by seepage due to a rise in the water table adjacent to the road. Particularly with the clay/silt soils prevalent in Calcutta the additional moisture will decrease the strength of the road foundation. The resulting movement of the surface layers under the passage of heavy vehicles in this situation will further damage the surface layers and allow more moisture to penetrate.

The ideal solution under these circumstances so that the life of the pavement can be maximized is to improve the surface and sub-soil drainage so that the foundation moisture can be reduced and kept at a fairly uniform level throughout the season. Normally this would be achieved by roadside ditches or drainage pipes combined with subsoil drainage pipes as necessary. Such a drainage system can only be effective if the main drainage infrastructure is adequate and allows the ditches and pipes to drain freely. In Calcutta however, the drainage infrastructure cannot always cope with the heavy monsoon rains and flooding occurs. A heavy investment in drainage pipes, channels and pumping stations would be required so it may be many years before effective pavement and sub-soil drainage can be installed.

Since concrete roads are better able to tolerate higher foundation moisture levels and variations in the water table they should, if properly designed and constructed, be able to provide a relatively maintenance free pavement even under the conditions experienced in Calcutta.

In addition to the technical performance of the concrete road in service there are other important factors which must be given careful consideration before proceeding with any concreting proposals.

Firstly, any major existing underground utilities running along the roadway and underneath the pavement should be relocated to the verge so that access will be available for maintenance of the utility. For minor services it may be acceptable to leave the pipes or cables in position and construct the concrete pavement above after protecting as necessary. Should problems occur after construction it may be necessary to abandon the utility and construct a replacement beside the concrete road.

Where existing underground utilities are crossing the proposed concrete roadway it may be necessary to either construct a service duct around the utility so that it can be withdrawn if necessary or to provide additional protection, encasing in concrete for example to minimize the likelihood of future problems.

Possible requirements for the construction of new underground facilities in the future must also be considered and allowance made in the construction, by provision of ducts under the road at appropriate locations for example.

Provision for existing and future underground utilities could potentially add significantly to the cost of concreting roads and may make concreting uneconomical. It is for this reason that concrete roads are not often constructed in heavily built up areas with many underground utilities.

A second factor which must also be considered when working on existing roads is the longer construction time for concrete in comparison to asphalt resheeting. The time required for preparation, forming, reinforcing, pouring and then curing the concrete before traffic can be allowed is significant even if the road is constructed in short lengths and the disruption to traffic is substantially increased.

### 10.2.3 Project Costing

For estimation purposes the concrete pavement has been assumed to require the following;

1. Excavate existing pavement - 300mm
2. Aggregate Bedding Course - 100mm
3. Reinforced concrete slab - 200mm

Using the same methodology and assumptions described in Chapter 8 the cost of concreting has been estimated to be Rs. 3,100,000 per lane.km including overheads and 10% contingency. It has been assumed for estimating purposes that the final pavement levels should match existing to avoid problems with footpaths, curbs, intersecting roads, drainage etc. In some locations it may be possible to build above existing levels and a minor reduction in the above cost would be possible.

The estimated cost of constructing a concrete road along all the road sections nominated by CMC is summarized in the following Table 10.2.1.

Table 10.2.1 Cost of Concrete Surfacing for Existing Roads

| Item | Unit | Quantity | Total Financial Unit Price (Rs.) | Total Financial Cost (Rs.) |
|---|---|---|---|---|
| CONCRETE ROAD CONSTRUCTION | Lane. km | 87.5 | 1,953,000 | 170,887,500 |
| Total Direct Cost | | | | 170,887,500 |
| INDIRECT COST | % | 30 | | 51,266,250 |
| Construction Cost | | | | 222,153,750 |
| ENGINEERING SERVICES | % | 10 | | 22,215,375 |
| CONTINGENCY | % | 10 | | 22,215,375 |
| Total Financial Cost of Project | | | | 266,584,500 |
| Total Economic Cost of Project | | | | 225,975,750 |

To allow a comparison to be made with conventional resheeting costs, estimates have also been made for the following;

1. Remove surface layer
2. Prime Coat
3. AC Surface Course - 100mm

The estimated cost for conventional resheeting as above is Rs. 1,760,000 per lane.km including overheads and 10% contingency and the total costs are summarized in Table 10.2.2.

Table 10.2.2 Cost of Resheeting Existing Roads

| Item | Unit | Quantity | Total Financial Unit Price (Rs.) | Total Financial Cost (Rs.) |
|---|---|---|---|---|
| ASPHALT SURFACING | Lane. km | 87.5 | 1,125,460 | 98,477,750 |
| Total Direct Cost | | | | 98,477,750 |
| INDIRECT COST | % | 30 | | 29,543,325 |
| Construction Cost | | | | 128,021,075 |
| ENGINEERING SERVICES | % | 10 | | 12,802,108 |
| CONTINGENCY | % | 10 | | 12,802,108 |
| Total Financial Cost of Project | | | | 153,625,290 |
| Total Economic Cost of Project | | | | 102,506,040 |

Information was not available on existing utilities or drainage and no allowances have been made for drainage or utility relocations in the above estimates. It is assumed that major utility relocations or provision for future utilities are not required and that any other utility costs would apply equally to either approach and can reasonably be neglected for comparison purposes. Similarly, no allowance has been included for lighting.

### 10.2.4 Preliminary Feasibility Assessment

A simple economic comparison of the cost of the two options has been carried out by discounting all costs over the assumed 30 year life of the pavement to present values and then summing the costs. Costs are the initial construction costs as estimated above plus maintenance costs.

Maintenance costs for the concrete road should be minimal over the design life of say 30 years. A figure of 1% per annum of the initial cost has been assumed. The conventional pavement is likely to require substantial reconstruction after 15 years and resheeting after say 8 and 23 years, in addition to routine maintenance on a regular basis. For routine maintenance of the flexible pavement, 2% per annum of the initial cost has been assumed.

The result of the preliminary financial evaluation and comparison of the two options are summarized in the following Table 10.2.3.

Table 10.2.3 Economic Comparison of Asphalt and Concrete

| Type of Improvement | Net Present Cost (Rs. millions) for | | | |
|---|---|---|---|---|
| | Discount Rate | Inflation Rate 3% | 5% | 10% |
| Asphalt Surfacing | 12% | 257.9 | 302.0 | 484.7 |
| Concrete Surfacing | 12% | 249.7 | 255.0 | 277.9 |

Despite the higher initial cost of the concrete road it is clear that the investment appears worthwhile when the long life of the concrete road is taken into consideration. The result is quite sensitive to the discount rate and inflation rate assumed but even if a low inflation rate of 3% is assumed the concrete road is still more cost effective.

### 10.2.5 Recommendations

The preliminary assessment suggests that the construction of concrete roads would be a worthwhile investment in areas where existing and proposed services are minimal and concreting merits further investigation. Maintenance costs would be reduced and ride quality would be considerably improved.

It is recommended that the further investigations should be made of the following aspects to confirm the viability of the proposals;

a) Confirmation of the locations of existing and proposed underground utilities on the listed roads. Some data on the location of existing utilities was shown to be unreliable so further subsurface radar surveys on the candidate roads would be desirable. Should costly service relocations be required prior to concreting at any locations then concreting may not be justified.

b) Investigation of the causes of the existing high maintenance costs. Likely causes include poor drainage (see c) below) and substandard asphaltic concrete. In some sections of the candidate roads it may be possible to overcome the problem without resorting to the high capital cost of a concrete overlay.

c) A number of the candidate roads pass through areas where flooding has been identified as a problem in Chapter 2.6.2. At these locations it would be advisable to identify the source of the problem and to rectify it. While concrete roads would be better able to tolerate inundation and variations in sub-surface moisture content, there is a limit and some surface or subgrade drainage works may be necessary to protect the capital investment.

d) In order to be able to design the concrete roadway, further investigation should be carried out regarding the following;

- Present and future traffic volumes and heavy vehicle percentages. Slab thickness is a function of the number of heavy vehicles expected over the life of the pavement.

- For design of the concrete overlay, information is also required on the condition of the existing pavement. The first step should involve a thorough visual assessment of the pavement surface as this can give a good indication of areas where the existing pavement is weaker. The visual assessment should include surface roughness (ride quality), surface distress such as pavement cracking, permanent deformation, disintegration of surface layers, etc.

  Surface deflection measurements, providing the pavement deflection between loaded and unloaded states, would be appropriate considering the large area of pavement. These measurements give on indication of the structural adequacy of the pavement, or the ability of the pavement to support traffic without developing appreciable stress. Surface deflections can be measured as static deflection (Benkelman Beam) or by impact load response (dynamic response using a falling weight deflectometer).

  The above tests should be supplemented by test pits where the pavement thickness, particle size gradings, moisture content, saturated CBR, modulus of subgrade reaction etc. are estimated. These tests will allow better interpretation of the surface deflection measurements. If the equipment required to measure surface deflections is not available in Calcutta it may be necessary to base the concrete overlay design on test pits, although more test pits would be necessary in this case.

- To gauge the effect of the wet season on pavement condition and strength it would be desirable to carry out testing in both the wet and dry seasons.

## 10.3 Traffic Signal Improvements

### 10.3.1 Traffic Signal Control

Signalization is one of the proven techniques for increasing intersection handling capacity which in-turn would directly contribute to the alleviation of traffic congestion. The city of Calcutta should consider a system the provision of well-coordinated signal operation and well-designed control timings to many of the intersections in the core area.

The present manner of manual traffic control by policemen is not desirable as cycle times becomes excessively long. Analyses of field survey data have indicated that only 50% of the right-of-way times are effectively utilized by saturation flows at most intersections. Moreover, this method of control will not be able to cope with increasing traffic complexity and volumes in the near future.

Traffic signals are effective for the orderly management of both pedestrian and vehicular traffic in so far as the road users observe the signals, a behavior which can be instilled through effective traffic safety awareness campaigns. Traffic signals generally have the following merits as a traffic controlling tool:

a. Signal control is much more efficient in controlling traffic than manual control especially if signals are brought under coordinated control such as area traffic control (ATC). Traffic signals under such a system are responsive to traffic demand changes. Signal timings are allocated based on optimal cycle times and split computations and are not limited by human judgment.

b. Signals can substantially increase the traffic handling capacity of the intersections.

c. Signals can effectively control several and complex traffic movements particularly at intersections with irregular configurations. With signalization, traffic regulations such as right-turn prohibition or one-way operation can be removed without decreasing the intersection handling capacity.

d. Signals can be coordinated to provide for a continuous movement of traffic at a definite speed along a given route within the road network.

e. Pedestrian signals installed at critical intersections can promote safe and easy crossings by all pedestrians particularly the old, young and handicapped.

f. Policemen need not be subjected to traffic accident hazards and concentrated air pollution at intersections.

g. Policemen can be relieved of their traffic control duties to concentrate more on enforcing traffic regulations, helping instill better driving behavior among drivers and assisting pedestrians or broken down vehicles.

### 10.3.2 Traffic Signalization Plan

The Study Team has considered a number of aspects such as practicality, economy and effectiveness in proposing an appropriate signalization plan for the central core of Calcutta. The proposal here constitutes part of the overall traffic management measures recommended for Calcutta by this Study. The traffic signalization proposal includes a combination of the three basic methods of signal control, namely, area traffic control (ATC), arterial intersection control and isolated intersection control. The area coverage for these three methods of signal control are indicated in Figure 10.3.1.

In this proposal, intersections in the central business district (CBD) would be centrally controlled by an ATC system where all the signalized intersections are linked and coordinated. This method of control is the most versatile and responsive to real time traffic conditions and demands. It is therefore most suitable for the heavily trafficked CBD area in Calcutta.

The ATC system would cover a total of 33 intersections within the central area of Calcutta as shown in Figure 10.3.1.

Intersections along the major arterials such as AJC Bose Road, APC Roy Road and Chowringhee-J.L. Nehru Road, are best controlled by the arterial intersection control method. This method of control coordinates the timings of signals along the arterials to ensure smooth and progressive traffic flows. Arterial intersection control can in fact enhance the benefits of the proposed flyovers which are mostly located along these arterials.

A total of 57 intersections along AJC Bose Road-APC Roy Road, J.L.Nehru Road-Chowringhee Road-Chittaranjan Avenue, M.Gandhi Road and Park Street would be signalized under this method.

Other important intersections nearby but not included in the above two methods of control would be signalized with isolated intersection control. A total of 36 intersections along minor roads within the area bounded by AJC Bose Road, APC Roy Road and the Strand; and including those in the Beniatola and Jorasanko areas, and along Khidirpur Road, would be controlled under this method. These isolated controlled traffic signals however would be designed in such a way that they could easily be brought under the ATC control if need arises.

To derive the full benefits of the traffic signalization proposal, the following two aspects however must also be considered:

a. The proposed traffic signalization plan should be implemented in total or at least not in any random or scattered fashion.

   If the proposal cannot be implemented in total as one project, the following order of priority is recommended:

   Priority 1: Arterial Intersection Control,
   Priority 2: ATC System for the CBD Area,
   Priority 3: Isolated Control for Other Intersections.

b. Improvements to ancillary traffic control devices such as traffic signs, lane markings and channelizations must also be carried out simultaneously when implementing the signalization plan.

The above proposed traffic signalization plan covering a total of 126 intersections in this Study can be regarded as Phase I of a Comprehensive Traffic Signalization Plan for Calcutta.

After Phase I has been completed, extensions of the signalization plan as Phase II or III should be considered. These later phases would cover intersections to the east of APC Roy Road, south of AJC Bose Road, and to the north of Circular Canal.

Preliminary designs and cost estimates for the recommended Signalization Plan (Phase I) has not been carried out and detailed cost estimate cannot be given at this stage. There are many variables including the level of sophistication of the system chosen, the location of the central control building, the availability of telephone lines, whether the system includes CCTV cameras etc. which can significantly affect the costs. However, the order of cost for the 126 intersections is likely to be around Rs 300 million, excluding the cost of civil works such as road widening, provision of turning lanes, channelization etc.

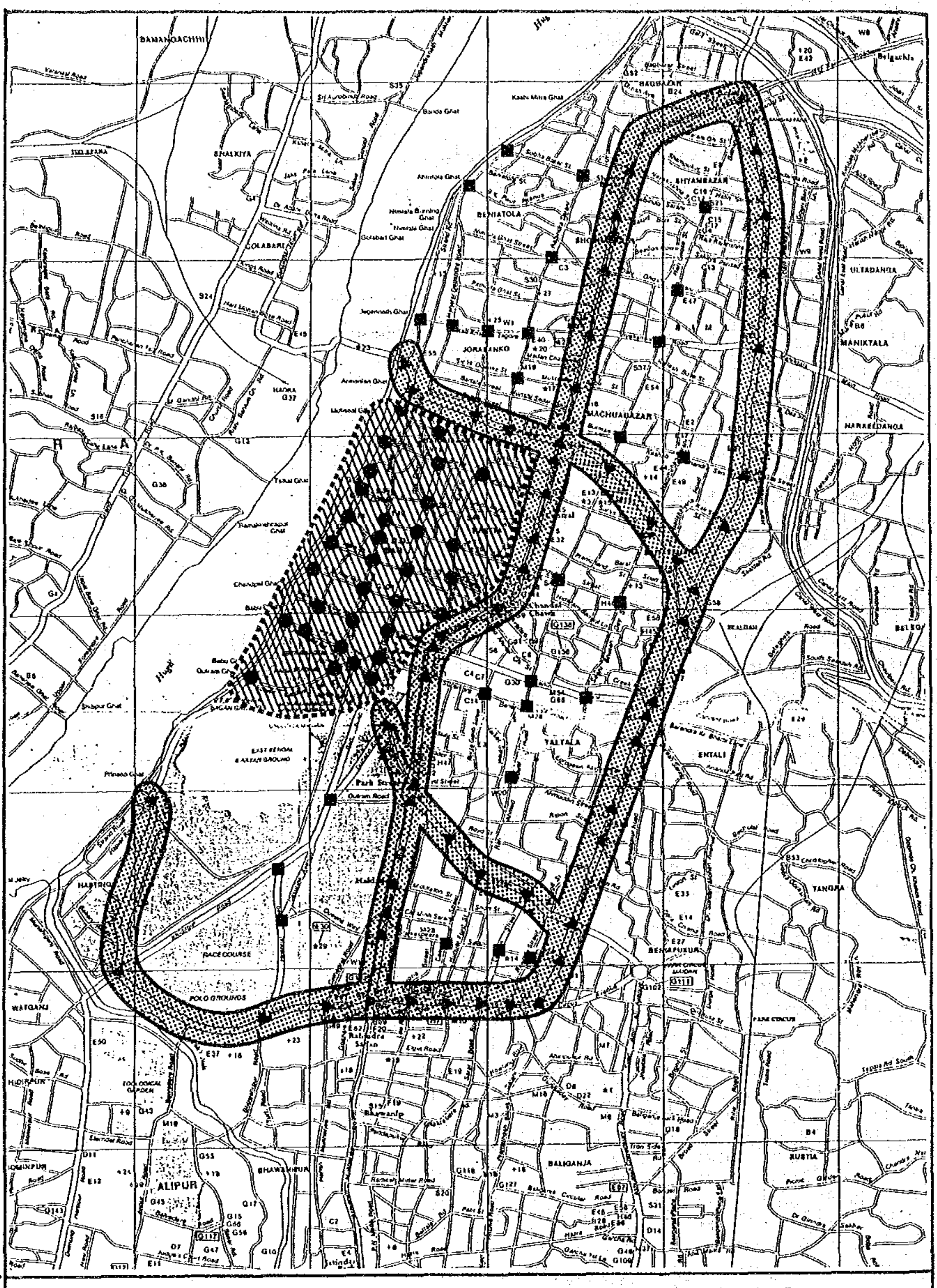


Figure 10.3.1 : Proposed Traffic Signalization Plan

Legend

Area Traffic Control

Arterial Control

Isolated Control

# CHAPTER 11

# CONCLUSIONS AND RECOMMENDATIONS

# CHAPTER 11 CONCLUSIONS AND RECOMMENDATIONS

The conclusions reached in this Study and the recommendations derived therefrom, are described in this chapter. Other future studies that may contribute to the improvement of traffic conditions in the city are also briefly considered.

## 11.1 Intersection Improvements

Based on the findings of this study as described hereafter, the following intersection improvement projects are recommended;

a- Construction of flyovers at each of Intersections No.1, No.8, No.9 and No.10

b- Construction of a continuous flyover linking Intersections No.5 and No.6.

c- Implementation of at-grade intersection improvements at Intersections No.2, No.3, No.4 and No.7.

The economic evaluation of these projects as one package is very favorable, with an IRR of 18.4%.

Intersections No.1, No.5 and No.6 are located along A.J.C. Bose Road, which forms the south-eastern arc of the ring road circling the city core area. The traffic volume demand on this road is expected to grow further with the opening of the new 2nd Hooghly Bridge.

Economic indices favour the construction of independent flyovers at each of Intersections No.5 and No.6, when compared to the construction of a continuous flyover linking the two intersections. However a continuous flyover is recommended for the following reasons.

(1) Beyond 1998 it is likely that a continuous flyover will become necessary to overcome the higher through traffic and congestion caused by turning movements at the at-grade intersections between the two flyovers. It would be very difficult and expensive to widen the two flyovers and convert them to a single continuous flyover at a later date. Traffic congestion during a later

conversion would also be very high. Construction of the continuous flyover initially is therefore recommended.

(2) Significant merging and diverging movements would be required on the short section of shared at-grade roadway between two separate flyovers. As well as increasing congestion and reducing the travel speed of through traffic, higher accident rates would result.

(3) The narrow road-space will limit the width of the ramps for the independent flyovers at each of intersection No.5 and No.6 to only two lanes while the construction of a continuous flyover between the two intersections will make it possible to construct three lanes, thus accommodating a higher traffic volume.

(4) The total length of the two independent flyover structures at Intersections No.5 and No.6 is over 70% of that of a continuous flyover structure between them and therefore there is no significant difference in terms of overall structural length.

(5) With the opening of the new 2nd Hooghly Bridge the through traffic at Intersections No.5 and No.6 is expected to increase significantly. This traffic demand can be better served by a continuous flyover linking the two intersections.

Traffic congestion is extremely heavy at Intersections No.2 and No.8 along J.L. Nehru Rd. and Chowringhee Rd. at present, and improvement plans are urgently required there. At-grade improvement at Intersection No.2, accompanied by widening of the main north-south approach roads is recommended by the Study for the following reasons;

(1) At-grade improvements at Intersection No.2 will involve relatively small scale land acquisition and will improve the traffic flow to an extent which will be nearly equal to that of the flyover option.

(2) Construction of a flyover over the metro tunnel would require complex foundation works, significantly increasing construction costs and lengthening the construction period. A protracted construction period

will create severe traffic congestion.

(3) Even with the inclusion of land acquisition costs and costs for relocation and reconstruction of obstructing buildings, the overall cost of the at-grade improvement is approximately 40% of the cost of construction of a flyover.

Shyambazar Intersection No.4 is an important access to the north, particularly to Barrackpore and Kalyani areas which are undergoing rapid urban growth. On the other hand, upgrading Lock Gate Rd by the construction of a flyover over the railway crossing (No.9) will cause the traffic coming from B.T. Rd in the north to divide between Lock Gate Rd and Shyambazar. Intersection No.4 would then be able to handle the reduced traffic volume coming to A.P.C. Roy Rd. The flyover at Lock Gate Rd will therefore have similar effects as having flyovers at both Intersections No.4 and No.7. As there is no traffic at Lock Gate Rd, construction works there will be much easier than at other places.

At Intersection No.10, the right-of-way width both in the north-south and east-west directions are not sufficient to accommodate 3 or 4-lane flyovers. Considering the high potential demand for the east-west traffic with improved access to the Eastern Metropolitan Bypass, an east-west 2-lane flyover will have an important role in serving the traffic demand.

Additional flyovers at Intersections No.3, No.4, and No.7 will only produce marginal benefits. At Intersection No.3, the 1998 traffic volume will not exceed the capacity of an at-grade intersection, however the construction of a flyover will become necessary when the traffic volume increases in the future, expected after the target year of this Study. The construction of flyovers at Intersections No.4 and No.7 is also likely to become necessary as the traffic volume on B.T. Road further increases after 1998.

At grade improvements at Intersections No.3, No.4, and No.7 should be implemented prior to 1998 in order to be able to achieve full benefits from the construction of the other flyovers.

Other works required in conjunction with the flyover construction are improvements to Lock Gate Road at the northern end at B.T. Road, and at the southern end at Kasipur Road.

## 11.2 Parking Structures

Construction of multi-level parking facilities for B.B.D. Bag and the Esplanade would eliminate the need for roadside parking on the central area streets which are considered to have an important traffic function. The traffic capacity of these streets, which currently suffer from extreme congestion, would be greatly increased making the implementation of these projects desirable. Other benefits would be improvements in the flow of public transport, reduced pollution, and easier movement of pedestrians, provided that no-parking regulations were introduced and enforced on those important streets.

The economic evaluation of the car parking structures showed that the parking structures are not economically feasible. Moreover, the profitability of multi-level parking lots is highly doubtful. In order to sustain an above ground parking facility, parking charges alone will not be sufficient, 50% of the construction costs should be grants. In the case of an underground parking facility, it would be necessary for all of the construction costs and part of the operation costs to be provided from grants. In order to improve the profitability of the parking structures, redevelopment schemes incorporating off street parking with commercial office and retail space should be further considered. In this way the cost of constructing and operating the parking structure could be offset against more profitable activities.

Therefore, the separate, dedicated car parking structures considered in this feasibility study have not been included in the recommended list of works to be implemented. In view of the urgent need for measures to be taken to alleviate the parking shortage it is recommended instead that further consideration be given to area redevelopment schemes incorporating car parking facilities. The Esplanade site currently occupied by the tram terminus obviously has potential in this regard because of the location and value of the land, and there may be other potential sites.

## 11.3 Pedestrian Facilities

In Calcutta pedestrians often overflow onto the roadway and cross streets in a disorderly fashion, affecting both pedestrian safety and road effectiveness. Consequently, providing effective and safe countermeasures is an important goal.

When considering and evaluating proposals for improvements in pedestrian facilities, priority should be given to effective utilization of the entire sidewalk width for pedestrian flow. Measures could include footpath improvements, pedestrian crossings and protective barriers where necessary.

Pedestrian flows along B.B. Ganguly St. from Sealdah Station towards B.B.D. Bag, are very high. Although a preliminary economic evaluation of this facility indicated that it was not economically feasible, an overhead pedestrian walkway between Sealdah Station and Chittaranjan Avenue (Phase I) is recommended for inclusion in the list of projects to be implemented. The pedestrian flows along this narrow section are particularly high and vehicular traffic is expected to increase substantially when planned road works at the eastern end of B.B. Ganguly St. are implemented. The walkway will serve to segregate pedestrian flow from vehicular traffic which will continue to use the street level. The detail design should be carried out in such a way as to minimise the visual impact on the old city.

Following the opening of the Metro Central Station, expected in 1994, the movement of pedestrians between Chittaranjan Avenue and B.B.D. Bag is likely to increase substantially and extension of the overhead pedestrian walkway through to B.B.D. Bag (Phase II) is likely to become desirable. At present, pedestrian movements along this link are relatively small and no detailed information is yet available on likely pedestrian movements following the opening of the Metro.

It is therefore recommended that implementation of this second stage should only be carried out after further study of the Metro commuters, including likely pedestrian volumes, their destinations, and the most beneficial walkway route so that the need, the alignment and the width can be decided with more confidence. A connection from B.B.D. Bag to the approach to Howrah Bridge could also be considered as part of a future pedestrian facility network.

## 11.4 Traffic Signals

With the increase in Calcutta city center traffic, it is necessary to introduce a complete traffic signal system and increase the capacities of intersections and roads to ensure the safety of pedestrians and traffic police.

As a first phase for this project, installation of an ATC system (33 intersections) for the city center, an arterial intersection control system (57 intersections) along the main trunk roads of A. J. C. Bose Rd, Chowringhee Rd, etc. and isolated intersection control system for other important intersections (36 intersections) is proposed.

Of these intersections it is recommended that signals should first be installed along A.J.C. Bose Rd and Chowringhee Rd., for which there are intersection improvement proposals. This is necessary to increase the traffic capacity on these routes and allow the full benefit to be obtained from construction of the flyovers.

The observance of traffic regulations by drivers and pedestrians is a prerequisite to the success of traffic signal installation, making traffic education an essential part of any signalization program.

## 11.5 Concrete Pavement

Maintenance costs for concrete pavement are low compared to asphalt pavement and have advantages such as resilience against flooding in times of heavy rain. However the following points must be considered before recommending the conversion of existing flexible pavement to a rigid pavement by addition of a concrete slab.

- Whether there are underground utilities under the pavement or, there are plans for such in the future
- Heavy traffic volumes expected during the pavement life
- The causes of the existing high maintenance costs, eg. poor subgrade drainage, inundation, poor materials, poor placement etc.
- Whether improvements to drainage facilities are necessary
- Review of condition of existing pavements by visual inspection, surface deflection tests, test pits etc.

## 11.6 Summary of Recommendations

The recommended works to be implemented before 1998 under the Transport Infrastructure Development Project in Calcutta are shown in Figure 11.6.1 and are summarised below;

| Location | | Sub-Project | Cost (Rs.millions) |
|---|---|---|---|
| a) Int. No.1 | - | North-South Flyover | 230.7 |
| b) Int. No.2 | - | At-Grade Improvements | 75.0 |
| | - | Land Acquisition and Compensation | 100.5 |
| b) Int. No.3 | - | At-Grade Improvements | 21.6 |
| b) Int. No.4 | - | At-Grade Improvements | 31.0 |
| c) Int. No.5&6 | - | Continuous Flyover | 675.5 |
| b) Int. No.7 | - | At-Grade Improvements | 20.3 |
| d) Int. No.8 | - | North-South Flyover | 160.7 |
| e) Int. No.9 | - | Flyover above railway | 174.2 |
| f) Int. No.10 | - | East-West Flyover | 91.1 |
| g) Ganguly St. | - | Overhead Pedestrian Walkway Sealdah to Chitaranjan Ave. | 161.7 |
| | | Total Cost | 1,742.3 |

Other projects considered or identified during the Study, but not included above, are shown on the list below. The flyovers at Intersections No.3, No.4 and No.7 need not be implemented before 1998.

| Location | | Sub-Project | Approx. Cost (Rs.millions) | Notes |
|---|---|---|---|---|
| a) Int. No.3 | - | North-South Flyover | 172.5 | After 1998 |
| b) Int. No.4 | - | North-South Flyover | 157.6 | After 1998 |
| c) Int. No.7 | - | North-South Flyover | 252.7 | After 1998 |
| d) Ganguly St. | - | Overhead Pedestrian Walkway Chitaranjan Ave. to BBD Bag | 130.0 | |
| e) Esplanade | - | Parking Structure | 193.5 | |
| f) BBD Bag | - | Parking Structure | 587.9 | |
| g) Metrocore | - | Traffic Signalization | 300.0 | Order of cost |
| h) Metrocore | - | Concrete Road Surfacing | 266.6 | Excludes Util. |
| | | Total Cost | 2,060.8 | |

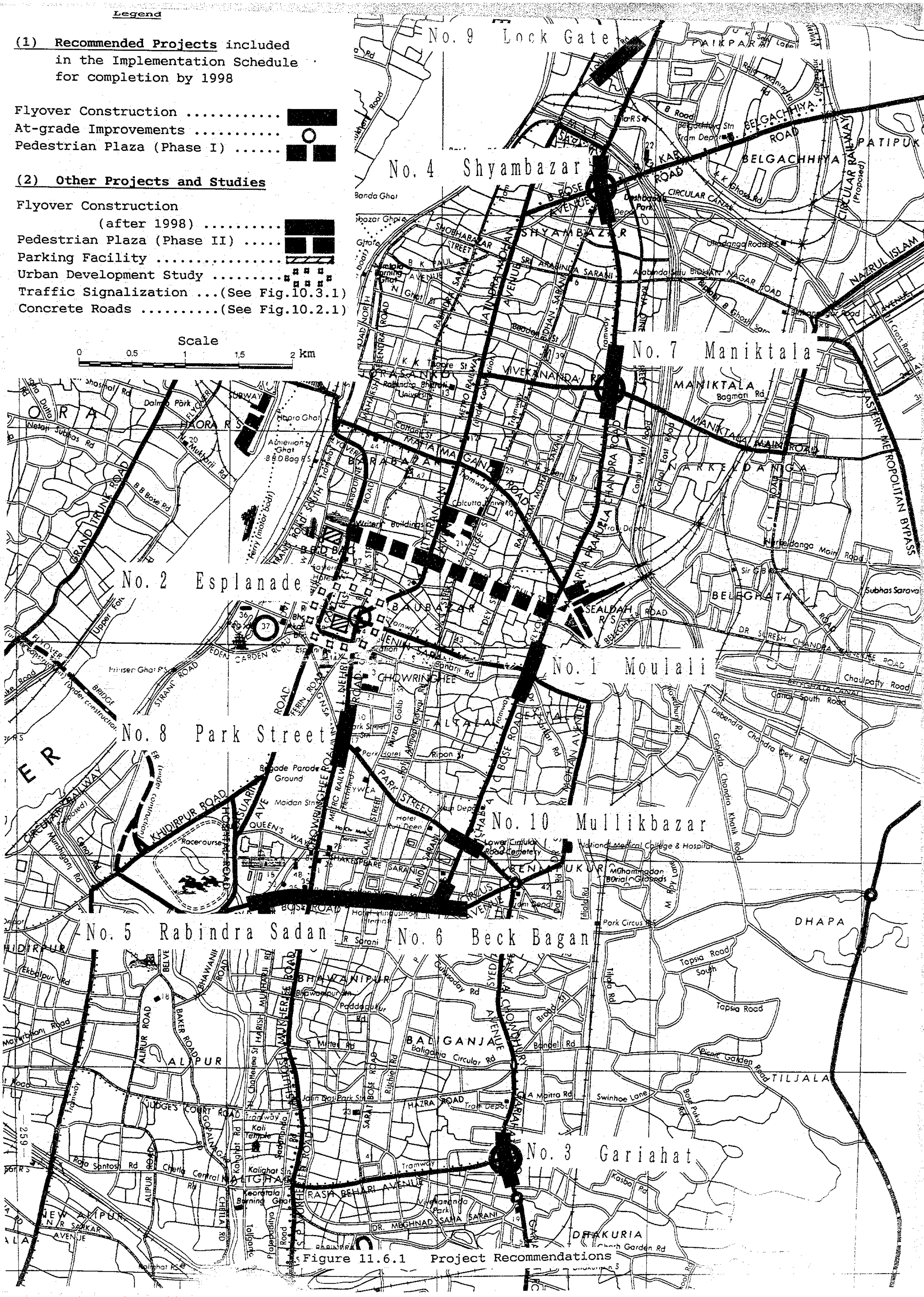


Figure 11.6.1 Project Recommendations

## 11.7 Relevant Future Studies

It is recommended that the following studies be implemented for the bearing they will have on the future Calcutta city traffic improvements.

(1) Esplanade Intersection No.2 is located in the city core area and connected to major transport modes through the adjacent metro station, and bus and tram terminals. It is a central commercial and transport node. However the tram terminal facilities and surrounding buildings (other than historical structures) are too old to support the activities and development associated with this location. At present the overflow of the pedestrians onto the carriageway and the traffic congestion in the vicinity of the intersection are very severe. These conditions cannot be remedied by road improvement alone, and it is considered that an urban renewal plan for the immediate surrounding area of the intersection would be desirable.

This Study considered two plans for the improvement of transport infrastructure in the vicinity of Intersection No.2, firstly at-grade intersection improvements, and secondly a parking facility within the grounds of the tram terminal. Implementation of the intersection improvements has been recommended and will require the widening of approach roads as well as land acquisition and payment of compensation costs, but the parking charges to be levied under the second plan were found to be insufficient to secure the profitability of the parking facility. It may be possible to resolve these problems through a development plan covering the area of the existing tram terminal and bus terminal. Overall costs would be decreased by mainly utilizing public owned land for an integrated terminal and commercial complex. Pedestrians movements could be provided for at the above ground level while bus and tram circulation could be rearranged at ground level.

(2) Calcutta city road traffic is causing serious pollution. As one of the benefits of this project, the reduction in fuel consumption as a result of intersection improvements should lead to a reduction in pollution. However, further improvements will be necessary

and additional pollution countermeasures should be studied. Countermeasures could include improvements to fuel quality and vehicle engines as a first consideration.

(3) The main objective of this Study has been to consider the feasibility of urgent construction of flyovers and parking facilities, and the study has not covered the road network configuration nor the transport facilities needed in association with the future development. Further data collection and study of traffic and transportation in Calcutta is recommended in order to define the policies and strategies for future development. The most suitable time to implement such data collection and study would be after the completion of the two ongoing large-scale transport projects in the city, the 2nd Hooghly bridge and the underground metro, so that their influence can be clearly gauged.

(4) Detailed Study of traffic signalisation for the Calcutta Metrocore area.

(5) Further Study of the application of concrete roads in Calcutta including confirmation of the location of existing and proposed utilities, traffic volumes, drainage and sub-soil conditions.

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