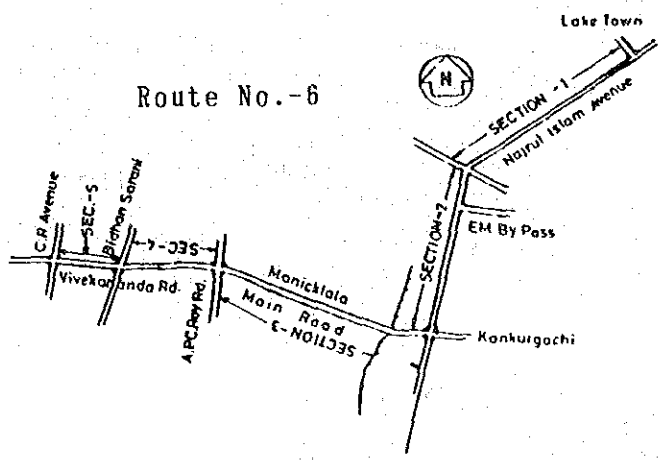


Route No.-2

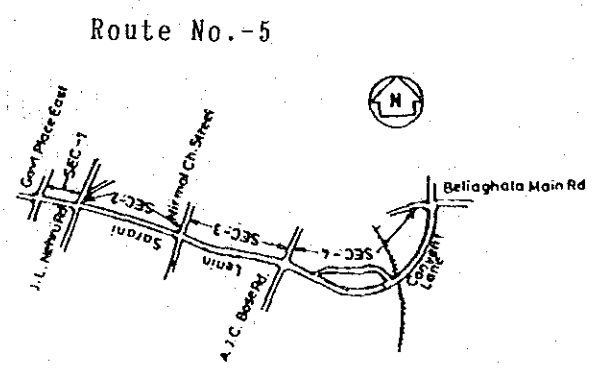
Figure T-1.1.3(1) Travel Speed Survey Route



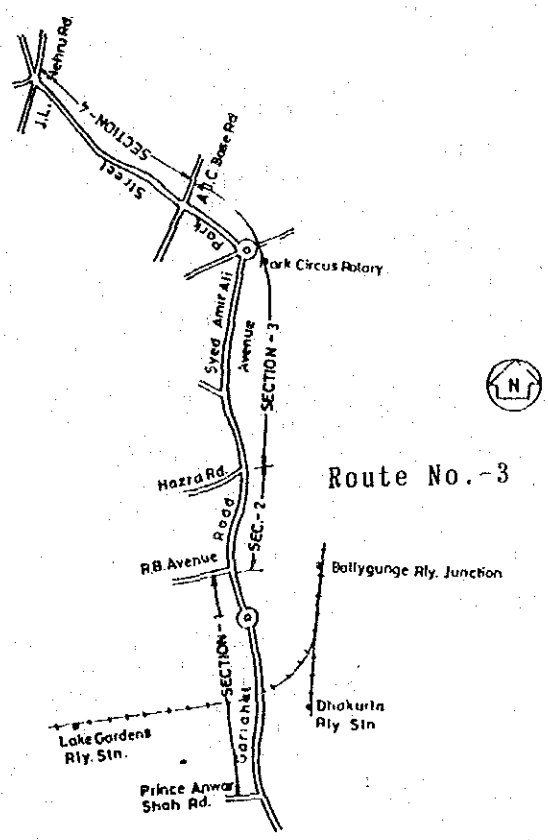
Route No.-7



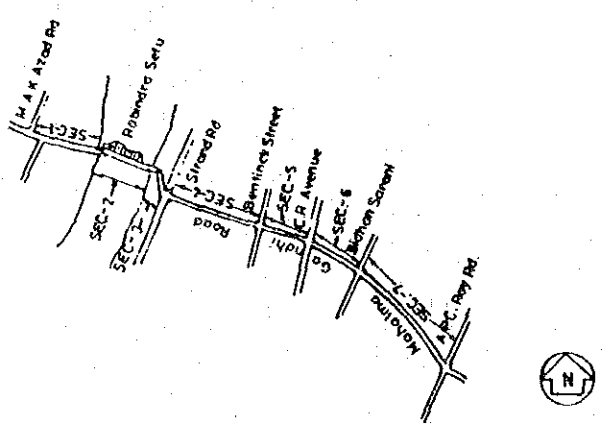
Route No.-6



Route No.-5

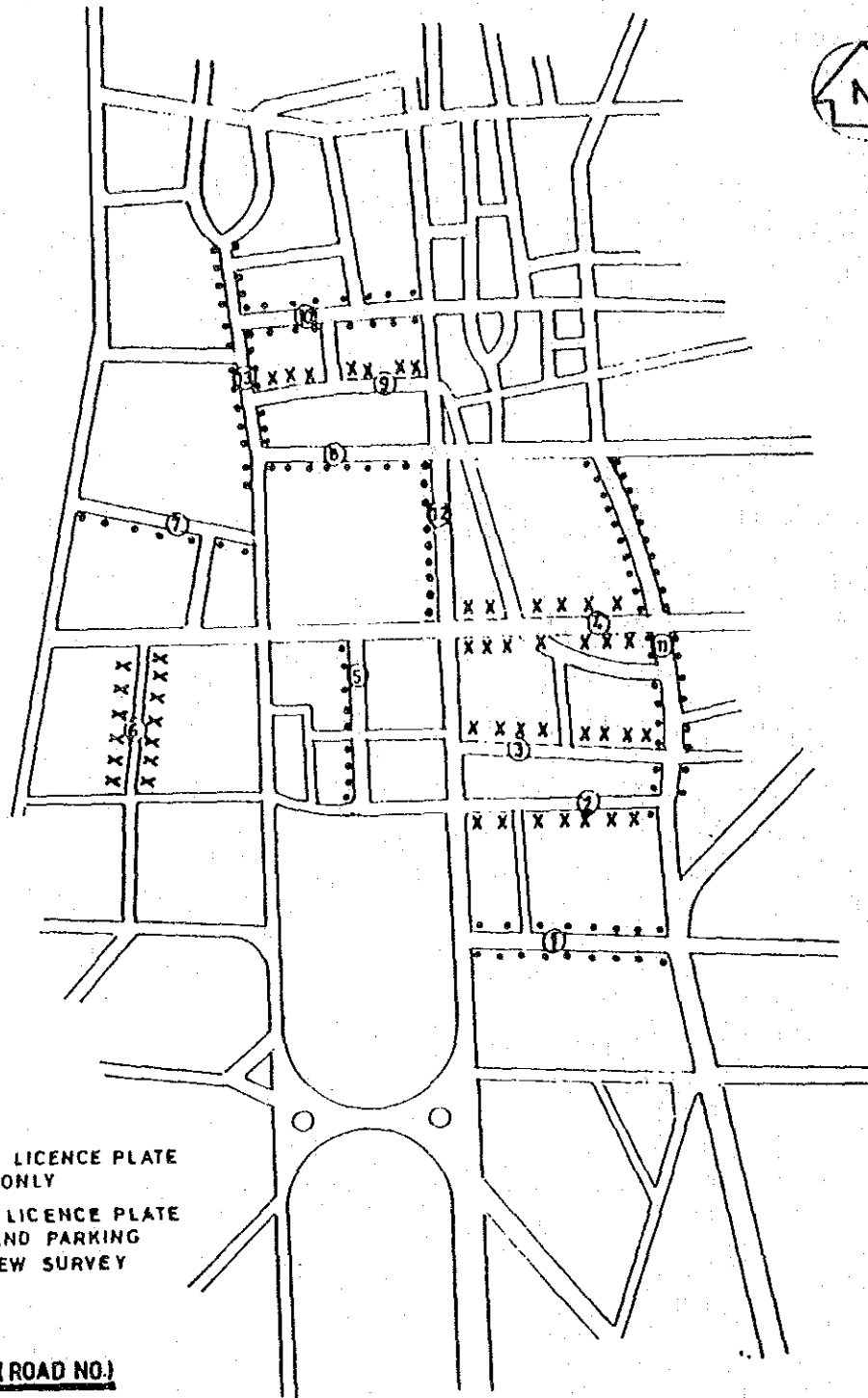


Route No.-3



Route No.-4

Figure T-1.1.3(2) Travel Speed Survey Route



**LEGEND**

- X X X X X    PARKING LICENCE PLATE SURVEY ONLY
- .....    PARKING LICENCE PLATE SURVEY AND PARKING INTERVIEW SURVEY

**SL.NO.    NAME OF ROAD(ROAD NO.)**

- ①    ESPLANADE ROW
- ②    WATERLOO STREET
- ③    BRITISH INDIA STREET
- ④    R. N. MUKHERJEE ROAD
- ⑤    RED CROSS PLACE
- ⑥    CHURCH LANE
- ⑦    COILAGHAT STREET
- ⑧    B. B. D. BAG (NORTH)
- ⑨    LYONS RANGE
- ⑩    INDIAN EXCHANGE PLACE.
- ⑪    BENTINCK STREET
- ⑫    B. B. D. BAG (EAST)
- ⑬    NETAJI SUBHAS ROAD

Figure T-1.1.4 Location of Parking Interview Survey and Parking Licence Plate Survey



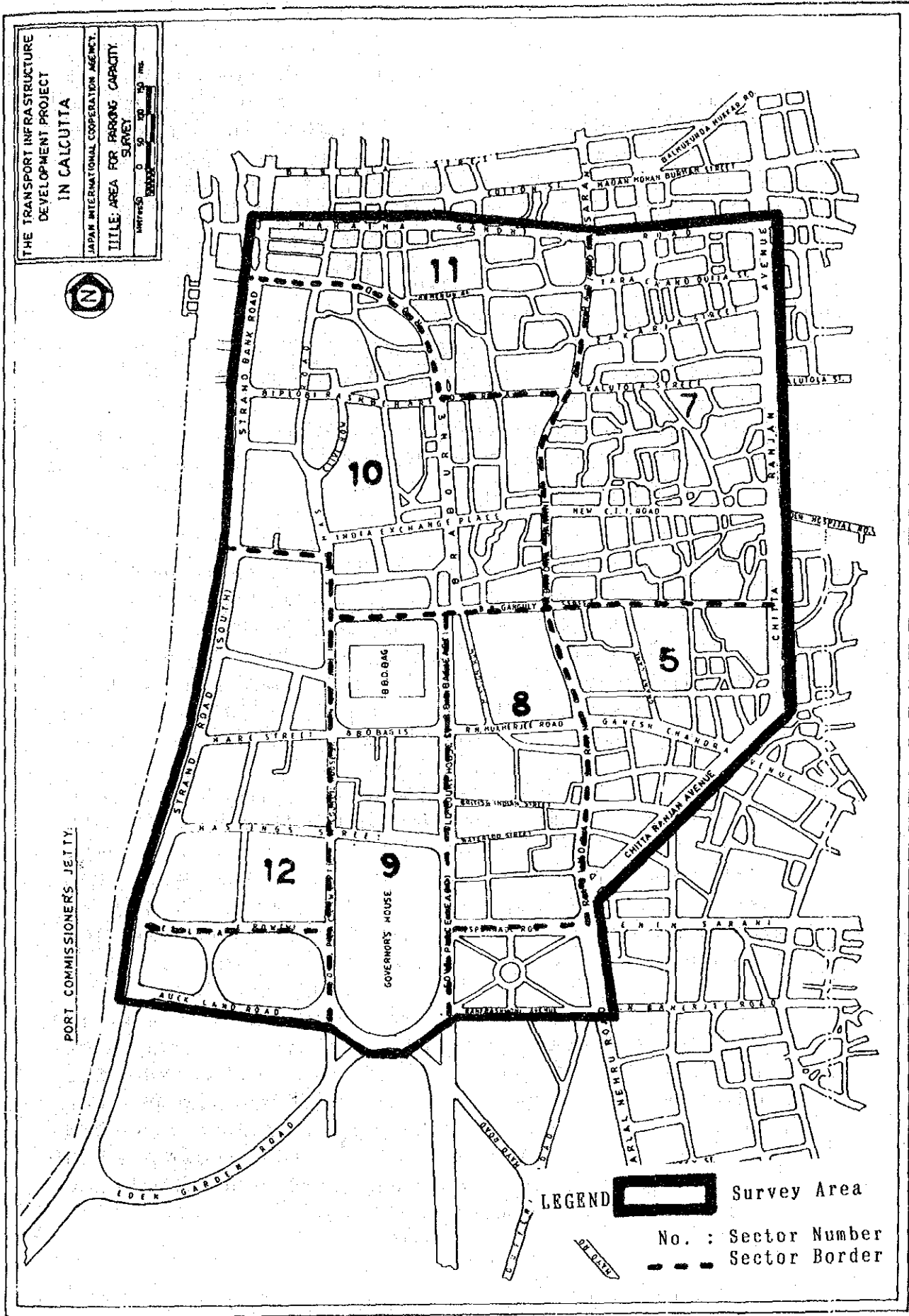


Figure T-1.1.5 Area for Parking Capacity Survey

c. Parking Capacity Survey (Parking Volume Count)

The parking capacity survey was conducted as parking volume count at periodic intervals by vehicle classification for 12 hours from 8:00 in the morning to 20:00 in the evening. Of the surveyed areas shown in Fig. T-1.1.5, at Bentinck Street the counting was carried out during November 18 to 24, 1991 for 7 days, while for the rest on one weekday and one holiday.

1.2 Traffic Volume

1.2.1 Result of Traffic Volume Count Survey

Fig. T-1.2.1 shows the hourly fluctuations by each intersection approach. The traffic volume count are summarized in Table T-1.2.1.

- (1) At the location No.1 (Moulali ; A.J.C. Bose Road and Lenin Sarani crossing), the peak hour was 12:00 to 13:00 and the peak hour factor (hereinafter referred to as the PHF) was 9.2% of the 12 hours volume. The major traffic flow was along A.J.C. Bose Road, from north to south with approximately 10,000 vehicles including 1,510 slow vehicles as 12 hours volume.
- (2) At the location No.2 (Esplanade ; C.R. Avenue and Esplanade Row East crossing), the peak hour was 12:00 to 13:00 and the PHF was 10.2% to 12 hours volume. The major traffic flow was from Jawahar Lal Nehru Road (hereinafter referred to as J.L. Nehru Road) to Bentinck Street, with approximately 7,000 vehicles including 150 slow vehicles as 12 hours volume.
- (3) At the location No.3 (Gariahat ; Gariahat Road and Rashbehari Avenue crossing), the morning peak hour was 9:00 to 10:00 and the PHF was 9.8%, and the evening peak hour was 18:00 to 19:00 and the PHF was 9.0% to 12 hours volume. The major traffic flow was from north to south along Gariahat Road, with approximately 9,000 vehicles including 770 slow vehicles as 12 hours volume.

- (4) At the location No.4 (Shyambazar ; Bidhan Sarani, R.G. Kar Road, A.P.C. Roy Road and Bhupen Bose Avenue crossing), the morning peak hour was 10:00 to 11:00 and the PHF was 8.6%, and the evening peak hour was 18:00 to 19:00 and the PHF was 9.0% to 12 hours volume. The major traffic flow was from A.P.C. Roy Road to Bidhan Sarani, with approximately 4,000 vehicles including 260 slow vehicles as 12 hours volume.
- (5) At the location No.5 (Rabindra Sadan ; Chowringhee Road and A.J.C. Bose Road crossing), the peak hour was 9:00 to 10:00 and the PHF was 9.7% to 12 hours volume. The major traffic flow was from south to north along Chowringhee Road, with approximately 12,000 vehicles including 460 slow vehicles as 12 hours volume.
- (6) At the location No.6 (Beck Bagan ; A.J.C. Bose Road and Circus Avenue crossing), the morning peak hour was 10:00 to 11:00 and the PHF was 10.3%, and the evening peak hour was 15:00 to 16:00 and the PHF was 8.5% to 12 hours volume. The major traffic flow was from west of A.J.C. Bose Road to Ballygunge Circular Road, with approximately 8,000 vehicles including 210 slow vehicles as 12 hours volume.
- (7) At the location No.7 (Maniktala ; A.P.C. Roy Road and Vivekananda Road crossing), the peak hour was 10:00 to 11:00 and the PHF was 9.6% to 12 hours volume. The major traffic flow was from west to east along Vivekananda Road, with approximately 8,000 vehicles including 1,140 slow vehicles as 12 hours volume.
- (8) At the location No.8 (Park Street ; J.L. Nehru Road, Park Street, Chowringhee Road and Outram Road crossing), the morning peak hour was 11:00 to 12:00 and the PHF was 9.7%, and the evening peak hour was 17:00 to 18:00 and the PHF was 8.6% to 12 hours volume. The major traffic flow was from Chowringhee Road to J.L. Nehru Road, with approximately 15,000 vehicles including 580 slow vehicles as 12 hours volume.

- (9) At location No.9 (Lock Gate ; Lock Gate Road and Railway crossing) there is no through road. The traffic therefore does not cross location No. 9, and traffic volume count was not carried out there.
- (10) At the location No.10 (Mullikbazar ; A.J.C. Bose Road and Park Street crossing), the peak hour was 10:00 to 11:00 and the PHF was 9.9% to 12 hours volume. The major traffic flow was from north to south along A.J.C. Bose Road, with approximately 10,000 vehicles including 730 slow vehicles as 12 hours volume.
- (11) At the location No.11 (A.J.C. Bose Road and Surendra Nath Banerjee Road (hereinafter referred to as S.N. Banerjee Road) crossing), the morning peak hour is 10:00 to 11:00 and the PHF was 9.5%, and the evening peak hour was 15:00 to 16:00 and the PHF was 9.0% to 12 hours volume. The major traffic flow was from north to south along A.J.C. Bose Road, with approximately 10,000 vehicles including 1,210 slow vehicles as 12 hours volume.
- (12) At the location No.12 (Nirmal Chandra Street, Lenin Sarani and Rafi Ahmed Kidwai Road crossing), the peak hour was 16:00 to 17:00 and the PHF was 9.4% to 12 hours volume. The major traffic flow was from west to east along Lenin Sarani, with approximately 8,000 vehicles including 720 slow vehicles as 12 hours volume.
- (13) At the location No.13 (C.R. Avenue and M.G. Road crossing), the morning peak hour was 11:00 to 12:00 and the PHF is 9.6%, and the evening peak hour was 15:00 to 16:00 and the PHF was 9.6% to 12 hours volume. The major traffic flow was from north to south along C.R. Avenue, with approximately 14,000 vehicles including 1,020 slow vehicles as 12 hours volume.
- (14) At the location No.14 (Government Place East and Esplanade Row East crossing), the morning peak hour was 10:00 to 11:00 and the PHF was 9.5%, and the

evening peak hour was 16:00 to 17:00 and the PHF was 9.3% to 12 hours volume. The major traffic flow was from north to south along Government Place East, with approximately 20,000 vehicles including 450 slow vehicles as 12 hours volume.

(15) At the location No.15 (Kidderpore Road, A.J.C. Bose Road and St. Georges Gate Road crossing), the morning peak hour was 11:00 to 12:00 and the PHF was 9.5%, and the evening peak hour was 15:00 to 16:00 and the PHF was 9.1% to 12 hours volume. The major traffic flow was from A.J.C. Bose Road to St. Georges Gate Road, with approximately 5,000 vehicles including 330 slow vehicles as 12 hours volume.

(16) At the location No.16 (A.P.C. Roy Road and M.G. Road crossing ; Sealdah Fly Over), the morning peak hour was 11:00 to 12:00 and the PHF was 9.3%, and the evening peak hour was 15:00 to 16:00 and the PHF was 8.9% to 12 hours volume. The major traffic flow was from south to north along A.P.C. Roy Road, with approximately 9,000 vehicles including 470 slow vehicles as 12 hours volume.

(17) At the location No.17 (Howrah Bridge), the morning peak hour was 10:00 to 11:00 and the PHF was 6.7%, and the evening peak hour was 17:00 to 18:00 and the PHF was 6.6% to 24 hours volume. The traffic volume was approximately 71,000 vehicles including 9,140 slow vehicles by both direction as 24 hours volume.

(18) At the location No.18 (J.L. Nehru Road, S.N. Banerjee Road, Dufferin Road and Ochterlony Road crossing) which was conducted by Counterpart Team on January 3rd, 4th and 5th, the peak hour was 12:00 to 13:00 and the PHF was 12.5% to 12 hours volume. The major traffic flow was from south to north along J.L. Nehru Road, with approximately 11,000 vehicles only fast vehicles as 12hours volume.

The night hours factor was 45% for 12 hours by 24 hours volume count at Howrah Bridge. Fig. T-1.2.2 shows the vehicle type composition at the survey points.

Table T-1.2.1 Summary of Traffic Volume Count Survey

Location	Peak Hour		PHF(%/12hours)		Major Flow(12hours)	
	Number	Morning	Evening	Morning	Evening	Direction
1		12:00		9.2	North	10,000
		-13:00			-South	
2		12:00		10.2	South	7,000
		-13:00			-North	
3	9:00	18:00	9.8	9.0	North	9,000
	-10:00	-19:00			-South	
4	10:00	18:00	8.6	9.0	A.P.C. Roy	4,000
	-11:00	-19:00			Bidhan Sarani	
5		9:00		9.7	South	12,000
		-10:00			-North	
6	10:00	15:00	10.3	8.5	North	9,000
	-11:00	-16:00			-South	
7		10:00		9.6	West	8,000
		-11:00			-East	
8	11:00	17:00	9.7	8.6	South	15,000
	-12:00	-18:00			-North	
9	-	-	-	-	-	-
10		10:00		9.9	North	10,000
		-11:00			-South	
11	10:00	15:00	9.5	9.0	North	10,000
	-11:00	-16:00			-South	
12		16:00		9.4	West	8,000
		-17:00			-East	
13	11:00	15:00	9.6	9.6	North	14,000
	-12:00	-16:00			-South	
14	10:00	16:00	9.5	9.3	North	20,000
	-11:00	-17:00			-South	
15	11:00	15:00	9.5	9.1	East	5,000
	-12:00	-16:00			-West	
16	11:00	15:00	9.3	8.9	South	9,000
	-12:00	-16:00			-North	
17	10:00	17:00	6.7	6.6	-	71,000
	-11:00	-18:00	(PHF%/24 hours)			(24hours)
18		12:00		12.5	South	11,000
		-13:00			-North	

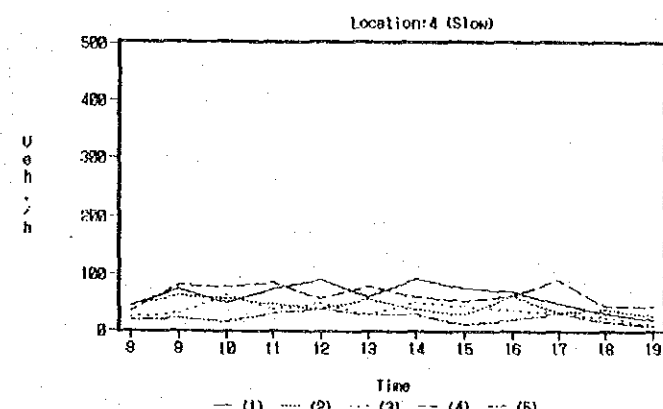
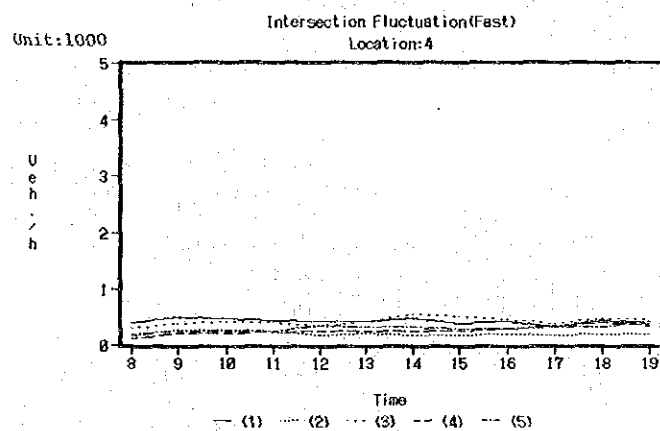
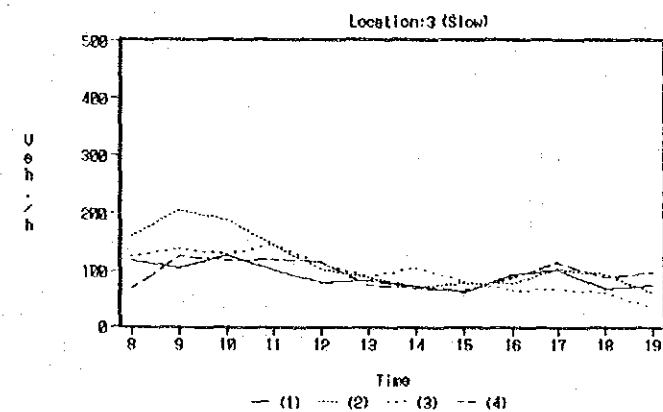
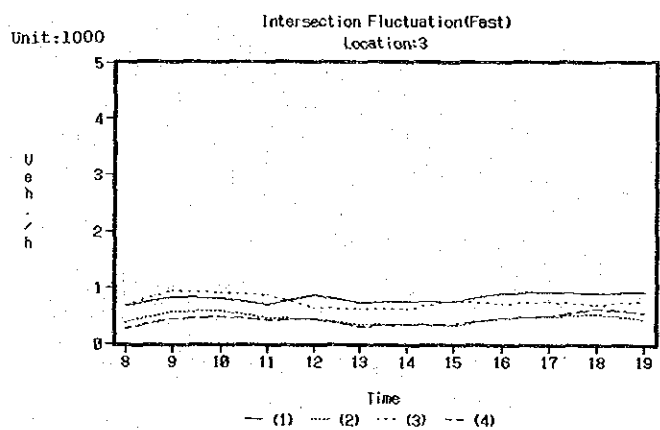
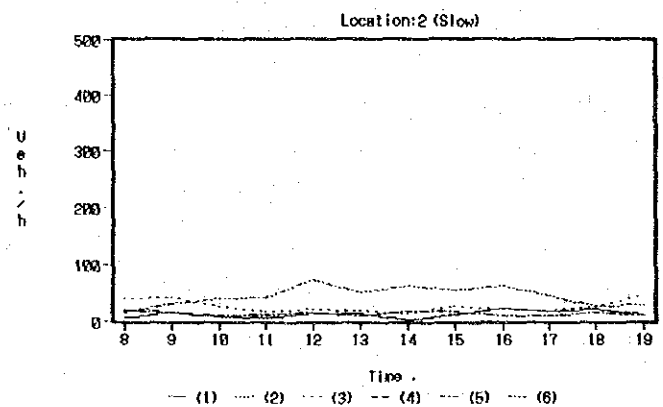
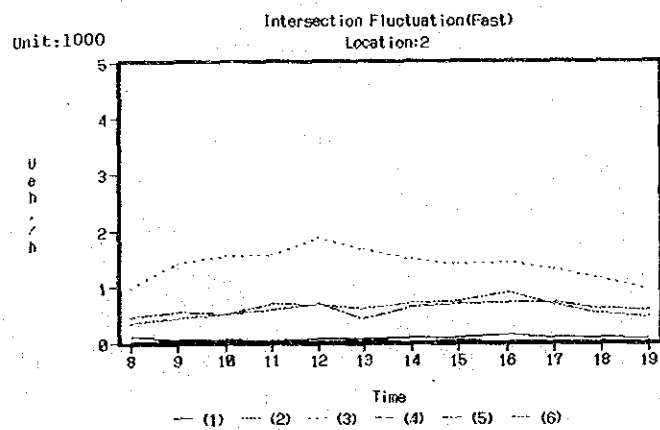
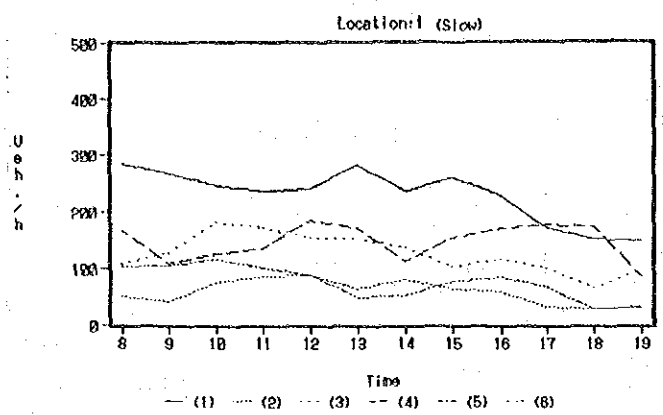
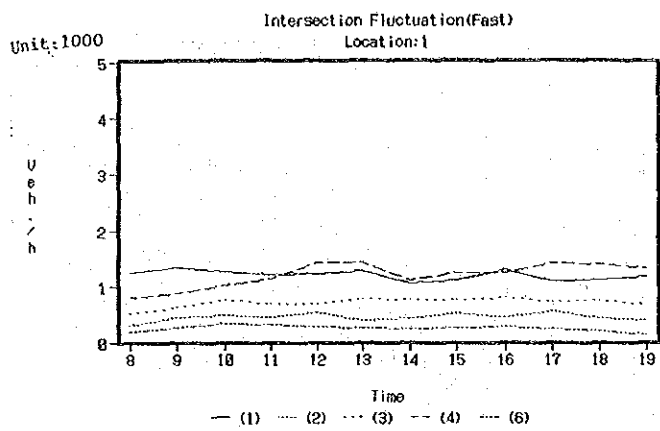


Figure T-1.2.1(1) Traffic Volume Hourly Fluctuation  
1-17

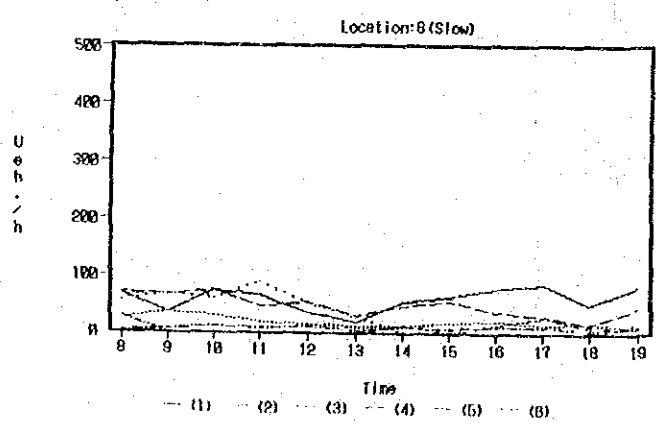
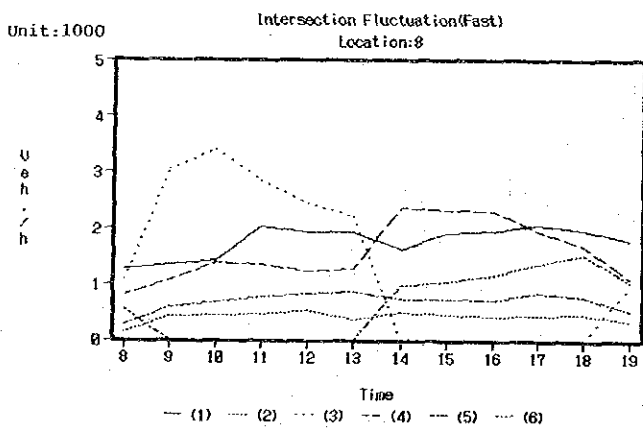
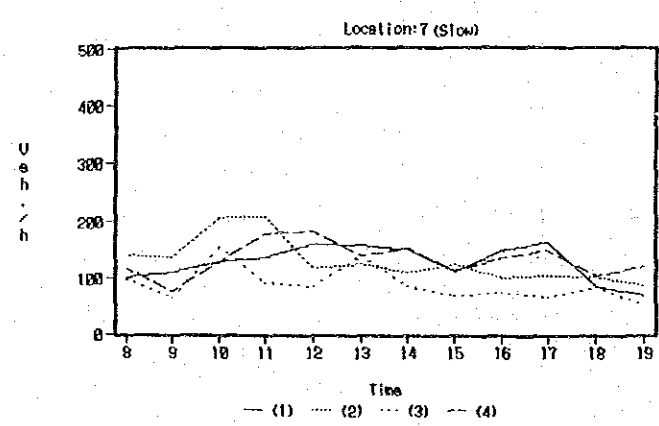
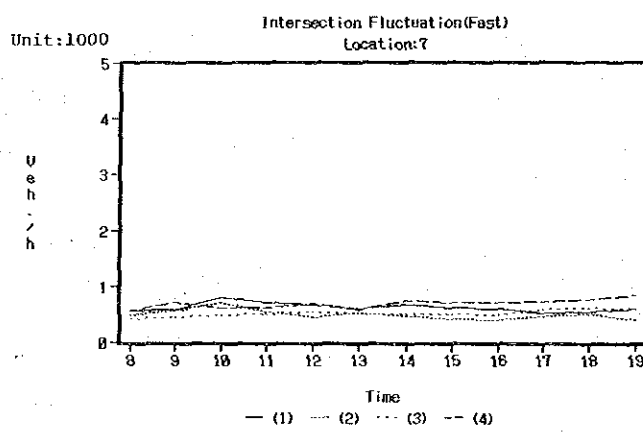
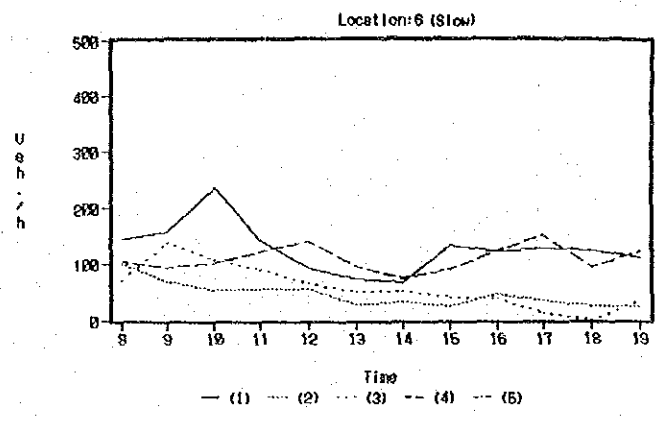
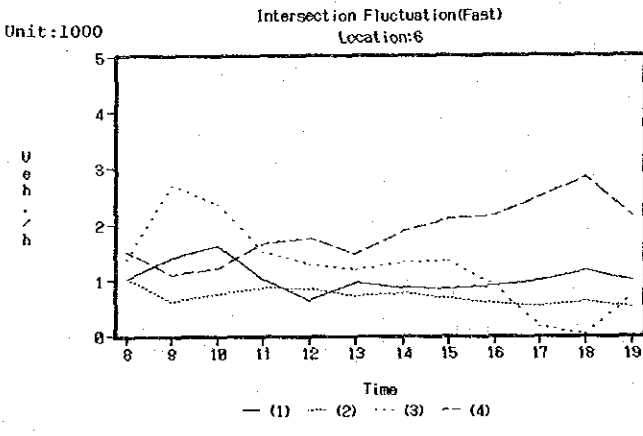
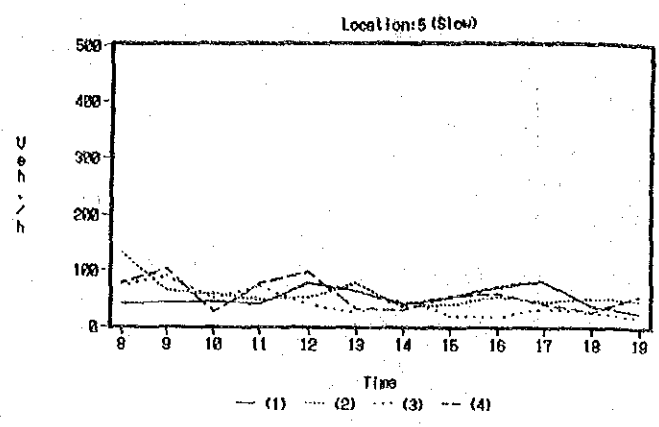
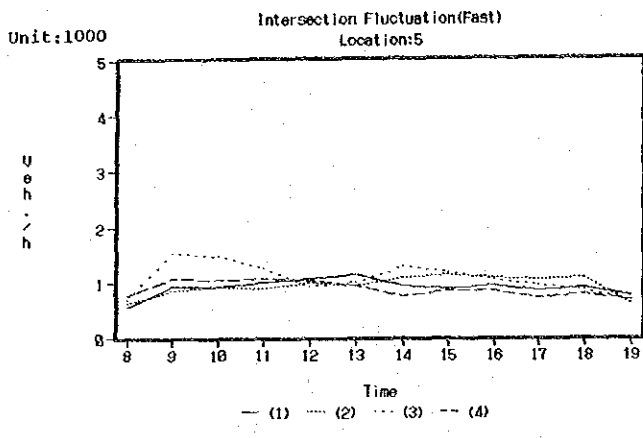


Figure T-1.2.1(2) Traffic Volume Hourly Fluctuation



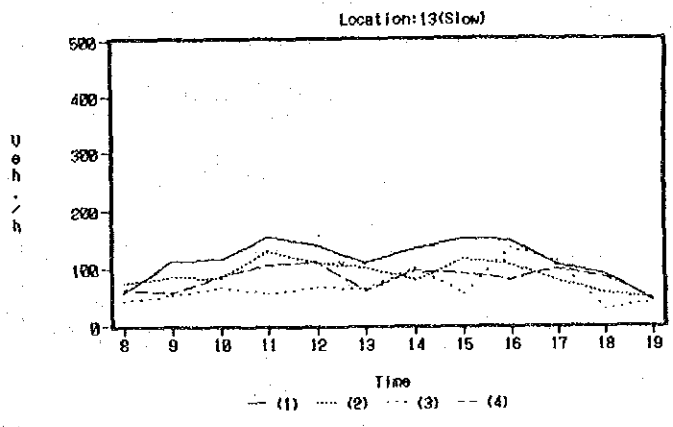
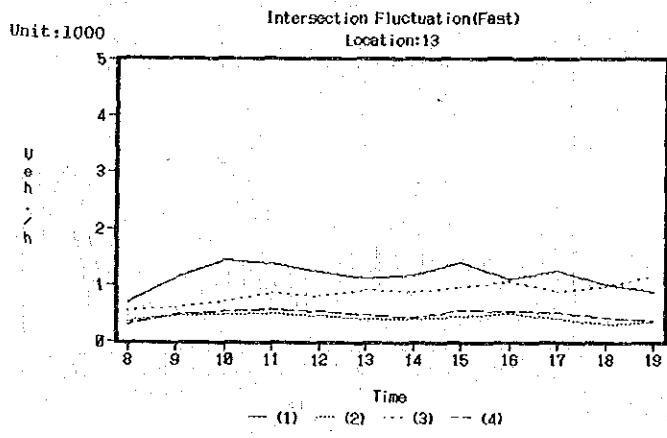
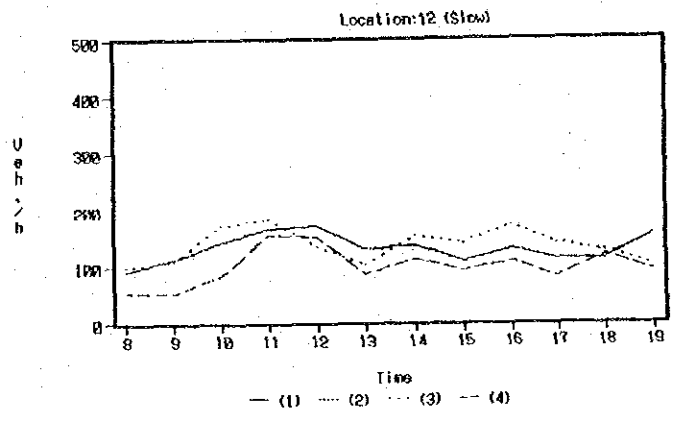
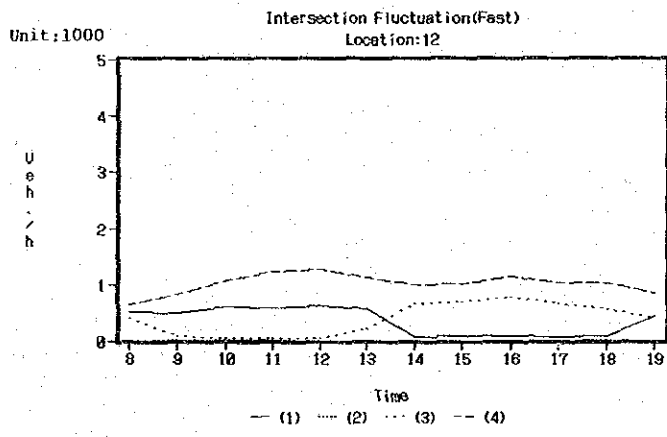
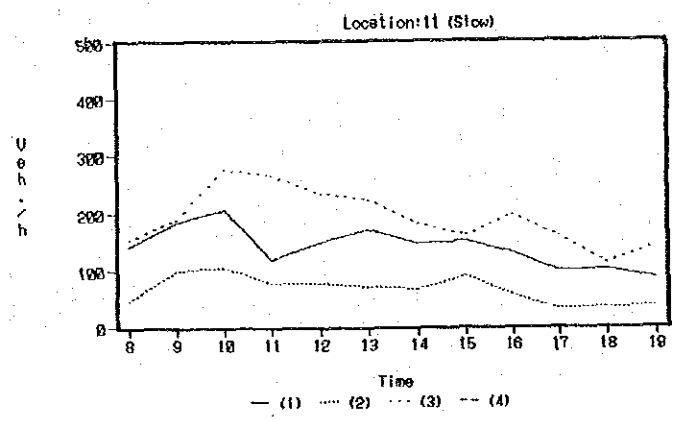
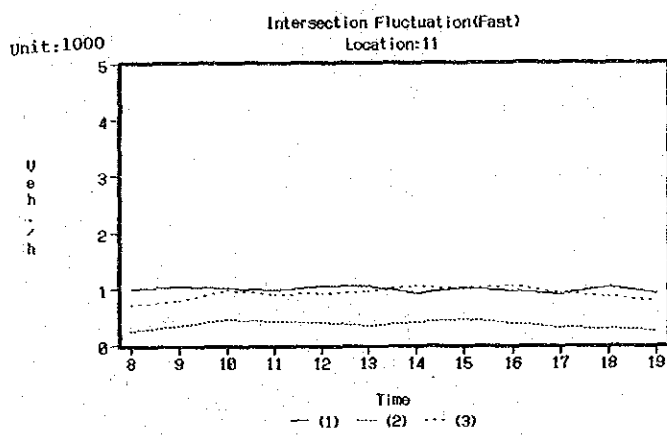
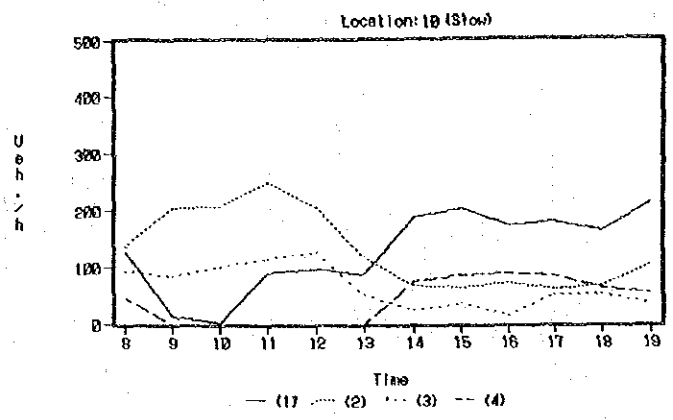
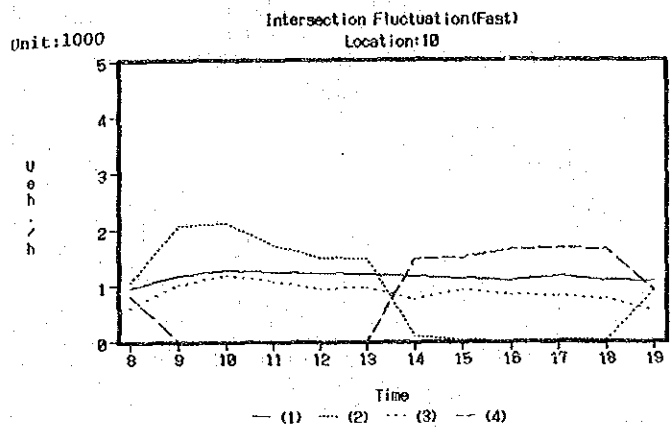


Figure T-1.2.1(3) Traffic Volume Hourly Fluctuation  
1-19

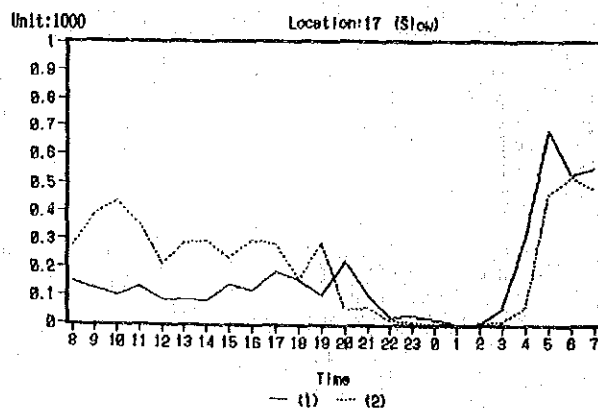
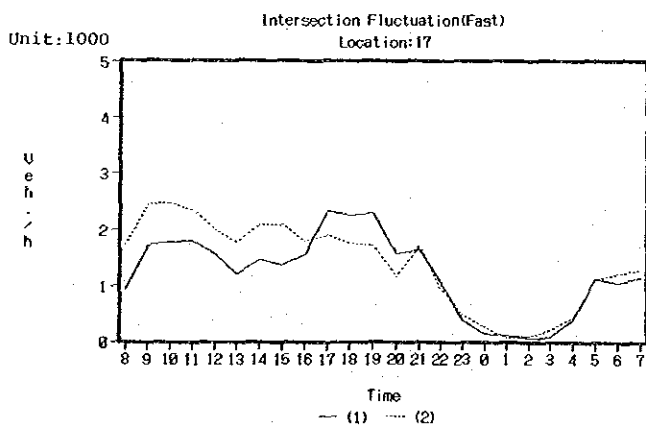
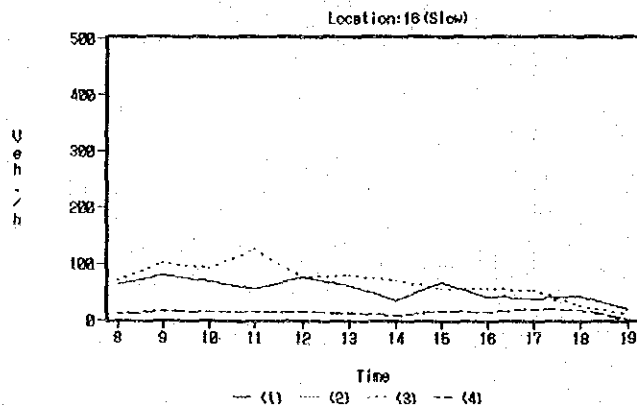
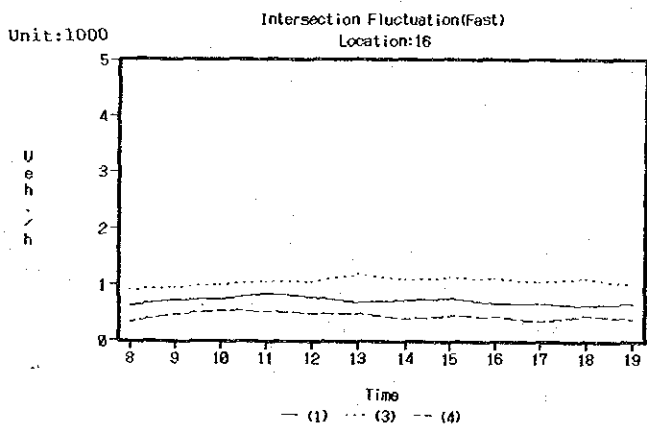
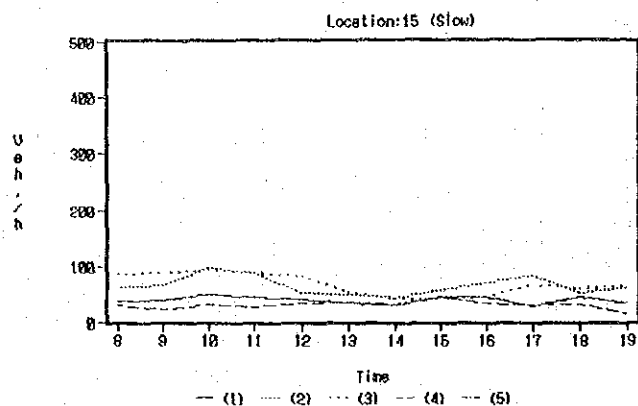
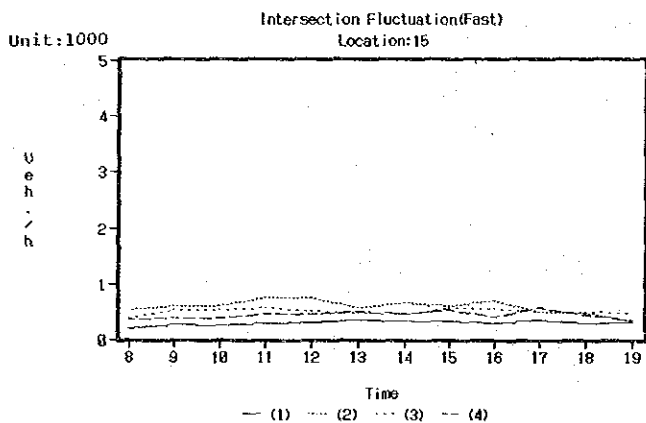
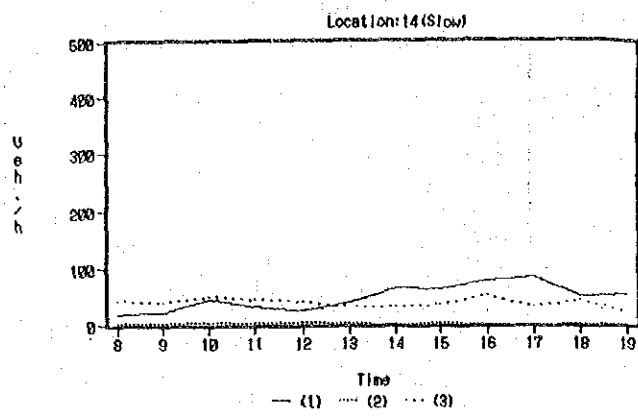
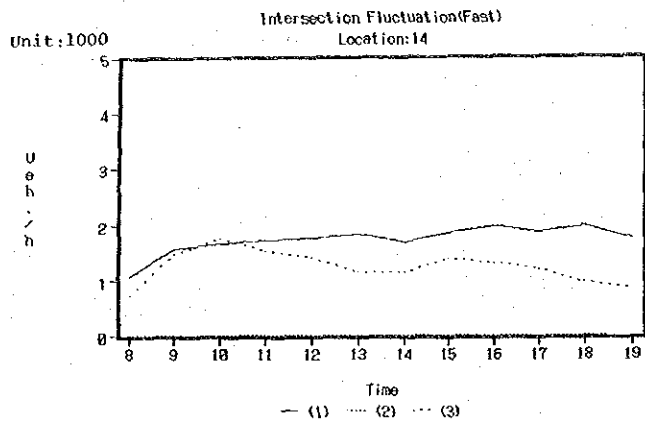


Figure T-1.2.1(4) Traffic Volume Hourly Fluctuation  
1-20

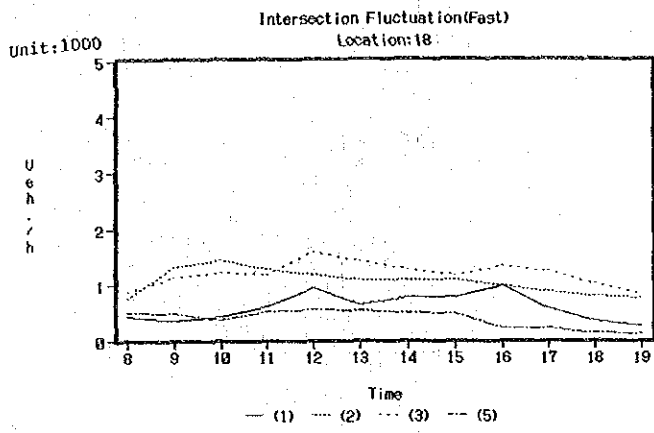


Figure T-1.2.1(5) Traffic Volume Hourly Fluctuation

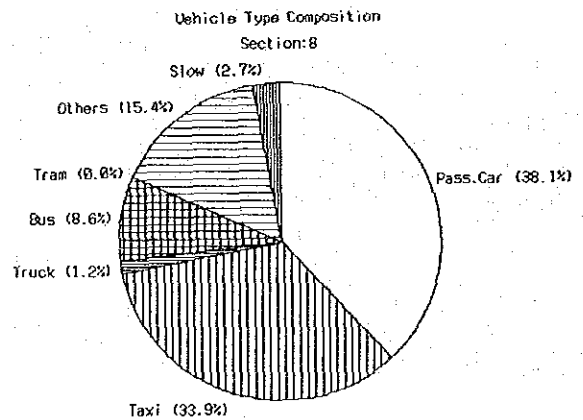
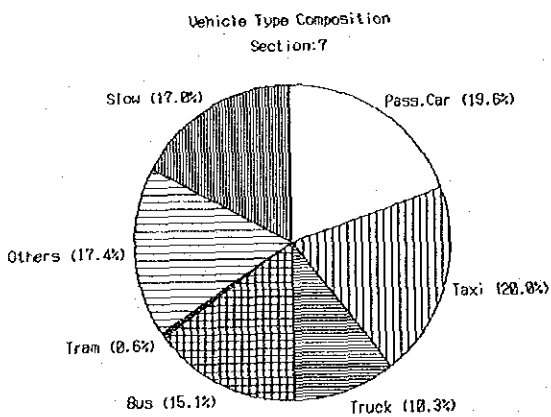
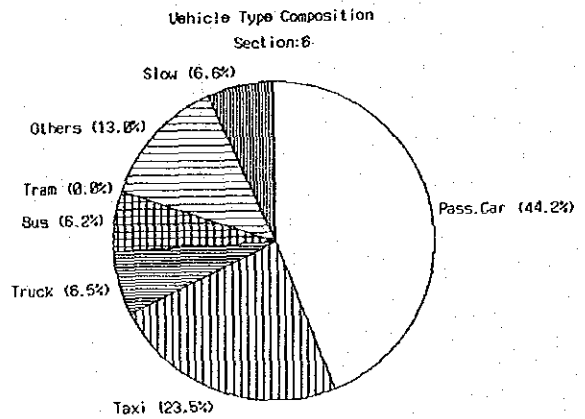
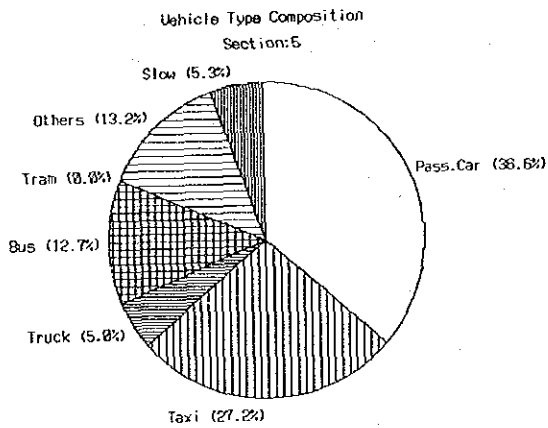
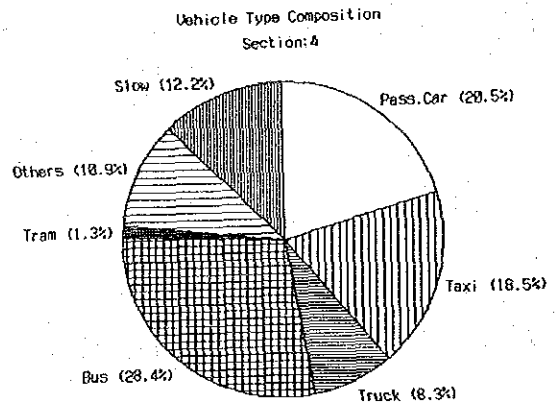
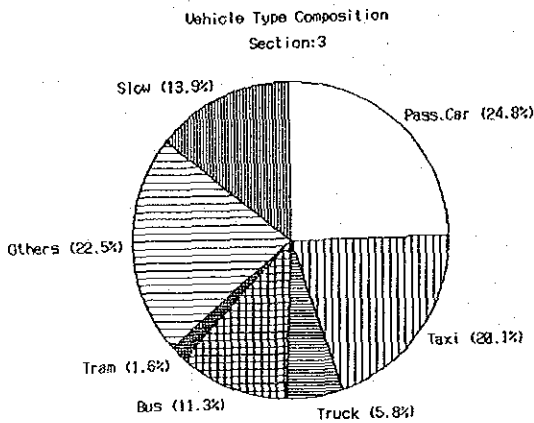
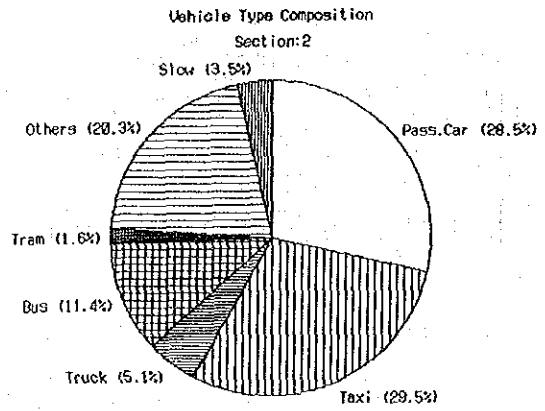
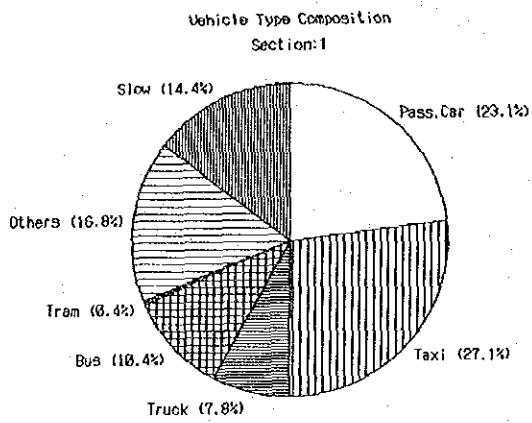


Figure T-1.2.2(1) Vehicle Type Composition

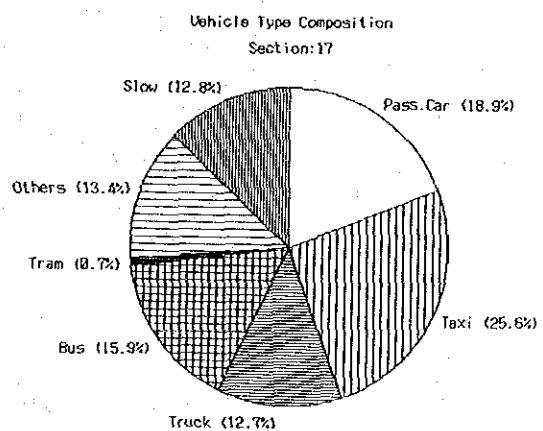
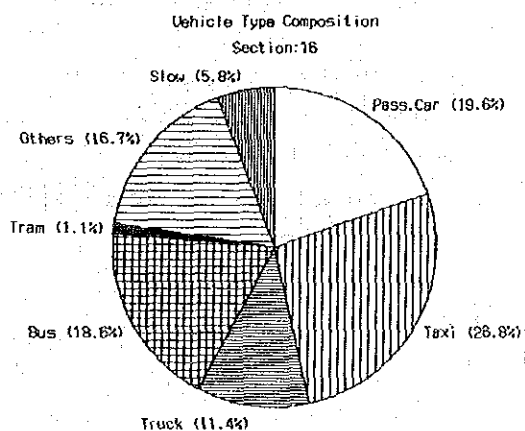
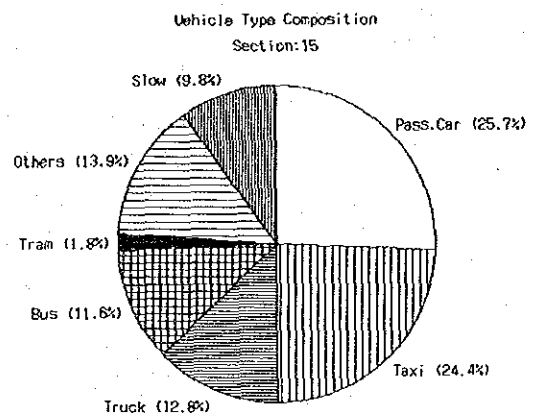
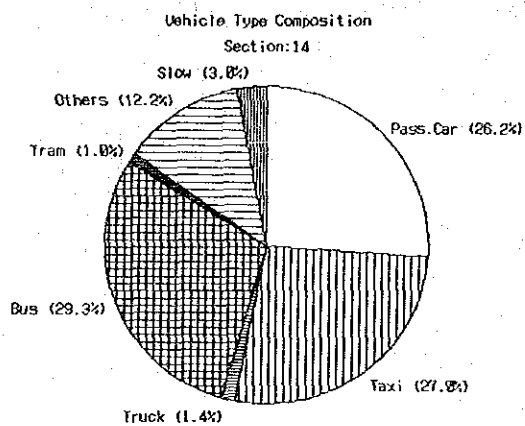
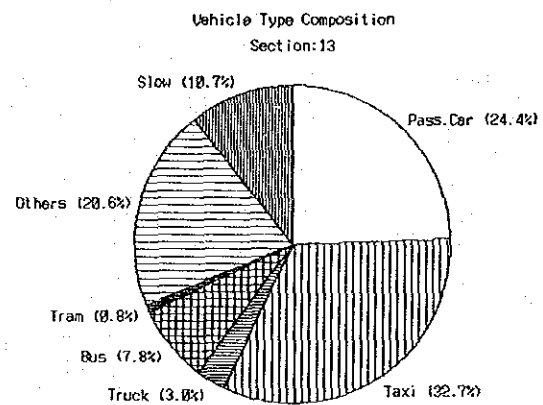
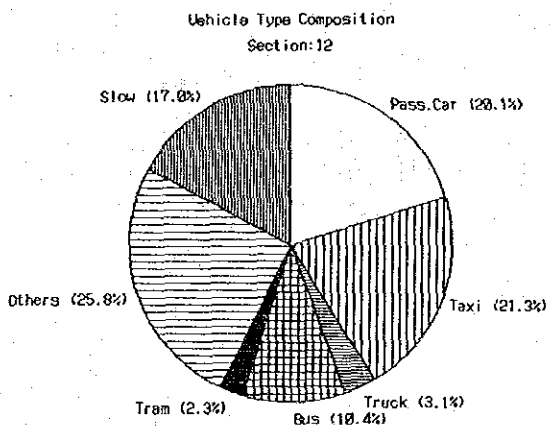
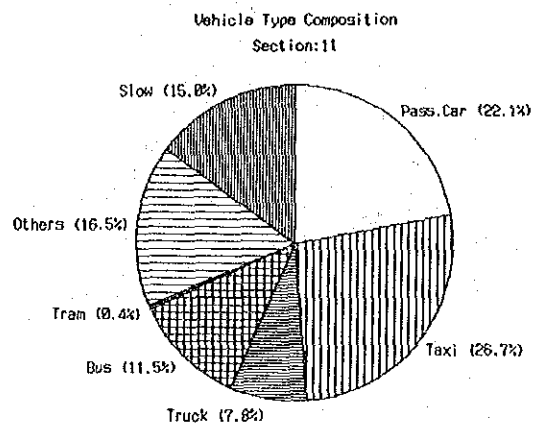
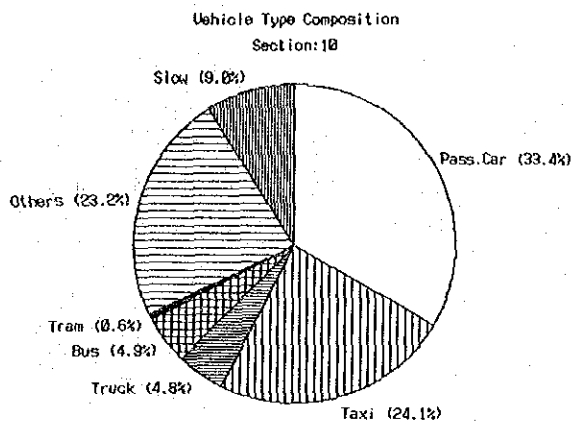


Figure T-1.2.2(2) Vehicle Type Composition

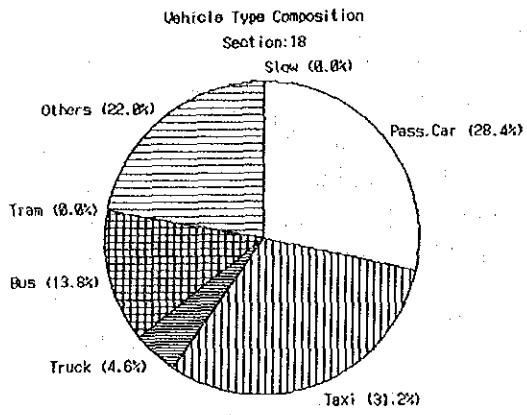


Figure T-1.2.2(3) Vehicle Type Composition

### 1.2.2 Traffic Flow

The traffic flow based on the intersection traffic counting by the passenger car unit (hereinafter referred to as PCU) in the Study Area is shown in Fig. T-1.2.3.

The Passenger Car Unit is shown in Table T-1.2.2

Table T-1.2.2 Passenger Car Unit

Vehicle Type	PCU
Passenger Car	1.00
Taxi	1.00
Truck	3.09
Mini Truck	1.63
Bus	3.09
Mini/Midi Bus	1.63
Motorcycle	0.50
Auto Rickshaw/Van	1.00
Tram	7.20
Other(motorized)	1.00

Source : Based on Transport Department Study carried out in Calcutta and Indian Road Congress

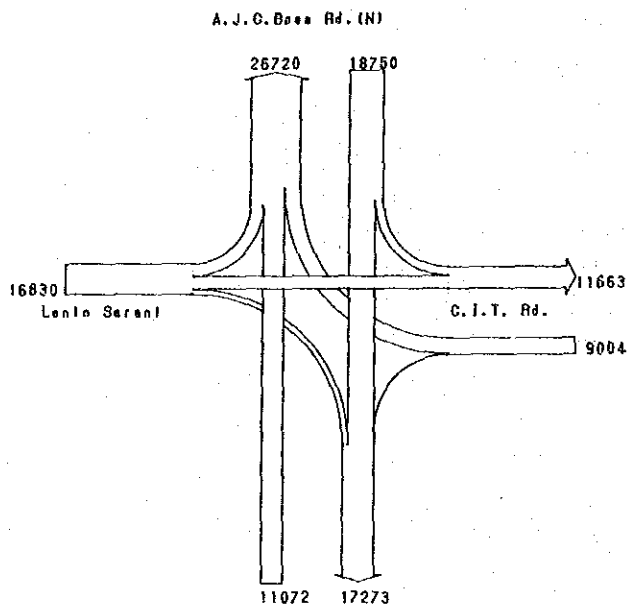
The streets with high traffic volumes were;

- 1) A.J.C. Bose Road with 20,000-50,000 PCU/12 hours
- 2) Park Street with 20,000-30,000 PCU/12 hours
- 3) J.L. Nehru Road with 25,000-50,000 PCU/12 hours
- 4) Howrah Bridge with 90,000 PCU/24 hours

### 1.3 O-D Survey

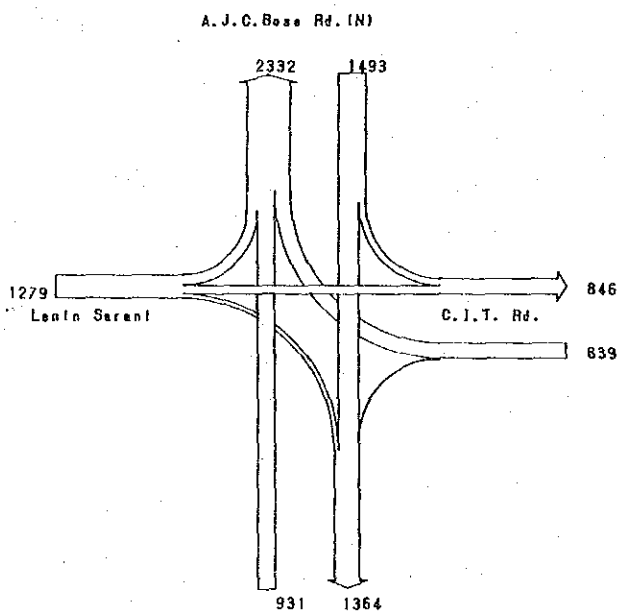
#### 1.3.1 Result of O-D Survey

Fig. T-1.3.1 shows the results of the O-D survey. The sampling ratio was maintained at more than 15%. The Generation and Attraction were concentrated into Howrah Station (Zone 34).



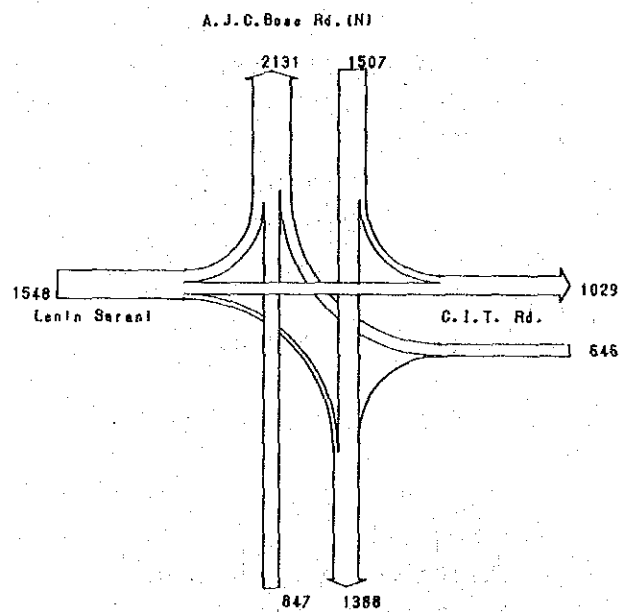
A. J. C. Bose Rd. (S)

12 hours Volume (8:00-20:00 : PCU)  
 LEGEND  $\longleftarrow$  20000.



A. J. C. Bose Rd. (S)

10:00-11:00 (PCU)  
 LEGEND  $\longleftarrow$  2000.

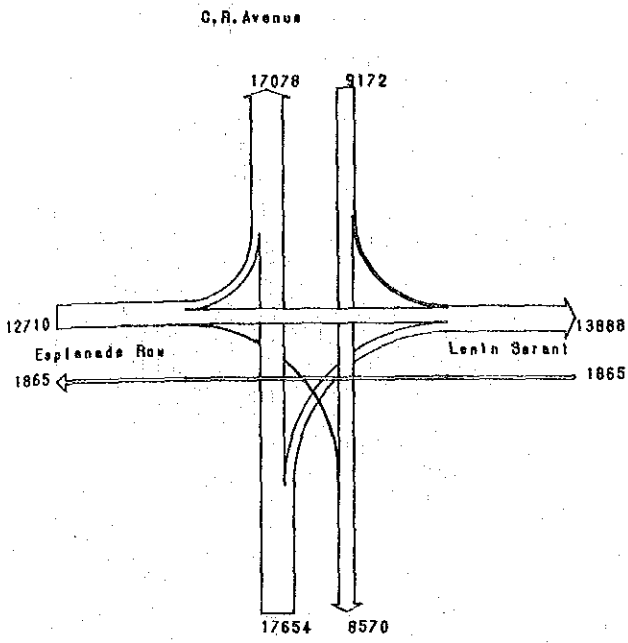


A. J. C. Bose Rd. (S)

18:00-19:00 (PCU)  
 LEGEND  $\longleftarrow$  2000.

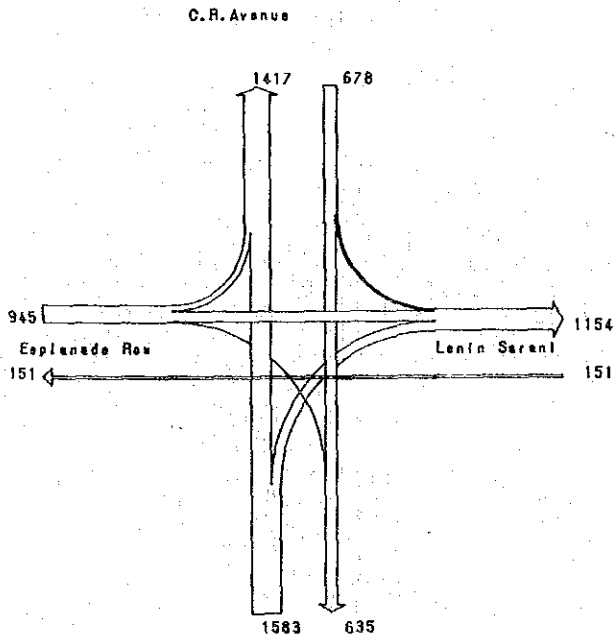
Figure T-1.2.3(1) Traffic Volume in Intersection (Loc.: 1)





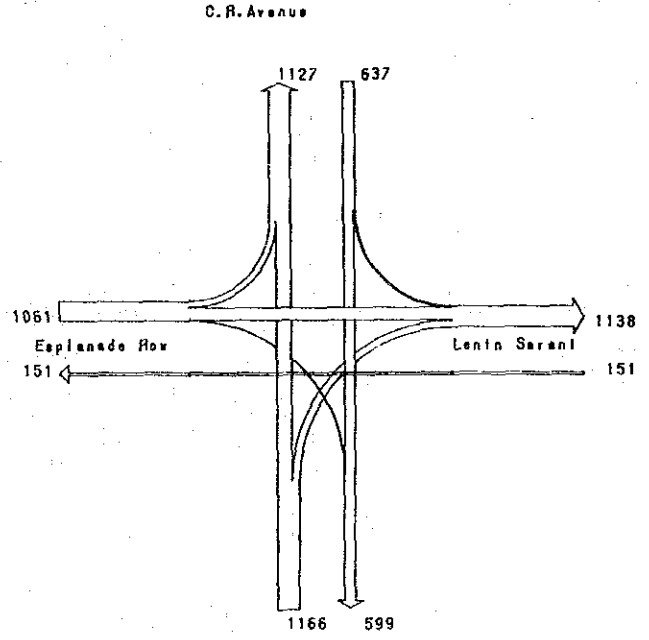
J.L. Nehru Rd.

12 hours Volume (8:00-20:00 ; PCU)  
 LEGEND ← 20000.



J.L. Nehru Rd.

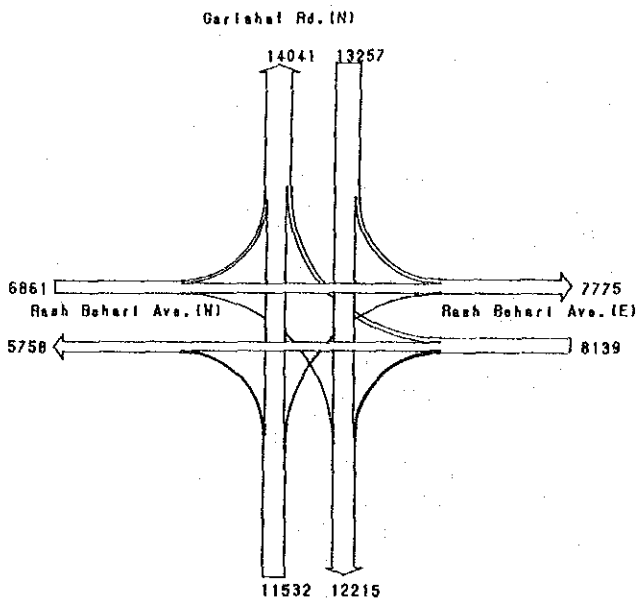
10:00-11:00 (PCU)  
 LEGEND ← 2000.



J.L. Nehru Rd.

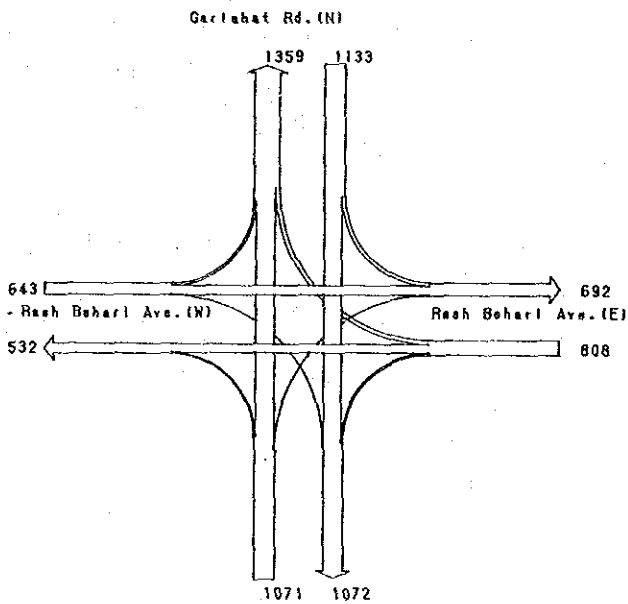
18:00-19:00 (PCU)  
 LEGEND ← 2000.

Figure T-1.2.3(2) Traffic Volume in Intersection (Loc.: 2)



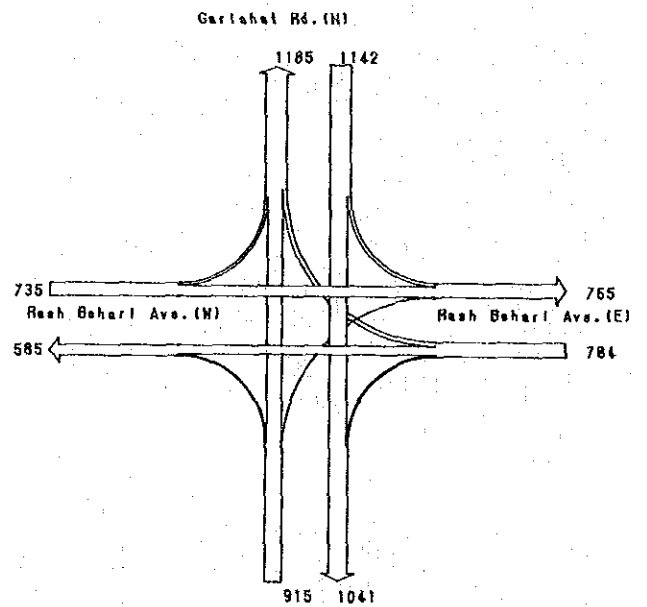
Garlabet Rd. (S)

12 hours Volume (8:00-20:00 ; PCU)  
 LEGEND  $\longleftarrow$  20000.



Garlabet Rd. (S)

10:00-11:00 (PCU)  
 LEGEND  $\longleftarrow$  2000.

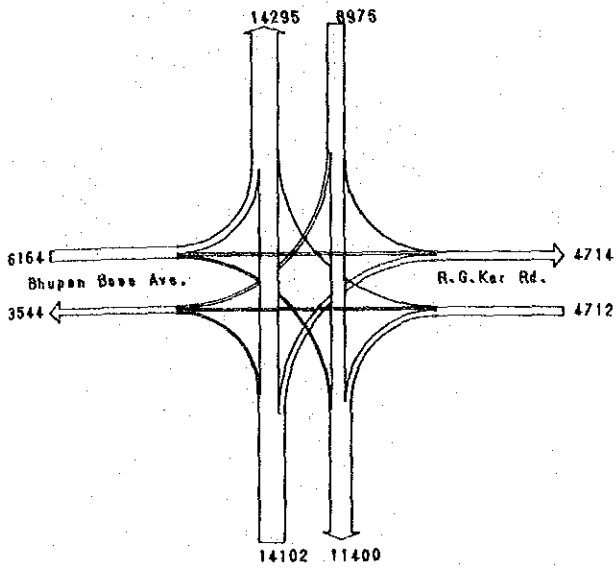


Garlabet Rd. (S)

18:00-19:00 (PCU)  
 LEGEND  $\longleftarrow$  2000.

Figure T-1.2.3(3) Traffic Volume in Intersection (Loc.: 3)

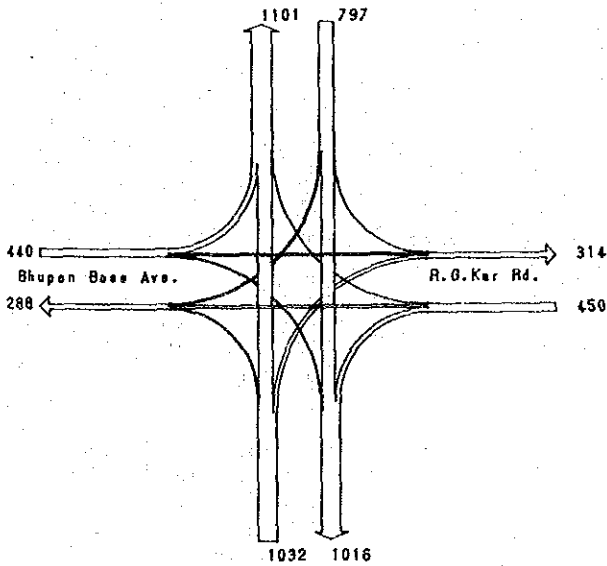
Bidhan Sarani (N)



Bidhan (S)+A.P.C. Roy

12 hours Volume (8:00-20:00 : PCU)  
 LEGEND  $\longleftarrow$  20000.

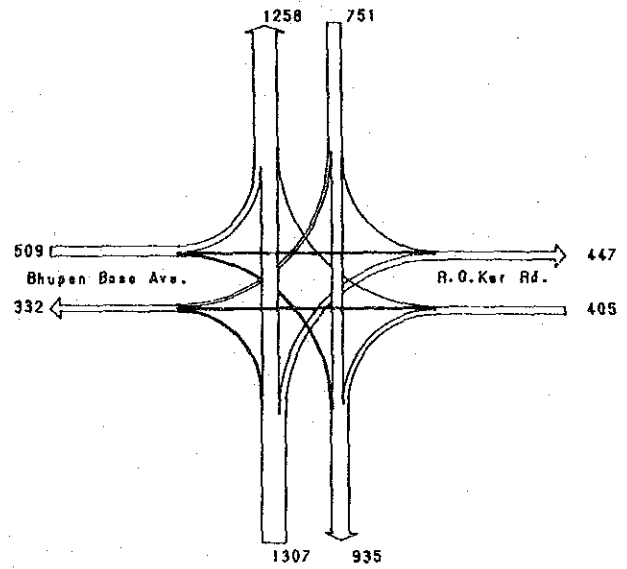
Bidhan Sarani (N)



Bidhan (S)+A.P.C. Roy

10:00-11:00 (PCU)  
 LEGEND  $\longleftarrow$  2000.

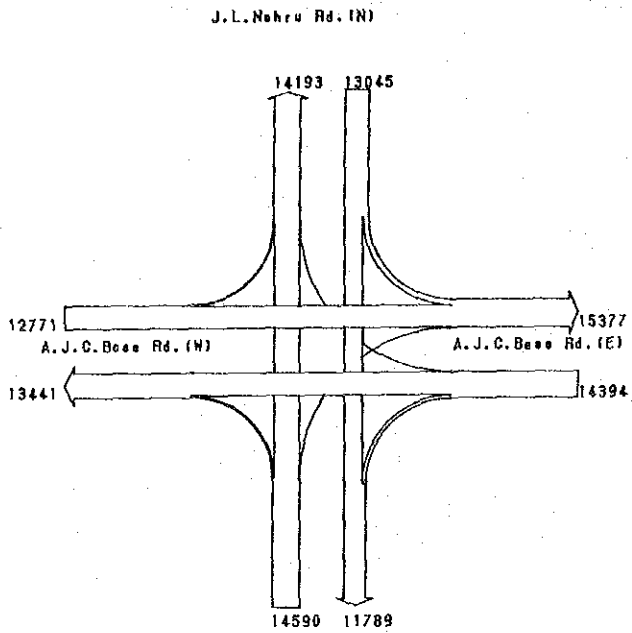
Bidhan Sarani (N)



Bidhan (S)+A.P.C. Roy

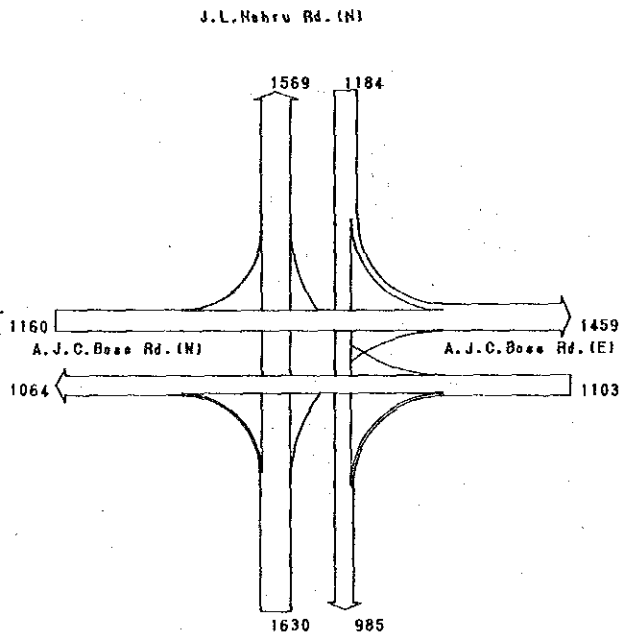
18:00-19:00 (PCU)  
 LEGEND  $\longleftarrow$  2000.

Figure T-1.2.3(4) Traffic Volume in Intersection (Loc.: 4)



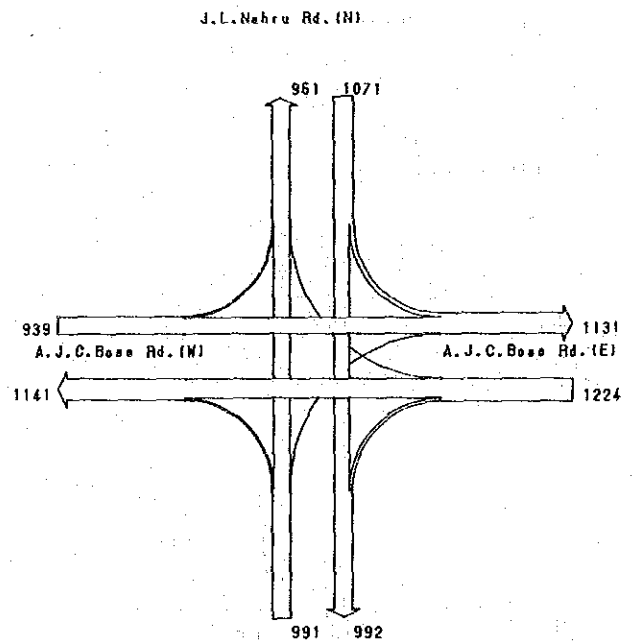
J.L.Nehru Rd. (S)

12 hours Volume (8:00-20:00 ; PCU)  
LEGEND — 20000.



J.L.Nehru Rd. (S)

10:00-11:00 (PCU)  
LEGEND — 2000.

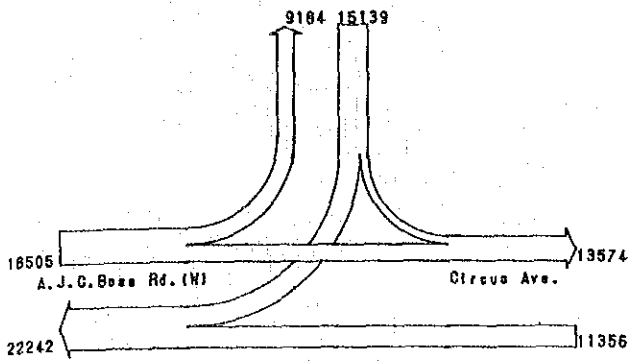


J.L.Nehru Rd. (S)

18:00-19:00 (PCU)  
LEGEND — 2000.

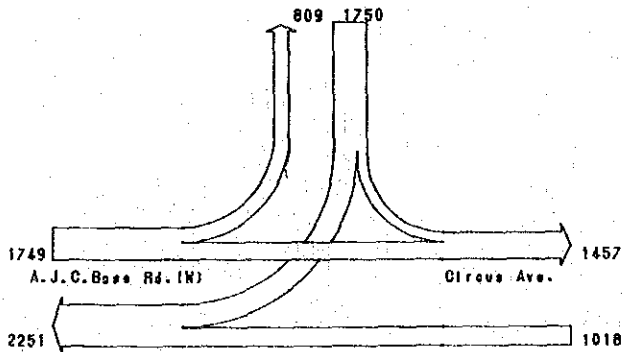
Figure T-1.2.3(5) Traffic Volume in Intersection (Loc.: 5)

A. J. C. Bose Rd. (N)



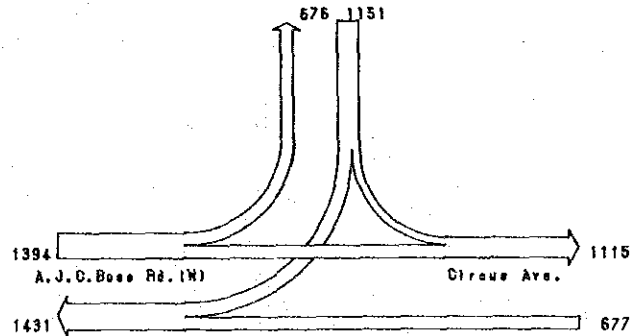
12 hours Volume (8:00-20:00 : PCU)  
 LEGEND — 20000.

A. J. C. Bose Rd. (N)



10:00-11:00 (PCU)  
 LEGEND — 2000.

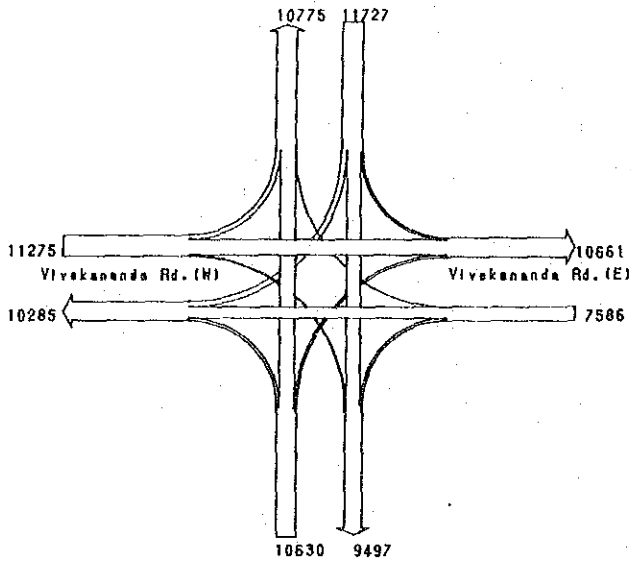
A. J. C. Bose Rd. (N)



18:00-19:00 (PCU)  
 LEGEND — 2000.

Figure T-1.2.3(6) Traffic Volume in Intersection (Loc.: 6)

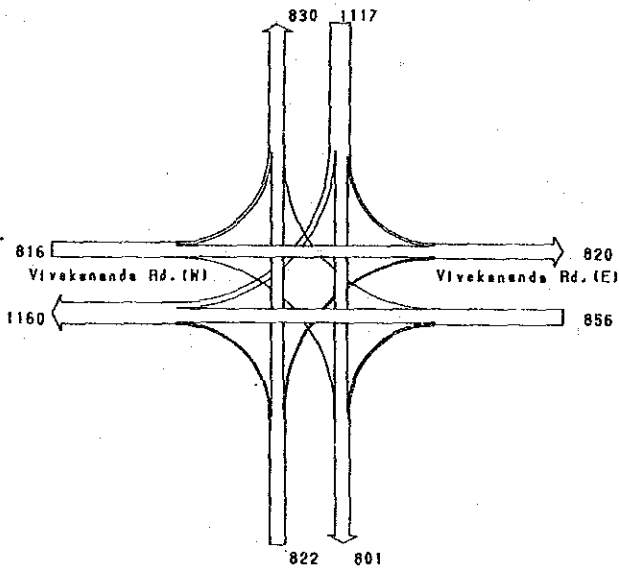
A.P.C. Roy Rd. (N)



A.P.C. Roy Rd. (S)

12 hours Volume (8:00-20:00 : PCU)  
LEGEND — 20000.

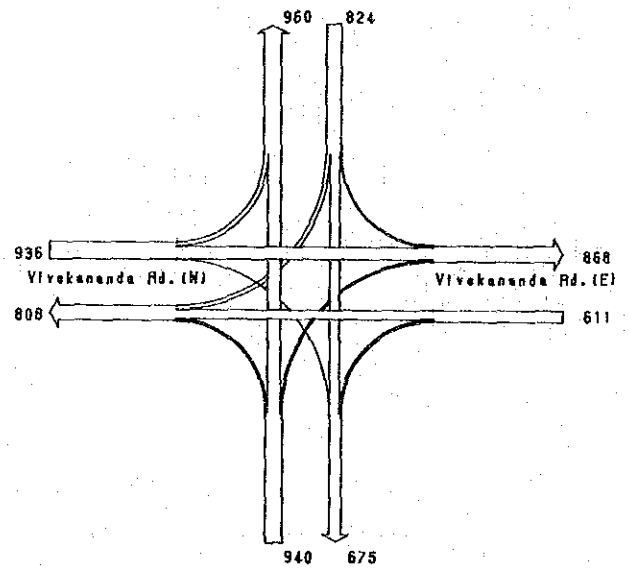
A.P.C. Roy Rd. (N)



A.P.C. Roy Rd. (S)

10:00-11:00 (PCU)  
LEGEND — 2000.

A.P.C. Roy Rd. (N)



A.P.C. Roy Rd. (S)

18:00-19:00 (PCU)  
LEGEND — 2000.

Figure T-1.2.3(7) Traffic Volume in Intersection (Loc.: 7)

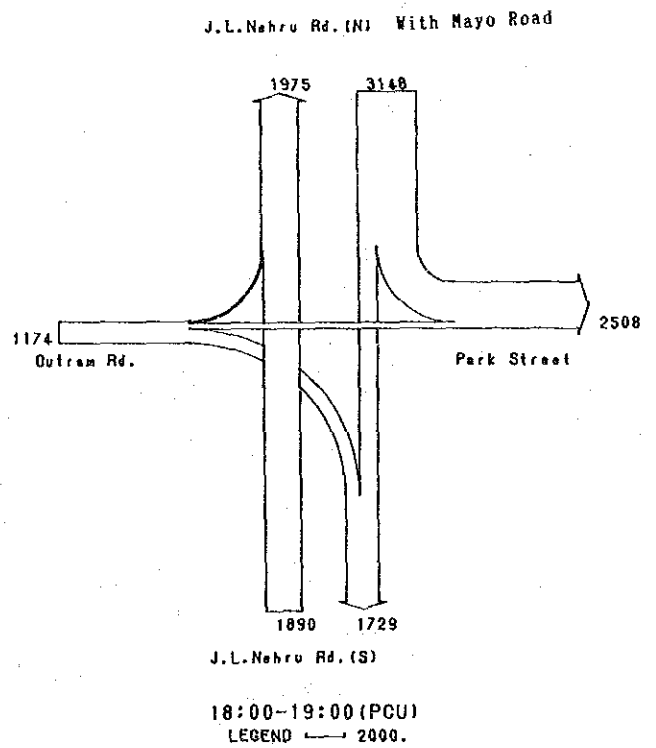
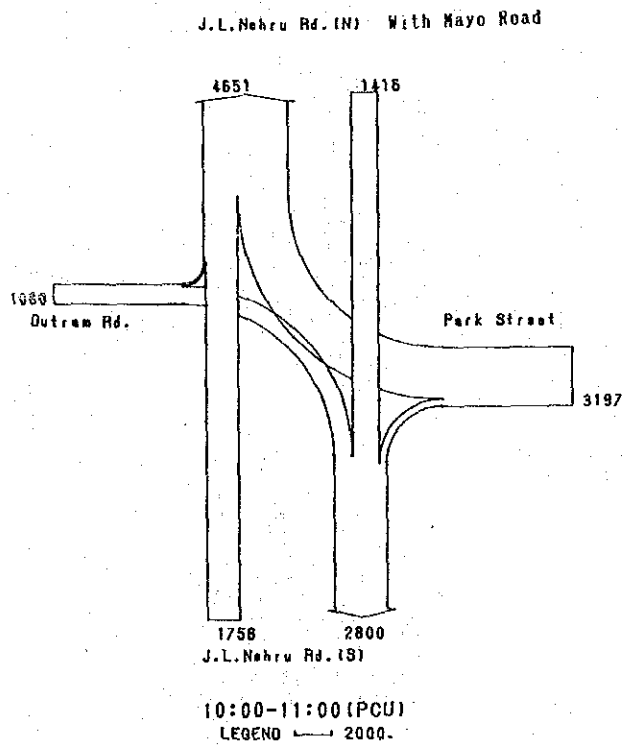
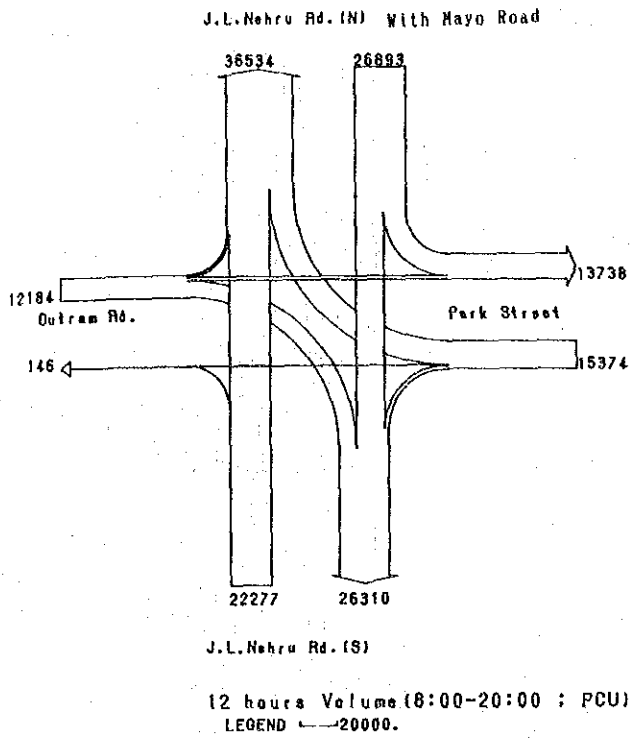


Figure T-1.2.3(8) Traffic Volume in Intersection (Loc.: 8)

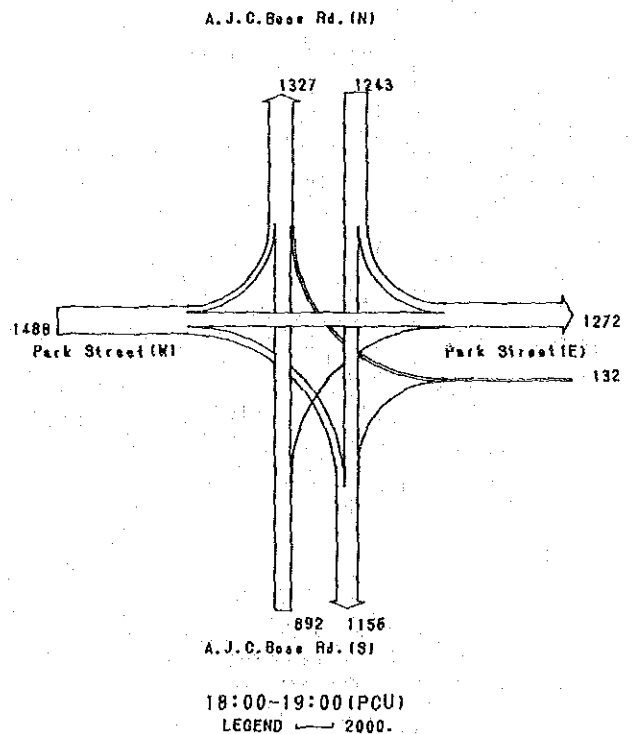
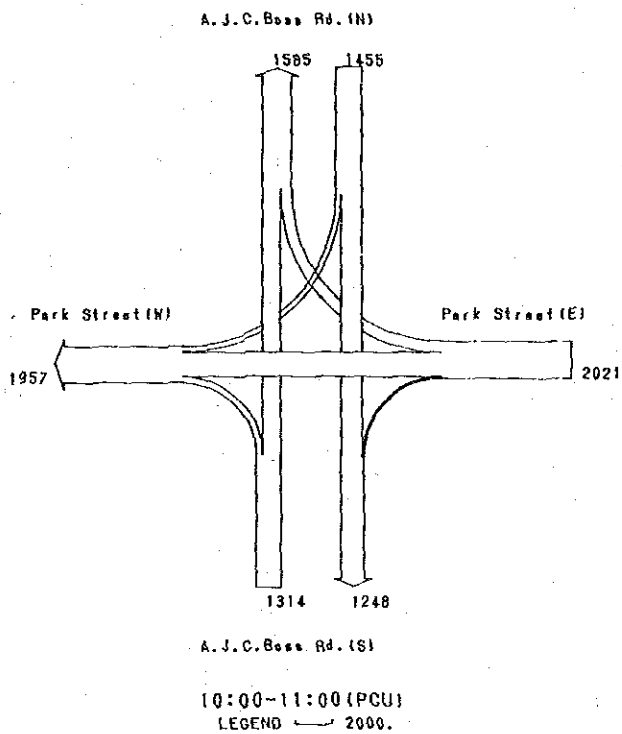
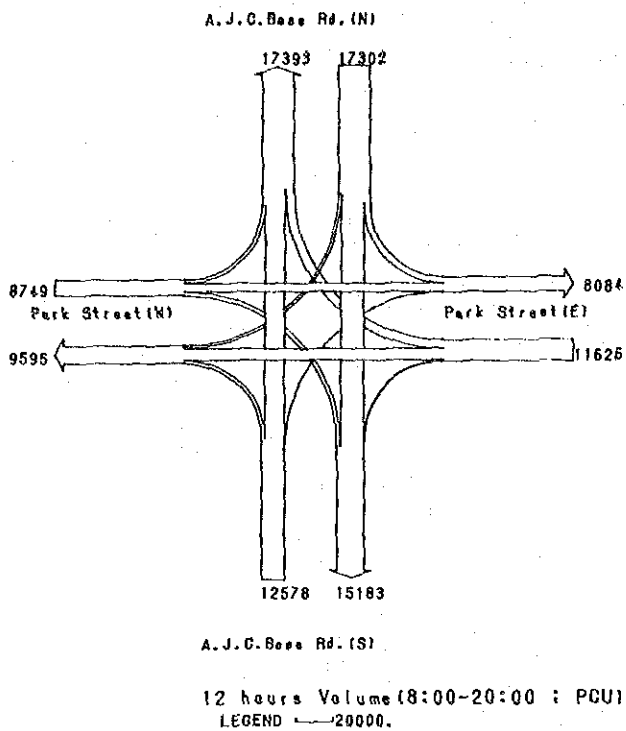
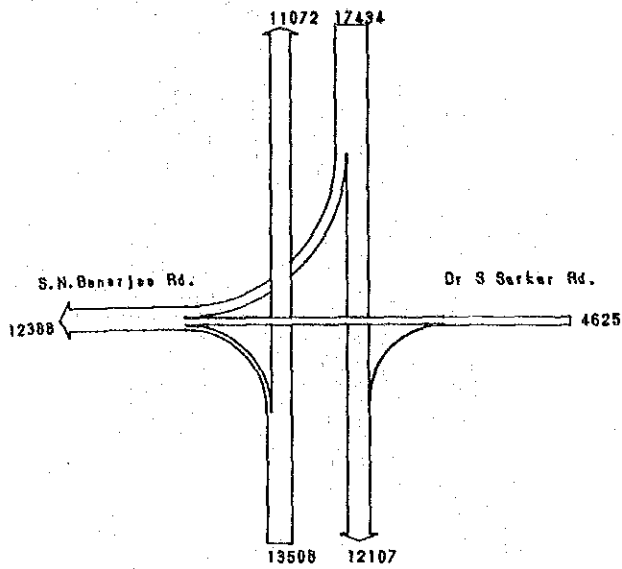


Figure T-1.2.3(10) Traffic Volume in Intersection (Loc.:10)



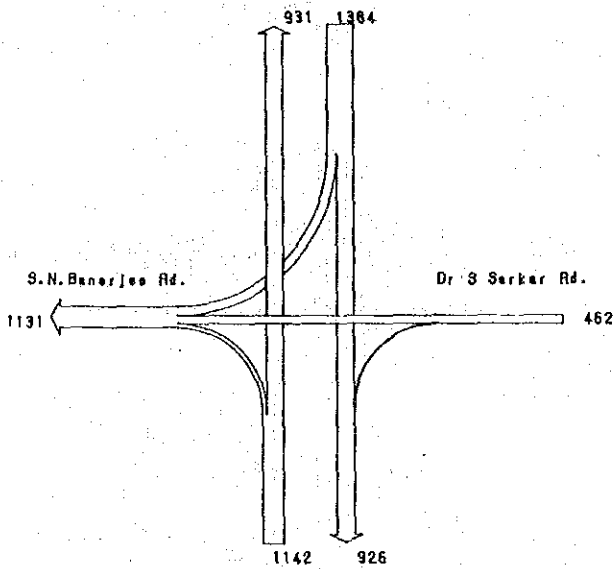
A. J. C. Bose Rd. (N)



A. J. C. Bose Rd. (S)

12 hours Volume (8:00-20:00 : PCU)  
LEGEND — 20000.

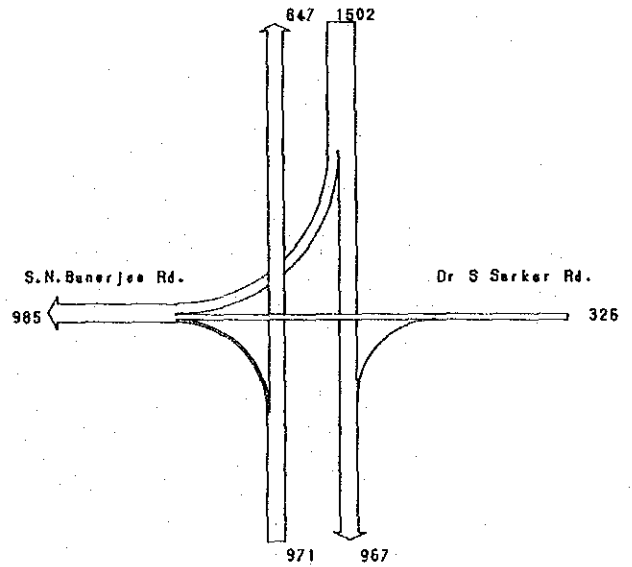
A. J. C. Bose Rd. (N)



A. J. C. Bose Rd. (S)

10:00-11:00 (PCU)  
LEGEND — 2000.

A. J. C. Bose Rd. (N)



A. J. C. Bose Rd. (S)

18:00-19:00 (PCU)  
LEGEND — 2000.

Figure T-1.2.3(11) Traffic Volume in Intersection (Loc.:11)

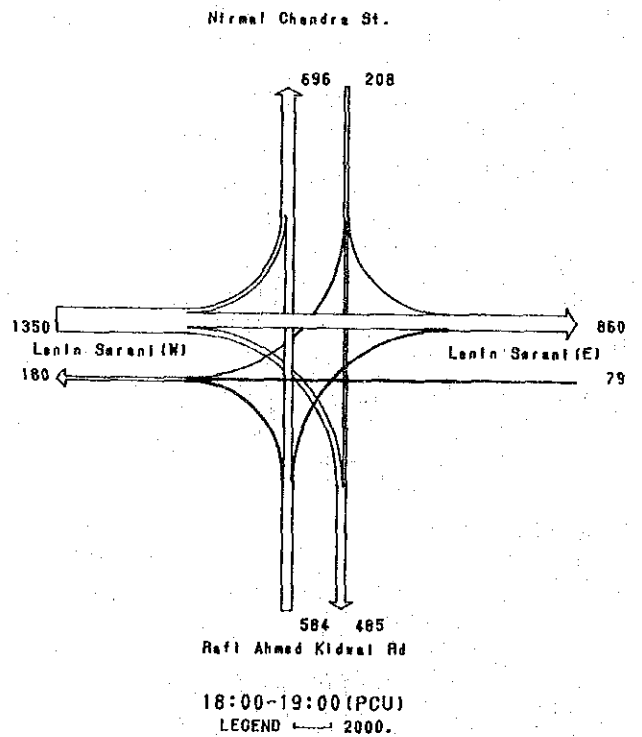
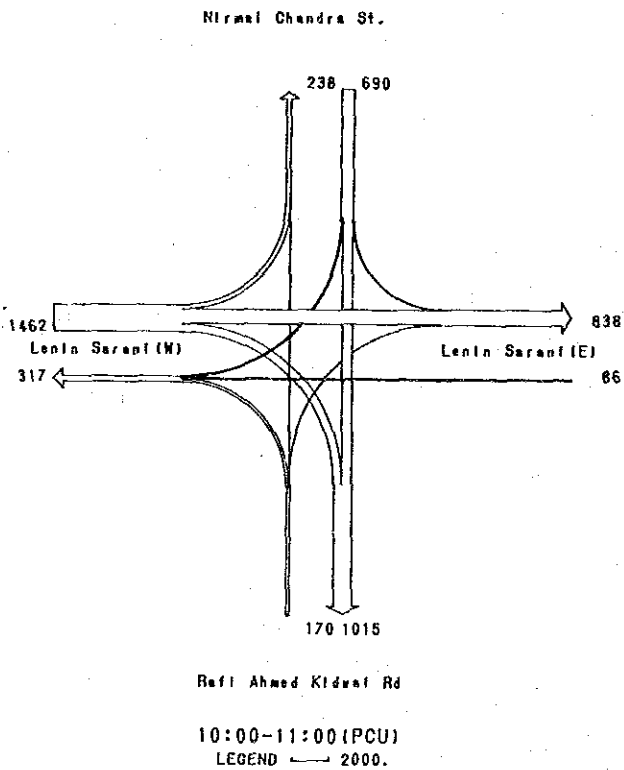
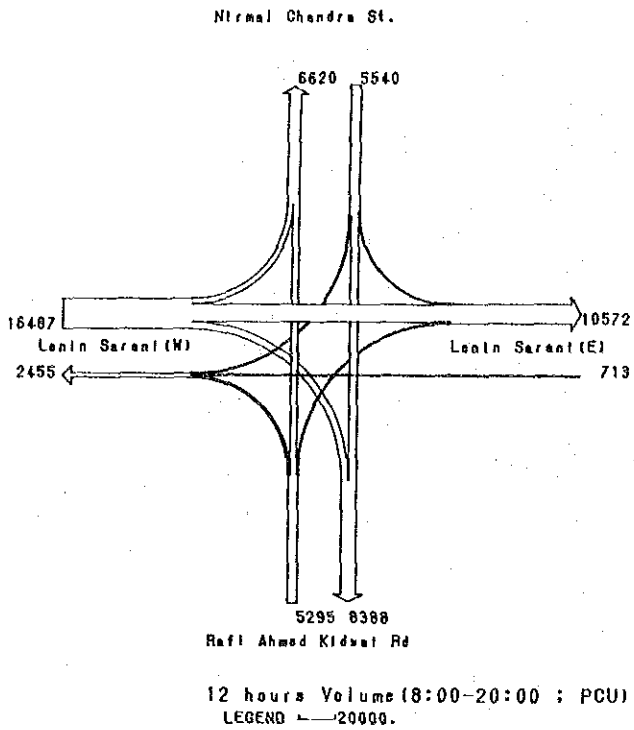


Figure T-1.2.3(12) Traffic Volume in Intersection (Loc.:12)

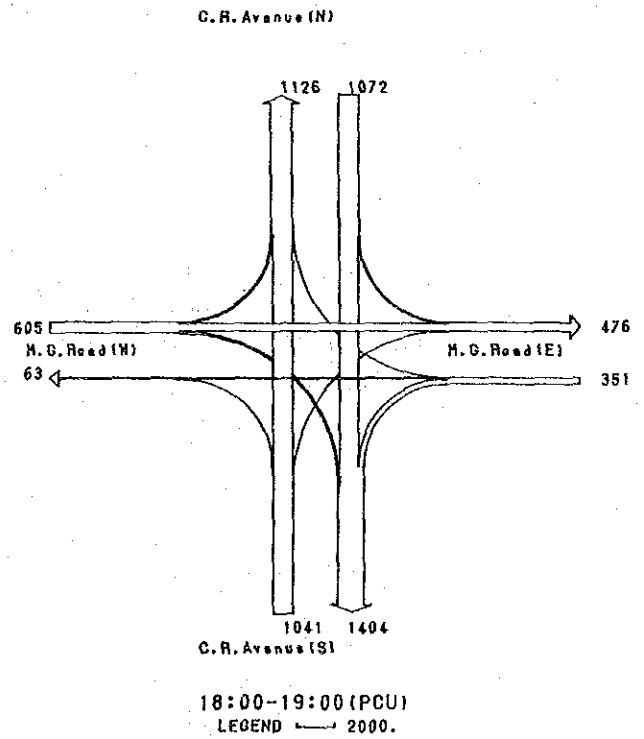
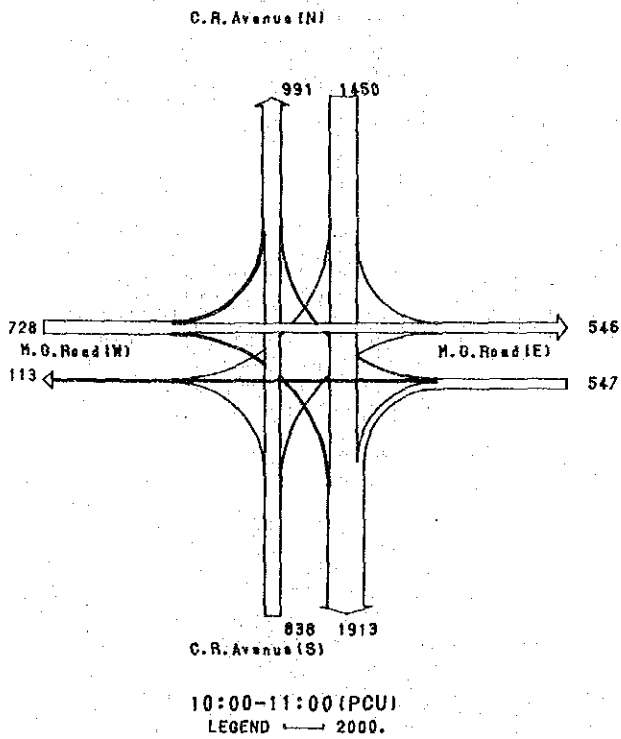
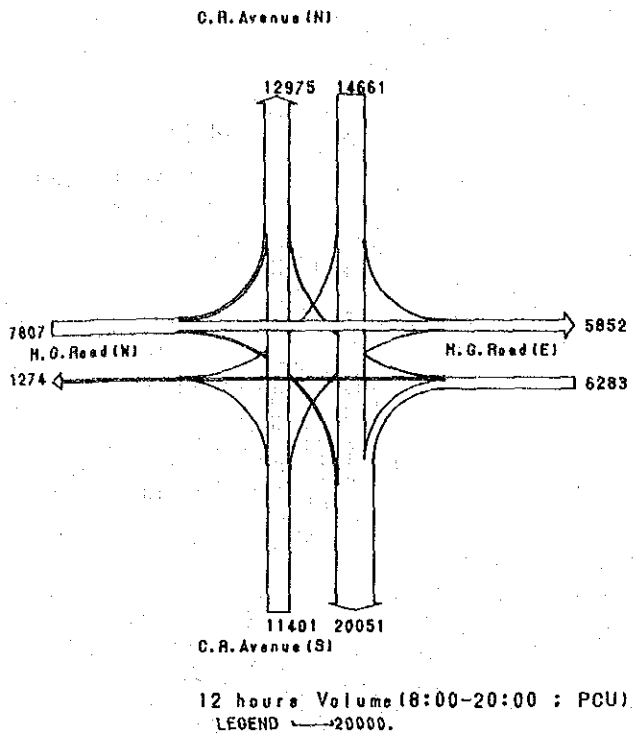
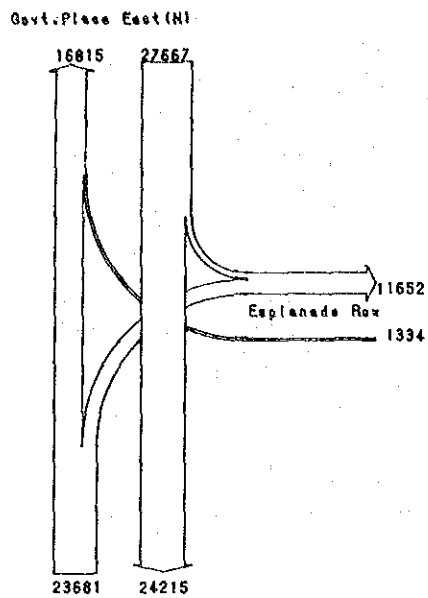
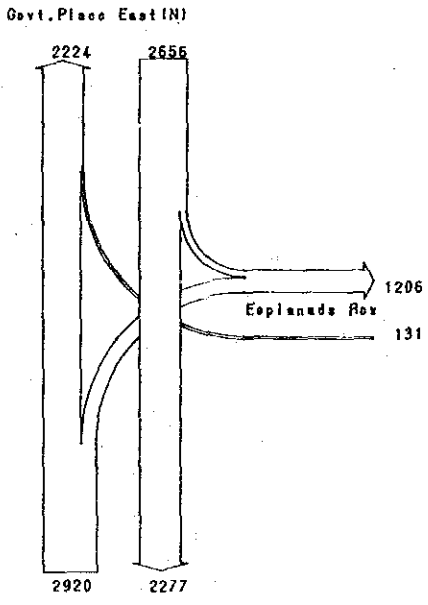


Figure T-1.2.3(13) Traffic Volume in Intersection (Loc.:13)



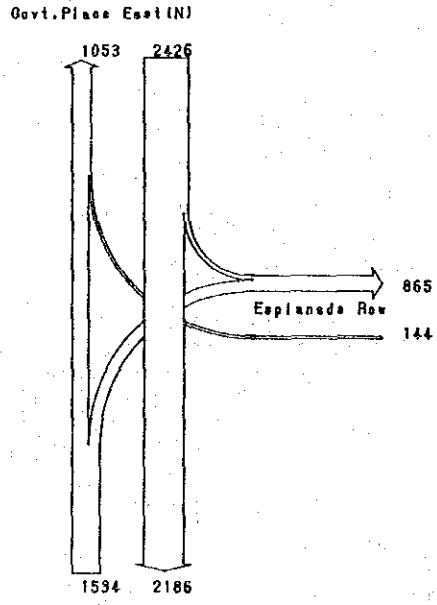
Govt. Place East (S)

12 hours Volume (8:00-20:00 : PCU)  
LEGEND ← 20000.



Govt. Place East (S)

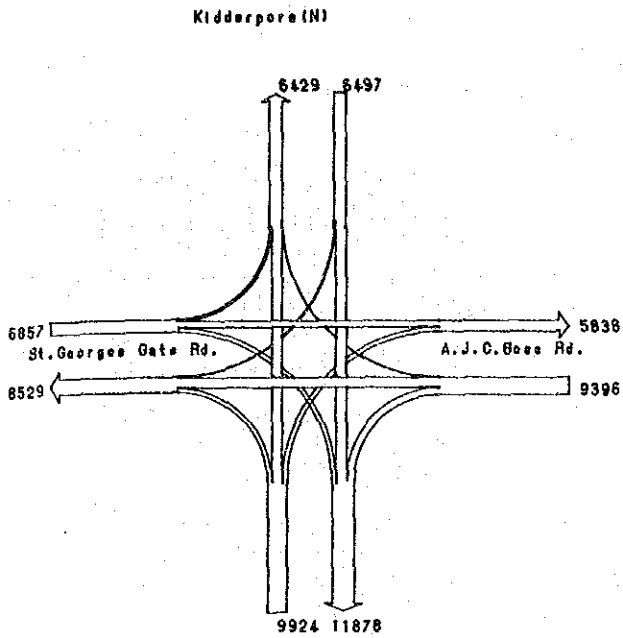
10:00-11:00 (PCU)  
LEGEND ← 2000.



Govt. Place East (S)

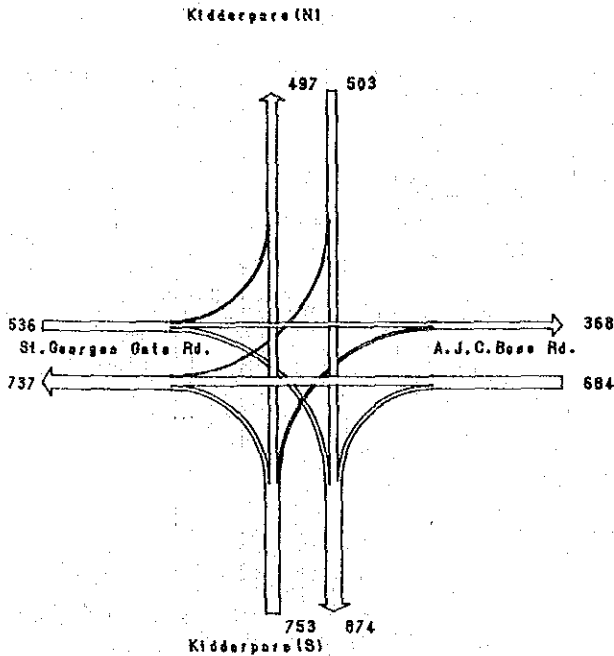
18:00-19:00 (PCU)  
LEGEND ← 2000.

Figure T-1.2.3(14) Traffic Volume in Intersection (Loc.:14)

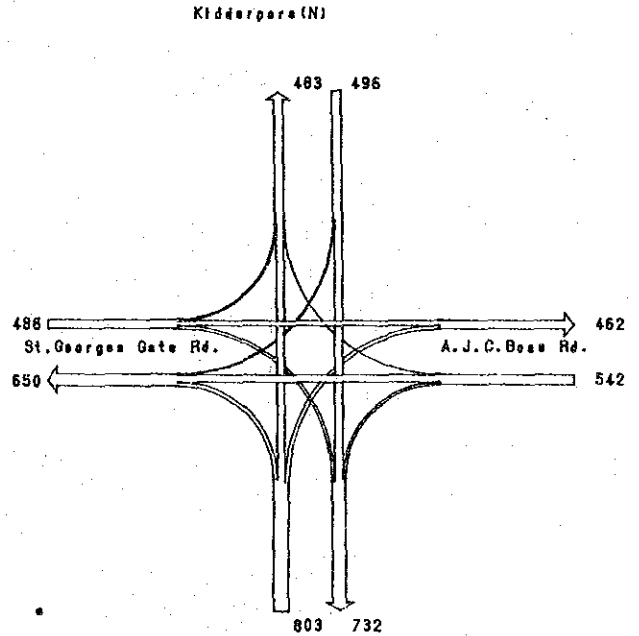


Kidderpore (S)

12 hours Volume (8:00-20:00 : PCU)  
LEGEND — 20000.



10:00-11:00 (PCU)  
LEGEND — 2000.



18:00-19:00 (PCU)  
LEGEND — 2000.

Figure T-1.2.3(15) Traffic Volume in Intersection (Loc.:15)

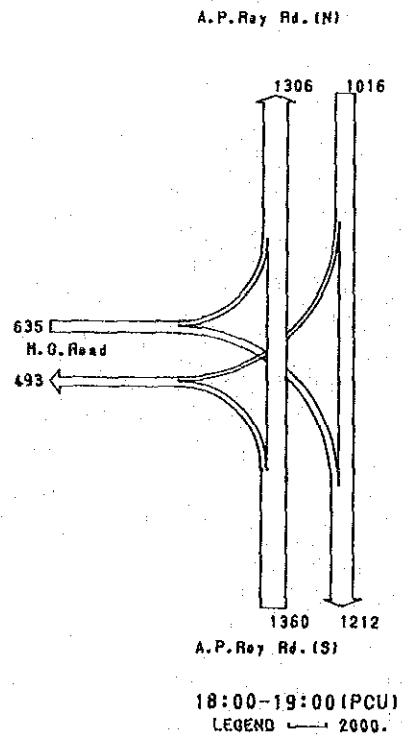
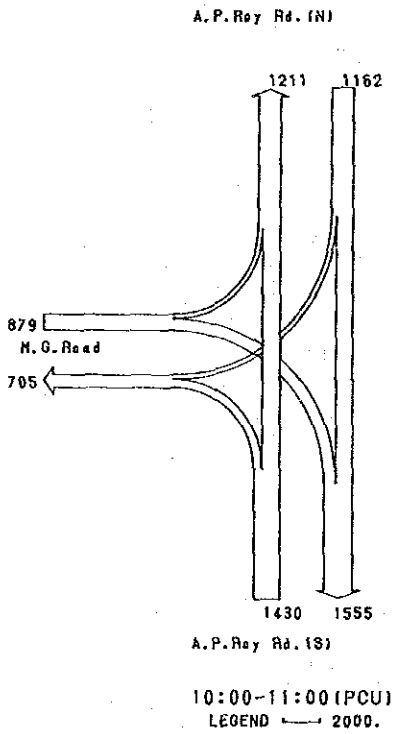
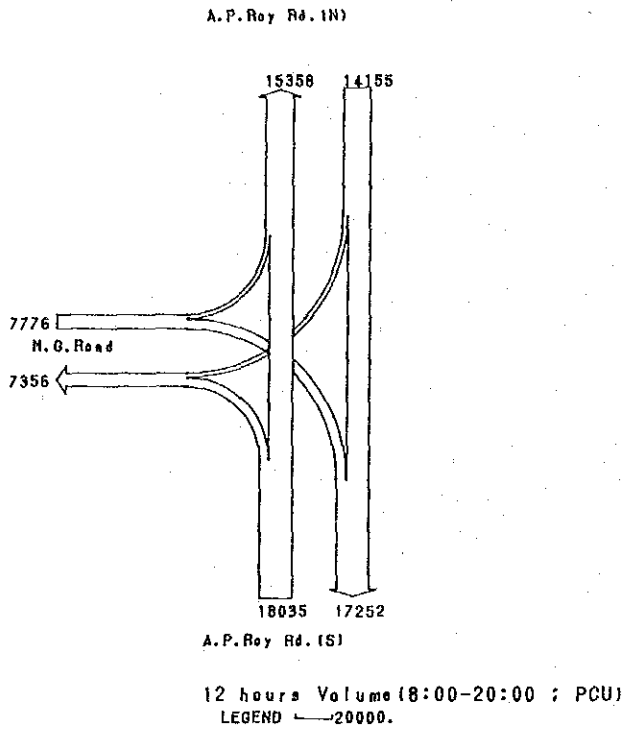


Figure T-1.2.3(16) Traffic Volume in Intersection (Loc.:16)

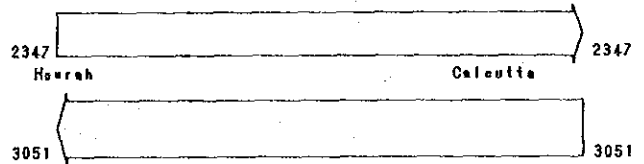
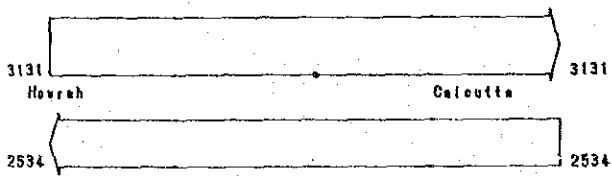
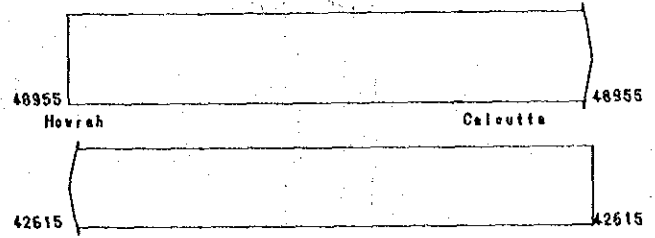
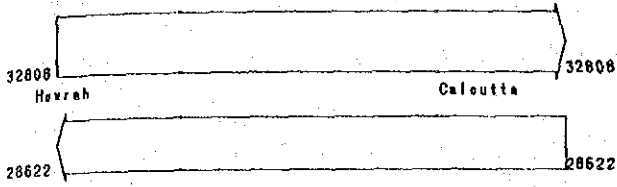
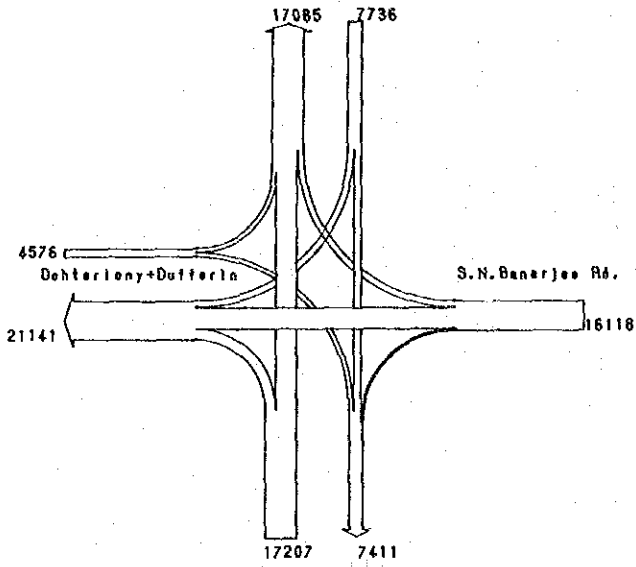


Figure T-1.2.3(17) Traffic Volume in Intersection (Loc.:17)

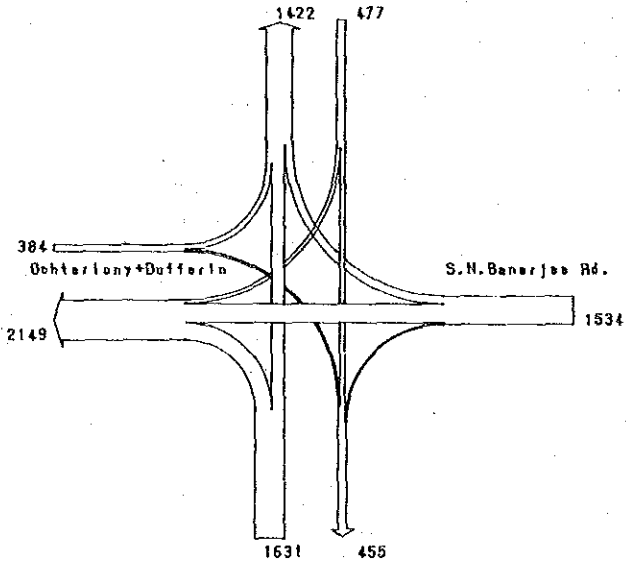
J.L.Nehru (N)



J.L.Nehru Rd. (S)

12 hours Volume (8:00-20:00 : PCU)  
LEGEND ←→ 20000.

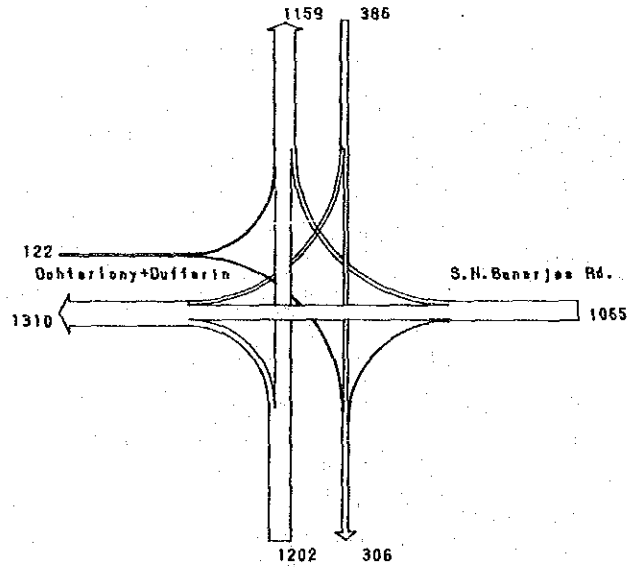
J.L.Nehru (N)



J.L.Nehru Rd. (S)

10:00-11:00 (PCU)  
LEGEND ←→ 2000.

J.L.Nehru (N)



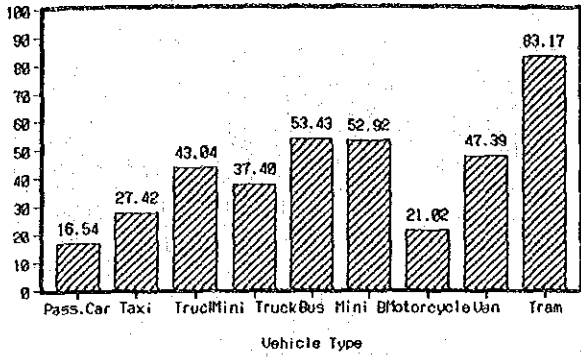
J.L.Nehru Rd. (S)

18:00-19:00 (PCU)  
LEGEND ←→ 2000.

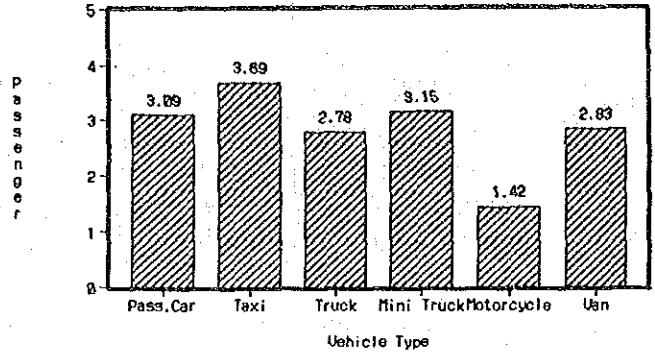
Figure T-1.2.3(18) Traffic Volume in Intersection (Loc.:18)



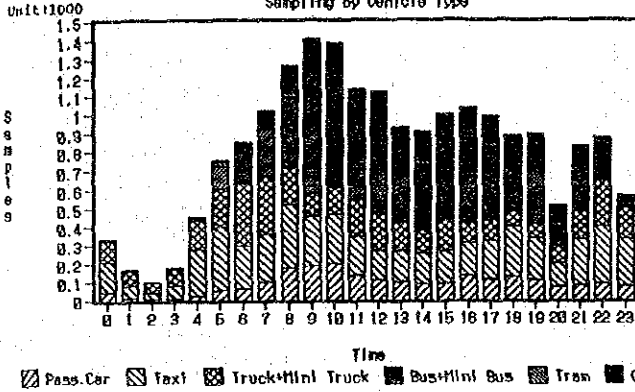
Origin-Destination Survey  
Sample Ratio



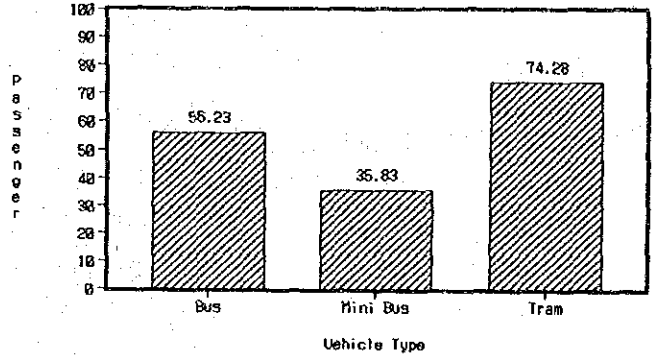
Origin-Destination Survey  
Average Passenger include Driver



Origin-Destination Survey  
Sampling by Vehicle Type

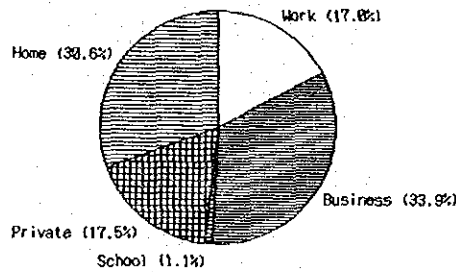


Origin-Destination Survey  
Average Passenger include Driver



Legend for Sampling by Vehicle Type:  
 Pass.Car (diagonal lines), Taxi (cross-hatch), Truck/Mini Truck (horizontal lines), Bus/Mini Bus (vertical lines), Tram (solid black), Other (white)

Origin-Destination Survey  
Purpose



Origin-Destination Survey  
Generation & Attraction

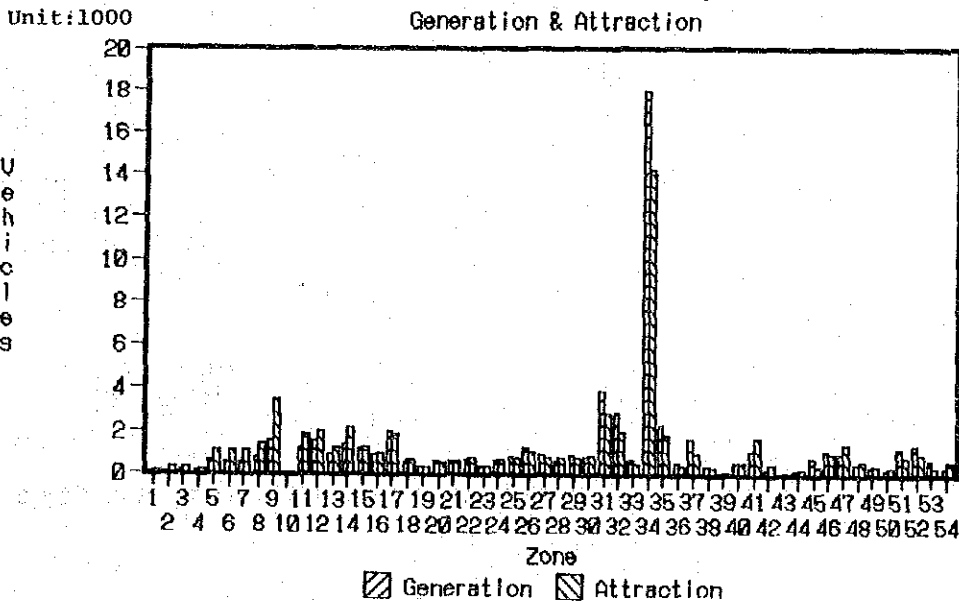
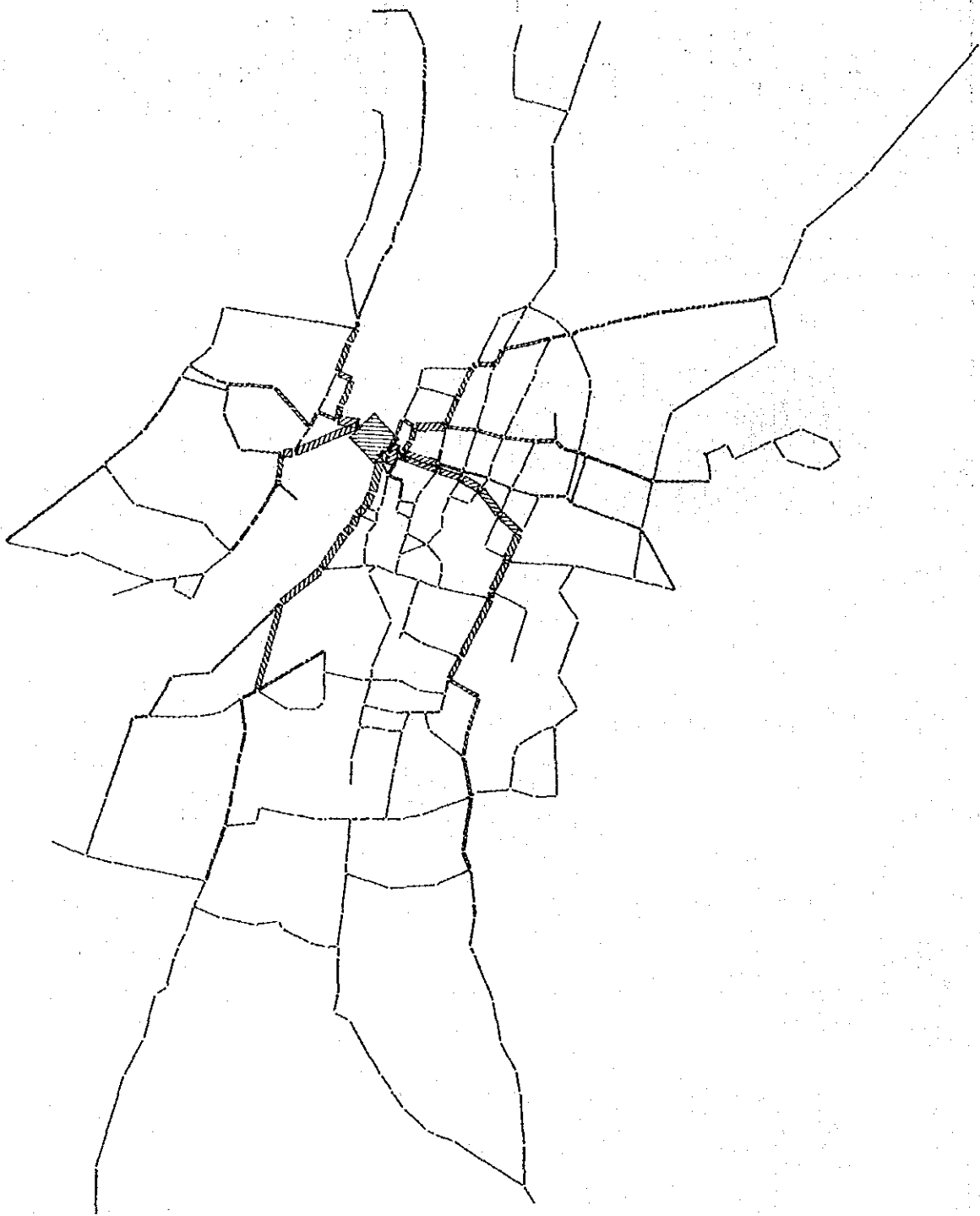


Figure T-1.3.1 O-D Survey Results



Assignment in 1991  
20000 PCU

Figure T-1.3.2 Assignment of Hooghly River Crossing Traffic in 1991

## 1.4 Travel Speed Survey

### 1.4.1 Result of Travel Speed Survey

Fig.T-1.4.1 shows the travel time by survey route and by section. The travel time and the average travel speed by route are summarized in Table T-1.4.1.

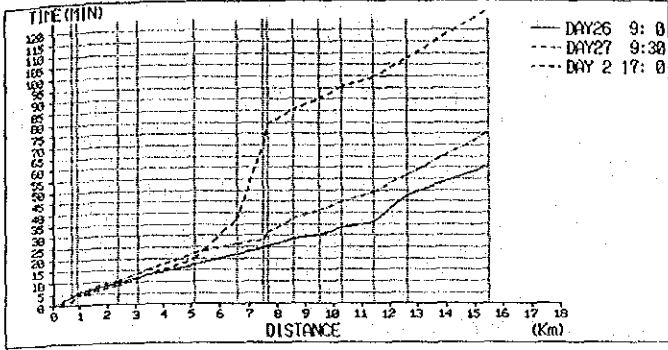
The average speed from the city center to Beliaghata Main Road (3.8 km) via Lenin Sarani (route No.5, refer to Fig.T-1.1.3) was 9.75 km/h, lower than that for corridor No.4 from Howrah Bridge to A.P.C.Roy Road via M.G.Road with average speed of 11.52 km/h. This may be attributed to the narrow road width of Lenin Sarani, the road side friction by commercial activities and Sealdah flyover on M.G. Road and A.P.C. Roy Road crossing.

The average speeds from south to north direction were always lower than the average speeds from north to south direction on corridors No.1, No.2 and No.3.

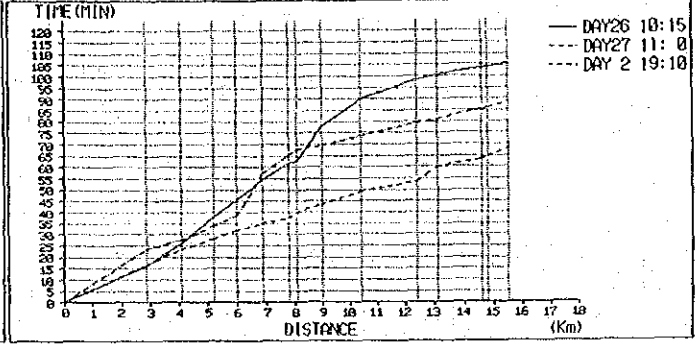
Table T-1.4.1 Travel Time by Route

Route	Direction	Distance (km)	Average Hour (min.'sec.)	Average Velocity (km/h)
1 Deshpran Sasmal Rd.				
-S.P.Mukherjee Rd.	1 South	15.5	88'30"	10.51
-A.T.Mukherjee Rd.	-North			
-J.L.Nehru Rd.				
-C.R.Avenue				
-J.M.Avenue	2 North	15.5	87'15"	10.66
-Bhupen Bose Rd.	-South			
-R.G.Kar Rd.				
-Raja Manindra Rd.				
2 Diamond Harbour Rd.				
-A.J.C.Bose Rd.	1 South	17.0	86'26"	11.80
	-North			
-A.P.C.Roy Rd.	2 North	17.4	75'04"	13.91
-Bidhan Sarani	-South			
-B.T.Rd.				
3 Gariahat Rd.				
	1 North	6.5	25'24"	15.35
-Syed Amir Ali	-South			
-Park Street	2 South	6.5	34'25"	11.33
	-North			
4 Howrah Bridge				
-M.G.Rd.	1 West	3.9	20'19"	11.52
	-East			
(Part of one way)				
5 Lenin Sarani				
	1 West	3.8	23'23"	9.75
-Convent Lane	-East			
(Part of one way)				
6 Najrul Islam Ave.				
	1 East	5.7	22'31"	15.19
-Manicktala Main Rd.	-West			
-Vivekananda Rd.	2 West	5.7	21'43"	15.75
	-East			
7 Circus Avenue				
	1 West	0.5	2'07"	14.20
	-East			
	2 East	0.5	2'03"	14.69
	-West			

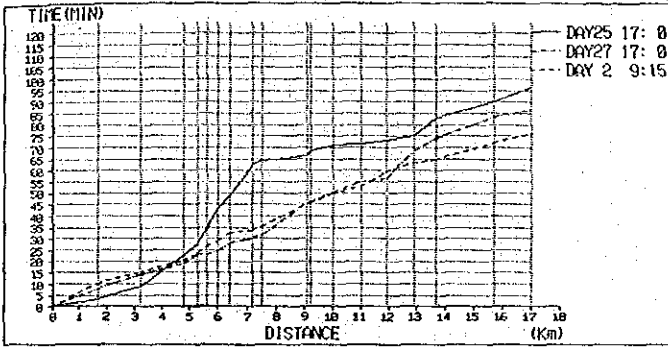
CORRIDOR NO. 1 DIRECTION- 1  
TRAVEL-SPEED  
WEEKDAY



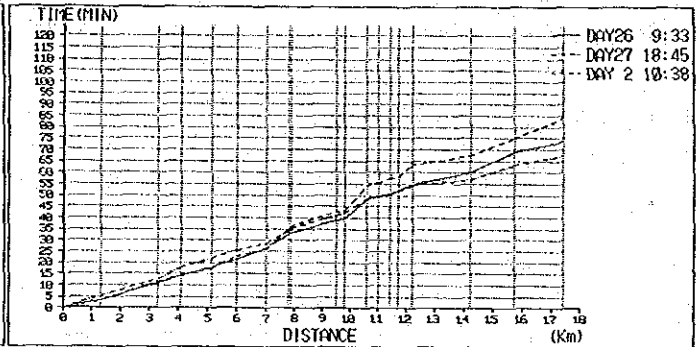
CORRIDOR NO. 1 DIRECTION- 2  
TRAVEL-SPEED  
WEEKDAY



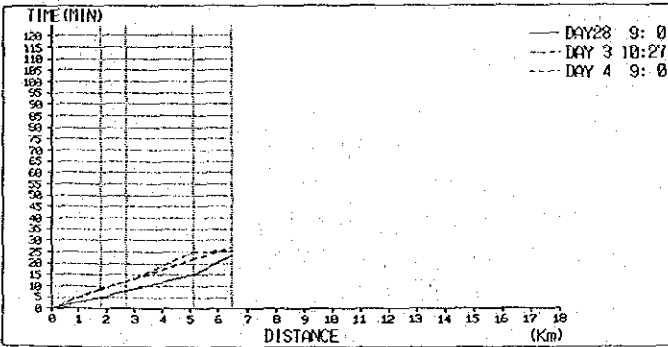
CORRIDOR NO. 2 DIRECTION- 1  
TRAVEL-SPEED  
WEEKDAY



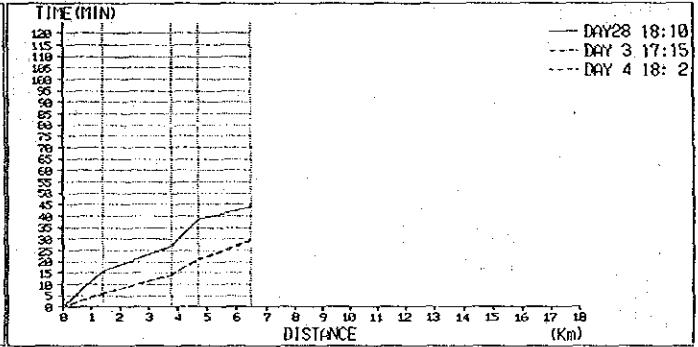
CORRIDOR NO. 2 DIRECTION- 2  
TRAVEL-SPEED  
WEEKDAY



CORRIDOR NO. 3 DIRECTION- 1  
TRAVEL-SPEED  
WEEKDAY



CORRIDOR NO. 3 DIRECTION- 2  
TRAVEL-SPEED  
WEEKDAY



CORRIDOR NO. 4 DIRECTION- 1  
TRAVEL-SPEED  
WEEKDAY

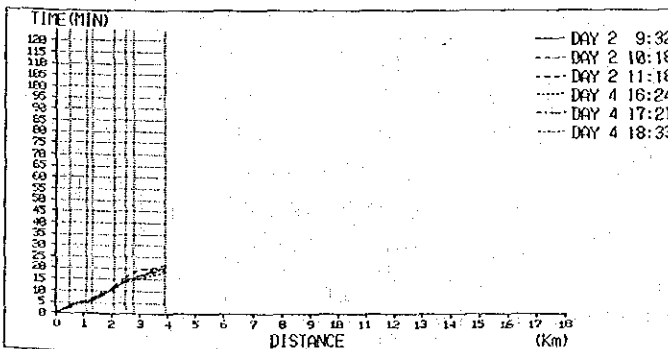
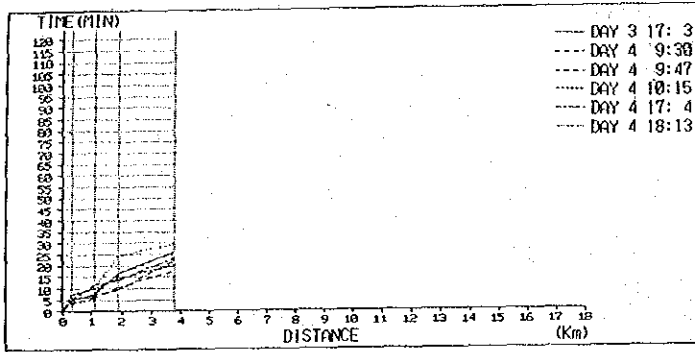
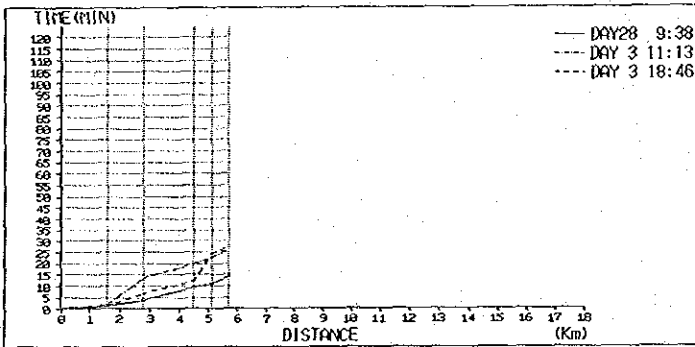


Figure T-1.4.1(1) Travel Time

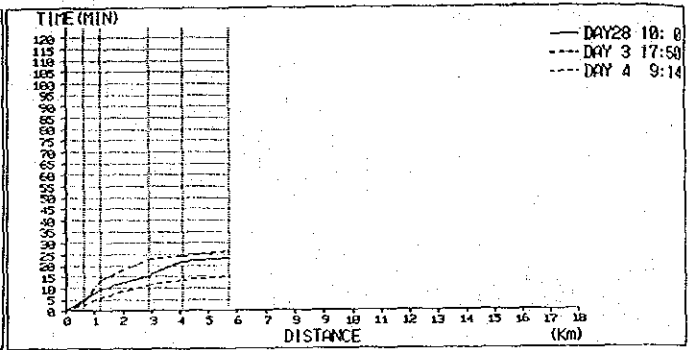
CORRIDOR NO. 5 DIRECTION- 1  
TRAVEL-SPEED  
WEEKDAY



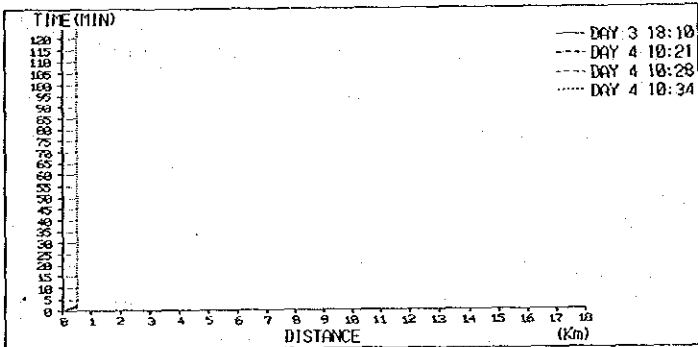
CORRIDOR NO. 6 DIRECTION- 1  
TRAVEL-SPEED  
WEEKDAY



CORRIDOR NO. 6 DIRECTION- 2  
TRAVEL-SPEED  
WEEKDAY



CORRIDOR NO. 7 DIRECTION- 1  
TRAVEL-SPEED  
WEEKDAY



CORRIDOR NO. 7 DIRECTION- 2  
TRAVEL-SPEED  
WEEKDAY

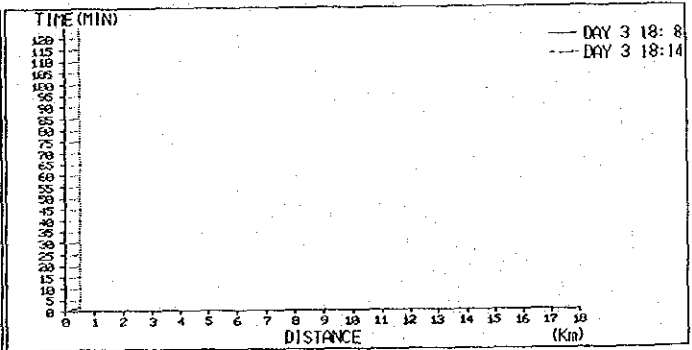


Figure T-1.4.1(2) Travel Time

## 1.5 Parking Survey

### 1.5.1 Result of Parking Survey

#### (1) Parking Interview Survey

Fig. T-1.5.1 shows the parking interview results by each road. However samples for Koila Ghat Street and B.B.D. Bag East were not obtained on Sunday.

Most of the Surveyed vehicles were Passenger cars, and walking distances were almost less than 2 minutes on a weekday. Parking duration for the majority was more than 4 hours on weekday for commuting to work, however parking durations were almost less than 20 minutes on Sunday by private purpose.

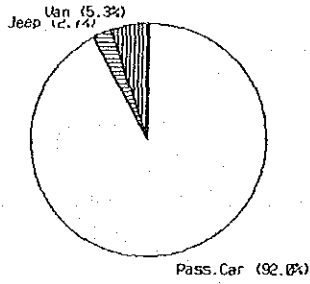
#### (2) Parking Licence Plate Survey

Fig. T-1.5.2 shows the cumulative passenger car parking volume of vehicles entering the parking place and those leaving the parking place by each road on weekday and Sunday. The Sunday parking volume was less than 300 passenger cars by each road section. The average parking durations are shown in Table T-1.5.1

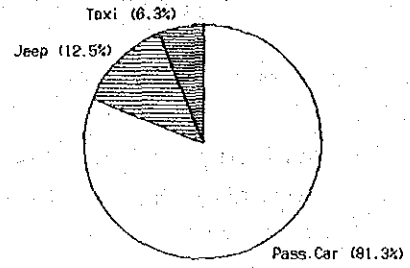
Table T-1.5.1 Average Parking Duration (Passenger Car)

Road Name	Weekday (min.)	Sunday (min.)
Esplanade Row	80	55
Red Cross Place	136	38
Koila Ghat Street	78	38
B.B.D. Bag North	95	57
India Exchange Place	72	44
Rabindra Sarani	52	38
B.B.D. Bag East	161	54
N.S. Road	107	63
Waterloo Street	94	93
British India Street	126	157
R.N.Mukherjee Road	93	43
Church Lane	108	154
Lyons Range	175	64

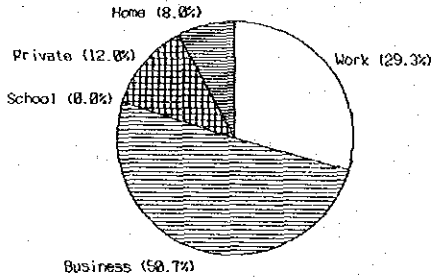
Parking Interview(Weekday)  
Vehicle Type(Esplanade Row East)



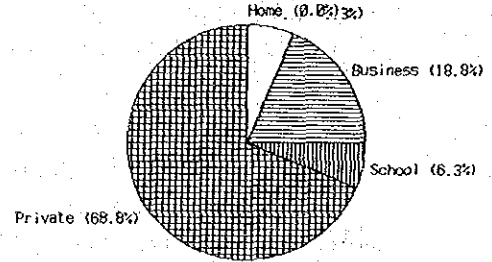
Parking Interview(Sunday)  
Vehicle Type(Esplanade Row East)



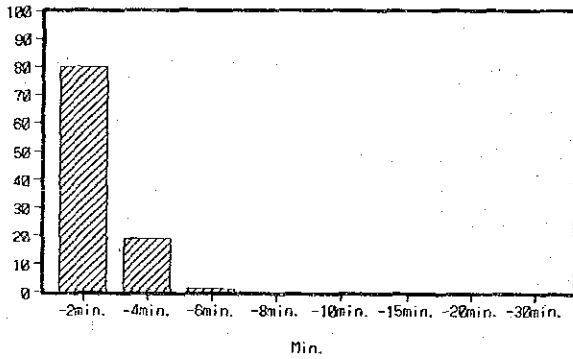
Parking Interview(Weekday)  
Purpose(Esplanade Row East)



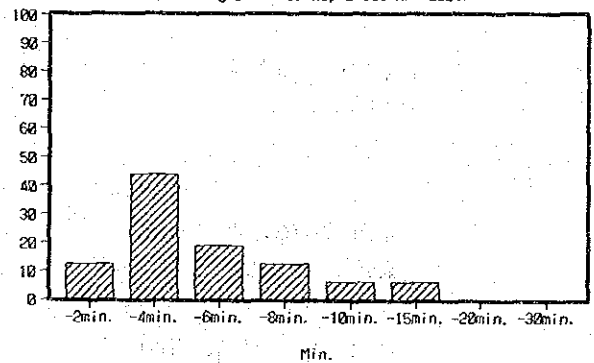
Parking Interview(Sunday)  
Purpose(Esplanade Row East)



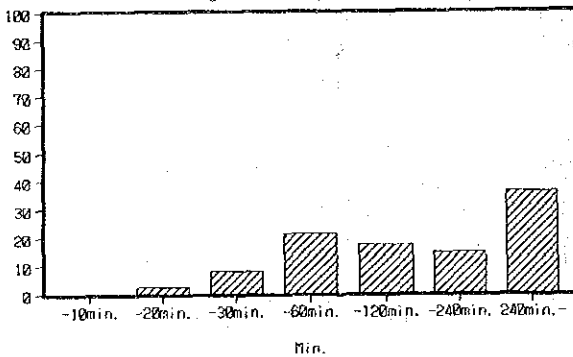
Parking Interview(Weekday)  
Walking Distance(Esplanade Row East)



Parking Interview(Sunday)  
Walking Distance(Esplanade Row East)



Parking Interview(Weekday)  
Parking Duration(Esplanade Row East)



Parking Interview(Sunday)  
Parking Duration(Esplanade Row East)

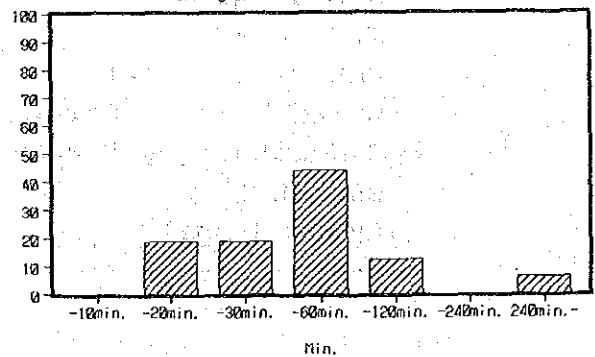
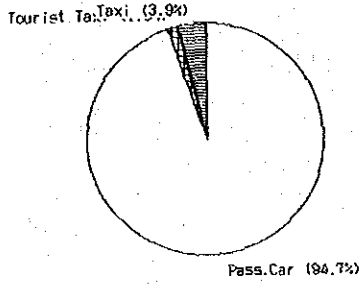


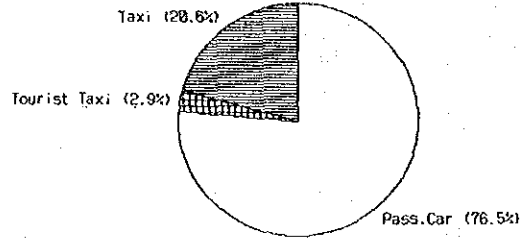
Figure T-1.5.1(1) Parking Interview Results (Esplanade Row East)



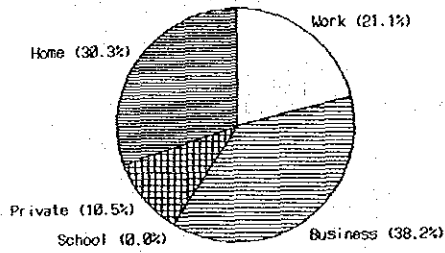
Parking Interview(Weekday)  
Vehicle Type(Red Cross Place)



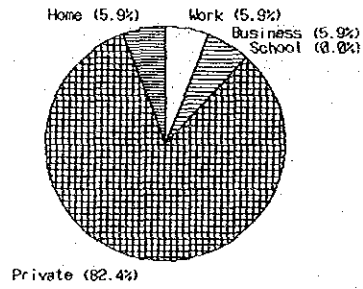
Parking Interview(Sunday)  
Vehicle Type(Red Cross Place)



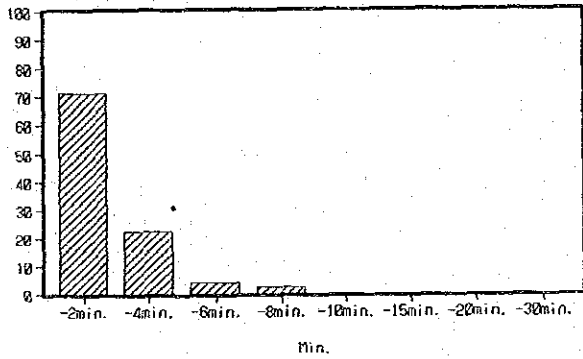
Parking Interview(Weekday)  
Purpose(Red Cross Road)



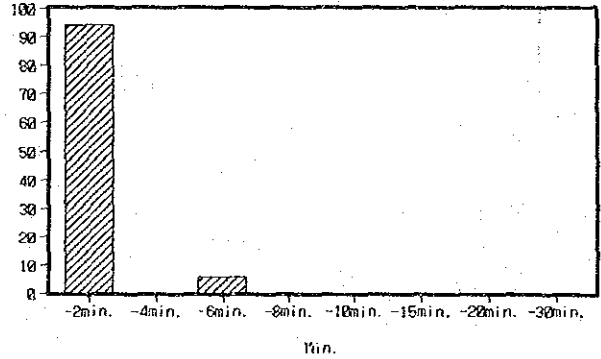
Parking Interview(Sunday)  
Purpose(Red Cross Place)



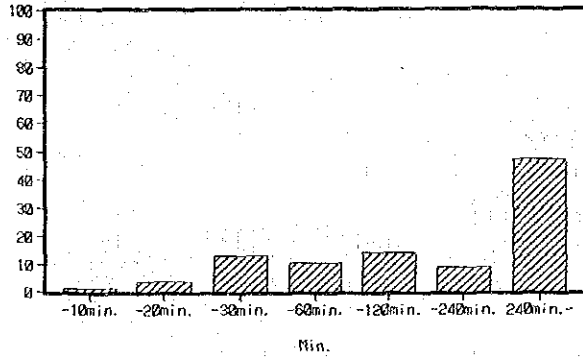
Parking Interview(Weekday)  
Walking Distance(Red Cross Place)



Parking Interview(Sunday)  
Walking Distance(Red Cross Road)



Parking Interview(Weekday)  
Parking Duration(Red Cross Place)



Parking Interview(Sunday)  
Parking Duration(Red Cross Road)

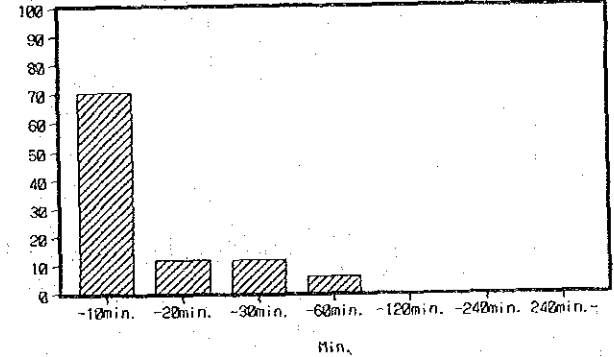
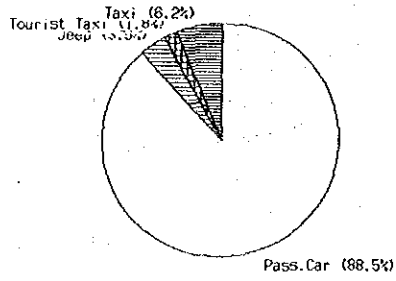
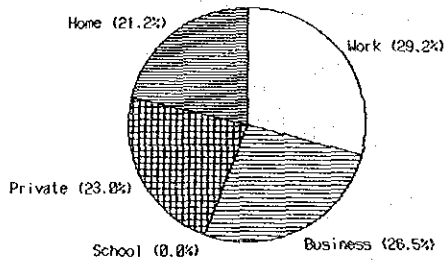


Figure T-1.5.1(2) Parking Interview Results  
(Red Cross Place)

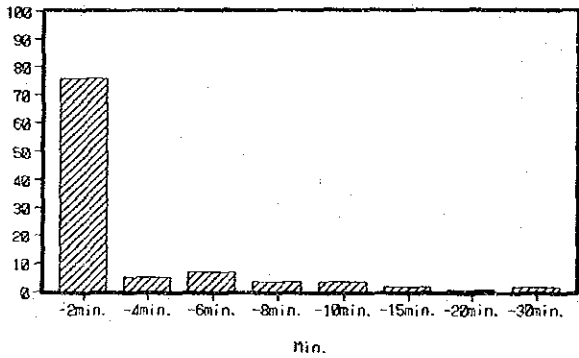
Parking Interview(Weekday)  
Vehicle Type(Koila Ghat Street)



Parking Interview(Weekday)  
Purpose(Koila Ghat Street)



Parking Interview(Weekday)  
Walking Distance(Koila Ghat Street)



Parking Interview(Weekday)  
Parking Duration(Koila Ghat Street)

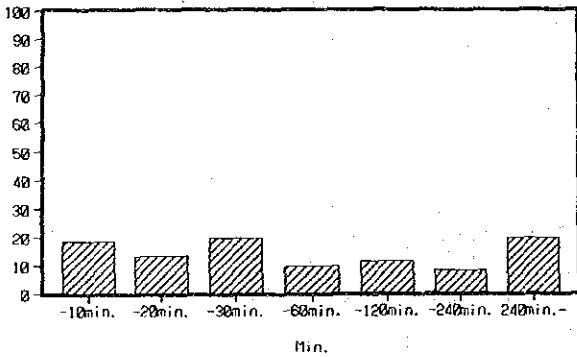
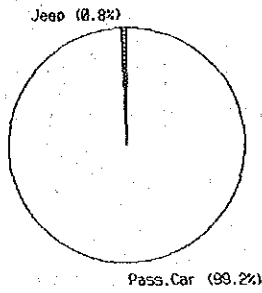
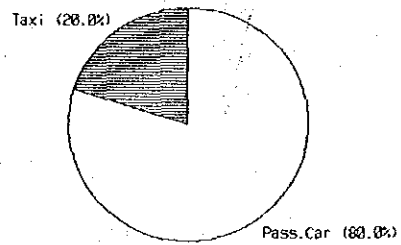


Figure T-1.5.1(3) Parking Interview Results (Koila Ghat Street)

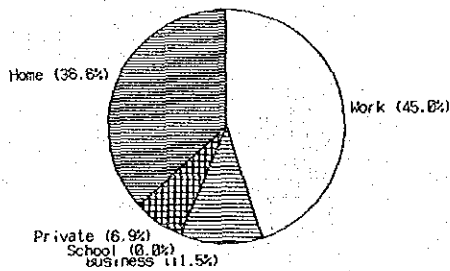
Parking Interview(Weekday)  
Vehicle Type(B.B.D.Bag North)



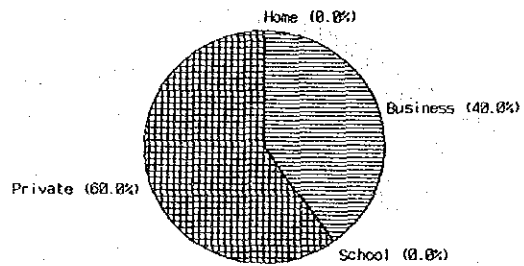
Parking Interview(Sunday)  
Vehicle Type(B.B.D.Bag North)



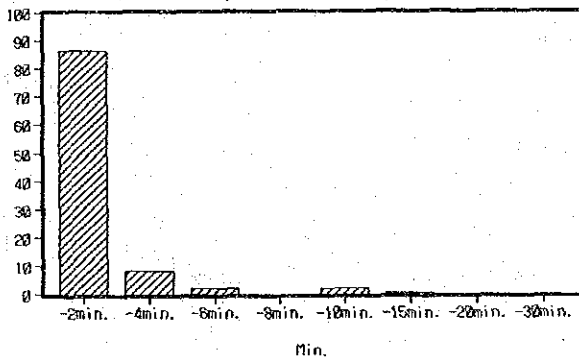
Parking Interview(Weekday)  
Purpose(B.B.D.Bag North)



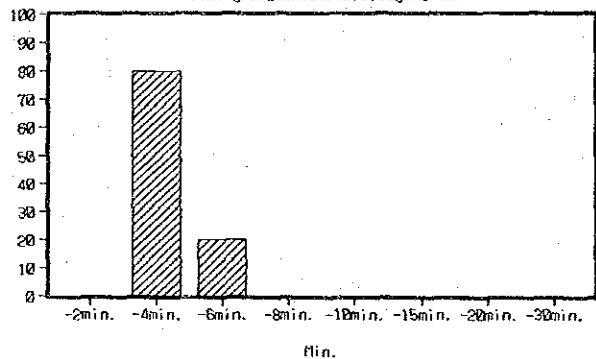
Parking Interview(Sunday)  
Purpose(B.B.D.Bag North)



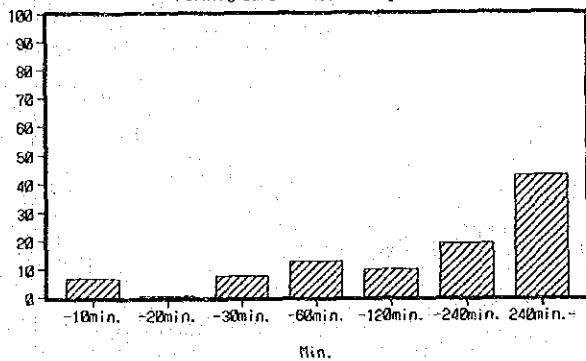
Parking Interview(Weekday)  
Walking Distance(B.B.D.Bag North)



Parking Interview(Sunday)  
Walking Distance(B.B.D.Bag North)



Parking Interview(Weekday)  
Parking Duration(B.B.D.Bag North)



Parking Interview(Sunday)  
Parking Duration(B.B.D.Bag North)

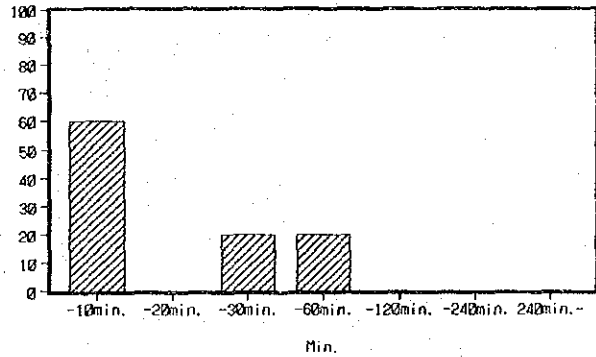
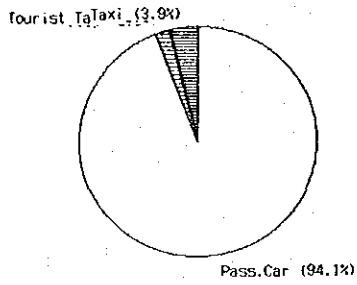
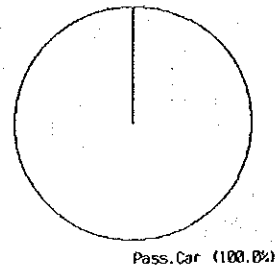


Figure T-1.5.1(4) Parking Interview Results (B.B.D. Bag North)

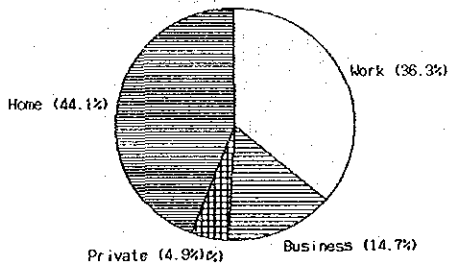
Parking Interview(Weekday)  
Vehicle Type(India Exchange Place)



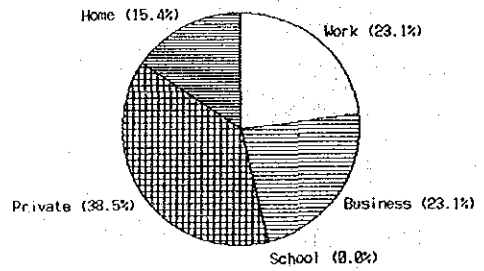
Parking Interview(Sunday)  
Vehicle Type(India Exchange Place)



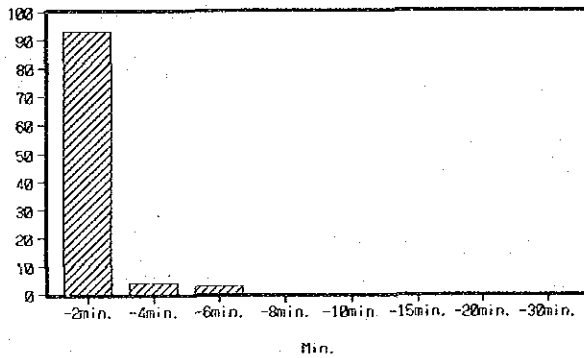
Parking Interview(Weekday)  
Purpose(India Exchange Place)



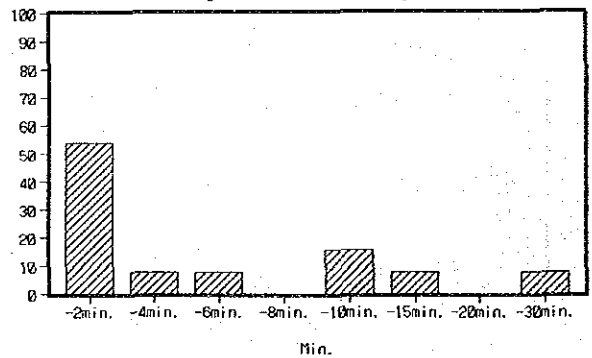
Parking Interview(Sunday)  
Purpose(India Exchange Place)



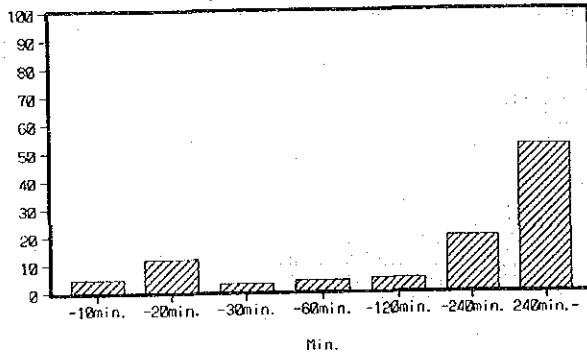
Parking Interview(Weekday)  
Walking Distance(India Exchange Place)



Parking Interview(Sunday)  
Walking Distance(India Exchange Place)



Parking Interview(Weekday)  
Parking Duration(India Exchange Place)



Parking Interview(Sunday)  
Parking Duration(India Exchange Place)

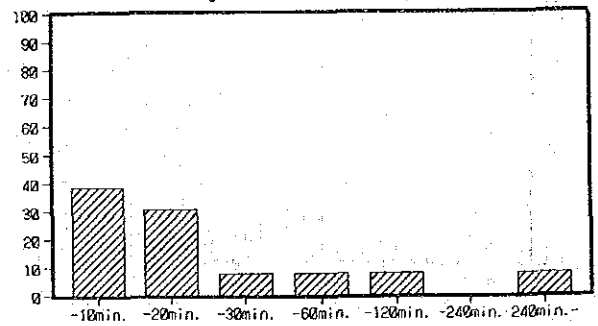
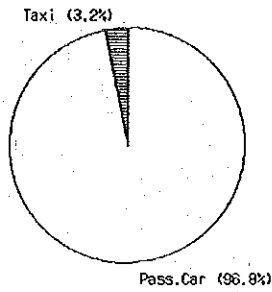
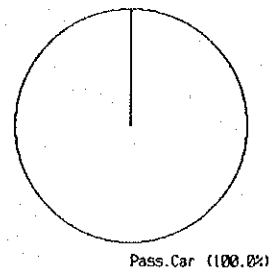


Figure T-1.5.1(5) Parking Interview Results (India Exchange Place)

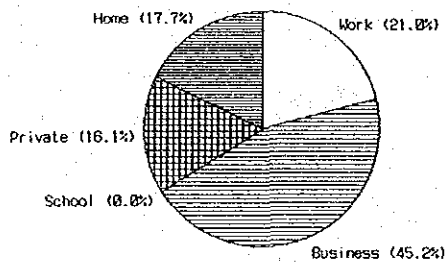
Parking Interview(Weekday)  
Vehicle Type(Rabindra Sarani)



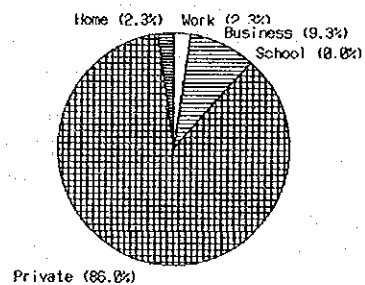
Parking Interview(Sunday)  
Vehicle Type(Rabindra Sarani)



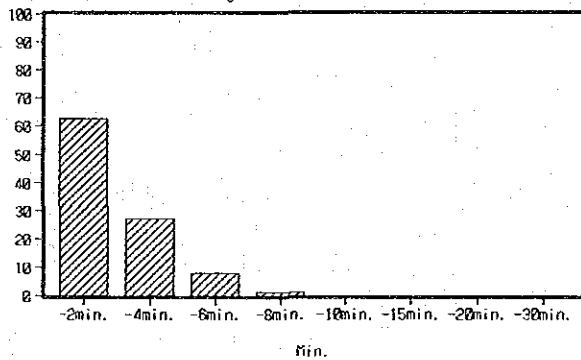
Parking Interview(Weekday)  
Purpose(Rabindra Sarani)



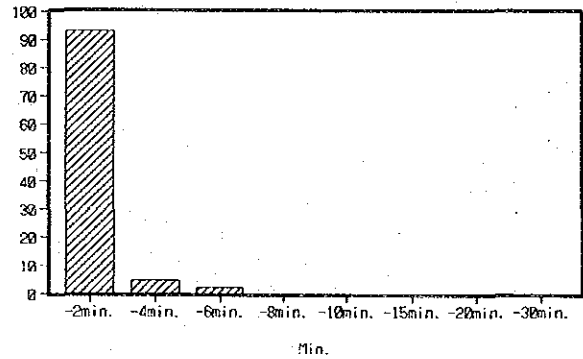
Parking Interview(Sunday)  
Purpose(Rabindra Sarani)



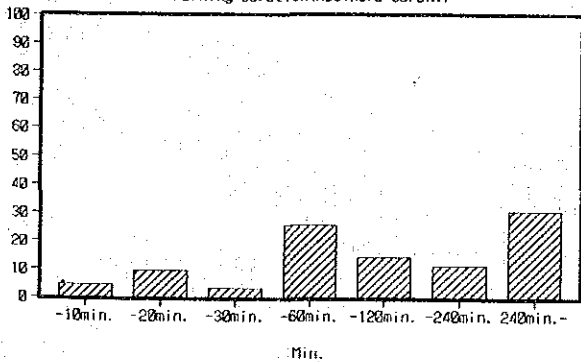
Parking Interview(Weekday)  
Walking Distance(Rabindra Sarani)



Parking Interview(Sunday)  
Walking Distance(Rabindra Sarani)



Parking Interview(Weekday)  
Parking Duration(Rabindra Sarani)



Parking Interview(Sunday)  
Parking Duration(Rabindra Sarani)

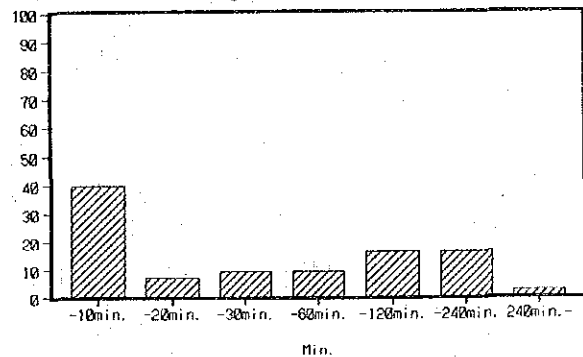
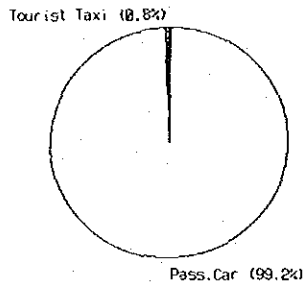
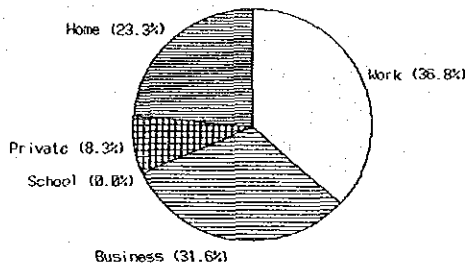


Figure T-1.5.1(6) Parking Interview Results (Rabindra Sarani)

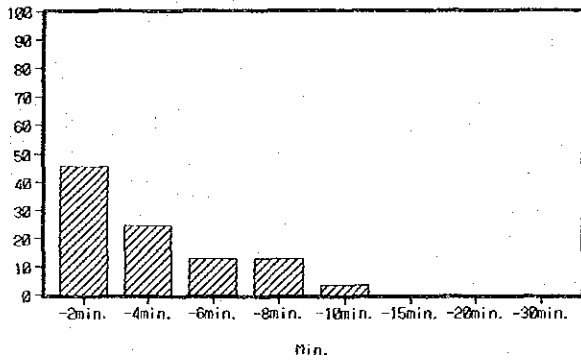
Parking Interview(Weekday)  
 Vehicle Type(B.B.D.Bag East)



Parking Interview(Weekday)  
 Purpose(B.B.D.Bag East)



Parking Interview(Weekday)  
 Walking Distance(B.B.D.Bag East)



Parking Interview(Weekday)  
 Parking Duration(B.B.D.Bag East)

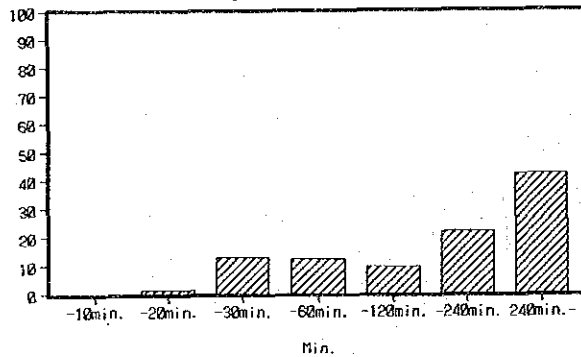
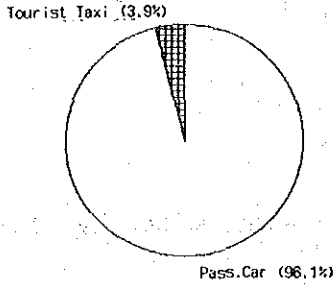
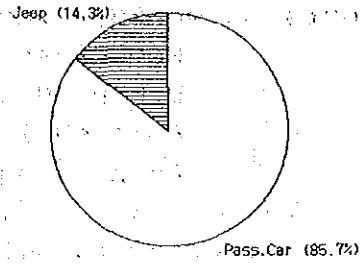


Figure T-1.5.1(7) Parking Interview Results (B.B.D. Bag East)

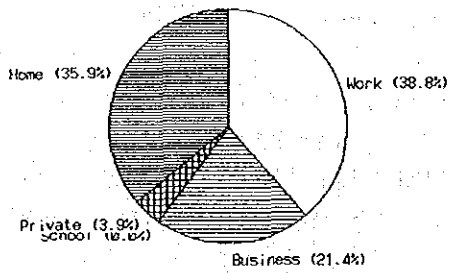
Parking Interview(Weekday)  
Vehicle Type(N.S.Road)



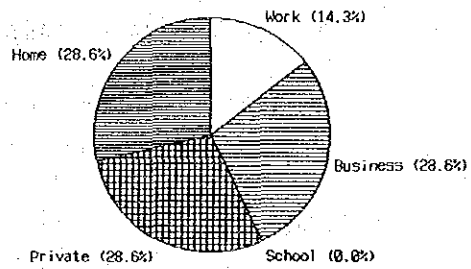
Parking Interview(Sunday)  
Vehicle Type(N.S.Road)



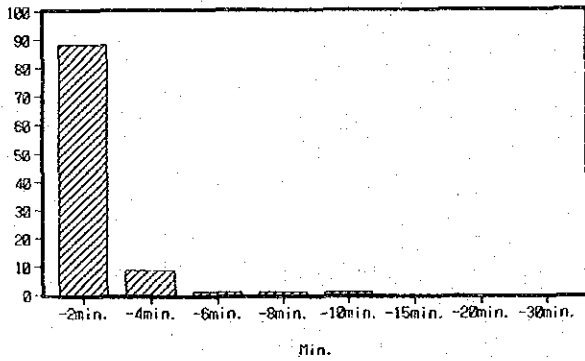
Parking Interview(Weekday)  
Purpose(N.S.Road)



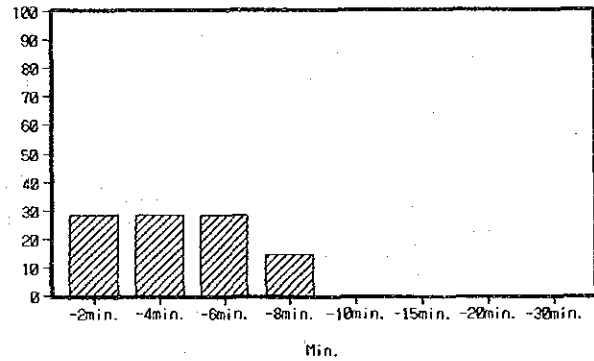
Parking Interview(Sunday)  
Purpose(N.S.Road)



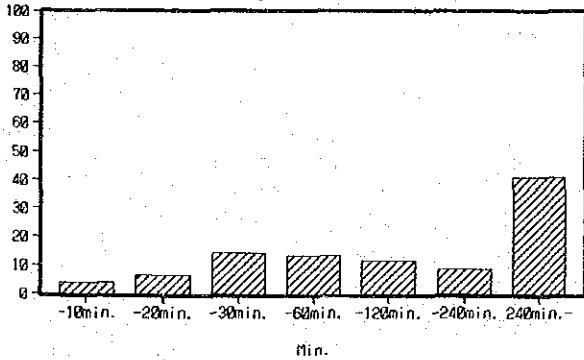
Parking Interview(Weekday)  
Walking Distance(N.S.Road)



Parking Interview(Sunday)  
Walking Distance(N.S.Road)



Parking Interview(Weekday)  
Parking Duration(N.S.Road)



Parking Interview(Sunday)  
Parking Duration(N.S.Road)

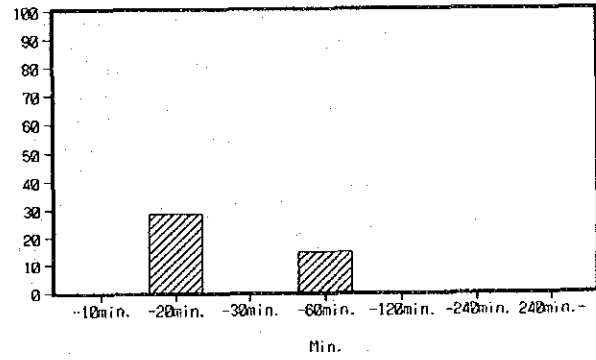


Figure T-1.5.1(8) Parking Interview Results (N.S. Road)

The streets where average parking duration was longer than 2 hours on weekday were;

- Red Cross Place
- B.B.D. Bag East
- British India Street
- Lyons Range

Vehicles parked on these streets mostly for commuting purpose.

The Streets where average parking duration was longer than 2 hours on Sunday were;

- British India Street
- Church Lane

Trips by vehicles parked on these streets were mostly for private (shopping, etc.) purpose.

(3) Parking Capacity Survey (Parking Volume Count)

Fig. T-1.5.4 shows the 12 hours parking volume by sector in the "PARKING STUDY CENTRAL AREA, CALCUTTA JULY 1975" prepared by "CALCUTTA METROPOLITAN PLANNING ORGANISATION". The sector parking volume of passenger car was always higher than the other vehicle types, and parking volume at sector 10 which was higher than other sectors was approximately 14,000 passenger cars for 12 hours.



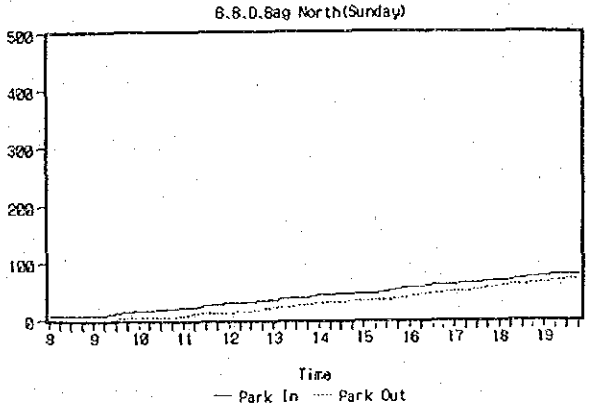
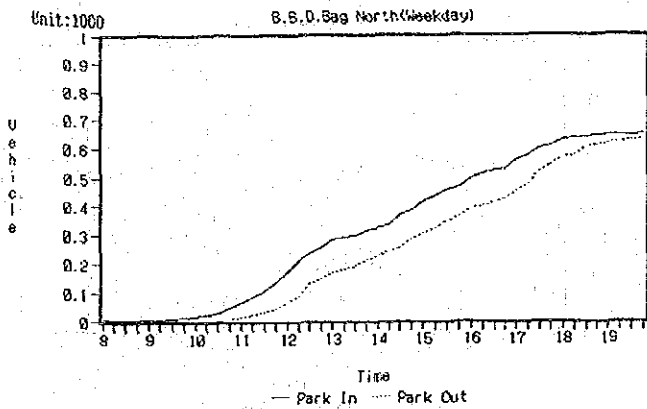
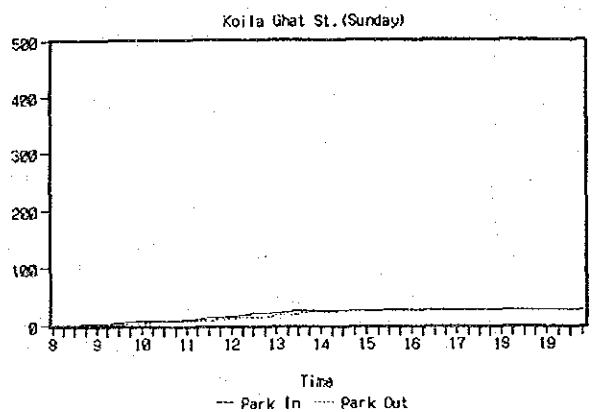
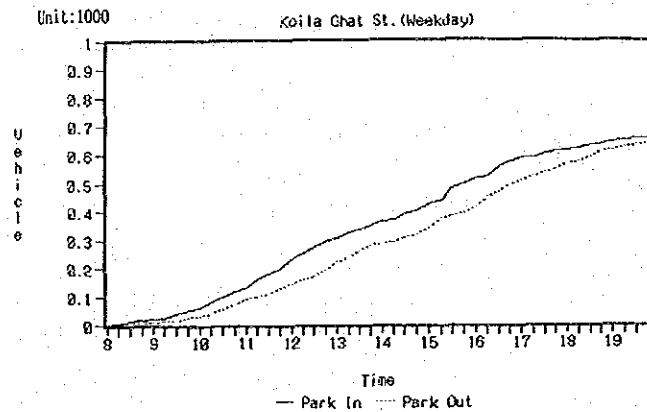
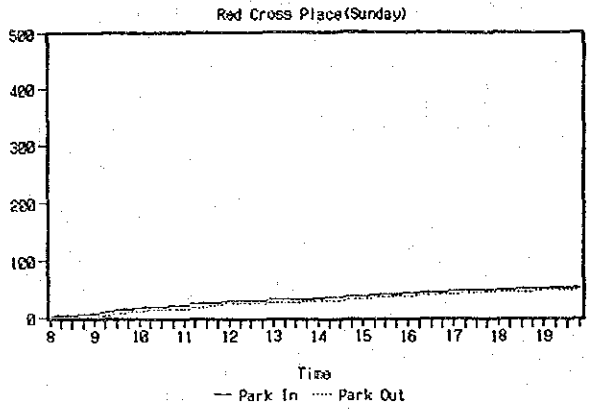
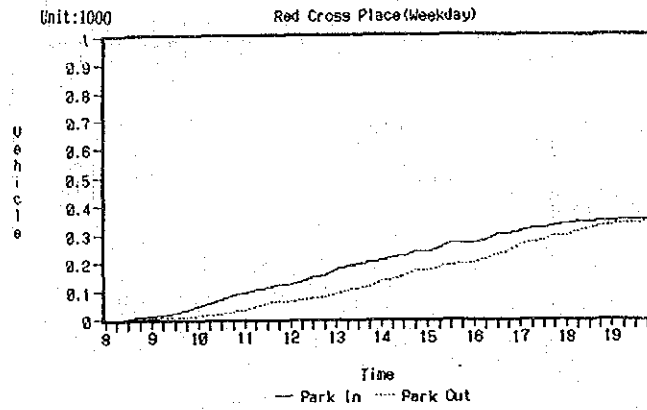
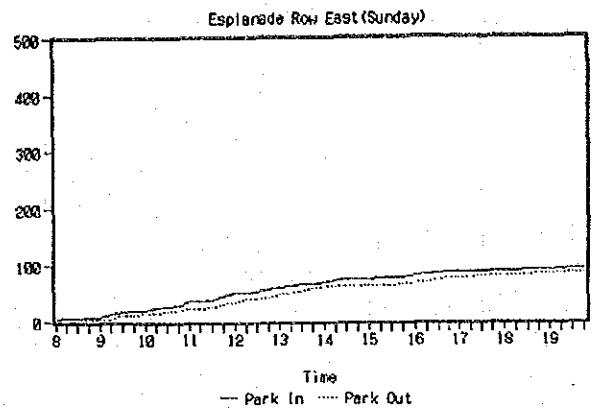
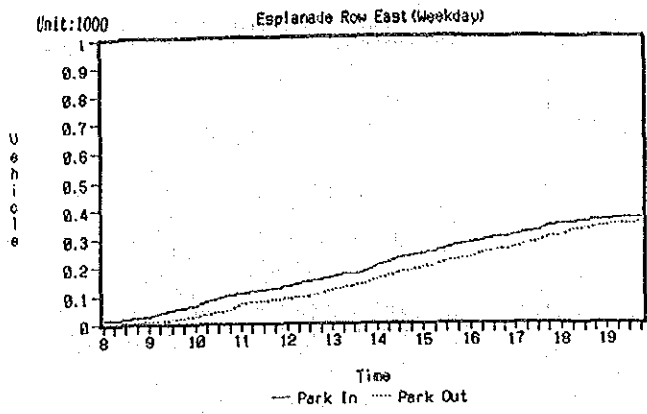


Figure T-1.5.2(1) Passenger Car Cumulative Parking Volume.

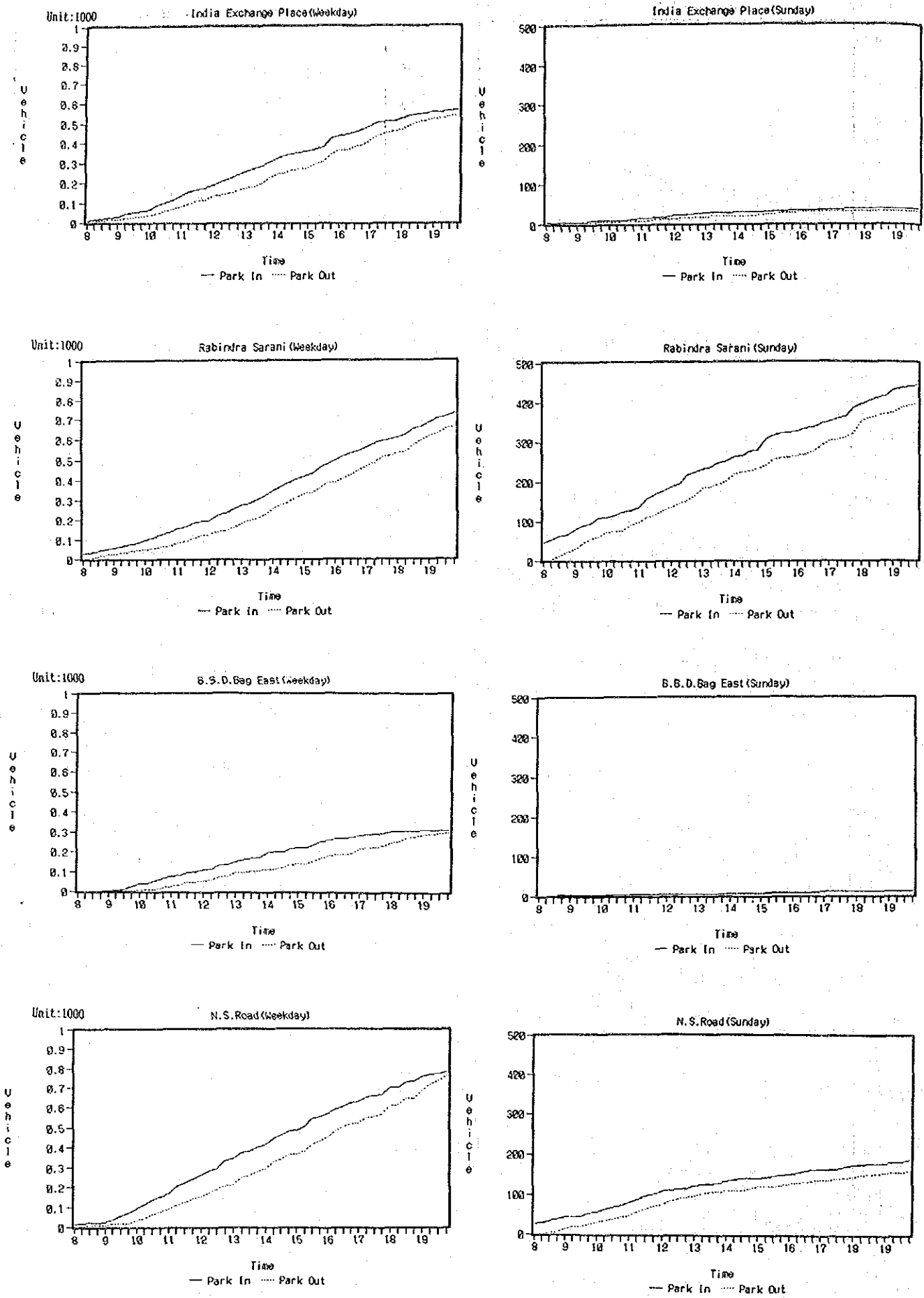


Figure T-1.5.2(2) Passenger Car Cumulative Parking Volume

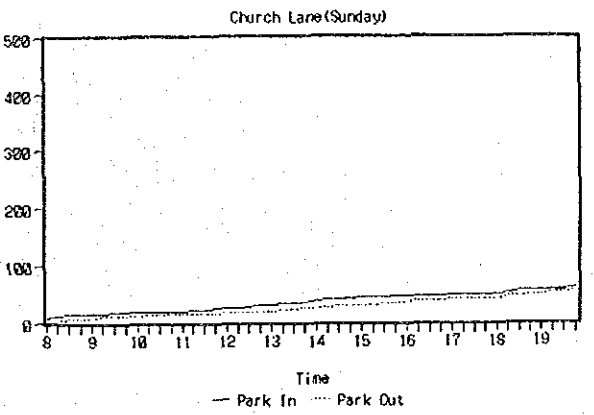
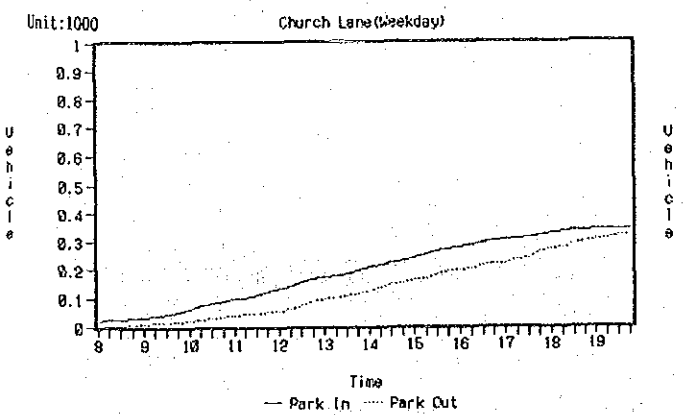
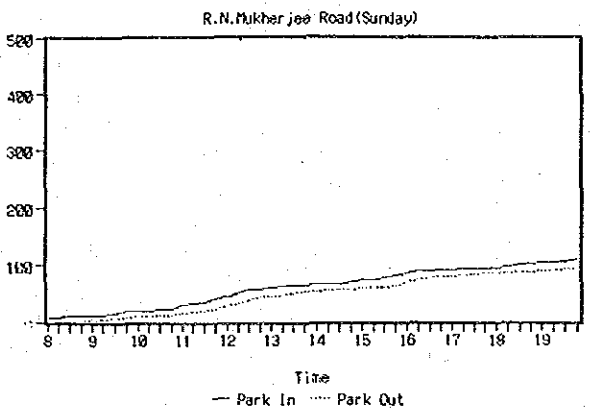
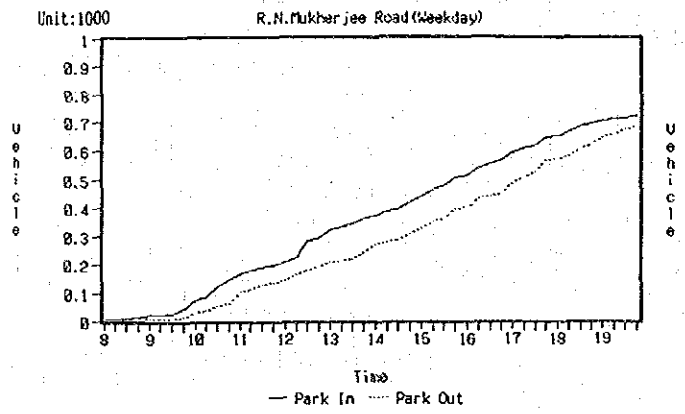
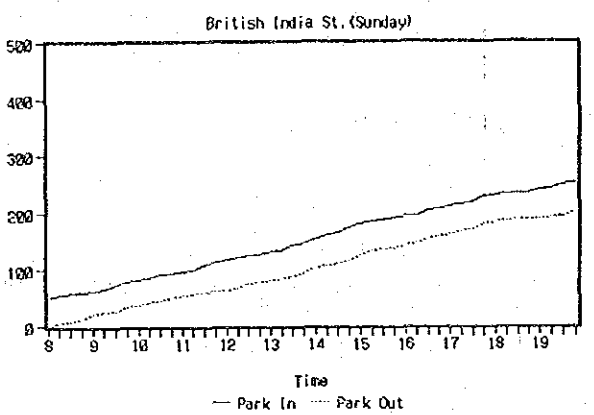
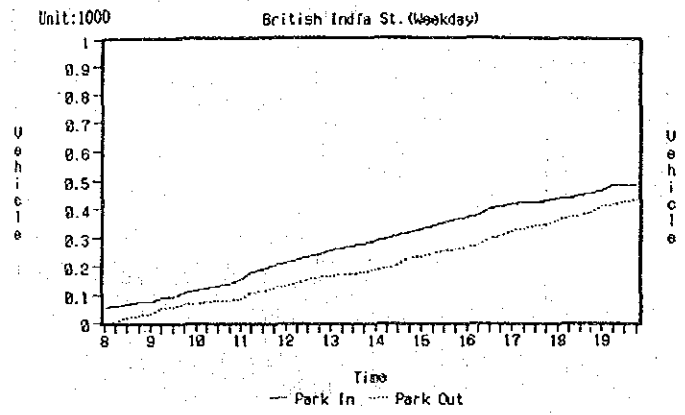
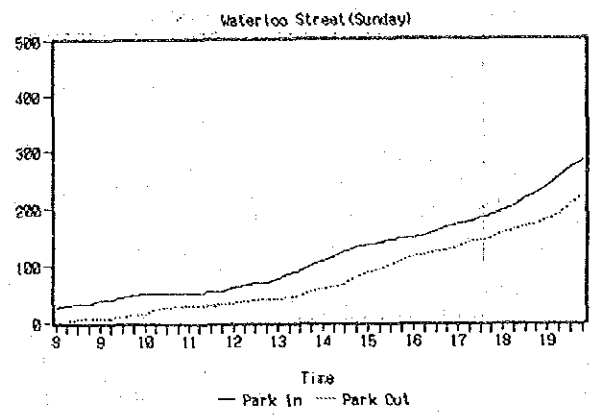
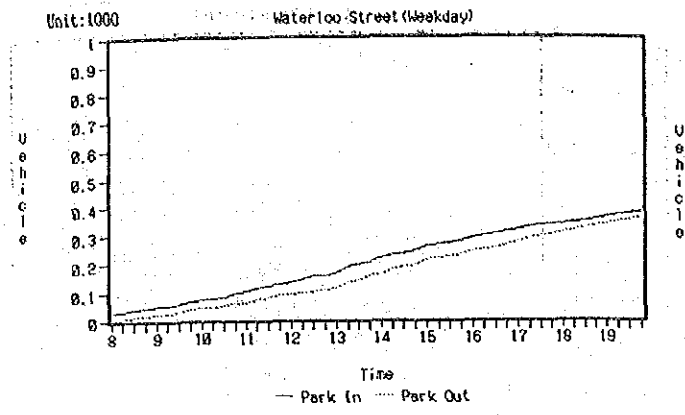


Figure T-1.5.2(3) Passenger Car Cumulative Parking Volume

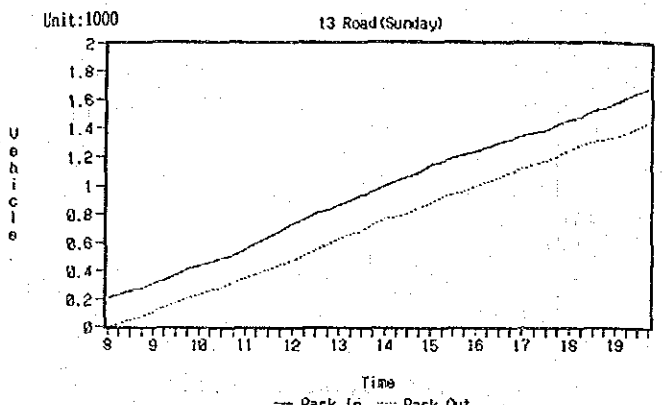
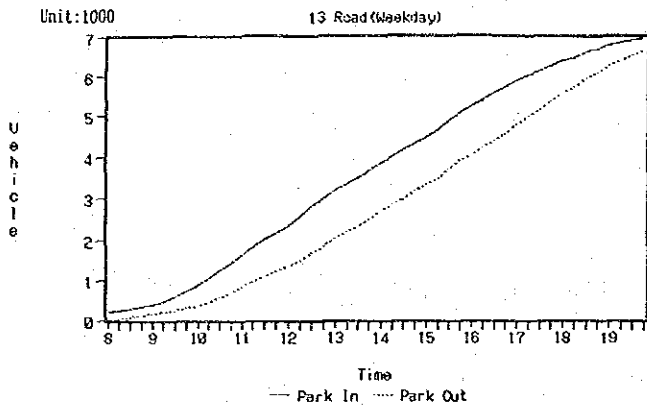
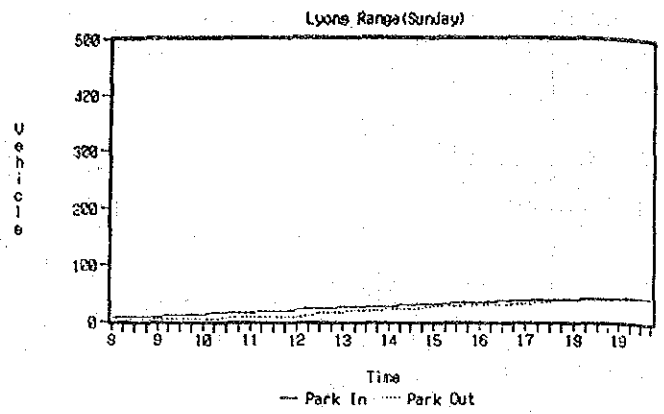
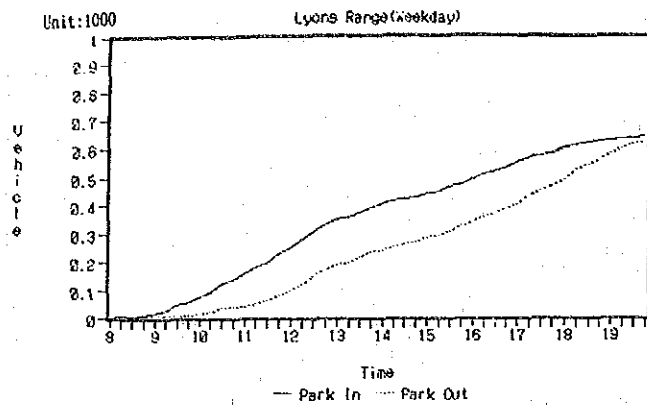


Figure T-1.5.2.(4) Passenger Car Cumulative Parking Volume

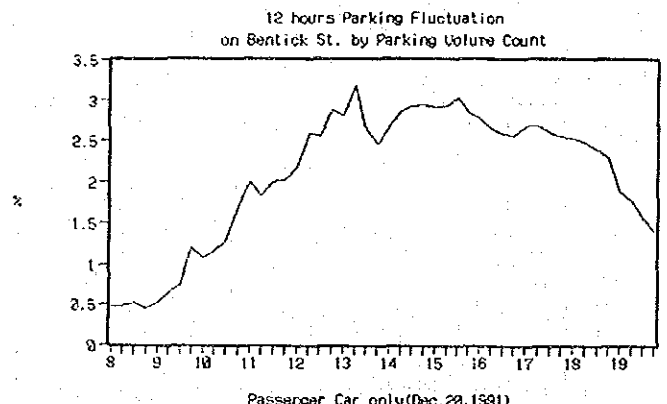
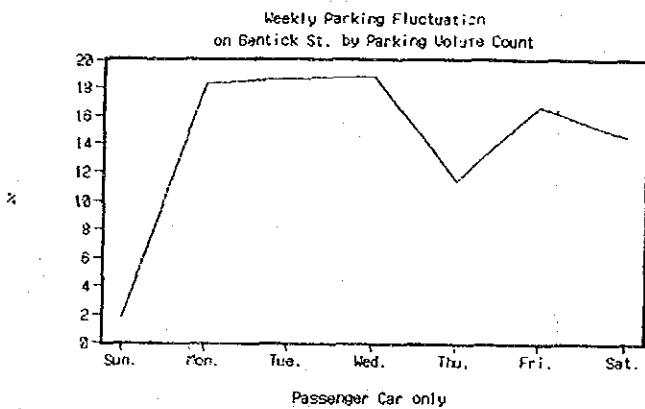


Figure T-1.5.3 Parking Fluctuation on Bentinck Street

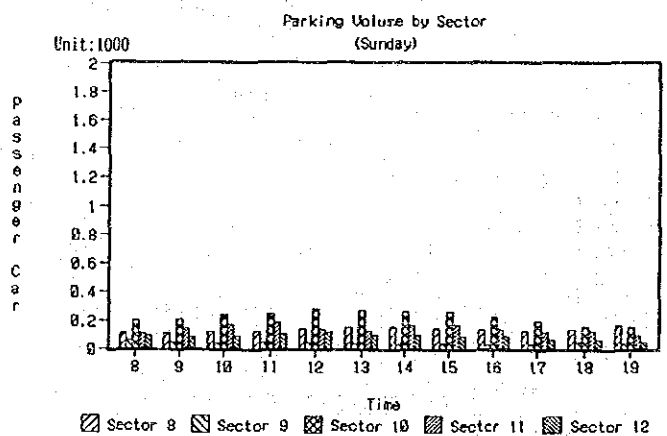
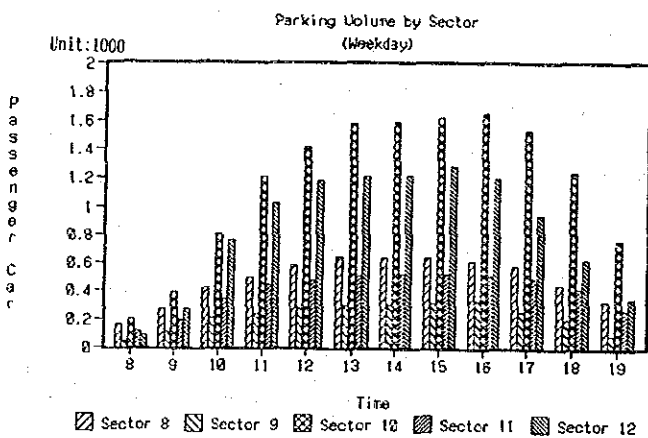


Figure T-1.5.4 12 Hours Parking Volume

## 1.6 Delay at Intersections

### (1) Definition of Delay at Intersection

Total delay at each of the study intersections are determined to indicate the extent of delay. The total delay at each intersection is calculated based on data gathered from the traffic volume and travel speed surveys. Delay at an intersection approach is defined as the traffic volume at that approach multiply by the difference in travel time at the observed speed and at free speed.

The computational equation used is:

$$D = V \times (T_t - T_f)$$

where,

D : Delay of an intersection approach in veh.hours  
V : Traffic volume on the approach  
T<sub>t</sub> : Travel time measured on link  
T<sub>f</sub> : Travel time at free speed on the link

The free speed in this computation is taken as 36.7 km/hr.

The total delay at the intersection is thus the sum of delays of all its approaches.

### (2) Total Delay For 8 Hours

The total 8 hours delay for two time periods between 8-12 and 16-20 hours are computed for the target intersections and ranked into categories as below:

<u>Category</u>	<u>Intersection Number and Name</u>
>3,000 veh.hours	No.2 : Esplanade No.8 : Park Street No.1 : Moulali
2,000-3,000	No.4 : Shyambazar* No.5 : Rabindra Sadan
1,000-2,000	No.6 : Beck Bagan No.7 : Maniktala
<1,000	No.10: Mullik Bazar No.3 : Gariahat*

(note: \* the total delay at intersection no.3 and 4 do not include delays at all approaches)

The average hourly delay in the morning and evening at the target intersections are also computed and shown in Table T-1.6.1 below:

Table T-1.6.1 : Total Delay in Vehicle.Hour

Intersection	Morning Ave.One Hour	Evening Ave.One Hour	Total Eight Hrs
No.1: Moulali	397	451	3,392
No.2: Esplanade	237	957	4,776
No.3: Gariahat*	80	137	868
No.4: Shyambazar*	224	307	2,124
No.5: Rabindra Sadan	305	199	2,016
No.6: Beck Bagan	209	263	1,888
No.7: Maniktala	230	159	1,556
No.8: Park Street	474	572	4,184
No.9: Lock Gate**	0	0	0
No.10: Mullik Bazar	29	74	412
<b>Total</b>	<b>2,185</b>	<b>3,119</b>	<b>21,216</b>

Note: \* Total does not include all approaches  
 \*\* Survey data not available

Morning Period : 8:00-12:00  
 Evening Period : 16:00-20:00

### (3) Average Hourly Delay at Each Approach

Figures T-1.6.1 and 1.6.2 show the average hourly delay in vehicle.hours for each of the intersection approaches at the study intersections during morning and evening hours.

In the morning, the greatest hourly delay of 247 veh.hour is calculated for the south bound approach at intersection No.8., followed by the south bound approach at intersection No.1 with 209 veh.hours.

In the evening, the greatest hourly delay of 691 veh.hours is calculated for the north bound approach at intersection no.2, followed by 503 veh.hours for the north bound approach at intersection no.8.

Data for the computation of delay is limited and will be supplemented by an additional survey scheduled from 14th to 17th January 1992. Nevertheless the above delay computations remain valid and will be further adjusted after the additional survey is completed.

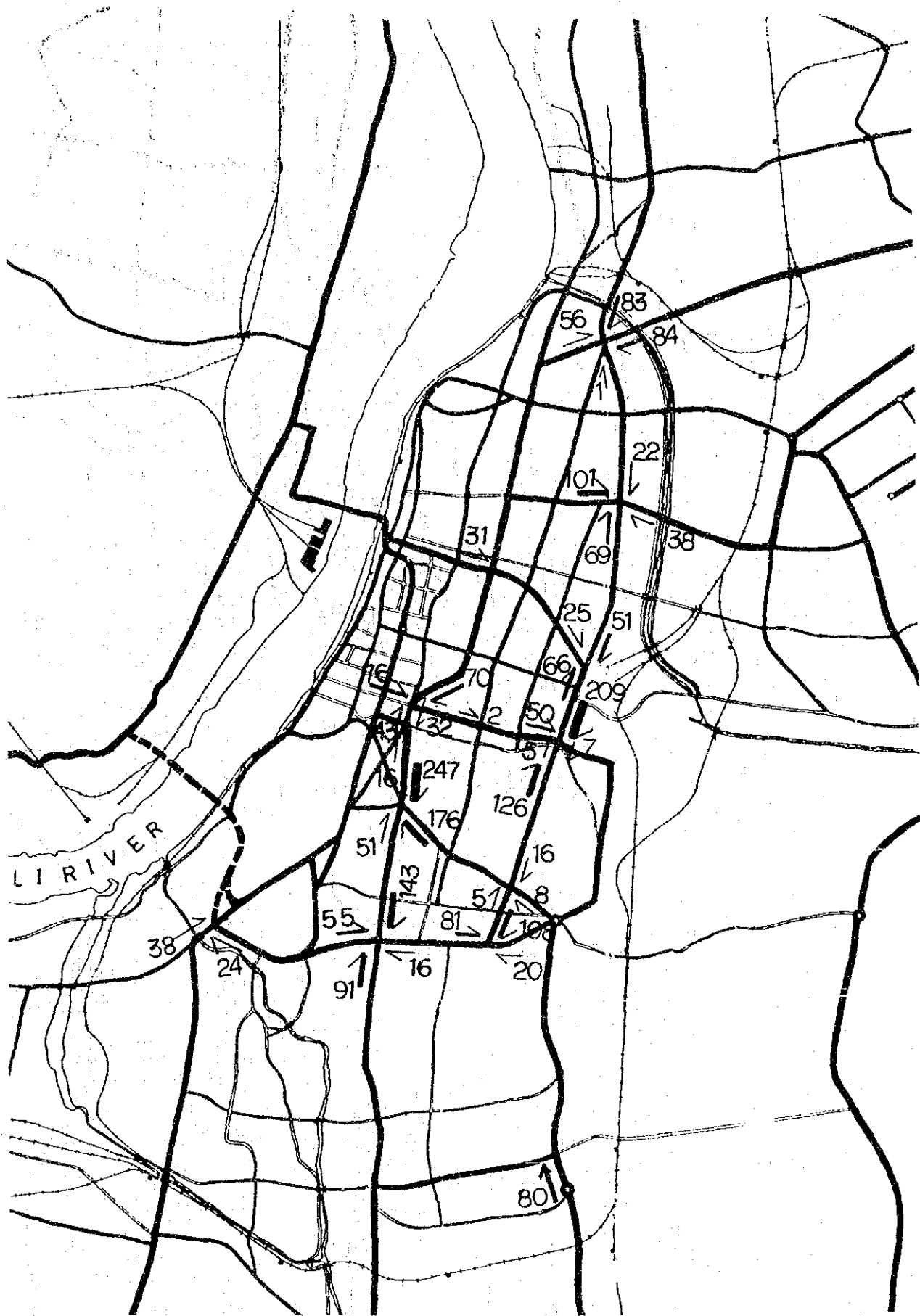


Figure T-1.6.1 Average Hourly Delay During Morning Hours  
 (Average Value for the Period 8:00-12:00hrs)

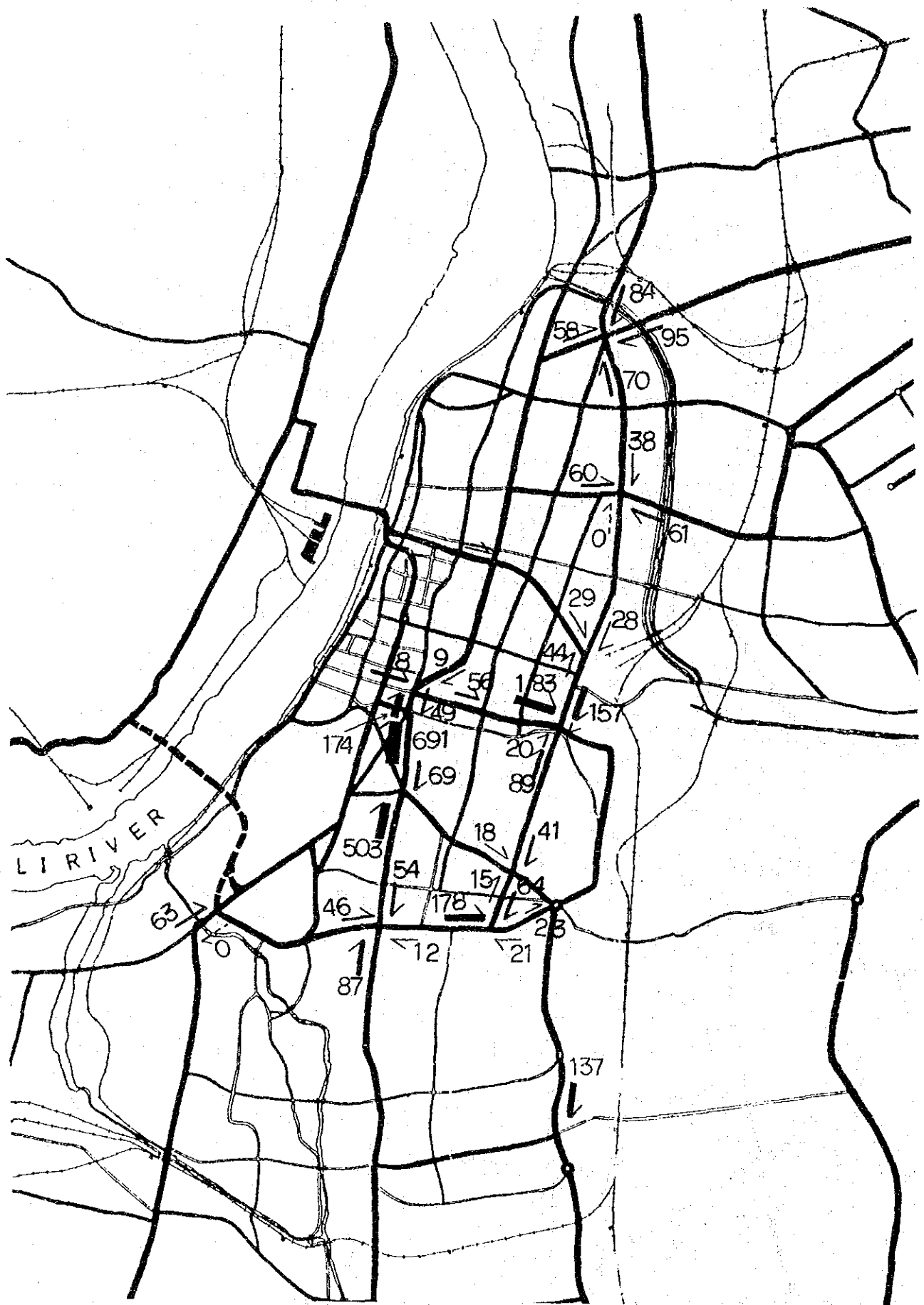


Figure T-1.6.2 Average Hourly Delay During Evening Hours  
(Average Value for the Period 16:00-20:00hrs)



1-7 Future Traffic Volume

Figure T-1.7.1 shows the future forecast traffic volume at each intersection.

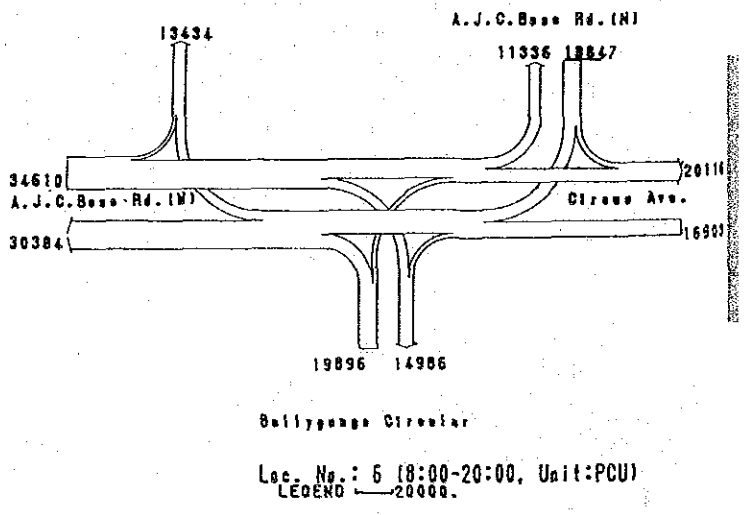
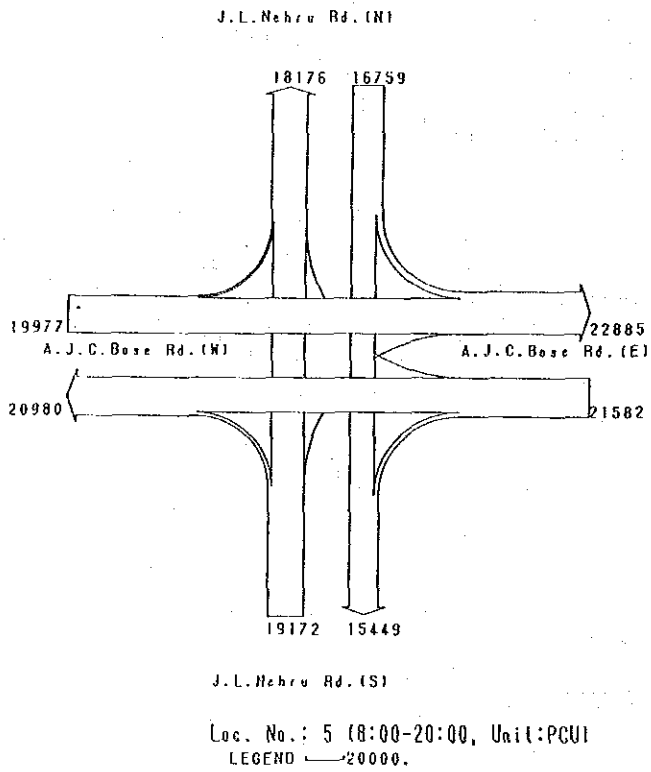
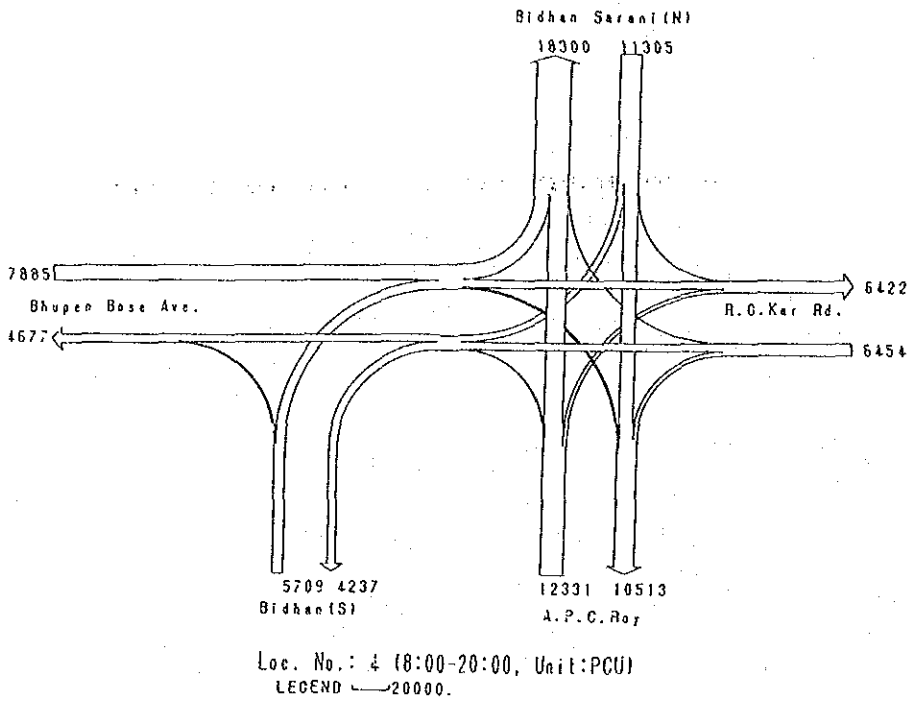
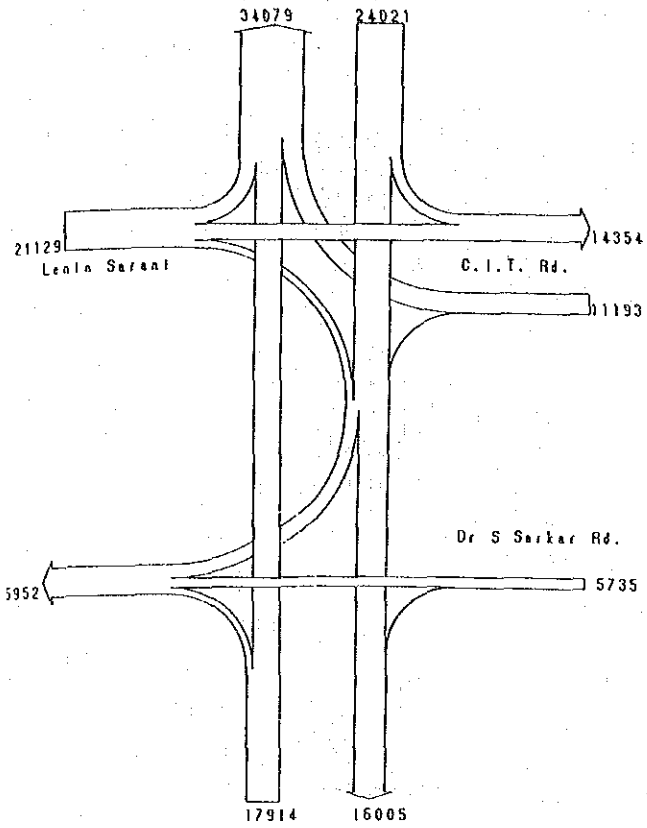


Figure T-1.7.1(1) Traffic Volume in Intersections

A. J. C. Bose Rd. (N)

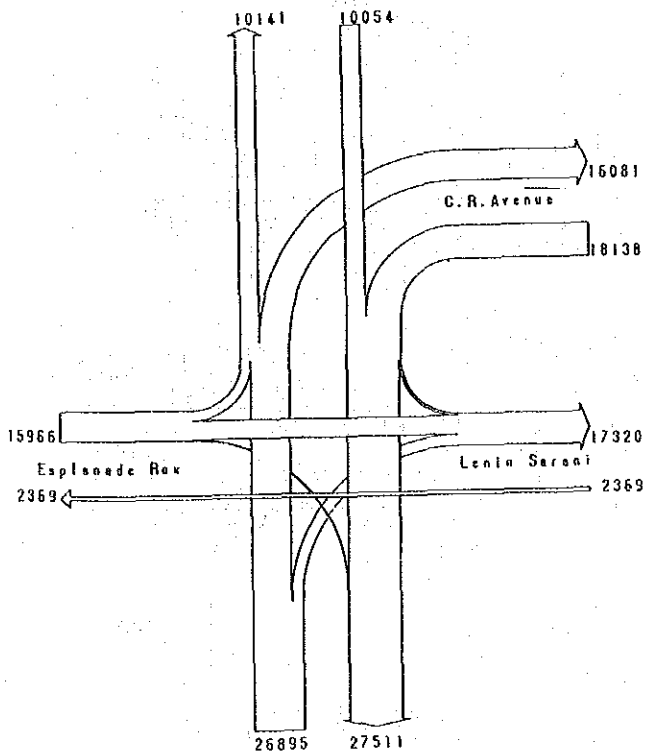


A. J. C. Bose Rd. (S)

Loc. No.: 1 (8:00-20:00, Unit:PCU)

LEGEND  $\longleftarrow$  20000.

Bentinet Street

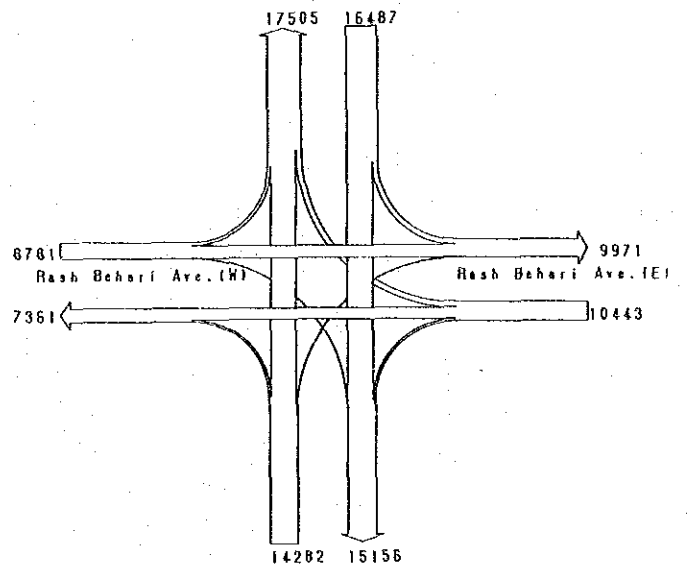


J. L. Nehru Rd.

Loc. No.: 2 (8:00-20:00, Unit:PCU)

LEGEND  $\longleftarrow$  20000.

Garishat Rd. (N)



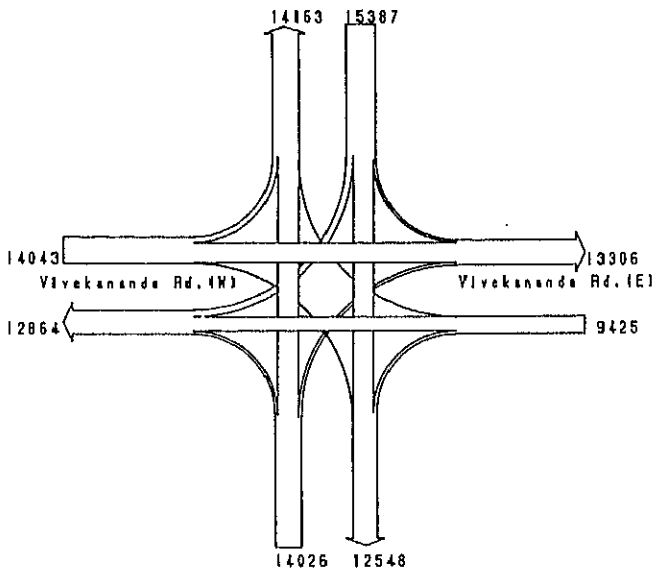
Garishat Rd. (S)

Loc. No.: 3 (8:00-20:00, Unit:PCU)

LEGEND  $\longleftarrow$  20000.

Figure T-1.7.1(2) Traffic Volume in Intersections

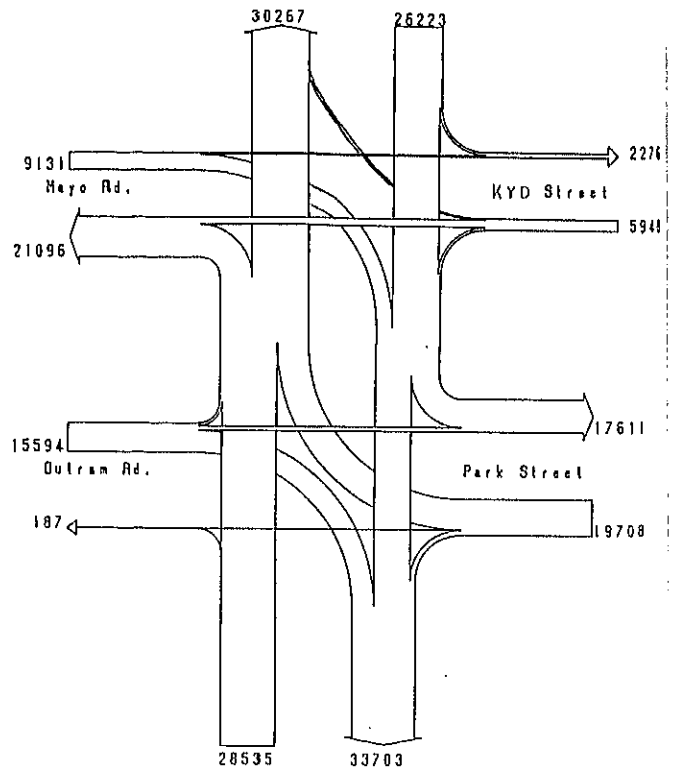
A.P.C. Ray Rd. (N)



A.P.C. Ray Rd. (S)

Loc. No.: 7 (8:00-20:00, Unit:PCU)  
 LEGEND —20000.

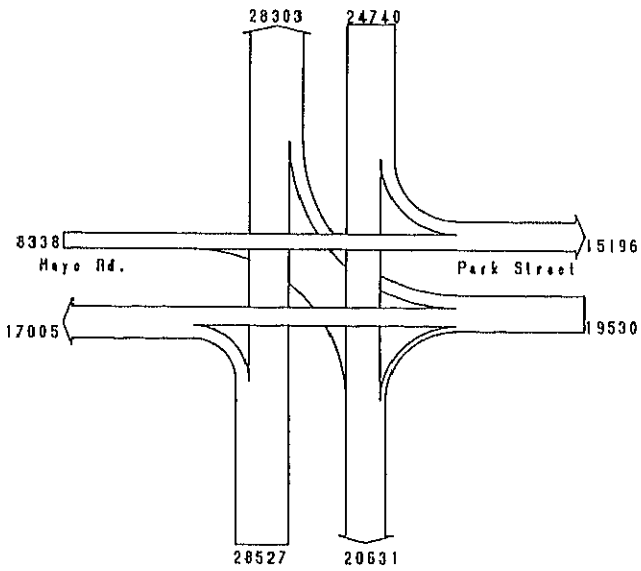
J.L.Nehru Rd. (N)



J.L.Nehru Rd. (S)

Loc. No.: 8 (8:00-20:00, Unit:PCU)  
 LEGEND —20000.

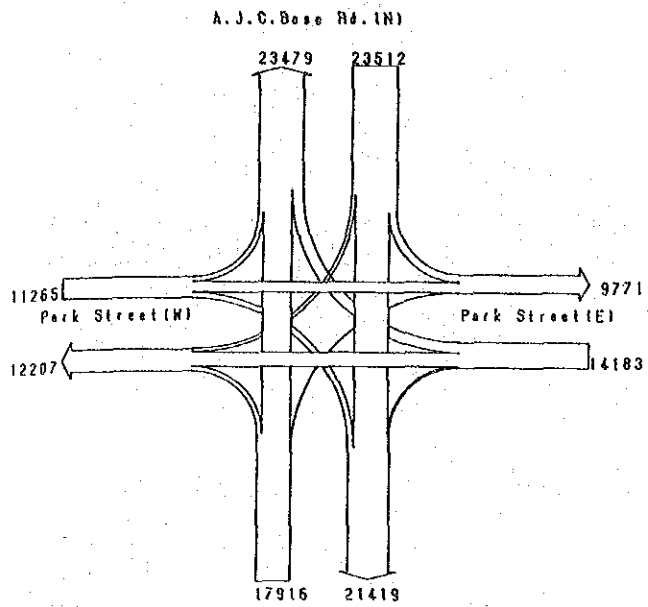
J.L.Nehru Rd. (N)



J.L.Nehru Rd. (S)

Loc. No.: 8 (8:00-20:00, Unit:PCU)  
 LEGEND —20000.

Figure T-1.7.1(3) Traffic Volume in Intersections



A. J. C. Bose Rd. (S)

Loc. No.: 10 (18:00-20:00, Unit: PCU)

LEGEND  $\longleftarrow$  20000.

Figure T-1.7.1(4) Traffic Volume in Intersections



CHAPTER 2  
FIELD SURVEYS





## CHAPTER 2 FIELD SURVEYS

### 2.1 Soil Investigation

#### 2.1.1 Survey Methodology

##### (1) Field Survey

The field survey was conducted at the ten intersections of this Study in order to prepare a preliminary understanding of the sub-soil conditions. Such an understanding is essential for selecting the most economical and technically suitable flyover structure at the surveyed intersections, should a flyover be deemed necessary.

One bore hole, of diameter 150 mm and depth of 40.0 meters from the ground level, was executed at each of the locations shown in Fig. T-2.1.1. Standard penetration tests were conducted at each hole, at one-meter intervals, undisturbed samples collected, and laboratory tests of soil samples were executed.

##### (2) Collection and Review of Previous Reports

Previous soil reports for bore holes executed in Calcutta by reliable authorities were collected to supplement the field survey carried out under this Study. Reports prepared on the soil conditions along the metro project route in 1970 and 1973 were very helpful in determining the soil conditions for the Study intersections numbers #2, #4, #5 and #8.

The reports collected and reviewed were as follows;

- a. Geology and Groundwater Resources of the Greater Calcutta Industrial Area, prepared by Geological Survey of India in 1964.
- b. Calcutta Mass Transit Study, prepared in 1970-1971, by the Governmental commission set up for studying the metro report.

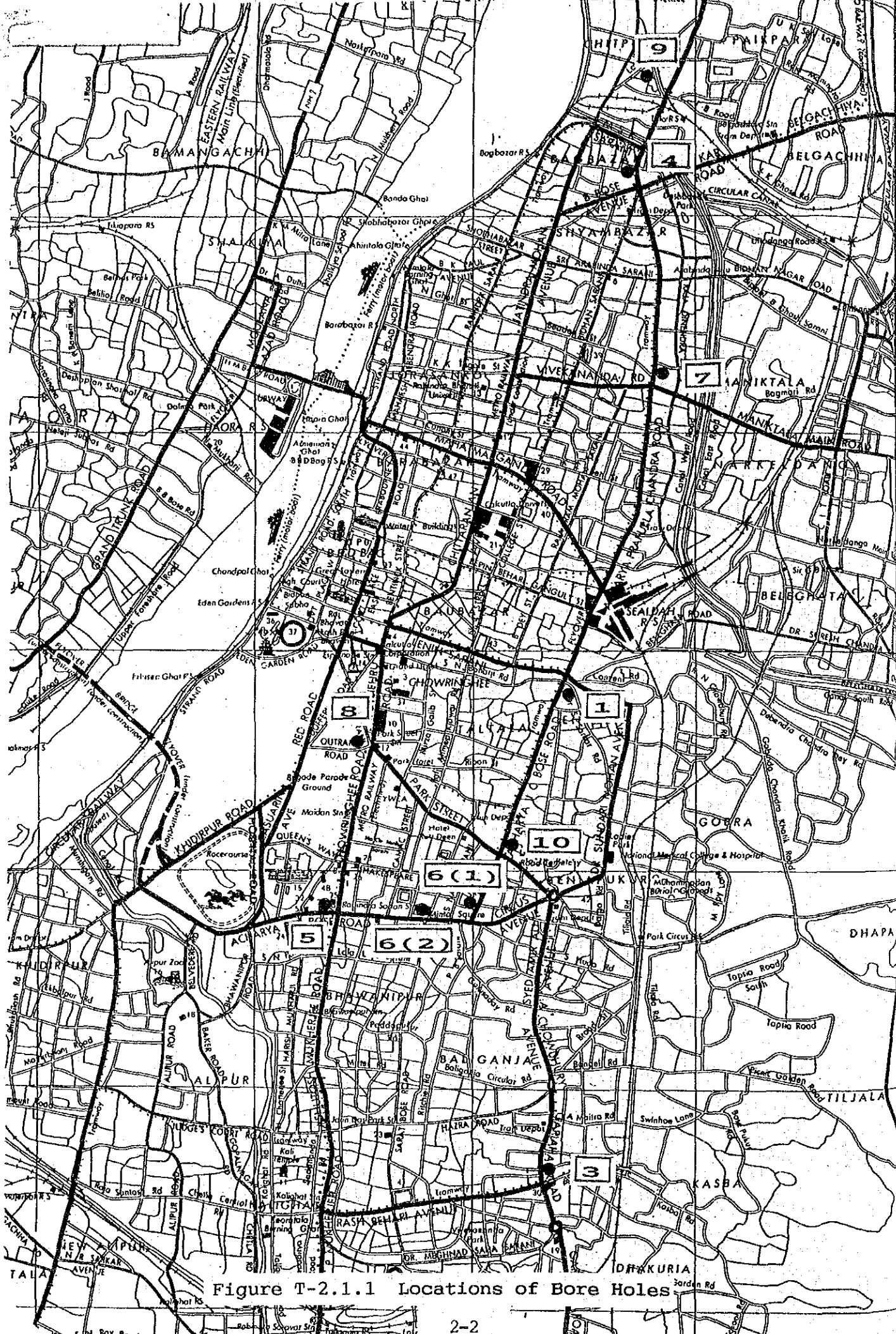


Figure T-2.1.1 Locations of Bore Holes

c. Metropolitan Transport Project, Rapid Transit System, prepared in 1973, for the design and execution of the metro project.

## 2.1.2 Field Survey

### (1) Survey Extent

A total of ten bore holes, of 40 meters depth each, were executed at the locations as shown in Fig. T-2.1.1. Bore hole locations were chosen along the expected path of the proposed flyover, except for Park Street intersection #8. At that intersection it was difficult to find a suitable location along Chowringhee street where pedestrian and vehicle traffic could not be disturbed, and so the bore hole was executed along Outram Road, just off of the crossing. The bore holes were located along the side walk and in two cases within the open spaces of Governmental building compounds.

The West Bengal Government Counterpart Team are considering the construction of an elevated viaduct extending between Rabindra Sadan intersection #5 and Beck Bagan intersection #6. Consequently, the tenth bore hole, number 6(2) was executed along A.J.C. Bose road, within Minto Park, facing Sarat Bose road along the route of the viaduct under consideration. On the other hand, the nature of Esplanade intersection #2, as a very busy traffic node, the ongoing construction of the metro there, and the ability to rely on the data produced by the two consecutive metro studies for that intersection and the results of Park Street intersection #8 bore hole, situated close by made it unnecessary to execute a bore hole survey there.

### (2) Survey Methodology

#### a. Site work

The local consulting firm of Consulting Engineering Services (CES) was entrusted with the execution of the ten bore holes, under the supervision of the Study Team. CES, in association with the specialized soil engineering firm

of Continental Consultants carried out the work during the period of November 11 to 25. Five rigs and gangs were mobilized to carry out the work.

At the start of the boring, trial pits were excavated to about two meters depth to determine the existence of any subsurface utilities. The bore holes were then advanced by dry auger method operated manually for shallow depths, up to 6 to 7 meters. At greater depths, mud rotary boring method was adopted for the entire remaining depth of 40.0 meters. Boring was executed in accordance with the Indian standard I.S. 1892/1979.

Four to six undisturbed samples were collected at each bore hole from each type of soil formation, using a thin-walled sampler, as per I.S. 2132/1972. The undisturbed samples in the tube samplers were waxed at both ends and attached with proper identification marks.

Standard penetration tests (SPT) were conducted inside the bore holes at 1.0 meter intervals, in accordance with I.S. 2131/1981. The split spoon sampler, of standard design and dimensions, was advanced by driving with a drop hammer weighing 65 kg, falling freely from a height of 75 cm. A record of the number of blows required to penetrate every 15 cm of soil layer, to a depth of 45 cm was maintained. The number of blows required for the last 30 cm penetration of the split spoon sampler was recorded as the N value. The samples from the SPT were maintained in polythene bags.

#### b. Laboratory testing

Tests were carried out in the laboratory to determine the properties and characteristics of the soil samples as follows. The tests were conducted under the relevant Indian codes. On average the tests were conducted on soil samples obtained from six different depths for each bore hole.

- Natural moisture content  
This test was carried out as per IS: 2720(p-II), 1973.
- Bulk and dry densities  
The bulk density was determined after measuring the