GOVERNMENT OF PAKISTAN
PLANNING COMMISSION
NATIONAL TRANSPORT RESEARCH CENTRE
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TRAFFIC IMPROVEMENT AT AN URBAN INTERSECTION

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GOVERNMENT OF MAURITANIA
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A C K N O W L E D G E M E N T

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SUMMARY

Murree Road has always been an important arterial connection for Rawalpindi with the hilly areas of Murree and Azad Kashmir. With the shifting of Capital to Islamabad in early Sixtes, ribbon development took place along this road specially on the section between Mareer Hasan and Chandni Chowk, which has now emerged as the most important commercial strip in the city. The enhanced commercial activities coupled with large volume of commuter traffic between the twin cities has further accentuated the congestion on the road.

The problems has been attracting attention of the concerned authorities for a long time and several measures have been attempted in the past but without any real success. In early 1984, views of the National Transport Research Centre (NTRC), were also sought. On the advice of the Centre a comprehensive study was initiated in late 1985 and completed in January,1987. NTRC stressed low cost remedial measures such as channelization and change of emphasis of enforcement.

A series of meetings were held to discuss the recommendations made by the centre. In 1990, with a view to overcome the problem of continued reservations expressed by various agencies, it was decided that NTRC should execute a Pilot Project to demonstrate the viability of the concepts propogated by it. However due to limitation of funds with NTRC it was agreed to restrict the project to Committee Chowk only which is one of the busiest intersection on the Murree Road. The project was launched in May 1990 and completed in June, 1990.

The NTRC study had identified (a) lack of channelization (b) blocking of the intersection by entering on red phase of the signal, (c) illegal stoppage of public transport; and (d) un-authorised parking of other vehicles at all approaches of the intersection as the root cause of the problem. The problem was most acute during evening time (1900-2100 hrs) mostly on account of stopping activties.

To overcome the problems, the following measures were implemented:-

1. Cat-eyes were fixed along stop-line. Lane Markings and Zebra Crossings were repainted and No-Turn-on-red sign boards were installed at each approach.

2. The medians were temporarily extended with the help of steel barriers to channelize the traffic.

3. The signals timing were adjusted in accordance with approach volume.

4. Traffic Police Personnels were posted at each approach to prevent entry of vehicles after green phase.

5. A limited local level compaign was carried out to enforce the road-users regarding justification for the measure being implemented.

After one month of the operation of traffic management measures at the intersection, the following results were achieved:-

1. The peak-hour capacity of the intersection increased by 10.5% for South approach and 58.1% for East approach. The figures for other two approaches were 13.6% for North and 22.9% for West respectively.

2. The average queue length were reduced by 17.4% for North, 18.3% for South, 12.2% for West and 16.7% for East approaches respectively.

3. The grid-locking of the intersection was eliminated after only one day of operation.

4. The duration of congestion period was reduced from 2 hours(1900-2100 hrs) to 1.5 hours(1900-2030 hrs)

5. The measures were greatly appreciated by the users who provisionly had experienced great difficulties during evening peak hours.

CHAPTER - I

INTRODUCTION

The traffic and transport management and control problems that are currently being faced by the district authorities in Rawalpindi are typical problems to those observed in many cities in developing countries i.e. rapid growth in population, insufficient public transport, consequent increasing demand for private vehicles, and unsatisfactory forecasting techniques in the past for future increase in number of vehicles, while designing the road. There is a major conflict between the demands for the use of the road space for through movement of the vehicles, by slow moving vehicles, pedestrians and street vendors, etc.

Murree Road is an important, commercial, arterial road about eight kilometers long between Rawalpindi (South) and Islamabad (North) experiences extra problems of traffic flow because it is used not only by many workers who travel daily from Rawalpindi to Islamabad, but also by many shoppers from Islamabad who are attracted to Rawalpindi by lower prices of the goods. It is a dual carriageway of varying width of 30 to 36 feet. It has fifteen at grade intersections as shown in figure 1 and problems of congestion arise during peak hours (i.e. morning 0700-0900 hrs, afternoon 1300-1500 hrs and evening 1900-2100 hrs), between Mareer Hasan Chowk (I-1) and Chandini Chowk (I-15). The distance between these two points of the road is 4 Km approximately. There are shops, garages, workshops and other public utility stores on the east and west sides of Murree Road and problems of congestion is due primarily, to the parked vehicles owned by the shopkeepers and customers, and also due to poor behaviour of drivers of the public transport vehicles (especially the buses, mini buses and wagons) while secondary reasons are pedestrian conflict between through traffic and other public buses and negative impact of the road side furniture and attractions of the drivers.

1.1 BACKGROUND

The traffic congestion problems during peak hours on the Murree Road has been attracting attention of the concerned authorities for a long time and several measures have been implemented in the past to alleviate the situation but without any real success. In early 1984, the existing problem of congestion was discussed in a meeting held under the Chairmanship of the Commissioner, Rawalpindi and it was decided that the advice of the National Transport Research Centre (NTRC), Planning Commission, Islamabad should be sought to solve this problem.

In early 1985, a programme outlining the objectives, scope of work, methodology, completion time and the cost for the survey to examine the congestion problem on Murree Road in detail was prepared by the NTRC. The survey was commenced in late 1985 and the survey report was completed in January,1987 entitled "Murree Road Traffic Study" (1).

In this project the following recommendations were made:-

1. Murree Road is an important commercial arterial road and must be used as such. This implies imposition of certain restrictions and accepting a degree of restraint particularly at peak hours.

2. Any attempt at major investments on Murree Road itself to meet the growing traffic demand would be counter productive, as has been amply demonstrated by the experience of the developed countries in similar situtations. The supply under no circumstances can be kept ahead of the demand. The strategy should be made to obtain maximum return from the investment already made.

3. There is considerable scope for increasing the capacity of Murree Road by: (a) operational restratints; (b) low cost engineering measures, particularly those which are self-enforcing; and (c) by ensuring smooth flow by greater discipline on the part of the road users.

4. Although improvement of other links between Rawalpindi and Islamabad are justified in their own right, there is very little likelihood of any of them providing a satisfactory alternative route in the near future for traffic presently using the Murree road due to inherent advantages of the road.

5. Diversion of traffic from Murree road to other alternate routes should be on voluntary basis and left to the discretion of the user themselves. The diversion is feasible only for the private vehicles and indications are that the phenomenon has already started, as regard Public Service Vehicles, it would not be advisable to impose any restriction even partially, by an executive measure. The matter should be left for the market economics.

6. Highest priority should be given for provision of proper footpaths at least "8" feet wide all along the Murree Road.

7. All utility poles, sign-boards, uncovered main holes and other obstructions on foot paths should be immediately removed.

8. Kerb lanes on both side of the road from Mareer Hasan to Chandni chowk should be reserved exclusively for buses.

9. All on-street parking on Murree road should be completely eliminated and provided an off-street premises as per location suggested at Annexure-I.

10. Strict notice should be taken of (a) encroachments; (b) illegal parking; (c) jay walking by pedestrian; (d) lane indiscipline; (e) unauthorized users such as animals, animal drawn vehicles; and (f) dangerous driving by cyclists, (g) loading and unloading of goods at the shops etc,.

11. In order to enable the Traffic Police to discharge their duties effectively; (a) the force should be stabilized by stopping forth-with all transfers to and from the department; (b) select persons with proper aptitude, education, age and physical fitness for the force; (c) provide proper training, equipment and powers to enforce the law;(d) ensure proper supervision to monitor the activities and performance of the force.

12. The Traffic Signs installed on the Murree Road by the Traffic Police are not only sub-standard but some of them are wrong. These need to be corrected.

13. The Committee Chowk intersection may be converted into grade separated junction with a cross-road going under-neath the Murree Road as per geometric design at Annexure-II.

14. The overhead pedestrian bridges are too costly a solution and require substantial extra investments in fences to achieve the objective. Instead, alternative of installing the fence in the median all along the Murree Road to physically prevent the pedestrian from crossing the road at places other than designated ones may be looked into.

15. Major pedestrian corssings should be clearly marked and provided with adequate facilities i.e. pedestrian crossing signals,etc."Left-Turn-On-Red" at such location should be banned to ensure proper safety of the pedestrians.

16. All the major intersections and links in the Study Area should be improved by low cost engineering solutions.

1.2 OBJECTIVES

The objective of this study is to demonstrate the impacts of Low Cost traffic management techniques for improvement in the traffic flow at the Committee Chowk on the Murree Road. The effects of changes after improvement at the intersection would be quantified in terms of the following:-

- Changes in vehicle delays within the area of influence of the intersection
- Improvement in terms of reduction in delays to the crossing pedestrians and reduction in the exposure to accident risk.
- Improvement in traffic safety evidence by a reduction in the traffic accident rate.

1.3 SCOPE OF THE STUDY

Owing to limited funds of the NTRC Pilot Project is restricted to the Committee Chowk only as it is one of the busiest intersection on the Murree Road. There are two main linking roads at the Committee Chowk one is known as Iqbal Road (West approach) which leads to Raja Bazar. The other is known as Sherpao road (East aproach) which leads to the area of Dhok Khabba and Airport etc. as shown in Annexure III.

1.4 METHODOLOGY

The basic method for studying the intersection is that of before and after comparisons.

The steps and procedures involved are given below:-

1. Preliminary appraisal of the site and traffic conditions.
2. Road Markings, Lane Markings, Zebra Crossing , fixing of cat eyes, putting of steel barriers for medians. Installation of sign boards, adjustment of signals timing and other traffic management measures e.g. education to road users etc.
3. Survey of existing flows and delays.
4. Analysis of traffic counts to provide design data on entry and circulating volumes.
5. Continue monitoring of scheme and minor adjustments where considered necessary.

1.5 DEVELOPMENTS

In 1988, the Commissioner, Rawalpindi requested to the NTRC that a demonstration project should be under-taken to improve the traffic flow between Committee Chowk and Asghar Mall Chowk by considering the following lines (i.e.from I-5 to I-14 as shown in fig-1):

- Controlling the pedestrians and cyclists movement.
- By providing exclusive bus lanes.
- Proper channelisation at the intersection.
- Progressive settings in the signals timing.
- Parking control.
- Construction of the foot-paths.
- Construction of the parking lots, etc.

It was also agreed by the Commissioner, Rawalpindi that the remaining portion of the Murree Road should be improved with their own funds.

NTRC had under taken the Pilot Project to "Stream Line the Traffic flow at Committee Chowk" under the traffic improvement scheme on Murree Road. After preliminary survey it was felt that the proposed section from Committee Chowk to Asghar Mall Chowk is too long for introducing the desired improvement scheme out of limited funds of the NTRC. It was then proposed to start the project at the Committee Chowk only with considering availability of limited funds of the NTRC. The matter was taken-up in the 4th Inter Ministerial Committee Meeting by the NTRC and the project was approved at a cost of Rs.59,000/-. After that these funds were transferred to the XEN,Punjab Highways Department, Rawalpindi in June, 1988 to complete the work for painting the lane markings, road markings, zebra crossings and also fixing of cat-eyes on stop lines at each approach of the intersection.

1.6. THE PLAN

The NTRC took a challenge and laid down the responsibility on its shoulders to solve the above mentioned problems. In this context several meetings were held between Traffic Officials of the Rawalpindi Municipal Corporation (RMC), Rawalpindi and the Officials of the NTRC, Islamabad. Hence the point selected for Demonstration project was the Committee Chowk (I-5) which is an intersection in the heart of the city and links the most thickly populated areas of Rawalpindi. After the parleys, a survey was chalked out. The plan included the road markings, lane markings, zebra crossings, fixing of cat eyes, putting of barriers for medians, installation of sign-boards, adjustment of signals timing and other traffic management measures e.g. education to road users, putting ban on tonga parking during peak hour and ban on parking to other vehicles close to the intersection etc.

CHAPTER - II

LITERATURE REVIEW

(IMPROVEMENT IN CAPACITY OF THE INTERSECTION)

2.1 INTRODUCTION

Road intersections are the most important elements in an urban road network. It is essential to have well designed intersections, since the capacity of the road network is usually governed by that of its intersections in any urban situation. Problems of capacity and safety often arises at the intersection, rather than on the links between them.

The capacity at any instant is the maximum number of vehicles which has a reasonable expectation of passing over a given section of a roadway in one direction (or in both directions) under the prevailing road and traffic conditions (2). Principally, capacity is affected by a few major factors:

a. roadway conditions established by the physical features of the road, which do not change unless some construction work is undertaken;

b. traffic conditions which depend on the nature of traffic on the roadway, and which may change from hour to hour; and

c. driver behaviour.

The capacity of a road system is usually controlled by the capacity of the individual interesection within the system. It is the intersection where the ratio of flow to capacity is highest which cause the problems. Such intersections usually have some form of control and a study of the capacity of the following two methods of control of an intersection is necessary:

a. roundabouts; and b. signalisation

Capacity of the intersection is a problem in urban road networks bringing costly problems of safety and delay. It is desirable to allow traffic to move without stopping if possible, but in urban areas drivers generally expect to have some stops and are more willing to tolerate delays. However, it must be realised that capacity, delay, safety, and amenity cannot be entirely separated from the cost of providing the infrastructure. A balance must be reached and practical capacities should be economic whilst taking account of these other factors.

When estimating the capacity of an existing intersection it is usual to assume that the present ratios of the flows on all movements through the intersection will be maintained.

2.2 TRAFFIC SIGNALS

The use of traffic signals for the control of conflicting streams of vehicular and pedestrian traffic is extensive in most towns and cities. The first traffic signal was installed in London in 1868. During the hundred years since then, traffic signals have been developed to a high degree of sophistication as now used in area-control systems by linked signals. Traffic signals can be either fixed-time or vehicle actuated, and in area-control may operate in both ways at different times of the day: a. Fixed-time signals; and b. Vehicle actuated signals.

The next set up from fixed time settings would be to incorporate a 24 hour clock into the controller which could select different timings to suit, for example, morning or evening peak and off-peak conditions. This would need to be checked fairly and regularly, since power disruption and climate can affect the reliability of electric clocks.

UK authorities now use vehicle actuated signals in which vehicles passing over an inductive loop or other sensor 'call' for priority at signals. These have great advantages of being adaptable to changing traffic conditions at the intersections, but they do entail extra capital cost and require sensors to be installed and maintained.

The British practice for the signals sequence is red, red/amber shown together, green and amber. The common practice is to use circular red, amber and green signals, although in certain circumstances green-arrow signals are also used. When the red signal is displayed the right of way is denied to the traffic from entering the intersection. The red/amber signifies an alert to drivers that the signal aspect is about to change to green so that they can be in readiness to go. The green signal aspect denotes to the driver that he or she may enter the intersection if it is safe to do so. The amber signal alerts drivers that the red signal aspect is about to commence & the green aspect is about to be terminated. A green arrow aspect permits the drivers to enter into the intersection to make the movement indicated by the arrow.

2.2.1 Advantages of Traffic Signals

a. They provide clear, positive instructions to the drivers and pedestrians.

b. They can provide for an orderly movement of traffic.

c. When proper geometric layouts and control measures are employed, they can increase the traffic-handling capacity of an intersection.

d. They can reduce the frequency of certain types of accidents, especially the right-angle type and pedestrian accidents;

e. Under favourable conditions, they can be coordinated to provide for continuous or nearly continuous movement of traffic at definite speed along a given route.

f. They can be used to interrupt heavy traffic at intervals to permit other traffic-vehicular or pedestrian to cross.

g. Traffic signals dispense with police control and can release policemen for other duties.

h. If properly designed and set they can assign right-of-way impartially to traffic, unlike manual control which can stop and interrupt traffic streams at the personal whim of the traffic controller.

2.2.2 Disadvantages of Traffic Signals

a. Excessive delay to vehicles may be caused, particularly during off-peak hours.

b. Unwarranted signals installations tend to encourage the disobedience of the signal indications.

c. Drivers may be induced to use less adequate and less safe routes to avoid delays at signals.

d. Accident frequency, especially of the rear-end type, may increase.

e. When the installations break down, due to any fault in the system, total and widespread confusion and difficulties can result.

2.3 TRAFFIC SIGNALS AT THE INTERSECTION

Most traffic signals in developing countries use settings which remain constant throughout the day and which are adjusted either by guesswork (hit and trial method) or calculated by using the Webster and Cobbe formula and criteria (3). Under relatively stable traffic conditions this form of control can be perfectly adequate and it is likely that significant benefits could be obtained in a city by simply re-setting all of the traffic signals using proper calculations.

Studies in Bangkok have demonstrated how settings using Webster's formula would result in less delay than the current practice of manual intervention by traffic police. Studies also suggested that time spent by police controlling signals would be much better spent keeping the stopline clear of obstructions and regulating driver behaviour (4)

2.4 SIGNALISED INTERSECTIONS

Generally, those intersections that are significant from a capacity standpoint are either already signalized or prime candidates for signalization. Therefore, most current intersection-capacity criteria apply to signalized intersection.

The capacity and service volumes that a signalized intersection can accommodate are dependent on the intesection geometrics, signal operation, and traffic factors. In the first category, the approach width is most critical. The existence of parking, one-way vs two-way operation, and lane configuration are also important. Other factors, such as grades and turning radii, are undoubtedly significant, but must be handled by judgment in the absence of specific criteria.

In the second category, the proportioning of green time is the single most important factor. Cycle length, phasing, and "lost-time" features are somewhat less significant.

Traffic factors include the pattern and composition of arriving traffic, turning movements, presence of pedestrians, and general driver characteristics. The latter appear to be related to the size of and location within an urban area and, although not well quantified, can be estimated from those factors. The pattern of traffic arrivals is strongly influenced by nearby traffic signals and their coordination.

Of major concern in evaluating intersection capacity and service volume is the proper measure to describe traffic performance at the intersections. Speed, density and volume (or v/c ratio), the criteria used in free-flowing traffic situations, are not directly aplicable and surrogate measures must be employed. Several offer potential for the future, but have complications that have impeded current application (9).

The capacity of an intersection controlled by traffic signals depends on the amount of green time given to each of the individual approaches and on the maximum rate of discharge of the queue during those green times. This later quantity is called the "saturation flow" and is the flow which would be obtained if there was a continuous queue and it was given 100% green time. When right-of-way is changed from one set of roads to another, time is effectively loss during the cycle because of all red periods, starting delays and reduced flow during the amber period. Hence, the capacity of a traffic signal intersection is determined by the signals time settings and the saturation flows.

2.4.1 Saturation Flow

In the modern-day urban street, traffic signals are a frequent form of control to the movement of traffic. For a busy intersection, a queue of vehicles will form when the traffic signals show red, but when the green period commences, vehicles will accelerate and move off from the intersection to their normal running speed. After the initial period for a driver to react and accelerate, the queue discharges at a more or less constant rate. This rate is called the "saturation flow" of the approach, as shown in Figure 2, where the flow in the central plateau region is the saturation flow. The level of flow is often found to remain more or less constant until either the queue is exhausted or the signal light changes to amber, which ever comes first. Saturation flow is usually expressed in vehicles per hour or passenger car units (PCU's) per hour of green time.

In their work, TRRL explain and define saturation flow "S" and the proportion of the cycle which is effectively green "λ" in the following way. Figure 2 shows a typical average flow profile (solid line) for a fully saturated green period, that is one where there is a queue present throughout the green. This profile is replaced by rectangle (broken line) of equal areas, and height equal to the height of the central part of the profile. This height represents the average rate of discharge from a queue (omitting the building and run down in rate at the beginning and end of the green and amber periods). It is this value which is shown as saturation flow. The displaced green and amber time is correspondingly reduced by subtracting "lost time" to compensate for the adjustment to the saturation flow. The remaining time, during which constant saturation flow is assumed, is known as the effective green time. The ratio of this to the total cycle time gives "λ" the proportion of the cycle which is effectively green and the TRRL in their computer program OSCADY for signalised intersections uses the following equation to find the capacity "μ" of any one stream (5), where $\mu = \lambda S$

2.4.2. Lost Time

'Lost time' is a widely accepted concept to allow for the average rate of flow being lower during the first few seconds, whilst vehicles are accelerating to normal running speed, and during the amber period when some vehicles decide to stop and others to carry on. Webster and Cobbe(3) use "2" seconds to represent total 'lost time' in a stage. Most recent work has been reported by Kimber, McDonald and Hounsell (6,7) that the average starting lost time was 1.35 seconds, and the average ending lost time was 0.13 seconds.

2.4.3 Cycle Time

As the cycle time increases, the ratio of lost time to effective green time decreases, so the capacity will increase: on this argument it is desirable to have a long cycle time to reduce the proportion of lost time in the cycle. In practice it is usual to set an upper limit of 120 seconds for the cycle time (3).

The cycle time with the minimum delay could be calculated by:

$$C_o = \frac{1.5L + 5}{1 - Y}$$

When C_o = Optimum Cycle time (Seconds)

L = Total lost time per cycle (seconds), and

$$L = \sum (i-a) + \sum l$$

where "i" is the intergreen period, "a" is the amber period and "l" is the lost time for each stage.

Y = sum of critical flow to saturation flow ratios, and

$$Y = \sum y,$$

y is the ratio of the flow to the saturation flow of the predominant arm of each stage.

2.4.4 Degree of Saturation

The ratios of arrival rate to capacity for the various traffic streams is important in the assessment of traffic flow performance. For signal controlled system this ratio is known as the degree of saturation "x" and can be expressed as:

$$x = \frac{qc}{g's}$$

Where q = average arrival rate (PCU/hr)

s = saturation flow (PCU/hr) c = cycle time (seconds), and

g' = effective green time (seconds)

In theory the degree of saturation must remain less than unity therefore specified, typically this is taken as 0.9. With this upper limit the practical capacity of the approach lane can be regarded as Psg'/c where "P" is the largest acceptable value (i.e. P=0.9).

2.5 ACCIDENTS AT THE SIGNALIZED INTERSECTIONS (8)

The road accidents are of following types:

a. Injury Accidents; b. Serious Injury Accidents; and

c. Fatal Accidents.

Among road accidents the accidents at the intersection are common due to many factors e.g. impatiance driving, jaywalking, pre-crossing the intersection by the vehicles before green phase commence, etc. There are two techniques to study the accidents at the intersection:

a. To assesses the safety of an individual intersection by the vehicle movement which result in near accident or conflict situation; and

b. To combine the accident data for the intersections of similar layout by location sampling.

The accidents occured on the location within 20 yards or at the intersection is included in the accidents at the intersection.

The National Accident Statistics of Great Britian shows that in 1970 just over 50% of all injury accidents occured at the intersection for roads of the build up areas (roads with low speed limits) and a further 7% occured at the intersection on roads of the non-build up areas (road with higher speed limits). In all areas the largest number of accidents were reported at T-intersections (including staggered intersection) and cross roads. Any remedial measures which can be established for these kind by intersections and nationally applied, will bring about the greatest saving in accidents at the intersection.

2.6 PROHIBITED LEFT-TURNING MOVEMENT

Left turning movement is not obstructive to the traffic and it is rare that they are prohibited. However, such prohibition may be needed to provide a safe crossing for pedestrian, especially when the pedestrian traffic across the minor road is heavy.

2.7 QUEUE LENGTH (9)

Another possible measure of traffic performance at signalized intersections is the length of queues developed.

Average queue length is approximated by the larger result of the two formulas:-

$$n = qR \quad \text{---------- (1)}$$

and

$$n = q (R / 2 + d) \quad \text{---------- (2)}$$

where n = average queue length in (number of vehicles)

q = approach flow in (veh/s)

R = red time in seconds.

d = average individual delay from equation

2.8 TRAFFIC QUEUES AND DELAYS (10)

The prediction of queue lengths and vehicular delays is important in three main areas of traffic engineering.

a. In the economic appraisal of intersection improvement schemes, it is the reduction of delays which forms the main benefit and so largely determine whether or not capital expenditure is justified.

b. In predicting the distribution of traffic within road networks, intersection delay is the main factor affecting the route choice of drivers, and to a considerable extent determines the effectiveness of alternative traffic management strategies.

c. The estimates of queue length are needed for detailed decisions in engineering design, for example in assessing storage requirements for queuing vehicles.

Methods which are available for predicting queue lengths and delays are as under:

a. steady-state;
b. deterministic; and
c. time dependent queuing theories.

Basically, whether or not queuing occurs in a given stream depends on the traffic intensity, this is the ratio of flow to capacity. If this ratio is very much less than unity, queuing is rare, but otherwise it occurs to a greater or lesser extent, and whenever there is queuing vehicles are delayed.

When demand is close to capacity, or when the capacity is exceeded for short periods, the queue growth lags behind the expectations of steady state theory. So steady state theory is only acceptance with the traffic intensity is much less than unity.

Deterministic queuing theory obtains delay as a simple integral of demand minus capacity. This theory can be used when demand and capacity vary in time. However, this treatment ignores the statistical nature of traffic arrivals and departures and leads to serious underestimation in the delay unless the capacity is exceeded by a considerable margin. So this theory is only acceptable when the traffic intensity is much greater than unity.

In practical terms the most important region is that where demand and capacity are approximately equal, that is to say when traffic intensity is between 0.8 and 1.0. In this region only the dependent queuing theory is particularly useful so this is the theory which could be referenced in greater detail.

CHAPTER - III

IMPLEMENTATION PLAN OF THE STUDY

3.1 INTRODUCTION

This study is concerned with improvement of traffic flow at the Committee Chowk intersection (I-5) only. This intersection is operated with 8 approaches in 4 stages as shown in phase-stage diagram in figure-3. There were three lane Traffic on the North and South approaches and two lane traffic on the West and East approaches but the traffic had used to stop in haphazard manner at all approaches. Before commencement of the Pilot Project and also before any improvement at the intersection. The still photography and the video film was made. The original layout plan of the intersection is annexed at annexure III. Mostly in Pakistan we follow the British practice at the signals which are operated in a sequence red, red-amber together green and amber. The same is at this intersection and the signals timing were also recorded as given in the table No.3.1 below:-

Table No.3.1 Signals Timing Before Improvement of the Intersection

(In Seconds)

Phase	Before Improvement	
	North-South	West-East
G =Green	80	30
A =Amber	2	2
RF=Right Filter	15	5
R =Red	60	120
R/A = Red + Amber	2	2
Total:-	159	159

3.2 PEAK HOUR TRAFFIC VOLUME BEFORE IMPROVEMENT (EVENING)

On the above signals timing the traffic counts were made manually between 1830 Hrs to 2130 Hrs with the interval of 30 minutes to know the turning movements at all approaches of the intersection. After collecting the data of turning movement peak hour was decided. The evening peak hour traffic flows were found between 1930 Hrs to 2030 Hrs as shown in Table 3.2.

Table No.3.2.

Approach	Vehicles/hr	PCU's/hr
North	2175	1743
South	2383	1703
West	1043	749
East	575	501

3.3 ROAD MARKINGS, LANE MARKINGS AND MEDIAN BARRIERS

The actual work to stream line the traffic flow at the Committee Chowk on the Murree Road, Rawalpindi was started after the traffic count surveys. In first phase of the plan, lane Markings, Road Markings and Zebra-Crossings were completed.

To avoid wrong "U" Turning, the steel barriers were placed at all approaches, to extend the medians of the intersection. It was also observed that due to non-availability of medians on East approach (Sherpao road) and West approach (Iqbal road) traffic congestion was increasing and no place was left for the traffic coming from both East and West approaches and vice versa to cross over the intersection and head-way. To solve this problem, the steel barriers were placed at the middle of the roads to act as medians and to channelize the traffic on both East and West approaches. The medians at North and South approaches were also extended.

Extention of the medians by 30 feet through steel barriers at the intersection on the North and South approaches of Murree road facilitated all the vehicles to bring close to the stop line and to cross the intersection in a minimum time from their stop lines.

To bring into the vision of the pedestrian and drivers the above mentioned markings, Sign-Boards of "Zebra-Crossing", "No Parking", "Keep your self in proper lane" and "No Left Turn on Red Light" were also installed. Beside that an exclusive Right Turning lane of nine feet width for heavy right turners was provided at the North and South approaches as shown at Annexure IV (Dhoke Khabba intersection to Committee Chowk).

It was observed that at night time the stop lines were invisible for the drivers due to which they were used to stop their vehicles hapharzardly on the stop line. For this purpose the cat-eyes were fixed on each stop line at all approaches of the intersection to make stop lines visible.

3.4 NEW SIGNALS TIMING

After the lane markings, road markings and fixing of cat-eyes and to observe the pressure of traffic at all approaches

the following signals timing were adjusted by hit and trial method just after an improvement of the intersection and recorded as given below in the table No.3.3:-

Table No.3.3 (In Seconds)

Phase	Approaches	
	North-South	West-East
G = Green	62	42
A = Amber	2	2
RF= Right Filter	36	15
R = Red	57	98
R/A = Red + Amber	2	2
Total:-	159	159

3.5 BAN ON ANIMAL DRIVEN VEHICLES (ADVs)

ADVs are an important part of our social and cultural inheritence. They have been the backbone of our transportation system till 60's; and are still struggling hard for their survival in the modern traffic system, although very little place has been left for them now. Among these, tonga has been and also is the most important of all.

At present tonga is an important element of the composition of traffic at the Committee Chowk intersection, while crossing it in East to West directions and vice versa.

Tonga is playing its role as under:-

1. To provide transportation facilities to the lower economic group.
2. Going at such places, (i.e. on unmetalled and at rough approach etc.) where other public vehicle do'nt usually go, However it creates some problems at the intersection as given below:-

   - Hinderence in the smooth flow of traffic due to slow pick-and-motion.
   - Hazard, as they have no formal brakes.
   - Having maximum value of PCU among different modes at the said intersection.

In addition to other measures the ban was also impossed on illegal parking of the Tongas on East and West approaches close to the intersection to avoid obstruction in smoother flow of traffic.

3.6 MEETING WITH TRAFFIC CONTROLLING AUTHORITIES

After taking the above mentioned, traffic management measures, a meeting was convened between the NTRC staff and Traffic Police to overcome the remaining congestion problem. Following points were brought under discussion for further improvement in flow of traffic at the intersection:-

1. Lack of coordination between NTRC Staff and Traffic Police for proper channelization of traffic flow.
2. Need for an extra Traffic Sergeant at the Committee Chowk.
3. To ensure no Wrong parking by the Tongas at the West and East approaches close to the intersection.
4. To ensure no Wrong parking by the Public Transport out side the Bus Stop at South approach (Near Moonlite Cafe) at the intersection.
5. An assurance to control the violations of Traffic Rules by the drivers of all types of vehicle.
6. Wrong parking of the public Transport should be strictly dealt with. The wagons and bus drivers were kept moving (in the nearside lane of the road) out side the bus stop.

Finally the problem of lack of coordination between the NTRC staff and Traffic Police was solved amicably. During the exercise it was observed that due to unnecessary stopping of Public Transport (Buses and Wagons) out side the bus stop near the Moonlite Cafe at the intersection the queue length (Number of vehicles) of traffic has increased. To alleviate this problem the Public Transport Drivers were instructed to keep their vehicles moving out side the bus stop with the help of extra Sergeant.

3.7. FINAL SIGNALS TIMING AFTER IMPROVEMENT OF THE INTERSECTION

To make the traffic flow more effective and smooth, again adjustments were made in the signals timing two week before finishing the project and recorded as shown below in Table No.3.4 which produced positive results i.e. reduction in queue length comparatively at each arm of the intersection as shown in the table No.4.6.

Table No.3.4 (figures in seconds)

Phase	Approach	
	North-South	West-East
G = Green	75	35
A = Amber	2	2
RF = Right Filter	30	15
R = Red	50	105
R/A= Red + Amber	2	2
Total:-	159	159

The stage and phase diagram may be seen in figure-3 to calculate the red timings of each approach. The signals timing can also be calculated by using Computer Package "SIGSET", if available.

3.8 OTHER TRAFFIC MANAGEMENT MEASURES

Besides the work of road painting the Education Campaign to educate the Traffic Police, Drivers, Pedestrians and Cyclists remain continue by the NTRC Officers/Officials upto end of the project.

Instead of issuing challans, emphasis was given on the education to the road users to observe traffic rules which will ultimately ensure their safety, free flow of traffic and saving precious time of the public. The exercise to "Stream-Line the Traffic Flow at the Committee Chowk" on the Murree Road was carried out daily between 0600 P.M to 1000 P.M.for the period of 30 days. During the month long campaign the Traffic Police, Pedestrian and cyclists were provided information about the Sign-Boards, Lane Markings, Road Markings, Stop Lines and Zebra-Crossings and also about the work being carried out by the NTRC. Pedestrian and Cyclists were cautioned as to from where and when and on which traffic signals light they have to cross the road.

Before winding-up the project again the traffic counts by types of vehicle were made manually between 1830 Hrs to 2130 Hrs to know the turning movements at the intersection based on the final signals time settings as shown in Table No.3.4 to compare the flow of traffic and queue lengths at each arm of the intersection with the traffic flow and queue length as they were before improvement.

3.9 PEAK HOUR TRAFFIC VOLUMES AFTER IMPROVEMENT (EVENING)

The peak hour turning movements at each approach after improvement of the intersection are counted as shown below in table No.3.5:-

Table No. 3.5

Approaches	Peak Hour Traffic Volume	
	in Vehicle/hr	in PCU's
North	2471	1997
South	2633	2121
West	1282	908
East	909	758

In addition the still photography and the video film were also made once more to compare the results and also to see situation after improvement in the scheme.

3.10 MONITORING OF THE PROJECT

After termination of the Project and also it was observed that the congestion period was reduced from 2 hours to 1.5 hours, three surprise visits were made between 0600 P.M. to 0900 P.M. to check/observe the traffic flow and enforcement by the Traffic Police and also to record the signals timing.

The enforcement by the traffic Police was found satisfactory and the traffic was flowing smoothly, inspite of comparatively long queue length and the signals timing were same as they were at the end of the project.

Finally the site was observed once more after two month of finishing the project to see as to what extent the plan has been succeeded and it was found that the people were following the guidelines being provided by the NTRC's Traffic Staff.

It was observed that the intersection was fully saturated and traffic was running smoothly. In this connection appropriate information and the guidelines were provided to on duty Traffic Police at the intersection and they were asked to carry on the project as it was carried out by the NTRC.

The Traffic police authorities were also asked that the signals timing should not be disturbed, they should remain as they were on the last day of the project.

Finally the congestion period was reduced from 2 hours to 1.5 hour and the traffic flow had streamlined at the Committee Chowk (I-5), based on the following traffic management measures:-

- Controlling the pedestrian and the cyclist movement.
- Buses kept moving in the kerb side lanes.
- By providing exclusive right turners lane on North and South approach at the intersection.

- Proper channelisation at the intersection.
- Progressive settings of signals timing.
- Parking control in the kerb-side lane at all approaches of the intersection.
- By putting ban on tonga parking on East and West approaches of the intersection.

The improved lay out plan of the intersection may be seen at Annexure-IV. After completion of the Pilot Project the remaining job is left for the Traffic Department of RMC, RDA. To maintain the traffic flow, to make public aware/follow it, unless they make public abide by the Traffic Rules strictly, these problems will remain as they are.

CHAPTER - IV

DATA ANALYSIS

4.1. INTRODUCTION.

Besides taking the traffic management measures and education campaign to train the road users at Committee Chowk on Murree Road, the Traffic Count surveys were conducted (i.e before and after improvement of the intersection).

The classification used for recording the traffic flow is as follow:-

1. Car	2. Jeep	3. Suzuki Van
4. Suzuki Pickup	5. Taxi	6. Rickshaw
7. Motorcycle	8. Tractor Trolley	9. Bus
10. Wagon	11. Bicycle	12. Truck
13. Mini Bus	14. Tonga	15. Hand Cart

Table No.4.1. Vehicle Classification Conversion Factors in PCUs

Serial No.	Types of Vehicle	P C U (Equivalance)
1.	Bicycle	0.22
2.	Motorcycle	0.33
3.	Rickshaw	0.75
4.	Car,Taxi,Jeep,Suzuki	1.00
5.	Light Commercial Vehicle	1.50
6.	Buses,Trucks and Tonga(Horse Cart)	1.75
7.	Tractor Trolley	3.00
8.	Trailer with more than two axles	4.00
9.	Bullock Cart	5.00
10.	Hand Cart	1.75

The Traffic volume at each approach of the Committee chowk was counted manually with the help of Survey Staff between 1830 hrs and 2130 hrs before and after improvement of the intersection. During the surveys the weather was clear. The vehicle-wise data of peak hour traffic was also converted into Passenger Car Units (PCU's) by using the values as shown in table No.4.1.

4.2 PEAK HOUR TRAFFIC VOLUME AT EACH APPROACH OF THE INTERSECTION

The Traffic was counted with half hour Interval to find out the Peak hour Values (No. of vehicles). From the half hourly collected traffic count data the traffic count values between 1930 and 2030 hours were maximum. So that the peak hour traffic was taken between 1930 and 2030 hrs. The comparison of Peak hour traffic (before and after Improvement) at each approach of the intersection are shown in table No. 4.2 below:-

Table No. 4.2

(Fig. in numbers)

Approach	Before Improvement		After Improvement	
	Vehicles	PCU's	Vehicles	PCU's
NORTH	2175	1743	2471	1997
SOUTH	2383	1703	2633	2121
WEST	1043	749	1282	908
EAST	575	501	909	758

The details of peak hour Traffic Volume before and after improvement by types of vehicle at all approaches of the intersection in vehicles per hour are annexed at annexures V and VI respectively and in PCUs per hour are annexed at annexures VII and VIII respectively.

4.2.1 Peak Hour Traffic Volume at North Approach

At this approach 2471 Vehicles/hr were counted after improvement as compared to 2175 Vehicles/hr passing through same approach counted before improvement . Hence 13.6% more Vehicles/hr were passing after improvement of the intersection.

4.2.2 Peak Hour Traffic Volume at South Approach

From South approach 2633 vehicles/hr were passing through the intersection after its improvement as compared to 2383 vehicles/hr before. It means that after improvement of the intersection 10.5% more Vehicles were passing in each hour.

4.2.3 Peak Hour Traffic Volume at West Approach

As regards West approach 1282 Vehicles/hr were passing after improvement of the intersection and 1043 Vehicles/hr were counted before improvement which shows an increase of 23% in vehicles passing through the intersection from this approach after its improvement.

4.2.4 Peak Hour Traffic Volume at East Approach

From this approach 909 Vehicles/hr were passing after the improvement as compared to 575 Vehicles/hr recorded before improvement. This means 50% more Vehicles were passing after improvement of the intersection.

4.3 AVERAGE VEHICLES STOPPED IN RED TIME OF THE SIGNAL CYCLE (BEFORE AND AFTER IMPROVEMENT OF THE INTERSECTION)

Table No. 4.3

Weather = Clear (in vehicles)

Approach	Before Improvement				After Improvement			
	(Lt+Th)	Th	(Th+R+U)	Total	(Lt+Th)	Th	(Th+R+U)	Total
North	30	33	35	98	20	27	29	76
South	78	46	32	156	75	36	78	189
West	75	-	45	120	59	-	36	95
East	27	-	39	66	18	-	28	46

Note:- Turning Movements Lt= Left, Th= Through, R=Right, U=U Turn

The above Table No. 4.3 shows the comparison of average number of vehicles stopped in red time of the signal cycle (i.e 159 seconds) before and after improvement of the intersection at all approaches and the description of average number of vehicles at each approach are as under:

4.3.1 Average Vehicles at North Approach

At the North approach a total number of 98 vehicles were stopped i.e. 30 in the (left + Through) lane, 33 in the through Lane and 35 Vehicles in the (Right + U Turners) Lane before improvement as compared to a total number of 76 vehicles were stopped i.e. 20 in the (left + Through) lane 27 in the through lane and 29 vehicles in the (Right + U) Turners Lane after the improvement.

4.3.2 Average Vehicles at South Approach

On the average a total number of 156 vehicles were stopped at this aproach at red time of the signal cycle i.e. 78 at (left + Through) Lane 46 at Through lane and 32 at (Right + U) Turners lane before improvement of the intersection as compared to a total number of 139 vehicles i.e. 75 at (left + through) lane 36 and 28 at (Right+ U) Turners lane after improvement of the intersection.

4.3.3 Average Vehicles at West Approach

At this approach of the intersection, on the average a total number of 120 vehicles were stopped at red time of the signal cycle i.e. 75 at (left + through) lane and 45 at(Th + R+U) Turners lane before improvement as compared to a total number of 95 vehicles i.e. 59 at (left + through) lane and 36 at (Through + Right +U) Turners lane after improvement.

4.3.4 Average Vehicles at East Approach

As regards at the east approach of the intersection, on the average a total number of 66 vehicles were stopped at red time of the signal cycle i.e. 27 at (left + through) lane and 39 at (through + Right + U) Turners lane before improvement as compared to a total number of 46 vehicles were stopped i.e. 13 vehicles at (Left + Through) lane and 28 vehicles at (Through + Right + U) Turners lane after improvement.

4.4 AVERAGE QUEUE LENGTHS AT EACH APPROACH OF THE INTERSECTION AND THEIR DECREASING EFFECT

To calculate the average queue length the formula n = q R was used and the data regarding number of vehicles with equivalent in PCU's and red timings of all approaches in single cycle time before and after improvement of the intersection have been taken from the annexures V,VI,VII,VIII,IX and X respectively. The decrease in queue length at each approach on vehicles /hrs as well as in PCU/hr may be seen in tables No.4.4 and 4.5 given below:-

The results shown in the tables No.4.4 to 4.6 stated that due to basic changes made in the Signals timing (i.e Phase timings) and other Traffic management measures taken have resulted in significant decrease in the queue length formed on red time of the signal cycle on the stop line at each approach of the intersection. The description of Table No.4.6 are given as under:-

Table No.4.4 QUEUE LENGTH AT ALL APPROACHES OF THE INTERSECTION BEFORE AND AFTER IMPROVEMENT

(In Vehicles/hr)

Approach	Before Improvement								After Improvement							
	Queue Length			(L+U) Q.L=------xRd.T / 3600				(R+U) Q.L=-----xRd.T / 3600	Queue Length			(L+Th) Q.L=------xRd.T / 3600				(R+U) Q.L=--------xRd.T / 3600
	L	Th	Rd.T		R	U	Rd.T		L	Th	Rd.T		R	U	Rd.T	
NORTH	197	1520	93	44	566	190	119	25	136	1382	80	34	499	158	125	23
SOUTH	125	2041	93	56	332	135	119	15	78	1928	80	45	277	100	125	13
WEST	540	656	113	38	86	-	140	3	470	589	120	35	37	-	140	1
EAST	194	447	113	20	268	-	140	10	134	288	120	14	213	-	140	8

Note :- Rd.T = Red Time in Seconds, Q.L = Queue Length.

Table No.4.5 QUEUE LENGTH AT ALL APPROACHES OF THE INTERSECTION BEFORE AND AFTER IMPROVEMENT

(In P.C.U/hr)

Approach	Before Improvement								After Improvement							
	Queue Length			(L+Th) Q.L =------x Rd.T / 3600				(R+U) Q.L =-----x Rd.T / 3600	Queue Length			(L+Th) Q.L=------xRd.T / 3600				(R+U) Q.L=-----xRd.T / 3600
	L	Th	Rd.T		R	U	Rd.T		L	Th	Rd.T		R	U	Rd.T	
NORTH	139	1371	93	39	358	128	119	16	94	1236	80	30	307	104	125	14
SOUTH	92	1662	93	45	255	112	119	12	53	1547	80	36	212	88	125	10
WEST	367	472	113	26	69	-	140	3	314	408	120	24	27	-	140	1
EAST	154	409	113	18	192	-	140	7	103	241	120	11	155	-	140	6

Note:- Rd.T = Red Time in Seconds, Q.L = Queue Length.

4.4.4 Decrease in Queue Length at West - East Approach

In the (Left + Through) Lane at this aproach of the intersection the average queue length was calculated as 20 vehicles before improvement as compared to 14 vehicles after, indicating a decrease in queue length of 30% in terms of vehicles, after improvement measures. The decrease in terms of PCU's was 38.9%. As regards (Right + U) Turners Lane of this approach the average queue length was 10 vehicles before the improvement measures of the intersection as compared to 8 vehicles calculated after improvement measures were taken registering a decrease of 20% in the queue length. The decrease in average queue length in terms of PCU's was 14.3%.

CHAPTER - V

CONCLUSIONS

On completion of the demonstration project. The following conclusions were made:-

1. Signals Timing of the intersection were not properly adjusted to manage maximum flow of Traffic.

2. The Police force deputed at the intersection was not properly trained to strictly enforce the traffic rules.

3. There were no Lane Markings, Road markings and Zebra Crossings on the road to guide the road users.

4. Parking of Tonga's near and at the intersection were one of the main reason for hinderence in the smoother traffic flow.

5. Foot Paths were not properly maintained and was a problem for pedestrians to use them as side walks comfortably.

6. Medians on Murree Road were not extended upto the stop lines which distrubs the smooth flow of traffic specially by U-Turn's and Right Turn's.

7. Behaviour of road users was indisciplined and haphazrd.

8. Due to non availability of medians on East and West approaches, discipline in traffic could not be maintained

Finally the site was observed again two months later after the completion of the project to see as to what extent the plan has been succeeded and it was found that the people were following the guidelines being provided by the NTRC's Traffic Staff.

It was observed that the traffic was running smoothly. In this connection all appropriate information and the guidelines were provided to the on duty Traffic Police at the intersection and they were asked to carry on the project as it was carried out by the NTRC.

The Traffic police authorities were also asked that the signals timing should not be disturbed, they should remain as they were adjusted while the project was carried out.

Finally efforts made by the NTRC staff have stream lined the traffic flow at Committee Chowk (I-5) and the congestion period reduced by half hour based on the following traffic management measures:-

- Controlling the pedestrians and the cyclists movement.
- Buses kept moving in the kerb side lanes.
- By providing exclusive right turners lane on North and South approach at the intersection.
- Proper channelisation at the intersection.
- Progressive settings of signals timing.
- Parking control in the kerb-side lane at all approaches of the intersection.
- By putting ban on tonga parking on East and West approaches of the intersection.

The improved lay out plan of the intersection may be seen at Annexure-IV.

To maintain the traffic flow after the completion of Pilot Project. The remaining job is left for the Traffic Department of Rawalpindi Municipal Corporation (RMC), Rawalpindi Development Authority (RDA), to make awareness of the guide lines and to follow them. Unless they make public abide by the Traffic Rules strictly, these problems will remain there.

Besides, adequate education of road users, strict enforcement measures by traffic police are absolutely essential for successful functioning of the intersection.

CHAPTER - VI

RECOMMENDATIONS

On the basis of conclusions and practical demonstration the following recommendations are made to keep smoother flow of traffic at the Committee Chowk that may be maintained to avoid further congestion at the intersection.

1. Before start and during the demonstration project. Wide publicity of all the projects may be undertaken by the concerned agencies by using all medias (i.e.Radio, Television, Press and Hand Bills etc.).

2. A detail design of the intersection should be prepared based on the following recommendations with the help of a Traffic Engineer.

3. It is better to provide 08 feet wide exclusive right turn lane at South arm of the intersection to avoid unnecessary delays for the through traffic.

4. Signal posts at all approaches of the intersection should be brought closer to the stop line of the intersection as shown at annexure IV.

5. The concrete median should be extended upto the stop lines at North and South ends of the major approaches of the intersection on Murree Road with existing width.

6. The median of concrete should also be constructed with a width of atleast one foot on West and East ends of the minor approaches. The median should be atleast 100 feet in length from the stop line of the intersection.

7. The Dhoke-Khabba intersection close to the Committee Chowk, may be opened for every traffic to reduce the load of traffic occured due to large volume of "U" Turns at the Committee Chowk from North Approach.

8. Lane markings, Road markings, zebra crossings should be painted regularly after every six months time to make awareness to the road users for using lane markings, road markings and zebra crossings etc.

9. Damaged Cat eyes should be replaced as and when required.

10. Signals timing should be checked and maintained regularly as recommended in the report.

11. A Mini round about should be provided at Shah-ke-Tallian for "U" Turns at South approach of the intersection to reduce unnecessary traffic load of U-Turners at this approach.

12. Steel Guard-rails should be installed at the intersection as shown in Annexure-IV.

13. Traffic rules should be enforced strictly by the traffic Police.

14. Foot-Paths should be maintained properly.

15. Electric poles, telephone poles and un-necessary obstacles should be removed from the vicinity of the intersection in order to avoid impaired visibility.

16. Restriction on tongas should be imposed on standing close to the intersection.

17. Couple of Sergeants with motor bikes may be deputed at Committee Chowk one has to be posted at bus stop (near moonlite Cafe) and other at Committee Chowk.

18. The Traffic Police force being posted at the intersections for duty should be given additional incentives in order to encourage them so that they may perform their duty efficiently and honestly.

19. Under passes for the pedestrians may be constructed in the long run as shown in the annexure-II.

20. Before carrying out any project or imposing new rules the representative from transport union and public should be involved for discussion.

21. Before widening or construction of new roads, the future growth of vehicles must be forecasted.

22. Finally to maintain the smoother traffic flow the signals timing given in the table No.3.4 may be followed.

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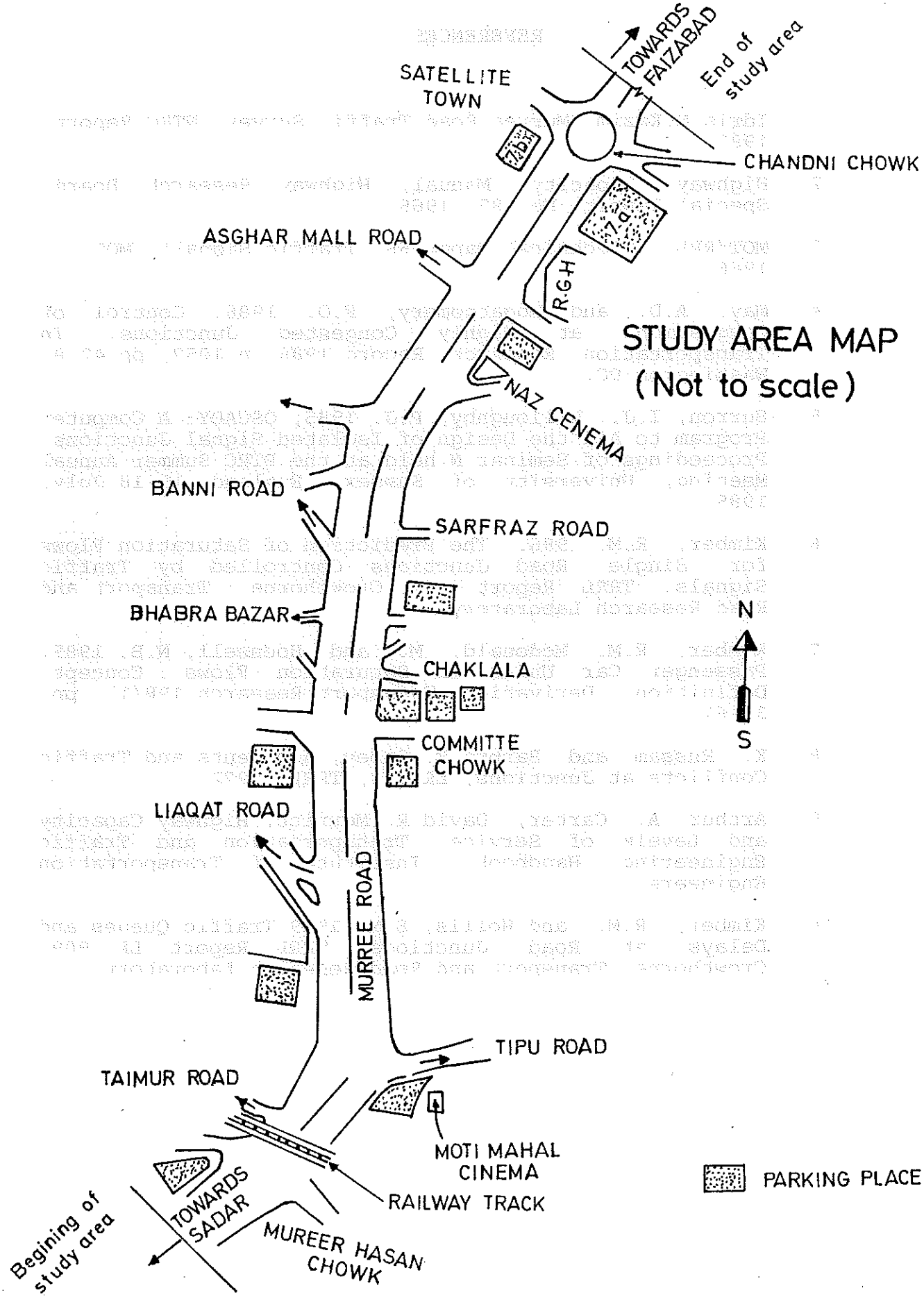
ANNEXURE–I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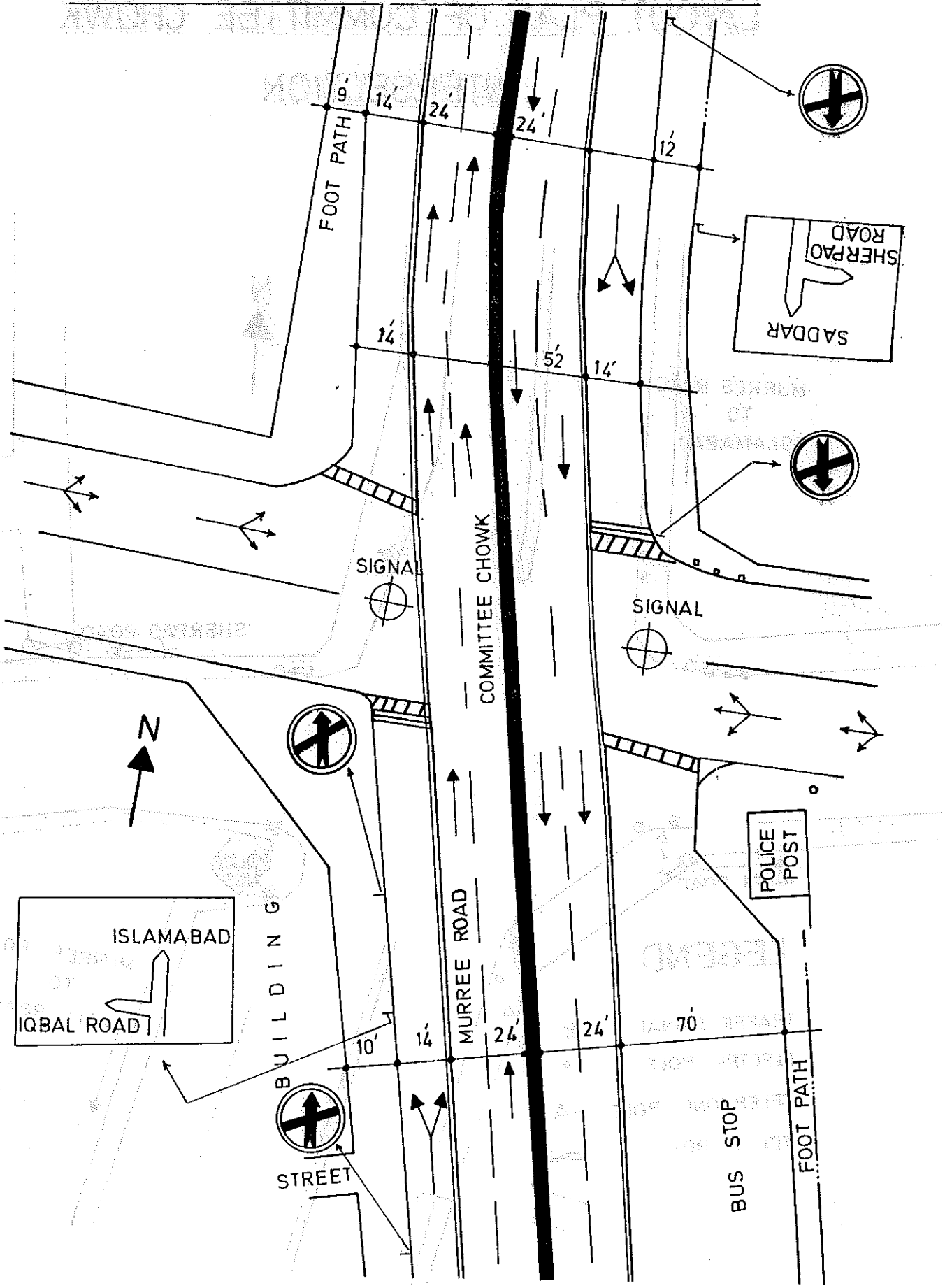
TOWARDS FAIZABAD
End of study area
CHANDNI CHOWK
7.b
7.a
ASGHAR MALL ROAD
R.G.H
NAZ CENEMA
STUDY AREA MAP
(Not to scale)
BANNI ROAD
SARFRAZ ROAD
BHABRA BAZAR
N
S
CHAKLALA
COMMITTE CHOWK
LIAQAT ROAD
MURREE ROAD
TIPU ROAD
TAIMUR ROAD
MOTI MAHAL CINEMA
RAILWAY TRACK
PARKING PLACE
TOWARDS SADAR
Begining of study area
MUREER HASAN CHOWK

ANNEXURE II

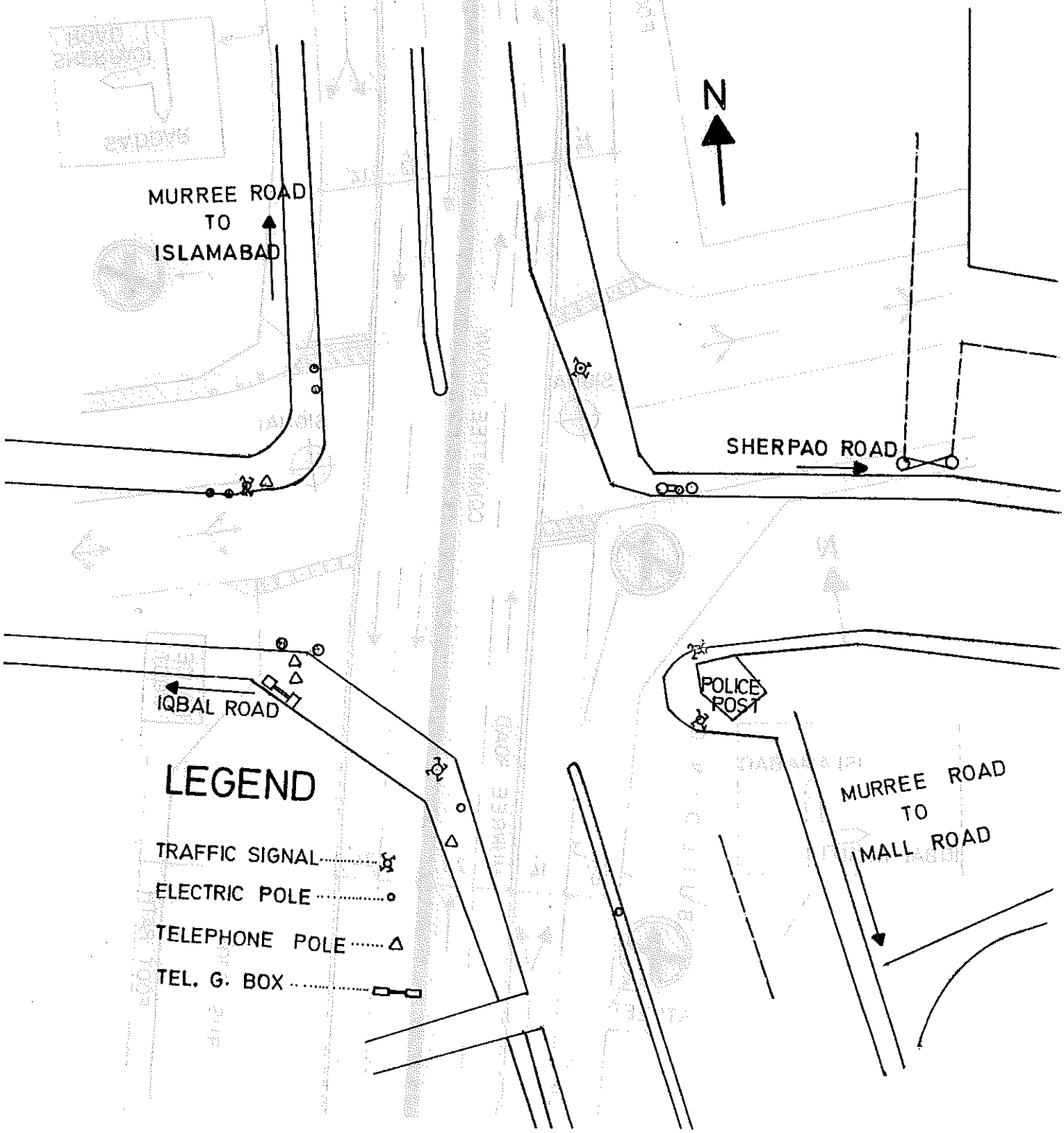
PROPOSED GRADE SEPARATED JUNCTION



ANNEXURE III

LAYOUT PLAN OF COMMITTEE CHOWK

INTERSECTION

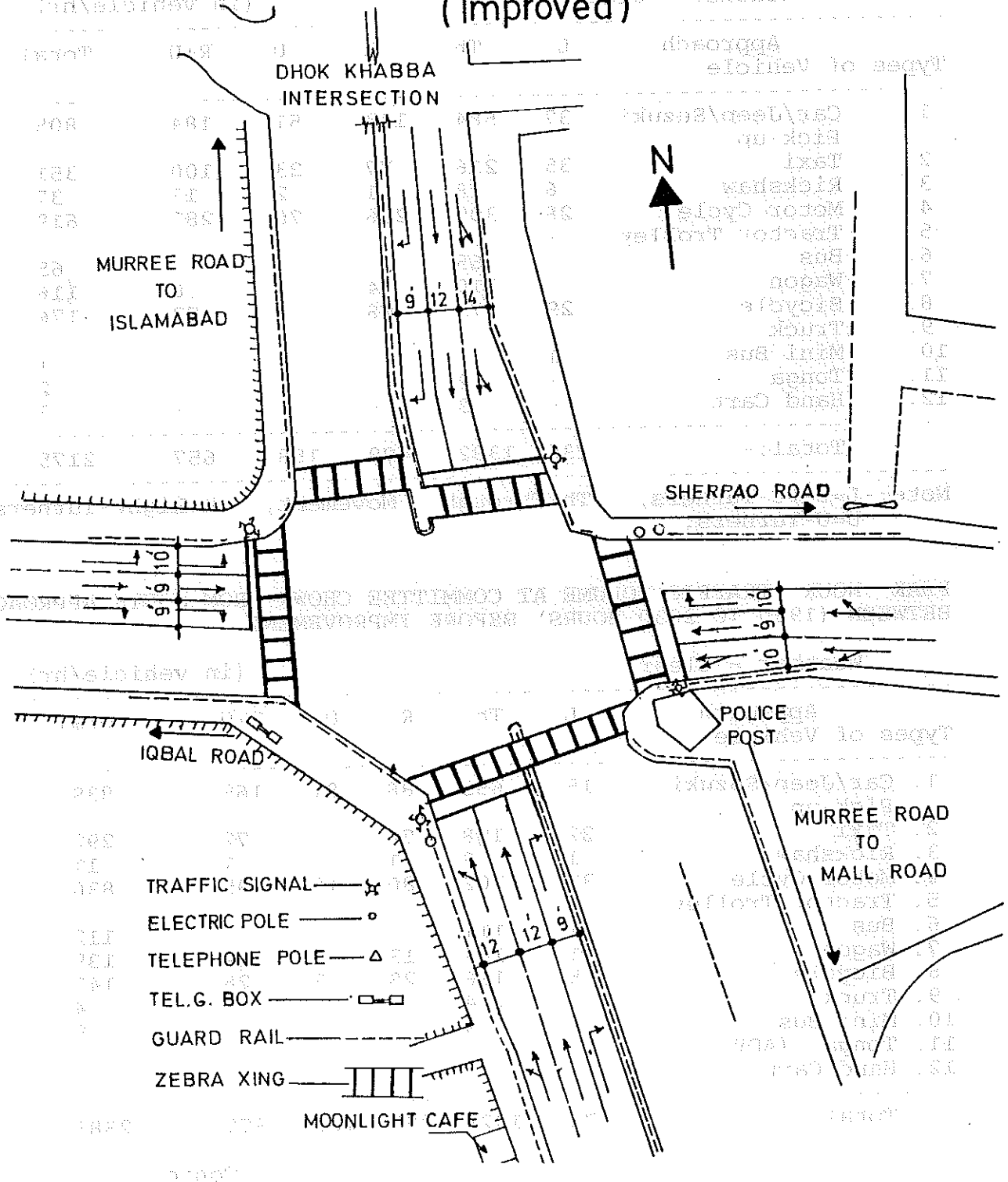


ANNEXURE - IV

LAYOUT PLAN OF COMMITTEE CHOWK

INTERSECTION

(Improved)



Annexure-V

HOUR TRAFFIC VOLUME AT COMMITTEE CHOWK FROM NORTH APPROACH BETWEEN (1930 TO 2030 HOURS) BEFORE IMPROVEMENT

Weather = Clear (in vehicle/hr)

Types of Vehicle	Approach	L	Th	R	U	R+U	Total
1.	Car/Jeep/Suzuki Pick-up	37	584	133	51	184	805
2.	Taxi	35	216	77	23	100	351
3.	Rickshaw	6	18	11	2	13	37
4.	Motor Cycle	28	309	206	76	282	619
5.	Tractor Trolley	-	-	-	-	-	-
6.	Bus	-	65	-	-	-	65
7.	Wagon	-	110	4	2	6	116
8.	Bicycle	29	75	68	4	72	176
9.	Truck	-	-	-	-	-	-
10.	Mini Bus	1	-	-	-	-	1
11.	Tonga	-	2	-	-	-	2
12.	Hand Cart	-	3	-	-	-	3
	Total:-	136	1382	499	158	657	2175

Note:-L=Left-Turners, Th=Through Movement, R=Right-Turners, U=U-Turners.

PEAK HOUR TRAFFIC VOLUME AT COMMITTEE CHOWK FROM SOUTH APPROACH BETWEEN (1930 TO 2030 HOURS) BEFORE IMPROVEMENT

Weather = Clear (in vehicle/hr)

Types of Vehicle	Approach	L	Th	R	U	R+U	Total
1.	Car/Jeep/Suzuki Pick-up	15	655	88	81	169	839
2.	Taxi	22	198	72	-	72	292
3.	Rickshaw	1	9	1	-	1	11
4.	Motor Cycle	33	702	80	15	95	830
5.	Tractor Trolley	-	-	-	-	-	-
6.	Bus	1	111	-	-	-	112
7.	Wagon	1	124	13	1	14	139
8.	Bicycle	5	116	23	3	26	147
9.	Truck	-	4	-	-	-	4
10.	Mini Bus	-	9	-	-	-	9
11.	Tonga (ADV)	-	-	-	-	-	-
12.	Hand Cart	-	-	-	-	-	-
	Total:-	78	1928	277	100	377	2383

Contd.....

Annexure-V

PEAK HOUR TRAFFIC VOLUME AT COMMITTEE CHOWK FROM WEST APPROACH BETWEEN (1930 TO 2030 HOURS) BEFORE IMPROVEMENT

Weather = Clear (in vehicle/hr)

Types of Vehicle	Approach	L	Th	R	U	R+U	Total
1.	Car/Jeep/Suzuki Pick-up	134	73	7	-	7	214
2.	Taxi	98	38	3	-	3	139
3.	Rickshaw	18	35	2	-	2	55
4.	Motor Cycle	158	202	19	-	19	379
5.	Tractor Trolley	-	-	-	-	-	-
6.	Bus	-	-	-	-	-	-
7.	Wagon	2	46	6	-	6	54
8.	Bicycle	7	142	-	-	-	149
9.	Truck	-	-	-	-	-	-
10.	Mini Bus	-	2	-	-	-	2
11.	Tonga	-	47	-	-	-	47
12.	Hand Cart	-	4	-	-	-	4
	Total:-	417	589	37	-	37	1043

PEAK HOUR TRAFFIC VOLUME AT COMMITTEE CHOWK FROM EAST APPROACH BETWEEN (1930 TO 2030 HOURS) BEFORE IMPROVEMENT

Weather = Clear (in vehicle/hr)

Types of Vehicle	Approach	L	Th	R	U	R+U	Total
1.	Car/Jeep/Suzuki Pick-up	21	-	107	-	107	128
2.	Taxi	43	49	-	-	-	92
3.	Rickshaw	4	22	3	-	3	29
4.	Motor Cycle	26	-	3	-	3	29
5.	Tractor Trolley	-	-	-	-	-	-
6.	Bus	-	-	-	-	-	-
7.	Wagon	1	8	-	-	-	8
8.	Bicycle	11	168	21	-	21	200
9.	Truck	-	1	-	-	-	1
10.	Mini Bus	4	6	-	-	-	10
11.	Tonga	-	75	-	-	-	75
12.	Hand Cart	-	2	-	-	-	2
	Total:-	110	331	134	-	134	575

Annexure-VI

PEAK HOUR TRAFFIC VOLUME AT COMMITTEE CHOWK FROM NORTH APPROACH BETWEEN (1930 TO 2030 HOURS) AFTER IMPROVEMENT

Weather = Clear (in vehicle/hr)

Types of Vehicle / Approach	L	Th	R	U	R+U	Total
1. Car/Jeep/Suzuki Pick-up	52	604	140	45	185	841
2. Taxi	50	241	99	35	134	425
3. Rickshaw	10	29	20	8	28	67
4. Motor Cycle	40	330	218	85	303	673
5. Tractor Trolley	-	-	-	-	-	-
6. Bus	-	85	-	-	-	85
7. Wagon	-	120	10	8	18	138
8. Bicycle	40	98	79	9	88	226
9. Truck	-	8	-	-	-	8
10. Mini Bus	5	1	-	-	-	6
11. Tonga	-	-	-	-	-	-
12. Hand Cart	-	2	-	-	-	2
Total:-	197	1518	566	190	756	2471

PEAK HOUR TRAFFIC VOLUME AT COMMITTEE CHOWK FROM SOUTH APPROACH BETWEEN (1930 TO 2030 HOURS) AFTER IMPROVMENT

Weather = Clear (in vehicle/hr)

Types of Vehicle / Approach	L	Th	R	U	R+U	Total
1. Car/Jeep/Suzuki Pick-up	28	690	95	86	181	899
2. Taxi	35	209	85	5	90	334
3. Rickshaw	5	15	5	4	9	29
4. Motor Cycle	42	710	89	25	114	866
5. Tractor Trolley	-	-	-	-	-	-
6. Bus	3	120	-	-	-	123
7. Wagon	2	140	23	5	28	170
8. Bicycle	10	135	35	10	45	190
9. Truck	-	10	-	-	-	10
10. Mini Bus	-	12	-	-	-	12
11. Tonga	-	-	-	-	-	-
12. Hand Cart	-	-	-	-	-	-
Total:-	125	2041	332	135	467	2633

Contd....

Annexure-VI

PEAK HOUR TRAFFIC VOLUME AT COMMITTEE CHOWK FROM WEST APPROACH BETWEEN (1930 TO 2030 HOURS) AFTER IMPROVEMENT

Weather = Clear (in vehicle/hr)

Approach Types of Vehicle	L	Th	R	U	R+U	Total
1. Car/Jeep/Suzuki Pick-up	149	77	15	-	15	241
2. Taxi	110	39	17	-	17	166
3. Rickshaw	29	48	8	-	8	85
4. Motor Cycle	169	210	27	-	27	406
5. Tractor Trolley	-	-	-	-	-	-
6. Bus	3	-	-	-	-	3
7. Wagon	5	55	12	-	12	72
8. Bicycle	75	159	5	-	5	239
9. Truck	-	-	-	-	-	-
10. Mini Bus	-	2	2	-	2	4
11. Tonga	-	59	-	-	-	59
12. Hand Cart	-	7	-	-	-	7
Total:-	540	656	86	-	86	1282

PEAK HOUR TRAFFIC VOLUME AT COMMITTEE CHOWK FROM EAST APPROACH BETWEEN (1930 TO 2030 HOURS) AFTER IMPROVEMENT

Weather = Clear (in vehicle/hr)

Approach Types of Vehicle	L	Th	R	U	R+U	Total
1. Car/Jeep/Suzuki Pick-up	50	10	140	-	140	200
2. Taxi	55	75	5	-	5	135
3. Rickshaw	10	39	9	-	9	58
4. Motor Cycle	45	5	75	-	75	125
5. Tractor Trolley	-	-	-	-	-	-
6. Bus	-	1	4	-	4	5
7. Wagon	5	15	-	-	-	20
8. Bicycle	20	185	35	-	35	240
9. Truck	2	3	-	-	-	5
10. Mini Bus	7	10	-	-	-	17
11. Tonga	-	99	-	-	-	99
12. Hand Cart	-	5	-	-	-	5
Total:-	194	447	268	-	268	909

Annexure-VII

PEAK HOUR TRAFFIC VOLUME AT COMMITTEE CHOWK FROM NORTH APPROACH BETWEEN (1930 TO 2030 HOURS) BEFORE IMPROVEMENT

Weather = Clear (in P.C.U./hr)

Approach Types of Vehicle	L	Th	R	U	R+U	Total
1. Car/Jeep/Suzuki Pick-up	37	584	133	51	184	805
2. Taxi	35	216	77	23	100	351
3. Rickshaw	5	14	8	2	10	29
4. Motor Cycle	9	102	68	25	93	204
5. Tractor Trolley	-	-	-	-	-	-
6. Bus	-	130	-	-	-	130
7. Wagon	-	165	6	3	9	174
8. Bicycle	6	17	15	1	16	39
9. Truck	-	-	-	-	-	-
10. Mini Bus	2	-	-	-	-	2
11. Tonga	4	-	-	-	-	4
12. Hand Cart	-	5	-	-	-	5
Total:-	98	1233	307	105	412	1743

PEAK HOUR TRAFFIC VOLUME AT COMMITTEE CHOWK FROM SOUTH APPROACH BETWEEN (1930 TO 2030 HOURS) BEFORE IMPROVEMENT

Weather = Clear (in P.C.U./hr)

Approach Types of Vehicle	L	Th	R	U	R+U	Total
1. Car/Jeep/Suzuki Pick-up	15	655	88	81	169	839
2. Taxi	22	198	72	-	72	292
3. Rickshaw	1	7	1	-	1	9
4. Motor Cycle	11	232	26	5	31	274
5. Tractor Trolley	-	-	-	-	-	-
6. Bus	2	22	-	-	-	24
7. Wagon	2	186	20	2	22	210
8. Bicycle	1	26	5	1	6	33
9. Truck	-	8	-	-	-	8
10. Mini Bus	-	14	-	-	-	14
11. Tonga	-	-	-	-	-	-
12. Hand Cart	-	-	-	-	-	-
Total:-	54	1348	212	89	301	1703

Contd.....

Annexure-VII

PEAK HOUR TRAFFIC VOLUME AT COMMITTEE CHOWK FROM WEST APPROACH BETWEEN (1930 TO 2030 HOURS) BEFORE IMPROVEMENT

Weather = Clear (in P.C.U./hr)

Types of Vehicle	Approach	L	Th	R	U	R+U	Total
1.	Car/Jeep/Suzuki Pick-up	134	73	7	-	7	214
2.	Taxi	98	38	3	-	3	139
3.	Rickshaw	14	26	2	-	2	42
4.	Motor Cycle	52	67	6	-	6	125
5.	Tractor Trolley	-	-	-	-	-	-
6.	Bus	-	-	-	-	-	-
7.	Wagon	3	69	9	-	9	81
8.	Bicycle	13	31	-	-	-	44
9.	Truck	-	-	-	-	-	-
10.	Mini Bus	-	3	-	-	-	3
11.	Tonga	-	94	-	-	-	94
12.	Hand Cart	-	7	-	-	-	7
	Total:-	314	408	27	-	27	749

PEAK HOUR TRAFFIC VOLUME AT COMMITTEE CHOWK FROM EAST APPROACH BETWEEN (1930 TO 2030 HOURS) BEFORE IMPROVEMENT

Weather = Clear (in P.C.U./hr)

Types of Vehicle	Approach	L	Th	R	U	R+U	Total
1.	Car/Jeep/Suzuki Pick-up	21	-	107	-	107	128
2.	Taxi	43	49	-	-	-	92
3.	Rickshaw	3	17	2	-	2	22
4.	Motor Cycle	10	-	20	-	20	30
5.	Tractor Trolley	-	-	-	-	-	-
6.	Bus	-	-	-	-	-	-
7.	Wagon	2	12	-	-	-	14
8.	Bicycle	2	37	5	-	5	44
9.	Truck	-	2	-	-	-	2
10.	Mini Bus	6	9	-	-	-	15
11.	Tonga	-	150	-	-	-	150
12.	Hand Cart	-	4	-	-	-	4
	Total:-	87	280	134	-	134	501

Annexure-VIII

PEAK HOUR TRAFFIC VOLUME AT COMMITTEE CHOWK FROM NORTH APPROACH BETWEEN (1930 TO 2030 HOURS) AFTER IMPROVEMENT

Weather = Clear (in P.C.U./hr)

Types of Vehicle	Approach	L	Th	R	U	R+U	Total
1.	Car/Jeep/Suzuki Pick-up	52	604	140	45	185	841
2.	Taxi	50	241	99	35	134	425
3.	Rickshaw	7	22	15	6	21	50
4.	Motor Cycle	13	109	72	28	100	222
5.	Tractor Trolley	-	-	-	-	-	-
6.	Bus	-	170	-	-	-	170
7.	Wagon	-	183	15	12	27	210
8.	Bicycle	9	22	17	2	19	50
9.	Truck	-	16	-	-	-	16
10.	Mini Bus	8	1	-	-	-	9
11.	Tonga	-	-	-	-	-	-
12.	Hand Cart	-	4	-	-	-	4
	Total:-	139	1372	358	128	486	1997

PEAK HOUR TRAFFIC VOLUME AT COMMITTEE CHOWK FROM SOUTH APPROACH BETWEEN (1930 TO 2030 HOURS) AFTER IMPROVEMENT

Weather = Clear (in P.C.U./hr)

Types of Vehicle	Approach	L	Th	R	U	R+U	Total
1.	Car/Jeep/Suzuki Pick-up	28	690	95	86	181	899
2.	Taxi	35	209	85	5	90	334
3.	Rickshaw	4	11	4	3	7	22
4.	Motor Cycle	14	234	29	8	37	285
5.	Tractor Trolley	-	-	-	-	-	-
6.	Bus	6	240	-	-	-	246
7.	Wagon	3	210	34	8	42	255
8.	Bicycle	2	30	8	2	10	42
9.	Truck	-	20	-	-	-	20
10.	Mini Bus	-	18	-	-	-	18
11.	Tonga	-	-	-	-	-	-
12.	Hand Cart	-	-	-	-	-	-
	Total:-	92	1662	255	112	367	2121

Contd...

Annexure-VIII

PEAK HOUR TRAFFIC VOLUME AT COMMITTEE CHOWK FROM WEST APPROACH BETWEEN (1930 TO 2030 HOURS) AFTER IMPROVEMENT

Weather = Clear (in P.C.U./hr)

Approach Types of Vehicle	L	Th	R	U	R+U	Total
1. Car/Jeep/Suzuki Pick-up.	149	77	15	-	15	241
2. Taxi	110	39	17	-	17	166
3. Rickshaw	22	36	6	-	6	64
4. Motor Cycle	56	69	9	-	9	134
5. Tractor Trolley	-	-	-	-	-	-
6. Bus	6	-	-	-	-	6
7. Wagon	8	83	18	-	18	109
8. Bicycle	16	35	1	-	1	52
9. Truck	-	-	-	-	-	-
10. Mini Bus	-	3	3	-	3	6
11. Tonga	-	118	-	-	-	118
12. Hand Cart	-	12	-	-	-	12
Total:-	367	472	69	-	69	908

PEAK HOUR TRAFFIC VOLUME AT COMMITTEE CHOWK FROM EAST APPROACH BETWEEN (1930 TO 2030 HOURS) AFTER IMPROVEMENT

Weather = Clear (in P.C.U./hr)

Approach Types of Vehicle	L	Th	R	U	R+U	Total
1. Car/Jeep/Suzuki Pick-up.	50	10	140	-	140	200
2. Taxi	55	75	5	-	5	135
3. Rickshaw	8	29	7	-	7	44
4. Motor Cycle	15	2	25	-	25	42
5. Tractor Trolley	-	-	-	-	-	-
6. Bus	-	2	8	-	8	10
7. Wagon	8	23	-	-	-	31
8. Bicycle	4	41	8	-	8	53
9. Truck	4	6	-	-	-	10
10. Mini Bus	11	15	-	-	-	26
11. Tonga	-	198	-	-	-	198
12. Hand Cart	-	9	-	-	-	9
Total:-	155	410	193	-	193	758

Annexure-IX

RED TIMINGS AT EACH APPROACH BEFORE IMPROVEMENT OF THE INTERSECTION (In Seconds)

Stages	I	II	III	IV	Red Timings
Approaches					
NORTH (Left+Through)	G	R	R	R	93
SOUTH (Left+Through)	G	R	R	R	93
NORTH (Right)	R	G	R	R	119
SOUTH (Right)	R	G	R	R	119
WEST (Left+Through)	R	R	G	R	113
EAST (Left+Through)	R	R	G	R	113
WEST (Right)	R	R	R	G	140
EAST (Right)	R	R	R	G	140
Green Times	62	36	42	15	

Note:- Cycle Time 159 Seconds including (Red + Amber) Time 02 Second and Amber Time 02 Second.

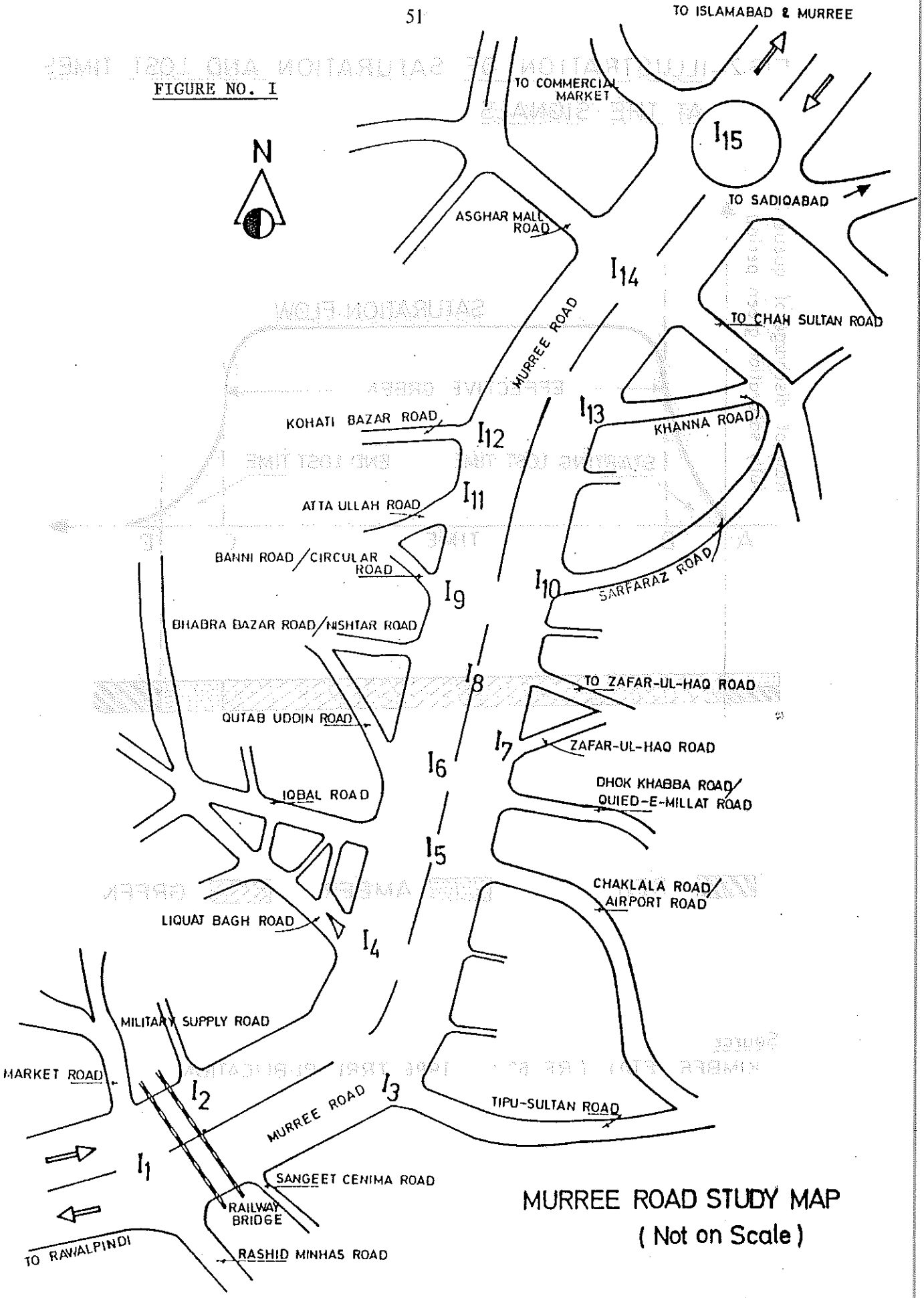
Annexure-X

RED TIMINGS AT EACH APPROACH AFTER IMPROVEMENT OF THE INTERSECTION (In Seconds)

Stages	I	II	III	IV	Red Timings
Approach					
NORTH (Left+Through)	G	R	R	R	80
SOUTH (Left+Through)	G	R	R	R	80
NORTH (Right)	R	G	R	R	125
SOUTH (Right)	R	G	R	R	125
WEST (Left+Through)	R	R	G	R	120
EAST (Left+Through)	R	R	G	R	120
WEST (Right)	R	R	R	G	140
EAST (Right)	R	R	R	G	140
Green Times	75	30	35	15	-

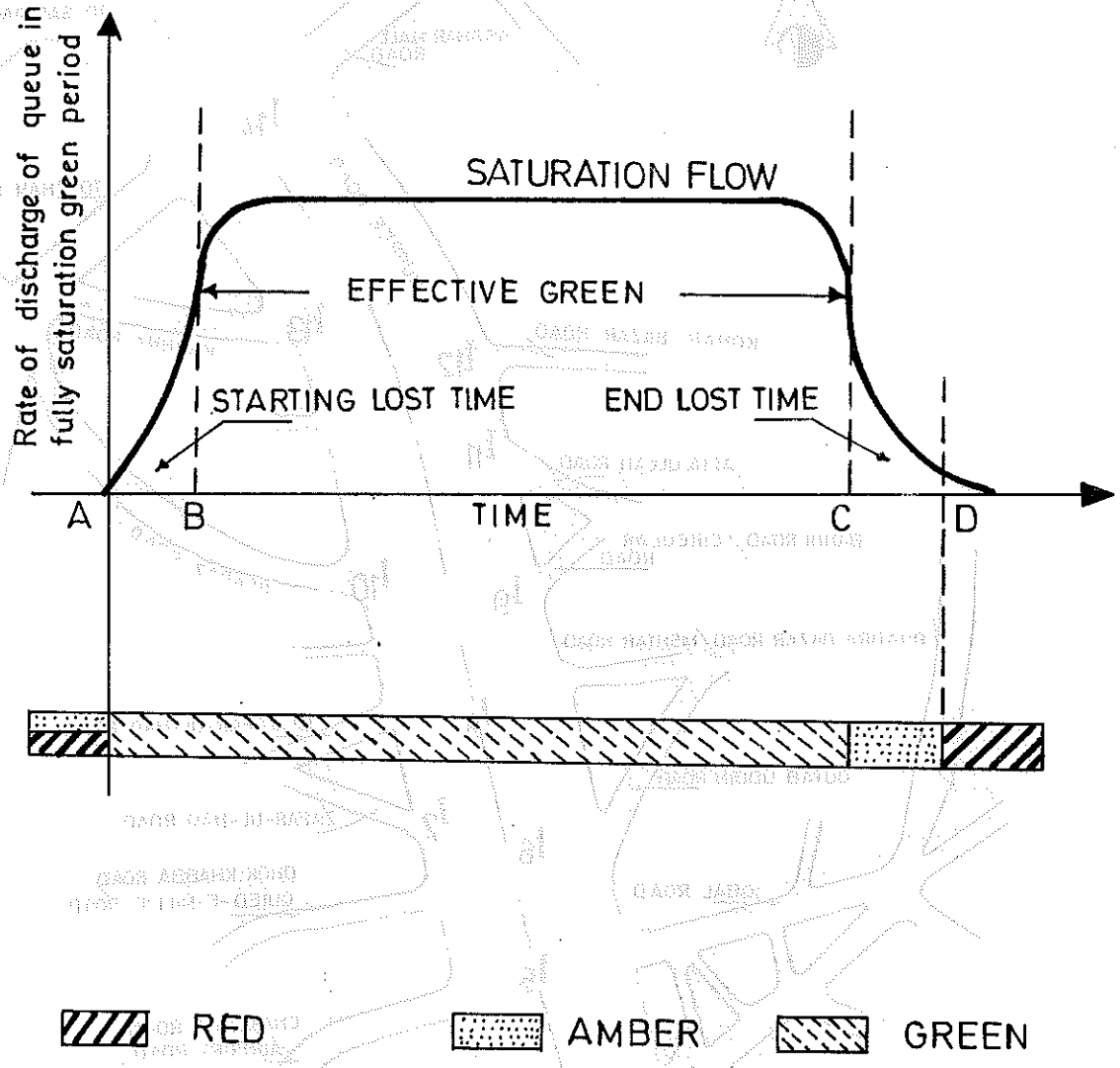
Note:- Cycle time 159 seconds including (Red+Amber) Time 02 Second and Amber Time 02 Second.

FIGURE NO. I



MURREE ROAD STUDY MAP
(Not on Scale)

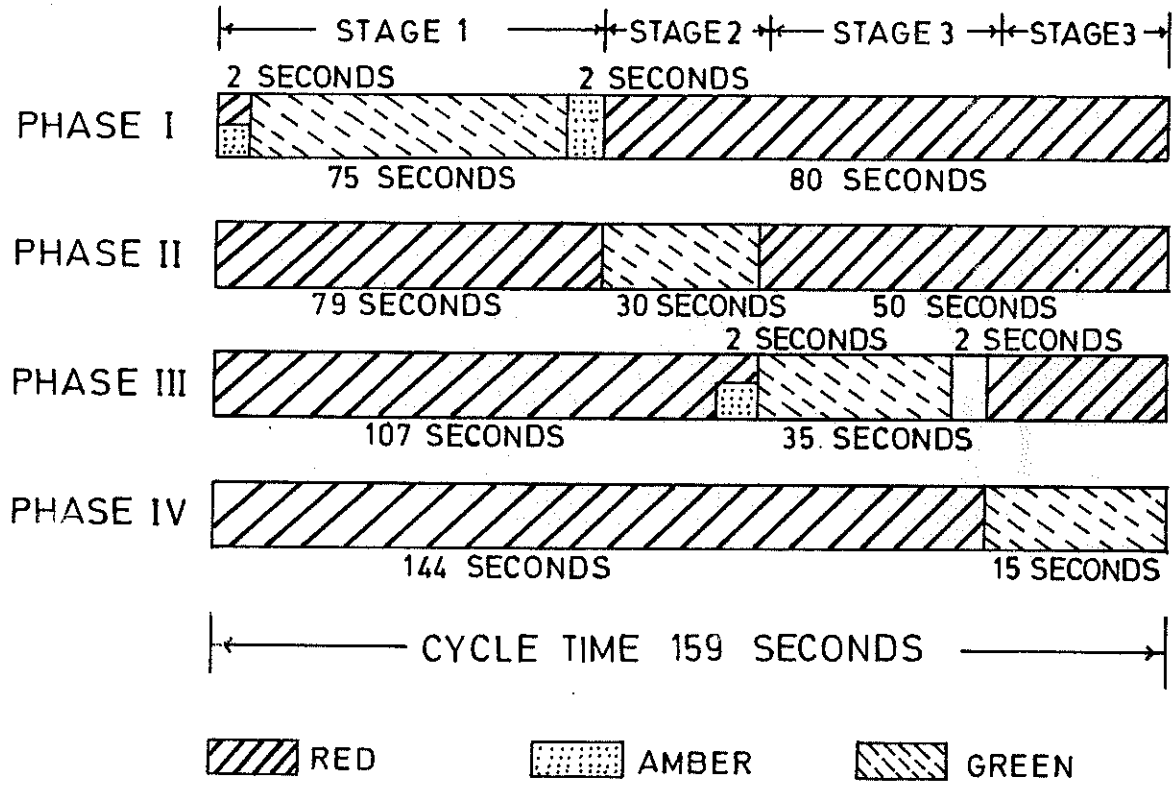
FIG:2–ILLUSTRATION OF SATURATION AND LOST TIMES AT THE SIGNALS



Source

KIMBER ETAL (RR 67) , 1986. TRRL, PUBLICATION

FIG-3: PHASE-STAGE DIAGRAM



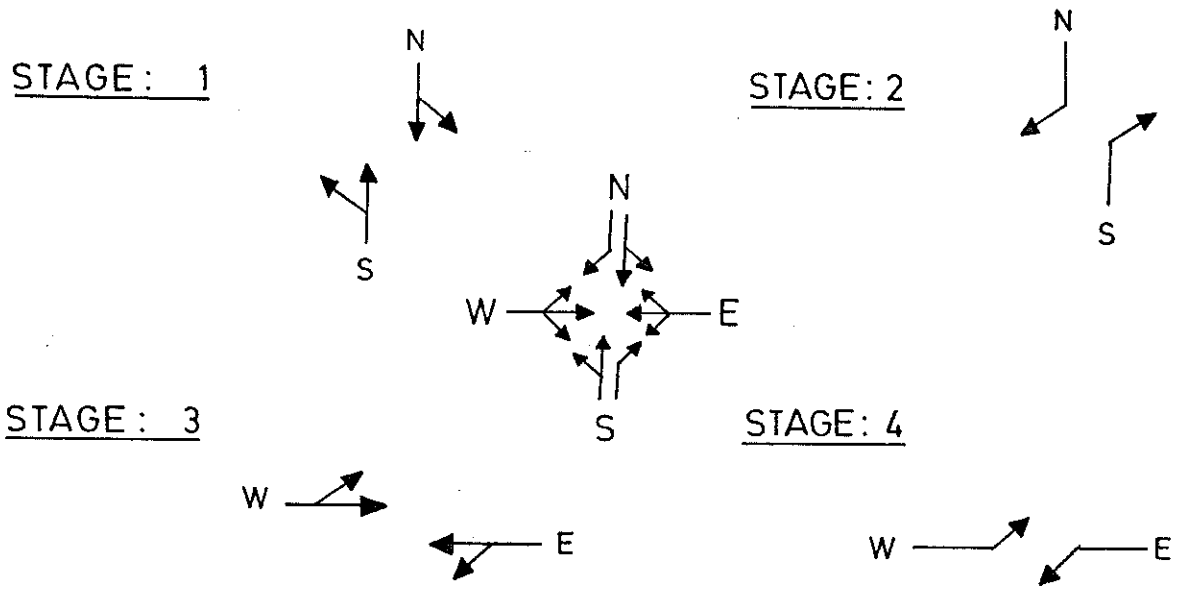


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FIG - 2 PHASE – STAGE DIAGRAM