7.2.2 Traffic Control Devices

It is imperative that traffic control devices should be unified in type to insure correct interpretation by all road users. Unified type enables road users to judge always spontaneously under the similar situation in the same way. The use of uniform traffic control devices does not, in itself, constitute uniformity. Unified traffic devices when they are not appropriate the devices are objectable as non-unified devices.

Traffic control devices consist of road markings, traffic signs and traffic signals to regulate, warn or guide traffic.

(1) Pavement Markings

Pavement markings are particularly important to help the proper control of vehicular and pedestrian traffic. They are not only used to supplement other devices, but are used alone to induce effects that cannot be expected by the use of any other devices.
Generally, there are two kinds of marking for roadway as follows:

(a) Continous centerlines for separating traffic travelling in opposite directions and pavement edge lines;

(b) Broken lane lines for separating lanes of traffice; and

(c) Pavement edge lines.

It is also a kind of traffic common sense that drivers are not allowed to cross yellow continuous lens lines. Markings at signalized intersections consist of crosswalks, stop lines, no-passing zones, symbol arrow and channelization etc. and contribute to increase traffic capacity by regulating traffic flows and reduce pedestrian accidents.

(a) Crosswalk lines at signalized intersections and across intersectional approaches on which traffic stops, serve primarily to guide pedestrians in the proper paths. Crosswalk lines across roadways on which traffic is not controlled by traffic signals, must also serve to warn the drivers of a pedestrians' crossing point.

In the following items attention must be paid on installation of crosswalk lines at intersections;

i) To install crosswalk lines as near to the center of intersection as possible and across roadway at right angle;

ii) To install crosswalk lines at points where drivers can recognize easily;

iii) Crosswalk width should be determined by pedestrian volume; however, the minimum width is 4m on arterial streets and 2m on minor streets.

(b) Stop lines (or limit lines) should be applied in the area where it is important to indicate the point, behind which vehicles are required to stop, in compliance with a STOP sign, traffic signal, or other legal requirements. Stop lines, where used, should ordinarily be placed 1 - 2m in advance of and parallel to the nearest crosswalk lines. In the absence of a crosswalk line, a Stop line should be applied at the desired stopping point where it has enough sight distance for drivers to recognize vehicles on the intersecting roadway.

(c) No-passing-zone markings and symbol arrow markings at typical intersections are shown in Fig. 7.2.5

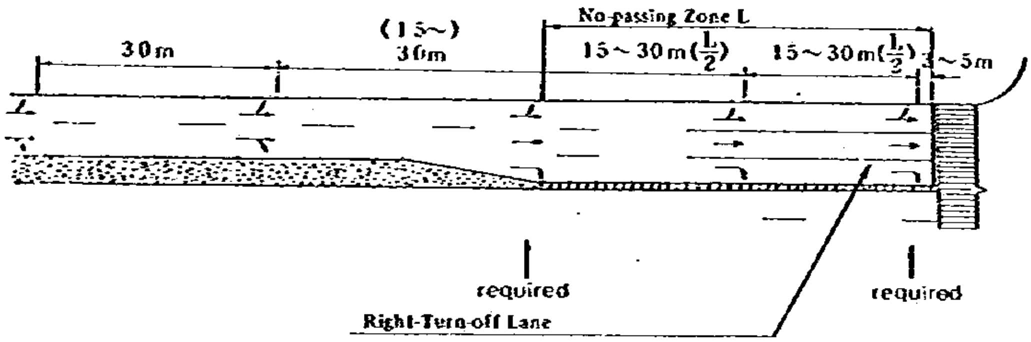

Fig. 7.2.5 Typical Locations of Symbol Arrows

No-passing zone markings behind stop line are usually continuous 30m long and any traffic cannot be permitted to change its lane within this zone. Symbol arrows should be repeated in advance of entering mandatory turn off lanes, when necessary, to prevent entrapment and to help drivers select the appropriate lane before reaching the end of waiting line of vehicles.

(d) Channelizing Lines

It is usually advisable to use channelizing lines for right-turn traffic at such intersections as follow:

i) Intersection with right-turn off lane by shifting centerline;

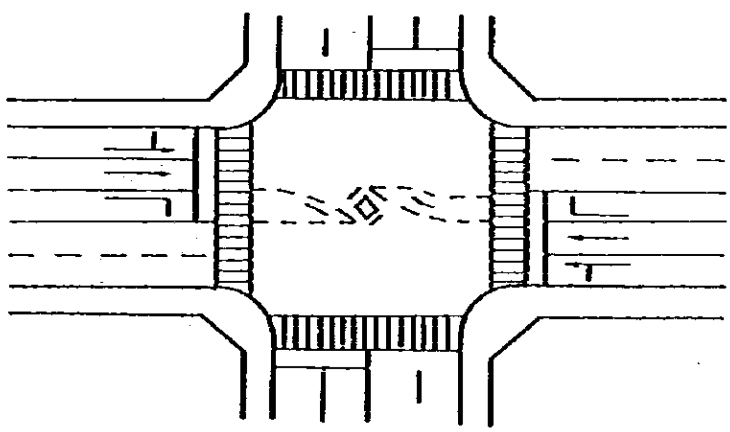

Fig. 7.2.6 Channelization Marking on Road Without Median

ii) Intersection where one of intersecting roads has a median;

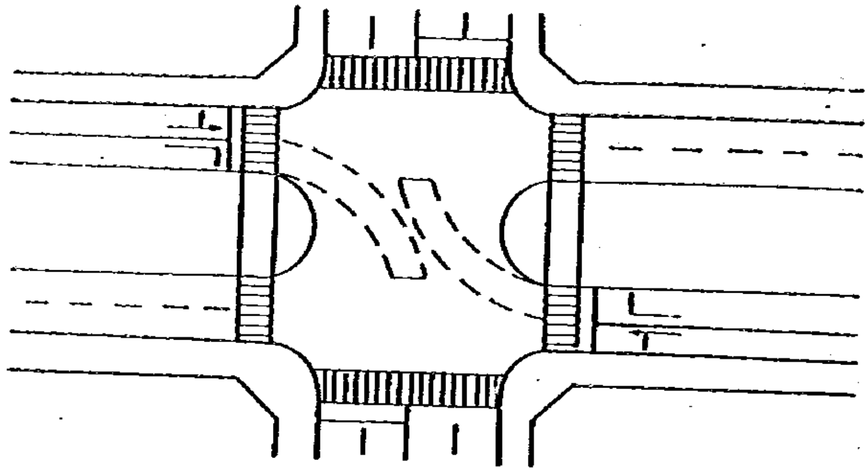

Fig. 7.2.7 Channelization Marking on Road With Median

iii) Intersection without insufficient road space for a traffic island and with an island in zebra and channelizing lines.

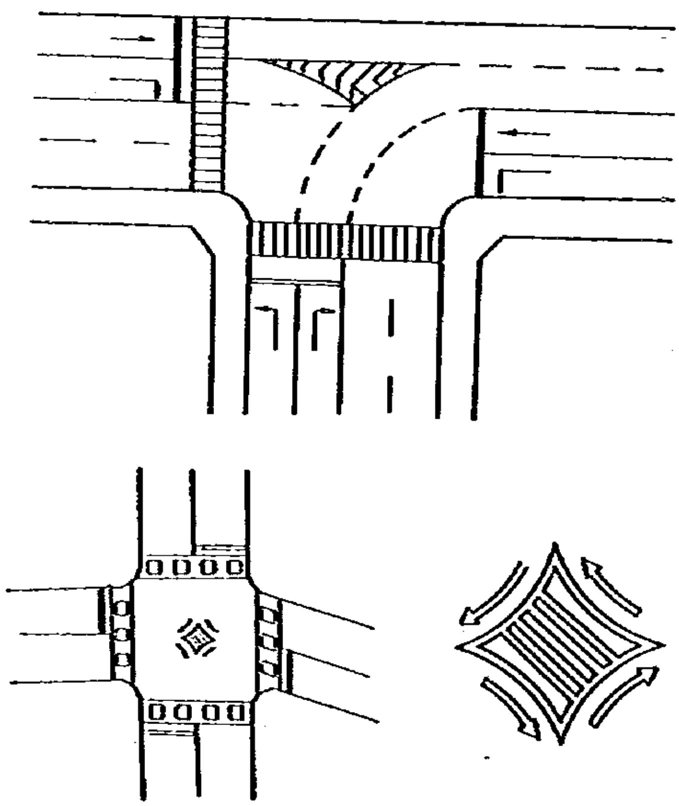

Fig. 7.2.8 Channelization by Traffic Markings

(2) Traffic Signals

Traffic control signals properly located and operated, usually have one or more of following advantages:

(a) They can guide the orderly traffic flows;

(b) If proper physical layouts and control measures are used, they can increase the traffic-handling capacity of the intersection;

(c) They can reduce the frequency of certain type of traffic accidents, especially at right-angle type intersections;

(d) Under favorable conditions, they can be coordinated to allow continuous or nearly continuous movement of traffic at a definite speed along a given route;

(e) They can be used to interrupt heavy traffic at intervals to permit other traffic, vehicular or pedestrian, to cross.

Traffic control signal installations, even though warranted by traffic and roadway conditions, might be ill-designed, ineffectively placed, improperly operated, or poorly maintained.

The following situations can result from improper or unwarranted signal installations:

(a) Excessive delay may be caused;

(b) Disobediance of the signal indications is encouraged;

(c) The use of less adequate routes may be induced in an attempt to avoid such signals;

(d) Traffic accident frequency, especially in the rear-end type collision may be significantly increased.

Standing on the viewpoint of traffic volume, it is advisable that traffic signal installation can be warranted by using the following criteria shown in Fig. 7.2.9.

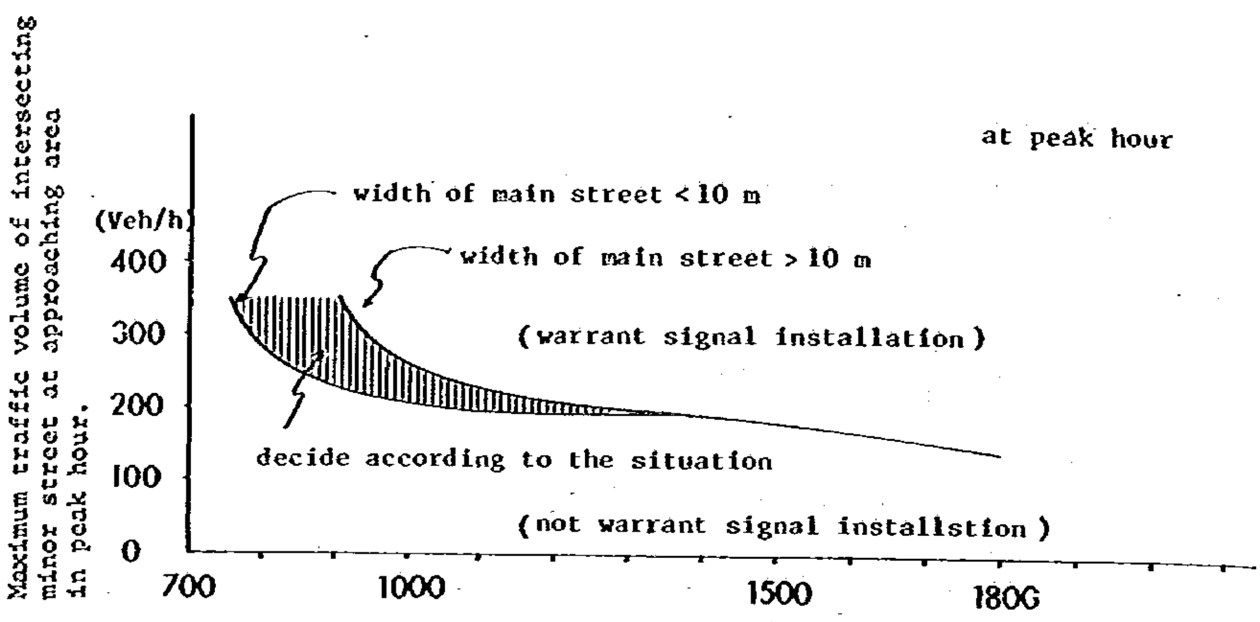

Fig. 7.2.9 Criteria for Traffic Signal Installation by Traffic Volume

The primary consideration in installing a signal at an intersection is the driver's visibility from his stopping position, which is affected by distance and the direction to signal face. Drivers approaching a signalized intersection or other signalized area, such as a mid-block crosswalk, shall be given a clear and unmistakable indication of their route assignment. The desirable location of signal faces is shown in Fig. 7.2.10.

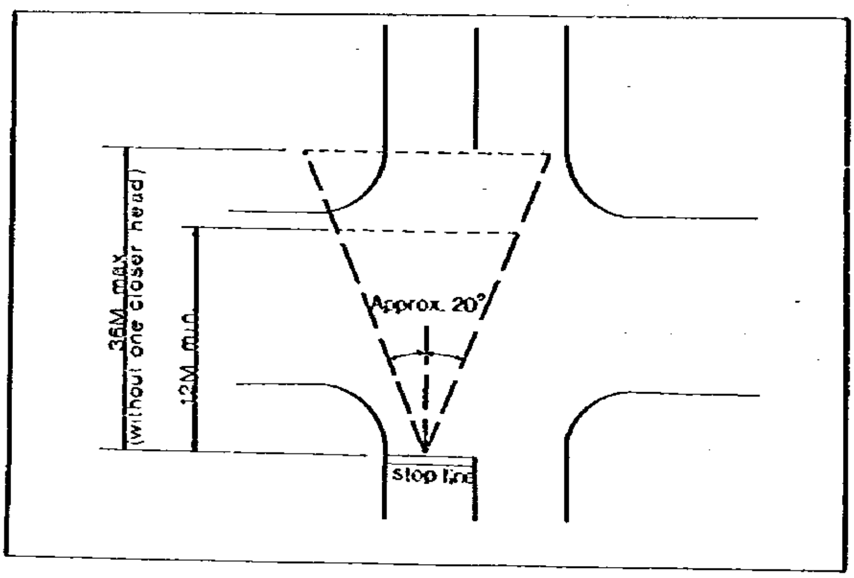

Fig.7.2.10 Desirable Location of Signal Faces

When the nearest signal face is more than 36m beyond the stop line, a supplemental near side signal indication shall be provided. Near side signals should be located as near as practicable to the stop line.

(3) Traffic Signs

Installing effective traffic signs on urban arterial streets is of vital importance for safe operation and smooth traffic flow. Traffic signs must be designed primarily for the sake of drivers who are not familier with local roads so that they will tend to react promptly, naturally and safely to the traffic conditions encountered.

Important qualities of traffic signs are target value, priority value, legibility and recognition. This means high visibility, lettering or symbols of adequate size and color, and short legend for quick comprehension by drivers approaching signs.

Fig. 7.2.11 shows the typical locations of guide sign installation.

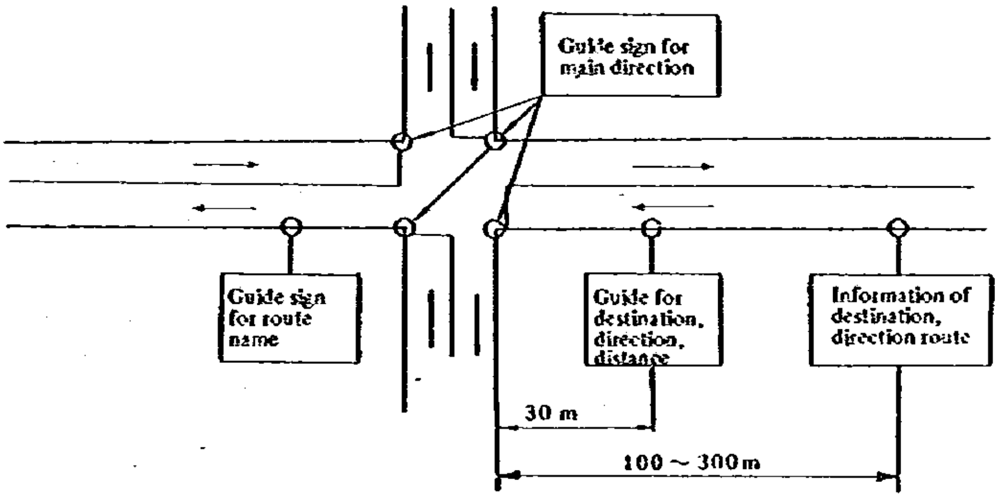

Fig. 7.2.11 Typical Locations of Guide Sign Installation

An example showing location of regulatory signs in the area where one-way traffic control is in force is shown in Fig. 7.2.12.

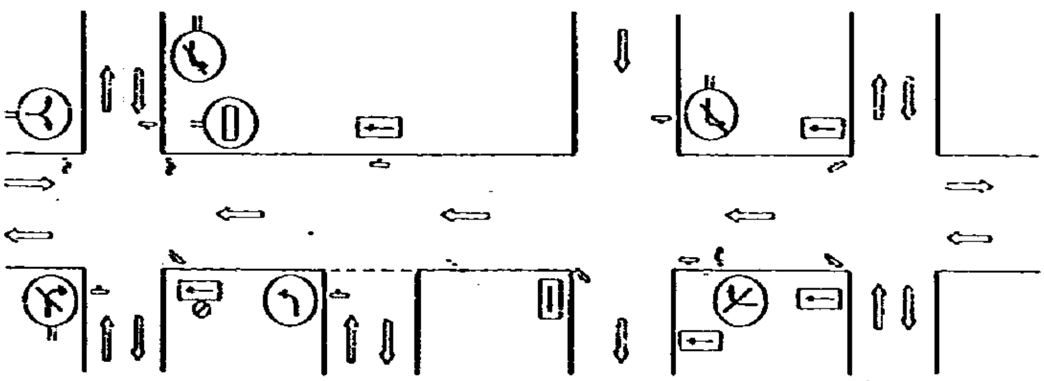

Fig. 7.2.12 Locations of Regulatory signs in the area where One-way Traffic Control is in Force

7.3 Proposed Improvement Plans

7.3.1 Railway Plan

(1) Improvement of Railway Crossings

The following inporvements are proposed in order to reduce hindrance to the road traffic and to make safety of train operation.

(a) Installation of Device to Inform Approaching of Trains

There exists presently not any device to inform approaching of trains to gate-men as well as to road users. Such device is necessary to reduce the time to close road traffic at crossings, which system is shown in Fig. 7.3.1. The distance from main apparatus to outer relays are about one kilometer in case that the maximum speed of trains is 59 km/h.

(b) Improvement of Barriers

The existing barriers of crossings do not cover the whole width of roads, and only case installed at one side of railway tracks on one-way road. Such barriers can not stop road traffic effectively. Some of road vehicles and pedestrians come into crossings easily even when gates are closed. Therefore some of crossing barriers in the CBD are to be replaced will the type of barriers which cover the whole width of roads on both sides of tracks. Several types of barriers are shown in Fig. 7.3.2. The number of location of those crossings to be improved is twelve. (Refer to Table 7-3-1).

(c) Installation of Cabins for Gate-men

There are some crossings without a cabin for gate-men. Cabins are to be installed at those crossings in order to install devices in them to inform gate-men approaching of trains and to prepare rooms for gate-men. Number of cabins to be constructed is five. (Refer to Table 7-3-1).

(d) Imporvement of Pavement at Crossings

Pavement at many crossings in the CBD is deteriorated which hinders smooth road traffic flows at with the materials of high durability. A kind of such pavement is shown in Fig. 7.3.3. The reinforced concrete block pavement is adopted in this proposal. The number of crossings to be rehabilitated is seventeen. (Refer to Table 7-3-1).

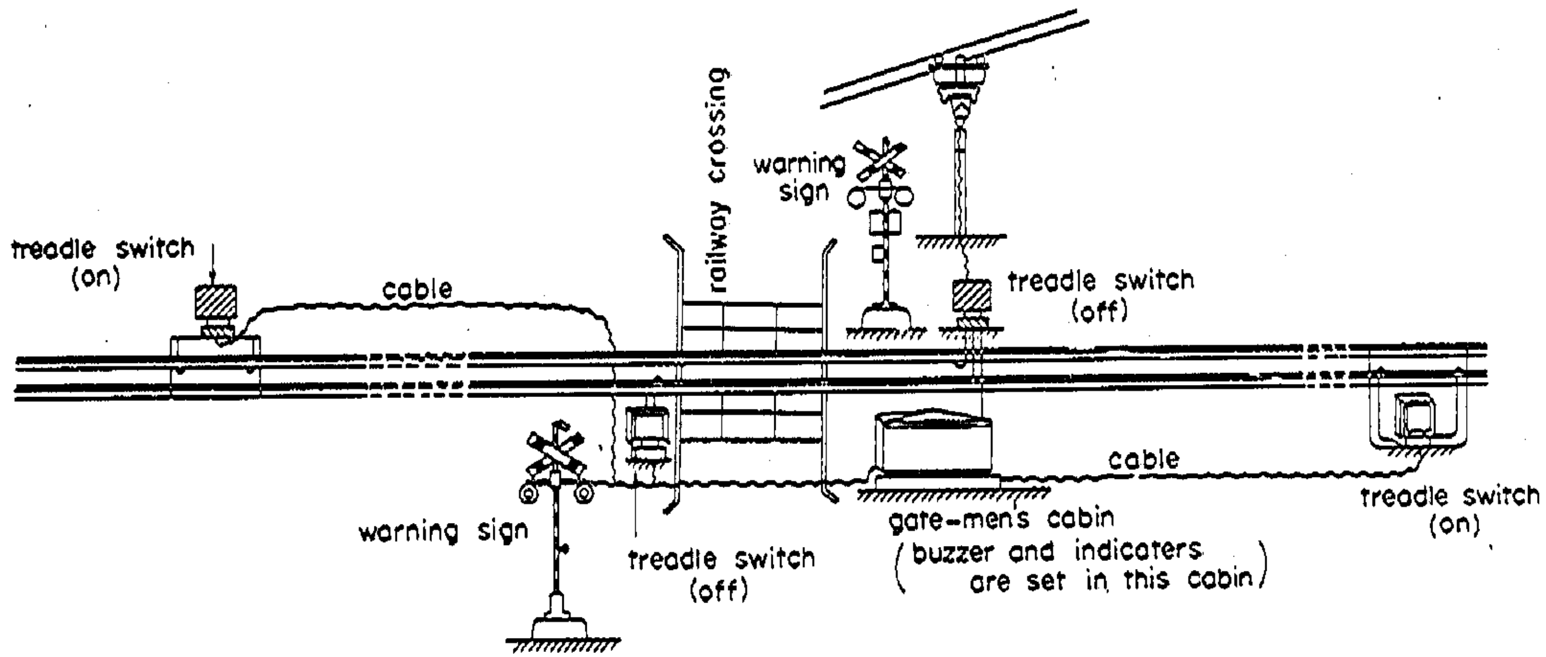

Fig. 7. 3. 1
Device to Inform Approaching Train

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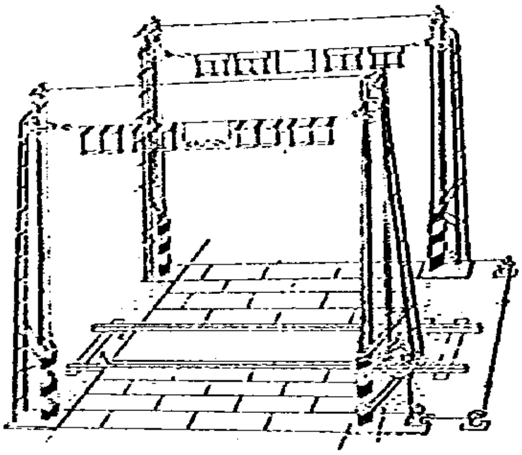
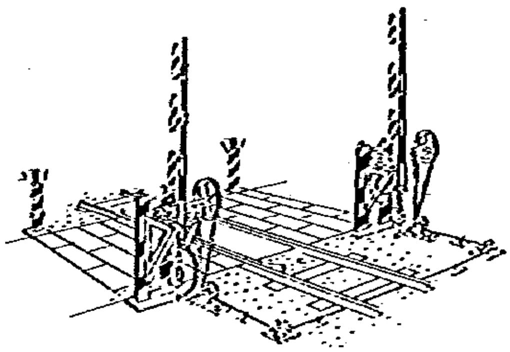
Legend

Manually Operated Crossing Barriers

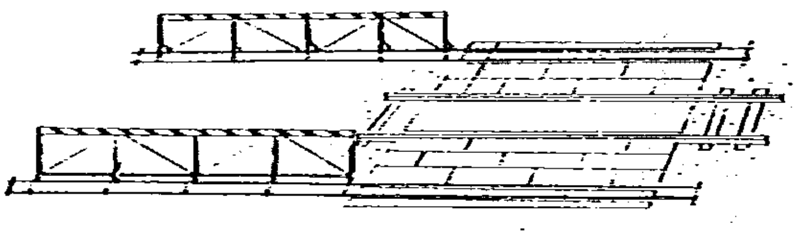
Up & Down Type



Swing up Type



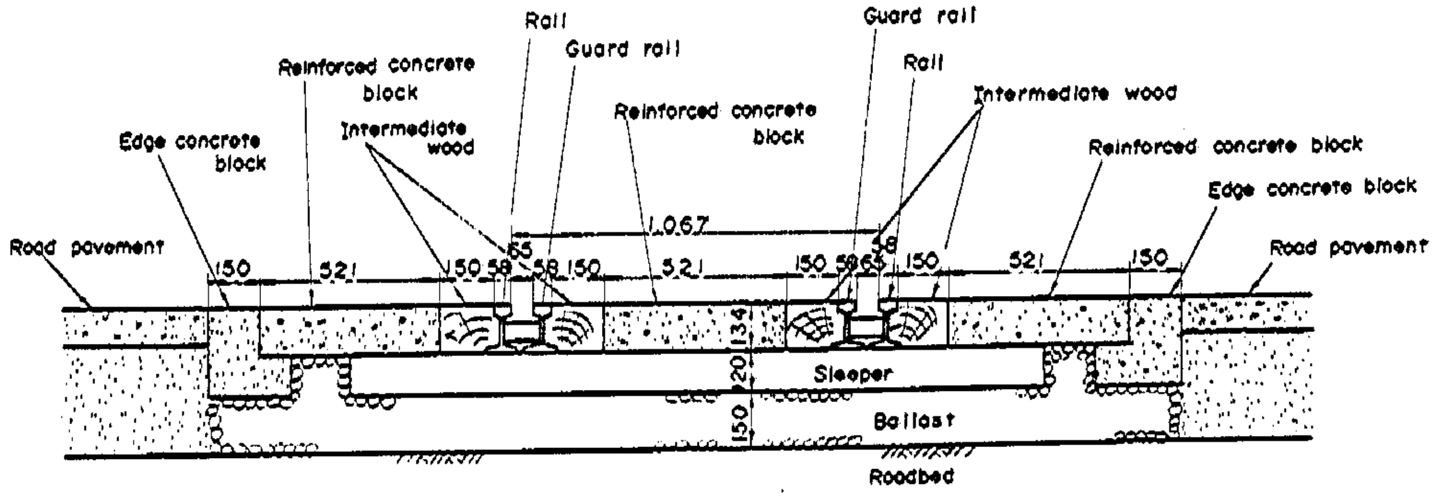
Sliding Type



	Up & Down Type	Swing up Type	Sliding Type
1. Barrier Range	10m ~ 30m	~10m	~ 20m
2. Crossing Watchman	1 ~ 2 Persons	1 ~ 2 Persons	2 ~ 4 Persons
3. Informed Location of Crossing	◎	○	×
4. Barries Efficiency	◎	○	×
5. Maintenance of Barriers	◎	○	◎

Fig. 7.3.2
Types of Manually Operated Crossing Barrier

Legend



Note: Reinforced concrete blocks are easily removed when it is necessary to tamp ballast for the maintenance purpose and are reinstalled back to the original positions after tamping.

Fig. 7.3.3 Standard Cross. Section of Railway Crossing at Grade	Legend
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Table 7-3-1 Summary of Railway Crossings to be Improved, Medan Area

Section	Location	Name of Roads	Train Approach Imforming Device	Barrier	Cabin for Gate-men	Pavement
	km.					
Medan-Belawan	0.342	Jl. Prof. H.M. Yamin	x	x		x
	0.699	Jl. Jati	x	x		x
	2.138	Jl. Karantina				x
	3.492					x
	3.688	Jl. Jl. Budi Pembangunan				x
	3.987					x
	4.368	Jl. Comara	x	x		x
Medan -Lubuk Pakam	0.600	Jl. Nusantara	x	x		x
	1.083	Jl. Panda	x	x		x
	1.164	Jl. Mahkamah	x	x	x	x
	1.324	Jl. Singamangaraja	x	x		x
	1.675	Jl. Sutomo	x	x		x
	2.277	Jl. Thamrin		x	x	x
	2.681	Jl. Bakaran Batu		x	x	x
	4.525	Jl. Mandara			x	
Medan-Binjei	1.380	Jl. Yossudarso Mdn.	x	x		x
	1.800	Jl. Galugur By Pass	x	x	x	x
	2.695	Jl. Skip				x

Note: X marks in the table show improvements needed at each location.

(2) Railway Passenger Service between Medan and Belawan

(a) Planning Policy

The volume of urban railway passenger traffic in Medan area is presently almost nil; however, its potential traffic in the long-term is evaluated high and its volume of the said railway section, which will be ranked as the highest of all railway trunk lines in Medan Area in 2000 A.D., is also forecasted to be as follow even in 1985 the target year of the shor term. (Refer to Table 7-3-2).

Table 7-3-2 Estimated Numbers of Railway Passengers on Medan - Belawan Line (1985)

Service Section	Potential Vol. of bus passengers per day	Rate of diversion to Railway if Railway reopen passenger service	Estimated No. of Railway Passengers per day
Belawan-Medan	10,048	0.24	2,400
Labuhan-Modan	8,869	0.14	1,200
Total	18,917	0.19	3,600

On the other hand, the distance of 21.6 km between Belawan and Medan is appropriate for the operation of urban railway passenger service as one of solutions of the Short-Term urban traffic problems although it is a little premature to be economically justified but is agreeable to regard it as a pioneering test of railway mass transit service in Medan Area for the Long-Term. In order to attain such an objective the State Railway has already decided, in the light of the basic policy that the State Railway should take the responsibility as the back bone of the urban passenger transport in Indonesia, to procure 3 sets of diesel railcar trains, each set consisting of 4 diesel rialcars, in the fiscal year 1980/81. In view of the estimated passenger transport demands in 1985, at least, the foregoing number of diesel railcars seems to be a little overstimated. To make the effective use of those railcars in terms of pioneering and training purposes a proposed plan of their use and upkeeping are mentioned hereunder for the current demands as well as for the demands in the near future up to 1985. The matters relevant to the demands in the Long-Term are to be mentioned in the Final Report on the Long-Term Improvements which will appear in the later date.

(b) Diesel Rail-Car Service Plan

The following is a brief description on the diesel rail-car service plan for the section Belawan-Medan:

i) Rail-Car to be used
Type : MCW 301 or equivalents
Principal Dimensions of a diesel rail-car

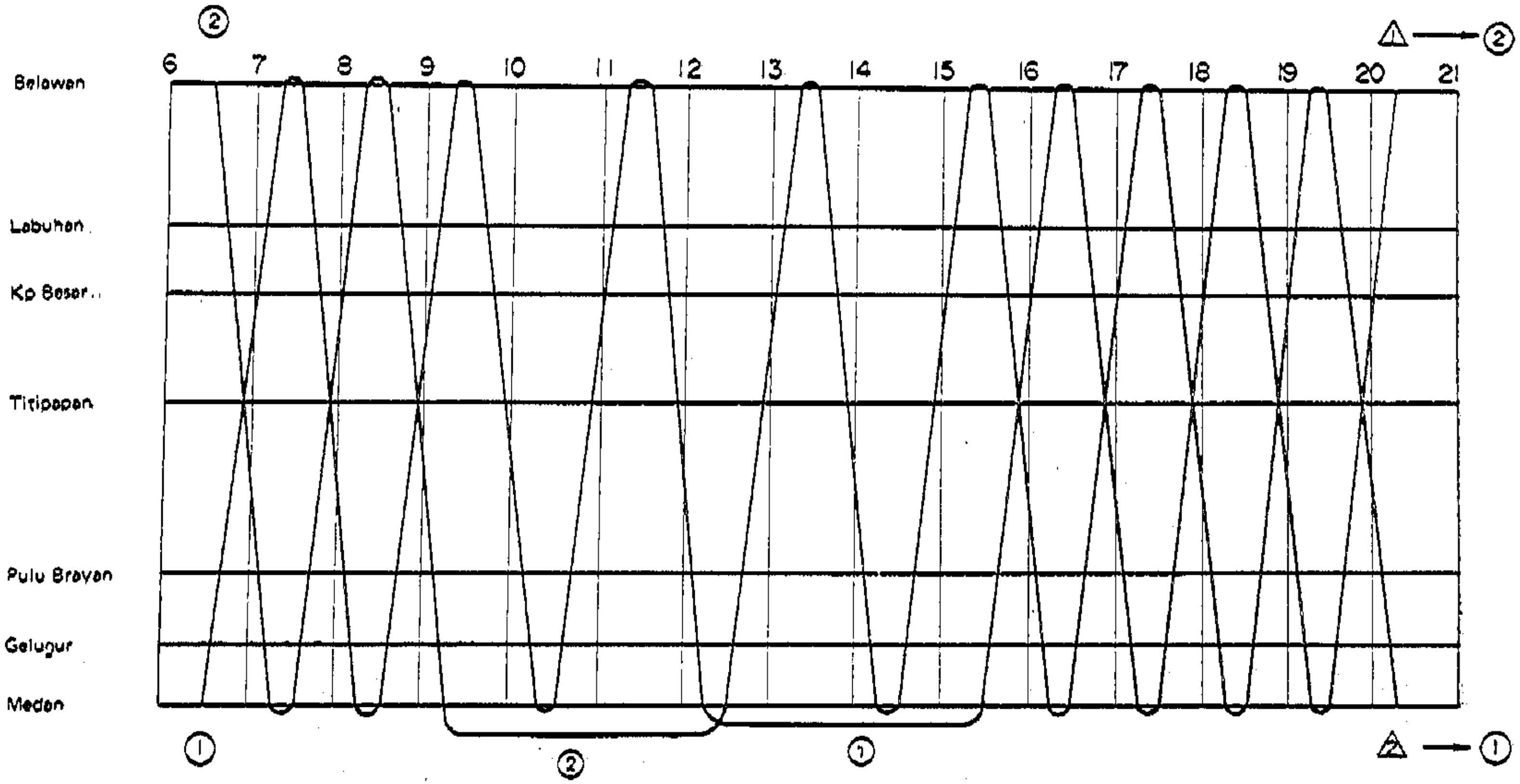

Fig. 7.3.4
Proposed Operating Diagram for Passenger Service (Medan-Belawan)

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Legend

- Height .... 3.60 m
- Floor level from the top of rail .... 1.20 m
- Length .... 20.00 m
- Width .... 2.99 m
- Interval between bogies .... 14.00 m
- Rigid wheel base .... 2.20 m

Maximum speed and output of the diesel engine

- Maximum speed (without load)
  - On flat grade .... 90 km/hr.
  - On 1.0 % up grade .... 38 km/hr.
- Diesel engine .... 180 H.P., 1500 r.p.m.
- Converter .... Hydraulic type
- Maximum axle load .... 10 tons (limited)
- Maximum number of passengers per diesel railcar .... 120 (seating & standing)

ii) Train Compostion

A set of train consists of 4 diesel railcars. Three sets of train are to be assigned, two for actual operation and one as a spare set.

iii) Scheduled Speed & Travelling Speed

Scheduled speed .... 30 km/hr.
Travelling time to over a distance of 21.6 km .... Approx. 45 min.

iv) Train Operating Diagram

Fig. 7.3.4 shows a proposed operating diagram of diesel railcar trains. This is an example of the maximum number of 11 trains per direction per day utilizing only Titipapan Station as the passing siding where trains in both directions cross one another. Such a number of daily trains is, of course, a little excessive for the estimated passenger traffic demand in the Shot-Term and can be deducted appropriately to cope with the actual demand. But it is strongly proposed to provide at least a train per direction per peak hour, carrying about 480 passengers per train, in order to divert some part of passengers originally using the existing bus service in the same service section.
In this diagram it is intended that the daily inspection and re-fueling of two sets of diesel railcar trains can be performed at Medan Locomotive Depot in the time band 9:00 - 16:00 every day when the passenger traffic is comparatively slack, taking 3 hours per train alternatively.
All diesel railcar trains are expected to stop actually at every existing station on this line for the convenience of local commuters as well as shoppers. The actual train operating diagram should be drawn, being well adjusted in the relation with all long-distance passenger trains leaving and arriving at Medan Station and also all freight trains which are proposed to be arranged in the time bands 21:00 - 06:00 and 10:00 - 15:00.

v) Inspection and light repairs of diesel railcar trains

Diesel rail-cars to be assigned to this service can be tentatively assigned to Medan Locomotive Depot which should be responsible for routine inspections and light repair of those diesel rail-cars. After a new diesel rail-car depot is established in future at Titipapan as a part of the long-term improvement plan, the new depot at Titipapan is responsible for all routine inspections (daily, mothly, three-monthly and six-monthly), and light repairs have to be performed at Pulu Berayan Work-shop. In the shot-term one out of two sets of train under operation, is to rest and to be prepared for the next day's operation at Medan Station, and the other at Belawan Station during the midnight in the regular operation schedule. The spare train is to be held either in the coach yard of the shed of depot.

(c) Necessary Improvement of Facilities

i) Stations

(Titipapan Station)

According to the proposed train operating diagram for the passenger service between Belawan and Medan for the shot-term as shown in Fig. 7.3.4. all diesel railcar trains cross each other at Titipapan Station. Consequently, the following inporvements rehabilitations are necessary:

- The construction of a passing siding (the effective length is 150 m) including affiliated signal system:
- The extension up to 150 m and rehabilitation of the existing platform::
- The rehabilitation of the existing station buildings and the installation of affiliated telephone system to communicate with all Stations on this line and the train despatcher office.

(Belawan Station)

Belawan Station can be used for this passenger service without carrying out any facility improvement. The freight stored at the existing platform has to be moved to some appropriate warehouses or sheds and should be cleaned for the passengers' use.

(Medan Station)

Medan Station can be used for this passenger service without carrying out any facility improvement.
No. 3 Platform Track can be used for departure and arrival of diesel railcar trains of Medan-Belawan Line.

(Other Stations)

The installation of affiliated telephone facilities are necessary at Gelugur Station, Kampung Besar Station and Labuhan Station in order to communicate with all other stations on this line as well as with the train despatcher office for the purpose of train control as well as handling commuters.

ii) Lecomotive Depot

For the purpose to perform routine inspections and light repairs of diesel railcars at Medan Locomotive Depot and additional inspection pit together with affiliated equipment are to be provided to the existing shed facilities. Fig. 7.3.5. shows the main dimensions and typical cross-sections of the new pit for

diesel rail-cars.
Some increase in the repairing capactiy of Pulu Berayan Workshop for the heavy repairs of those newly assigned diesel railcars is basically necessary, but it can be postponed to the long-term improvement plan.

iii) Tracks and Bridges
The maximum axle load for diesel rail-cars is limited within 10 tons. (Refer to Sec. 7.3.1. (2) b)). The standard design load of existing tracks and bridges on this line is presently 12 tons as shown in Fig. 3.4.6. and Table 3-4-6. Consequently, it is anticipated that there would be no problem in tracks and bridges of this line for the re-opening of passenger service on this line in the present stage. However, in view of the fact that the need of increasing the number of trains per day and somewhat speeding up of such commuters' trains in future the strengthening of tracks and bridges at least in Medan Area has to be taken up in the long-term improvements of this study.

(d) <u>Number of Personnel Newly Required</u>

The number of personnel to be newly required for the reopening the passenger service on the section between Medan and Belawan by using 3 sets of diesel railcar train are estimated to be as follows:

- Engine drivers 7
- Conductors 6
- Train despatchers or assistants 8
- Station clerks 8
- Diesel railcar inspectors and rapairmen 16

(3) <u>Opening of East-Side Gate of Medan Station</u>

Half of railway passengers from/to Medan station are originated form and terminate in the east side area of Medan station. Consequently, when the railway urban passenger service is re-opened, the east-side gate of Medan station is proposed to be opened. It consists of a station building, a bus terminal. This new building and the existing main building are to be connected with an underground path which is constructed by extension of the existing underpath, or a temporary footpath on the ground level. (Refer to Fig. 7.3.6.).
It should be noted as reference that after the railway is elevated in the long-term improvement plan all station rooms and a concourse are to be included underneath the elevated structure.

(4) <u>Improvement of Over-Bridge at Medan Station</u>

There is an over-bridge connecting the east and west sides across the tracks at Medan station, which is only for the use by pedestrians bicycles and motorcycles. The bridge is important for road traffic in the CBD. The present deck of the bridge is of wood but is rotten and broken. Rehabilitation of the bridge deck is essencial for safety of pedestrians and others. It is proposed that wooden deck be covered with steel plate to protect wood from abrasion and corrosion. Steel members of the bridge are to be examined before rehabilitation of deck is carried out.

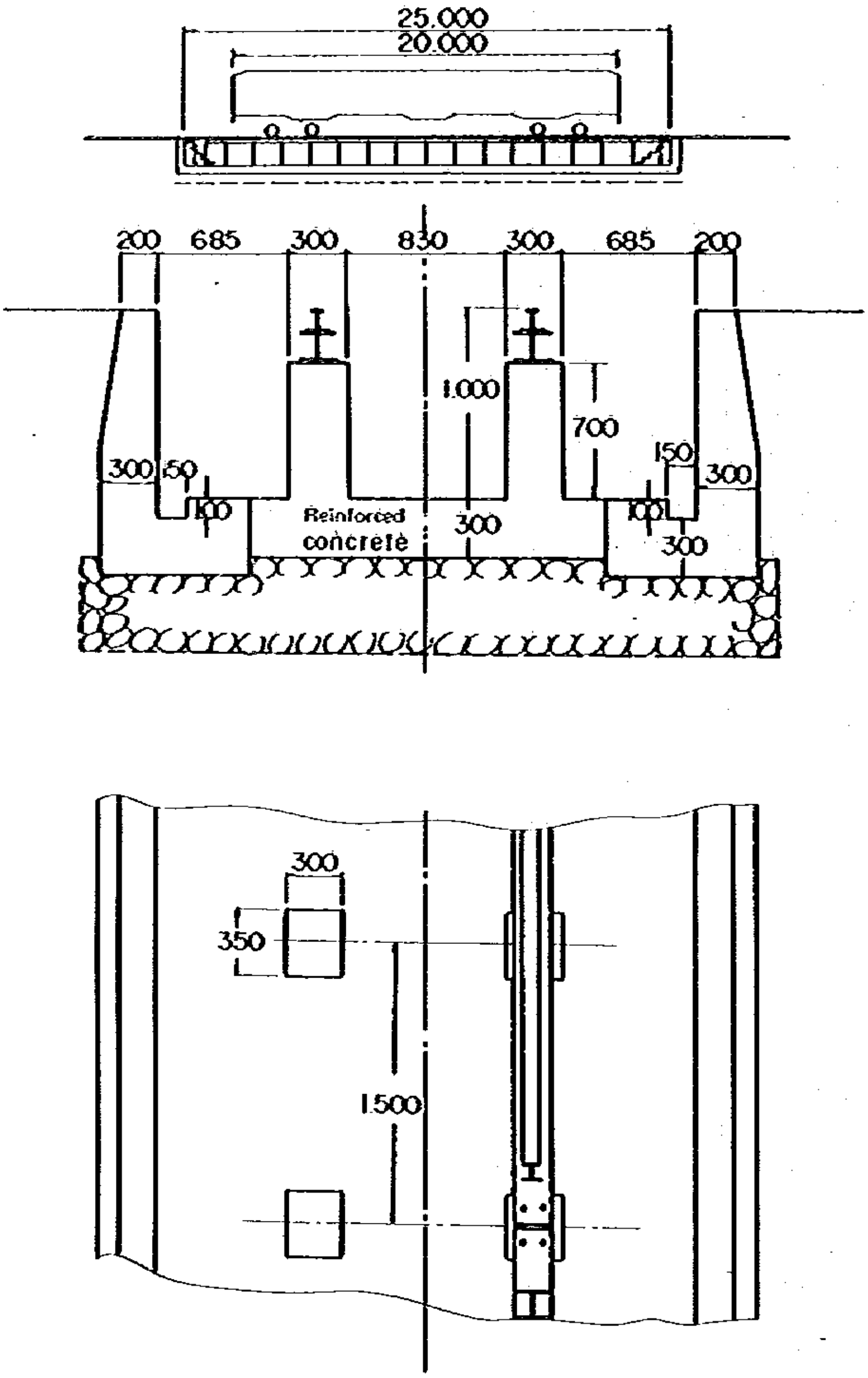

Fig. 7.3.5

Inspection Pit for Diesel Railcar

Legend

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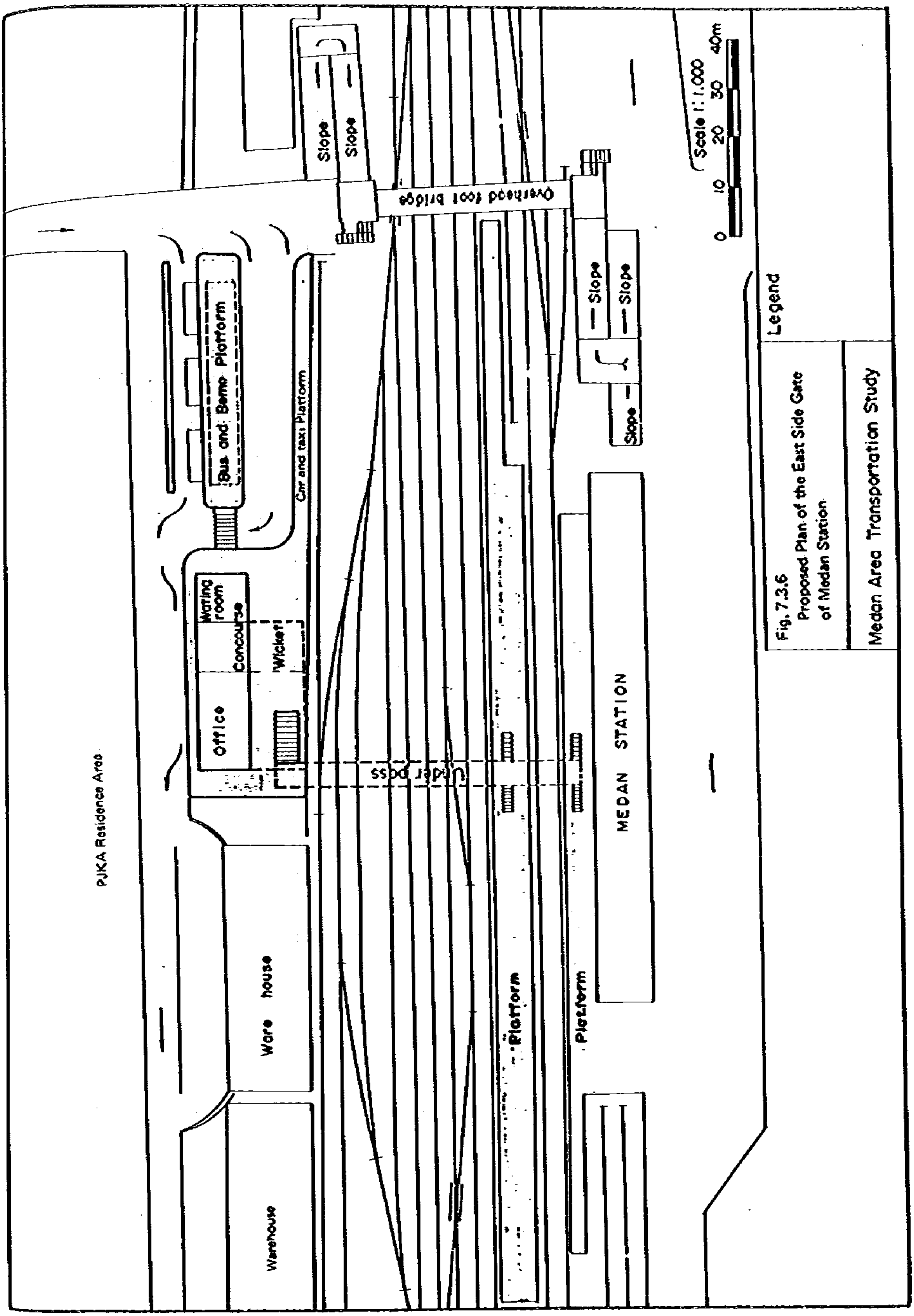

Fig. 7.3.6
Proposed Plan of the East Side Gate of Medan Station

7.3.2. Traffic Control System

The scope of traffic control system to be taken up as a part of the shot-tem improvement plan covers the improvement of one-way traffic system, intensifying signalization and improvment of intersections by channelization. Since the improvement of intersections are described in another section the rest items are herewith described.

(1) Re-Examination of One-Way Traffic System

(a) Aime in Planning

Two plans are worked out, the one is Case 1, in which it is intended to improve partially the existing one-way traffic system in order to improve the accessibility, while the other is Case 2, in which all wide roads wider than 8 m in carriageway are changed into two-way traffic system. The aims in planning of each plan is as follows. (Refer to Fig. 7.3.7.1 ∿ 7.3.7.3)

Case 1 : An improvement plan to eliminate such traffic passing through the CBD and improve the existing one-way traffic system, keeping unchanged those parts of road network which are obviously effective enough with the present one-way traffic system.

Case 2 : An improvement plan, in which all roads wider than 8.0 m are changed into two-way traffic system.

(b) Changes in Traffic Flows

Fig. 7.3.8. illustrates the effect of improvement of one-way traffic system by inter-block traffic flows in the CBD. Since Case 1 and Case 2 are similar in traffic flows the comparison was made here only between the present situation and Case 1. As shown clearly in Fig. 7.3.8. the traffic, which originate in the east side of the reilway and terminates in the same side, has to enter the west side of the railway and come back to the east side again crossing the railway and come back to the east side again crossing the railway twice and detouring over a large distance due to the present one-way traffic control system. Such traffic thus saved is expected to become approximately 17,000 units per day less than the present traffic by the partial improvement of the present one-way traffic system which is expected to result in relieving the traffic jams in the CBD and the noticeable reduction of railway crossing traffic.

(c) Vehicle-km & Vehicle-Hour

The total traffic volume occuring in A - D blocks shown in Fig. 7.3.8. amounts to 724,000 trip ends, accounting for some 63% of its total of 1,156,000 trip ends in Medan City. Table 7.3.3. compares vehicle-km & vehicle-hour between the existing oneway system and cases 1 and 2.

As the results of improvement of the existing one-way traffic system to Case 1 and Case 2, the vehicle-km & vehicle-hour conspicuously decrease even when the stopping time due to signal installtion is taken into account. The decrease in vehicle-km actually leads to a decrease in cross-sectional traffic volume due to decreased detours in the overall traffic volume within A - D blocks, giving a very favorable effect.

Table 7-3-3 Comparison of Vehicle-kms and Vehicle-Hours among Existing One-Way and Partically Improved One-Way Traffic Control Systems

(Unite: 1,000)

Case		Vehicle-Km	Vehicle-Hours
Existing		920.4	43.9
Improvement	Case 1	849.5	39.5
	Case 2	787.4	37.7

(d) Congestion Rate

Congestion rate along arterial roads and at intersections are shown in Fig. 7.3.9, in which a high level of traffic congestion is generally seen at present in the CBD. In improvement Case 1, however, the congestion is generally dispersed, giving an effective distribution of traffic over the entire road network in the CBD. In improvement Case 2, since the two-way traffic road capacity is a little lower than in the case of one-way traffic system, roads with high congestion rate is slightly increased than in other cases.

(e) Accessibility

The travel time contour-lines which indicate those points accessible in the same minutes from the center of the CBD are shown in Fig. 7.3.10. Since Case 1 is intended to improve the present accessibility with the partially improved one-way traffic system, a significant reduction in travel time is seen particularly in the central CBD and also in the south-eastern areas. In imporvement Case 2 travel time contour-lines show somewhat circular spread, indicating the relative difference in accessible distance in the a smae time have been significantly reduced, particularly in the south-eastern direction.

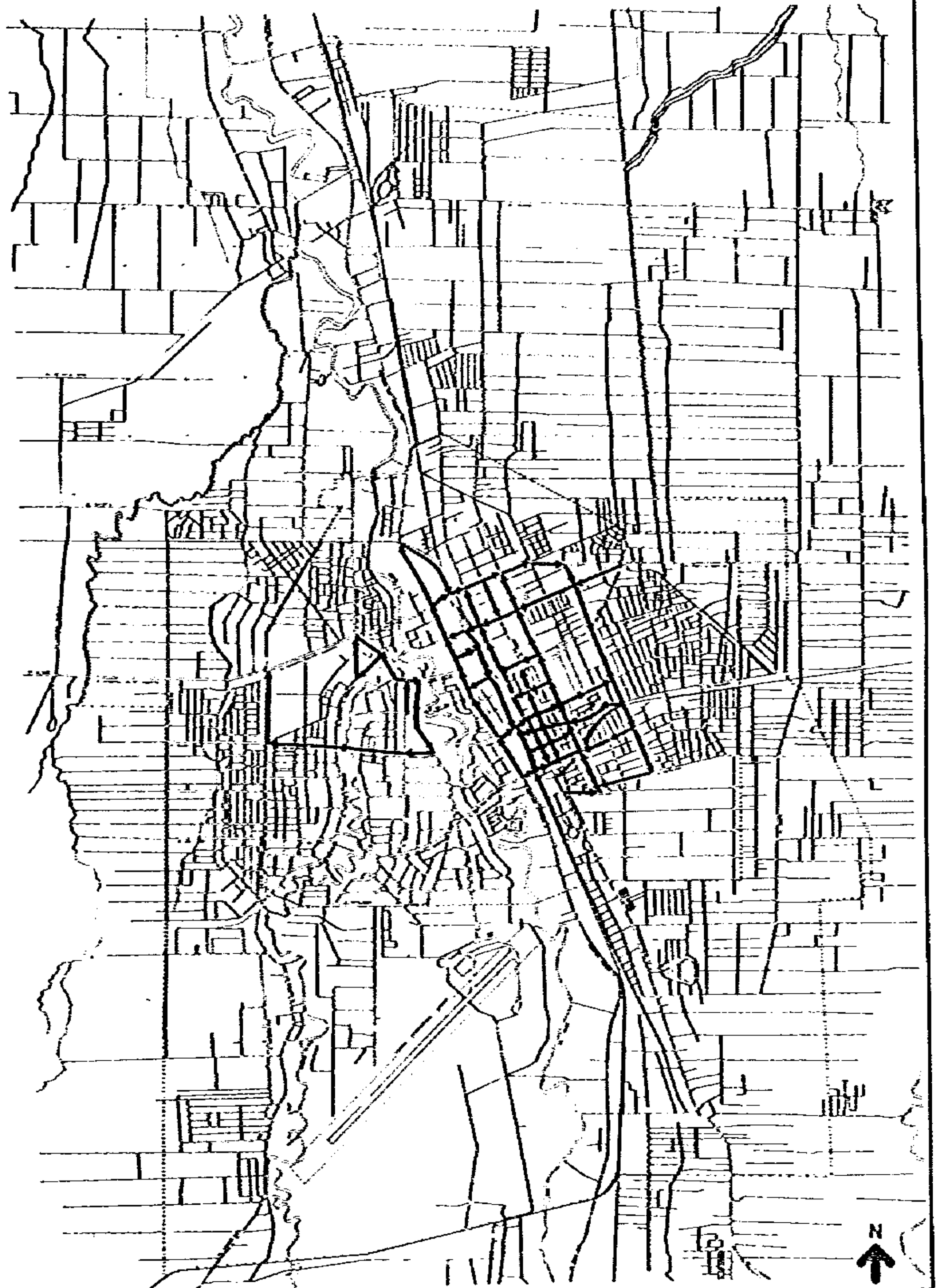

Fig. 7.3.7-1
Present One-way Traffic Control, Medan City (October 1979)

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Legend

One-way Traffic Controlled Routes & Directions

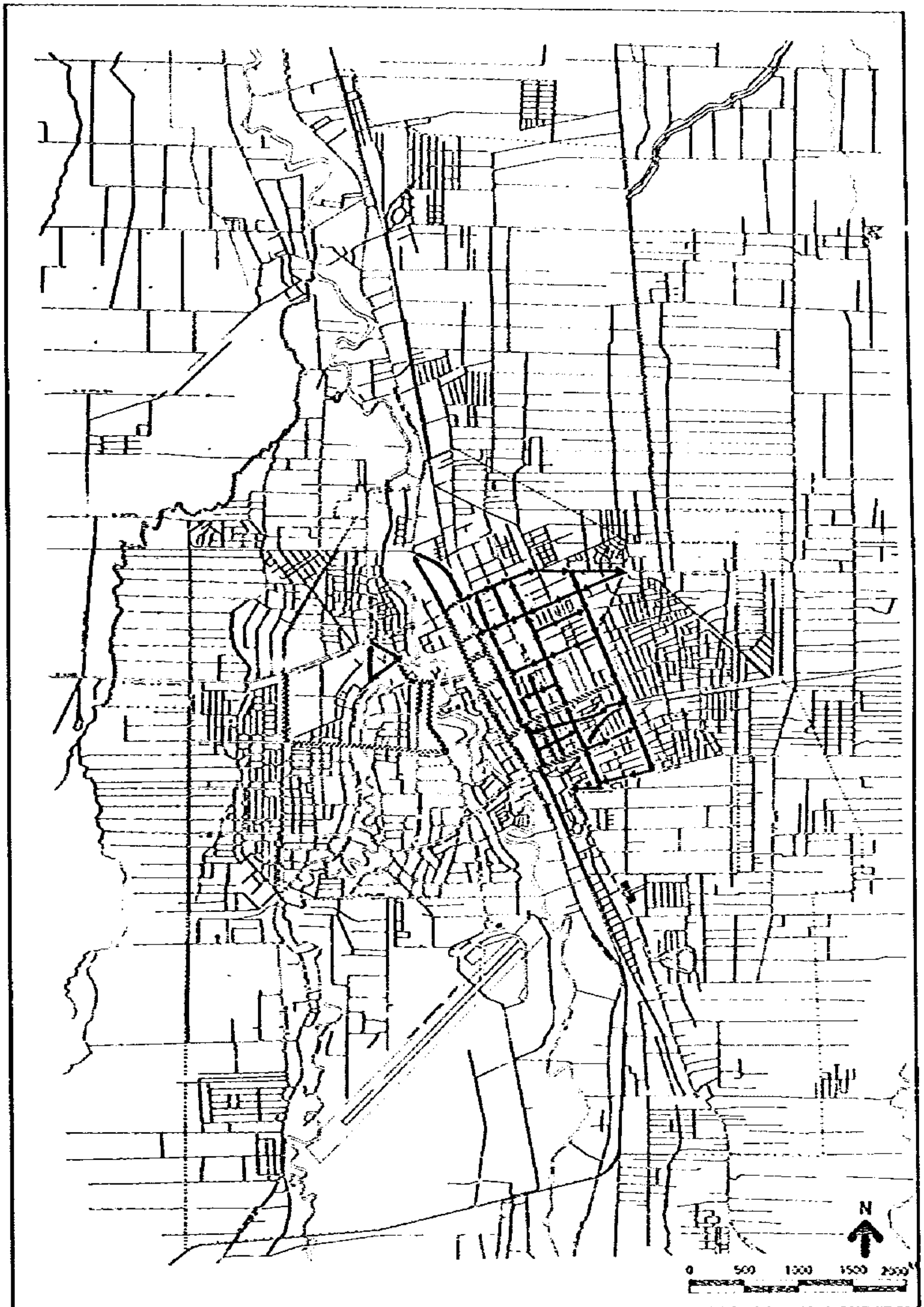

Fig. 7.3.7-2 Proposed Improvement of One-Way Traffic Control (Case-1)	Legend One-way Traffic Controlled Route & Directions To Be Released From One-way Traffic Control
Medan Area Transportation Study	

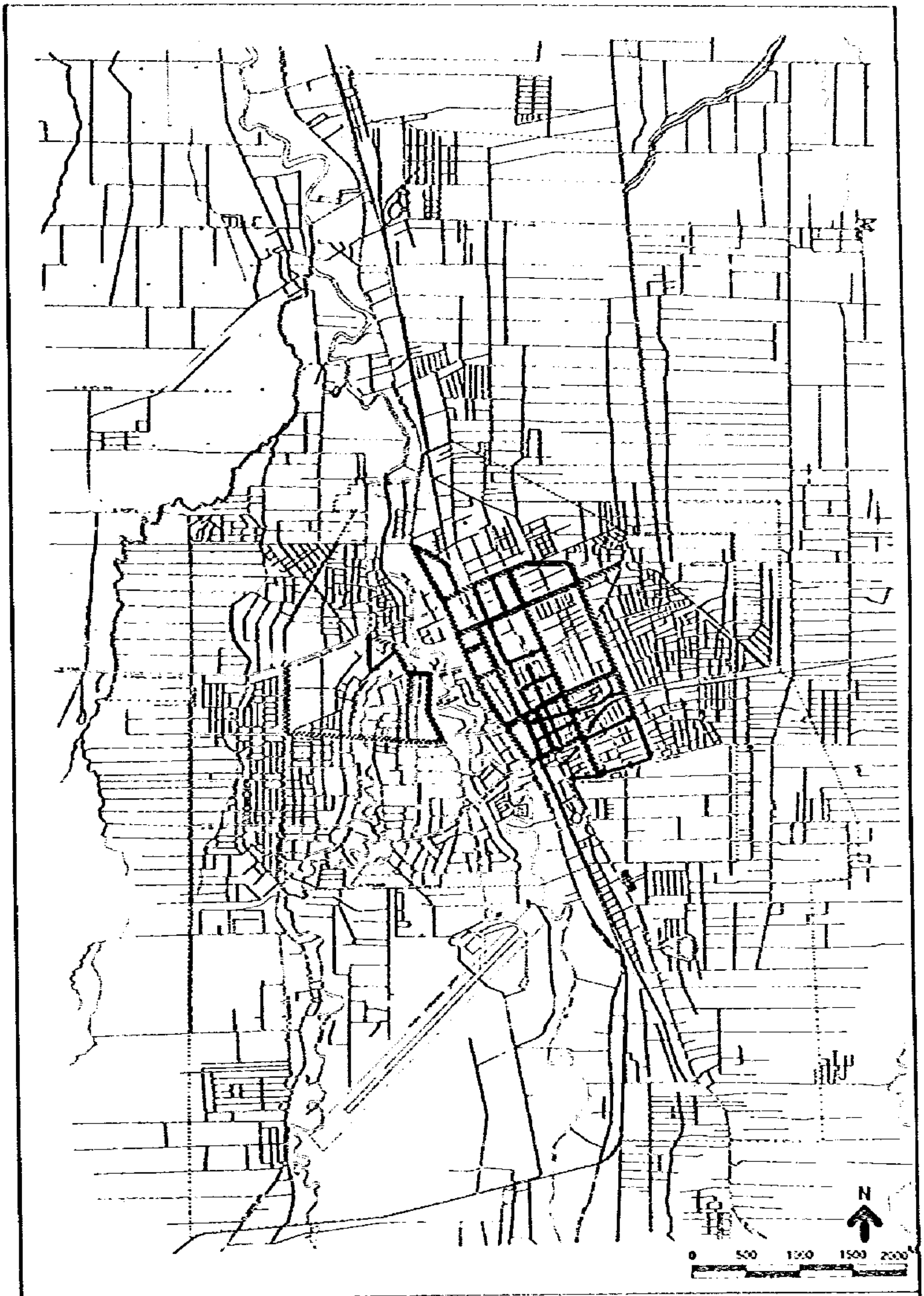

Fig. 7.3.7-3
Proposed Improvement of
One-Way Traffic Control (Case-2)

Legend

One-way Traffic Controlled Routes & Directions

To Be Released From One-way Traffic Control

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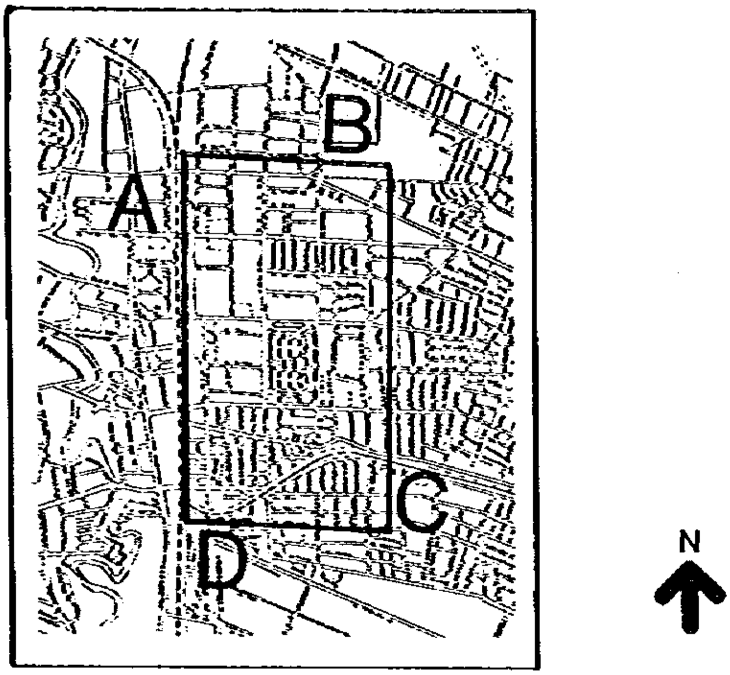
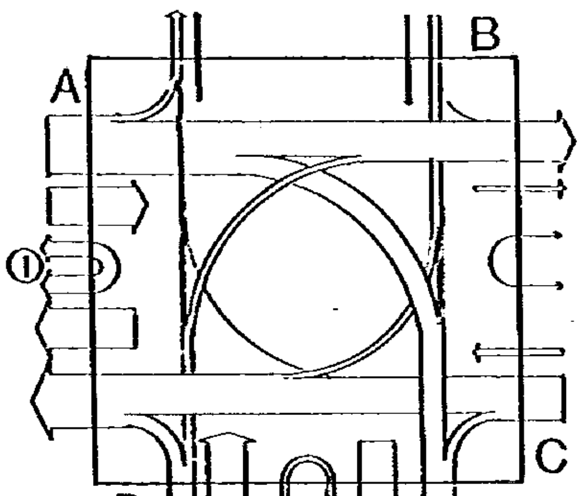
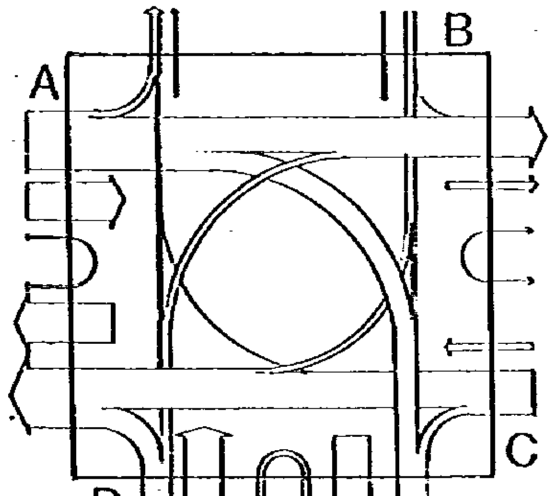




Existing Traffic Flows



Improved Traffic Flows in Case - I

Legend

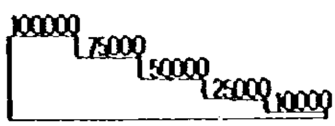
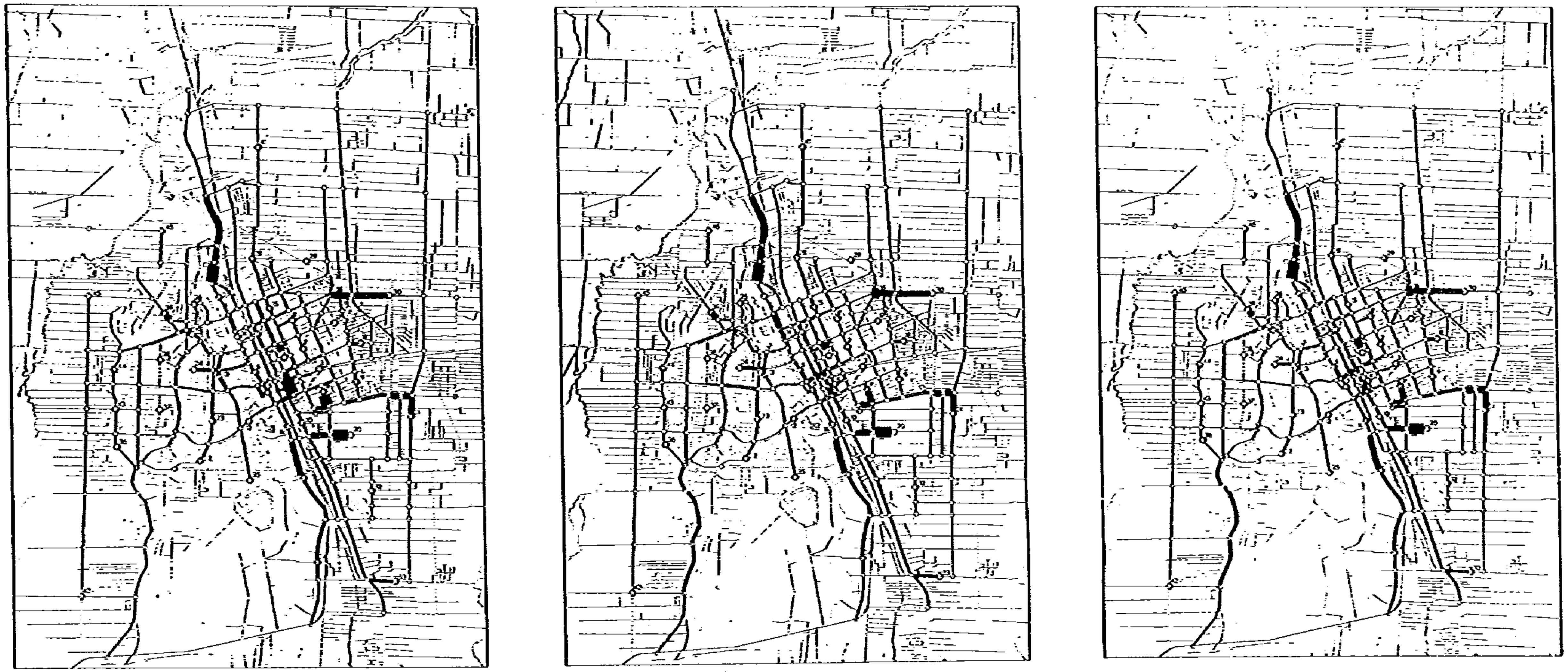


Fig. 7.3.8 Anticipated Traffic Flows in Central Area by Partially Improved One-way Traffic Control



Existing | Case 1 | Case 2

N ↑

Fig. 7.3.9

Congestion Rates on Streets in the City Central Area

Medan Area Transportation Study

Legend: Congestion Rates

(thinnest line)	~ 0.999
	1.0 ~ 1.499
	1.5 ~ 1.999
	2.0 ~ 2.999
	3.0 ~ 3.999
(thickest line)	4.0 ~

Fig. 7.3.10 Existing & Anticipated Improvement in Travel Time Countour-lines from JL. Sambu

Note: Figures mean travel time in minute from the Sambu

(2) Signal Control

In order safely and smoothly to deal with a large volume of automobile traffice, signal control is indispensable. At present in Medan City signalization is beginning to be carried out. In order to realize one-way traffic improvement mentioned in the preceding section, signal installation is a prerequisite condition.

Together with the general measure for signal installation, we discuss here an enhanced traffic handling system by intensive control of signals themselves. Generally speaking, depending upon the level of city, two signal control systems are conceivable, namely, the route coordinated control system and the area coordinated control system. In view of the present situation of Medan City, it seems to be a little premature to introduce the area coordinated control system.

Therefore, the route coordinated control system is examined in connection with one-way traffic improvement.

(a) Outline

The road network of Medan City is formed by both arterial roads which extend out from the central Medan to Belawan, Tanjun Molawa, and Binjey and arterial roads network including one-way traffic streets which connect those roads laterally in urbanized areas. Installing independently operating traffic signals at the various intersections in such a road network not only drastically impedes the flows of traffic on important arterial roads, but also repeated stops on red lights put psychological pressure on drivers, leading to increased traffic accidents. So that in this study it is intended in the future traffic signals at each intersection can fulfill their roles for which they were designed of guiding the flows of traffic and preventing traffic accidents, a plan is devised to systematize the function of those traffic signals. This plan will ensure a smooth flow of traffic by giving priority to the vehicles moving along principal arterial roads.

The followings are the merits of Route-Coordinated traffic signal system:

i) Reduction in the number of stops, and travel time in total compared to a system of independently operating traffic signals.

ii) Vehicles would move at speeds close to the designed speed since traffic would flow in bunches of vehicles. Therefore, this system reduces rear-end type collisons and ensure safe travelling.

(b) Premises to Determine a Cycle Time of Signals

i) Forms of Traffic Regulatory System:

- the simultaneous system, namely all traffic signals within the systematized area turn red or green at the same time;
- the mutual signal system, namely traffic signals at adjacent intersections on the same route become green or red together;
- the progressive system, namely traffic signals turn green one after another as a group of vehicles driving at a predetermined speed approaches them. In this system there are two kinds of "offsetting" - equal preferential offsetting where equal preference is given to traffic flowing in both directions, or one-way preferential offsetting where only traffic moving in one direction is given preference.

The proposed plan calls for the adoption of the progressive system with the use of equal preferential offsetting on two-way streets and one-way preferential offsetting on one way streets.

ii) The Optimum Cycle Time

This plan proposes to fix a cycle time based on the needs of Jl. Brigadejendral Katamso-Jl. Pemuda, Jl. Jenderal, A. Yani, Jl. Balai Kota and Jl. Laksma Yos Sudarsu (major roads connecting Belawan and Tg. Morawa). It is on these roads where it is foreseen that there will be the worst traffic problems due to an estimated increase in the volume of traffic by 1985 and in one-way traffic. The ideal cycle time of 116 seconds is determined according to the relationship of the cycle time and the time for a round trip time between various base intersections. The followings are set in determining the cycle time that the signal should be green for 50% of a cycle time and that a cycle time necessitated should be held within 120 seconds. Cycle lengths of route coordinated signal system thoroughfares, intersecting with those roads, are determined also in accordance with this time so that a cycle time of 116 seconds will be set for all route coordinated signal system roads.

iii) Controlling Methods

First, as shown in Fig. 7.3.11 and Fig. 7.3.12 an off setting signal cycle time on intersections of route 1 (which has been designated as the base route) is determined. In offsetting

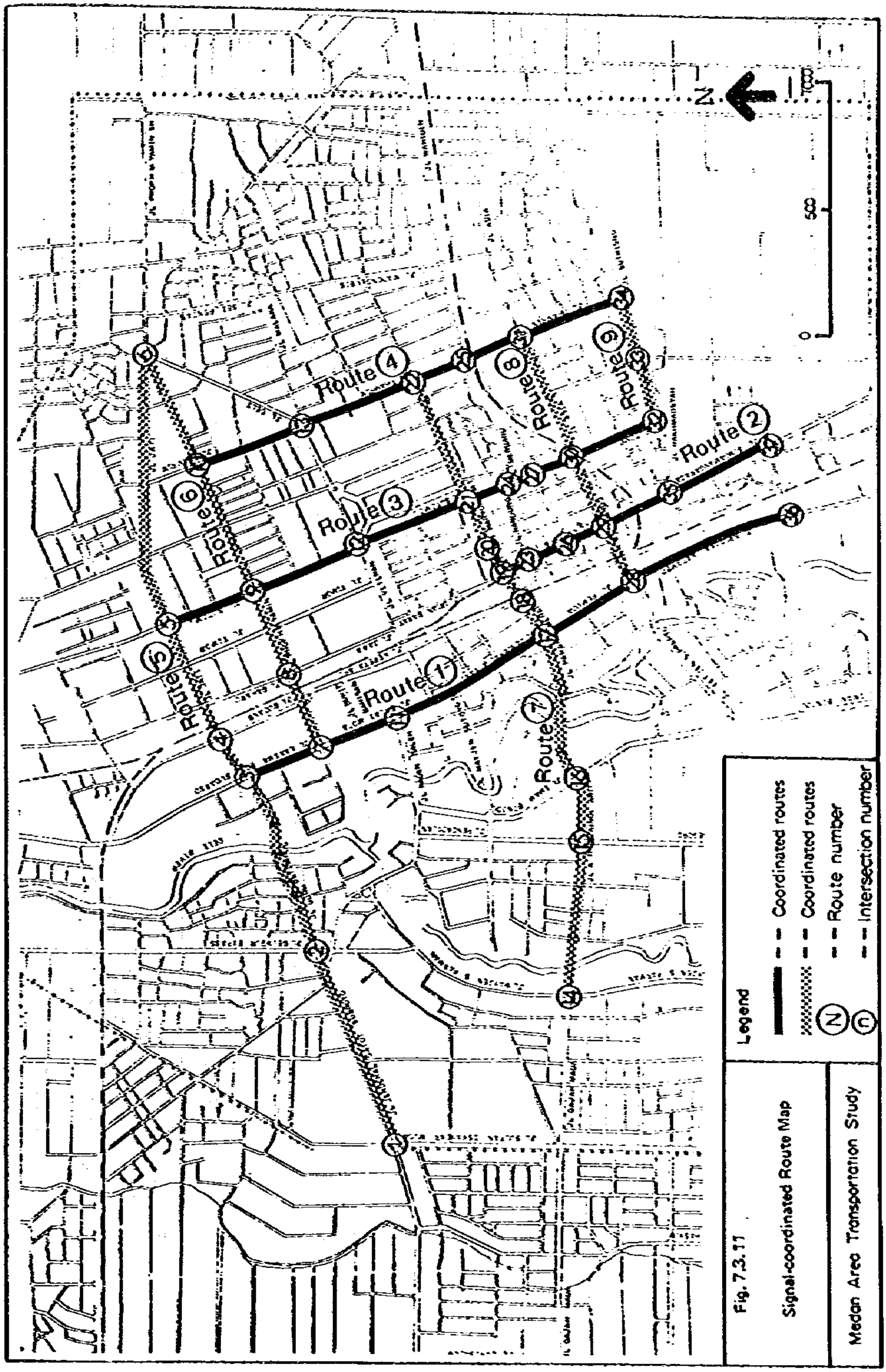


Fig. 7.3.11

Signal-coordinated Route Map

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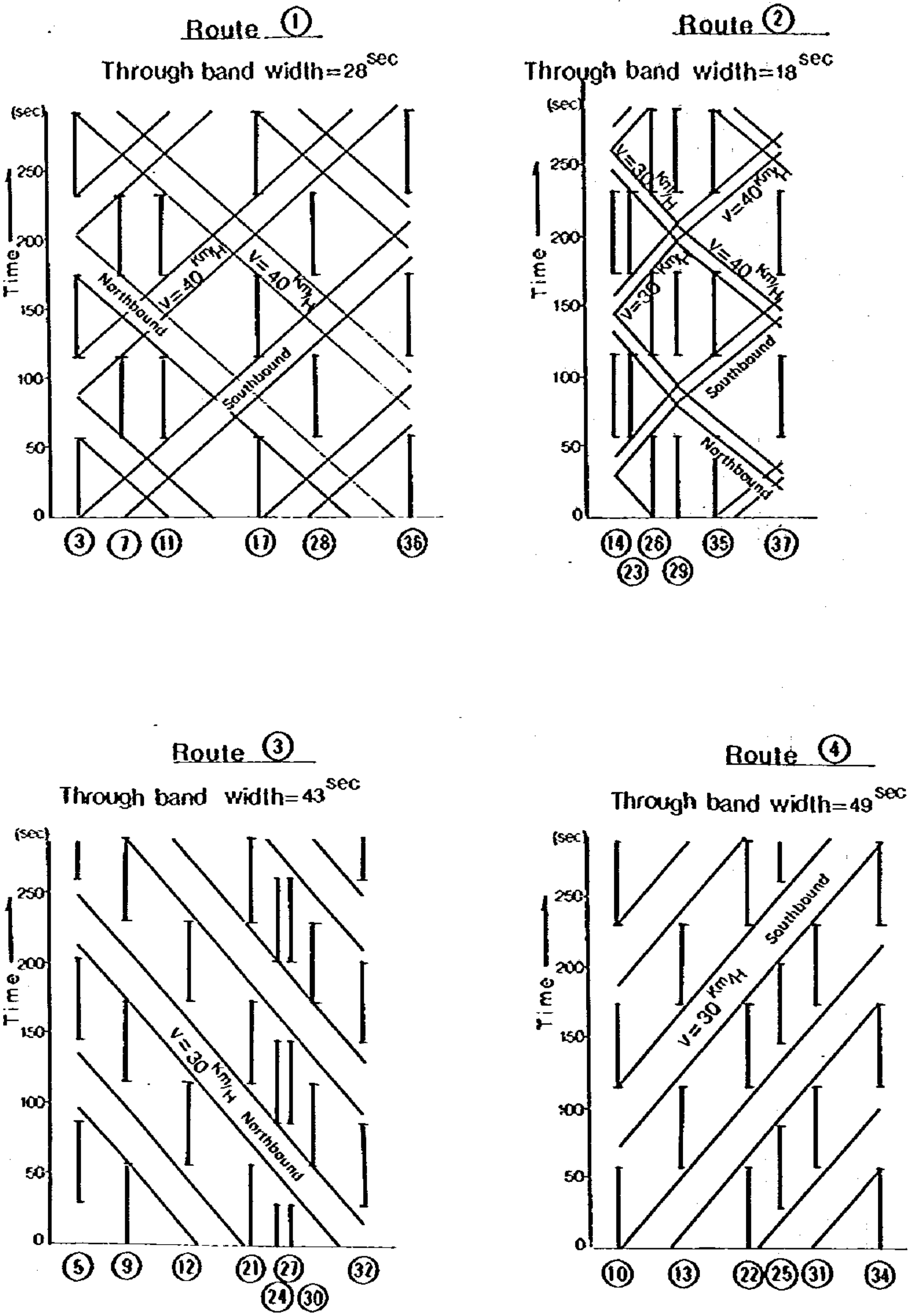

Fig. 7.3.12 Inter-Related Offsetting Through Band Diagram by Route
(Route 1 ∿ Route 4)

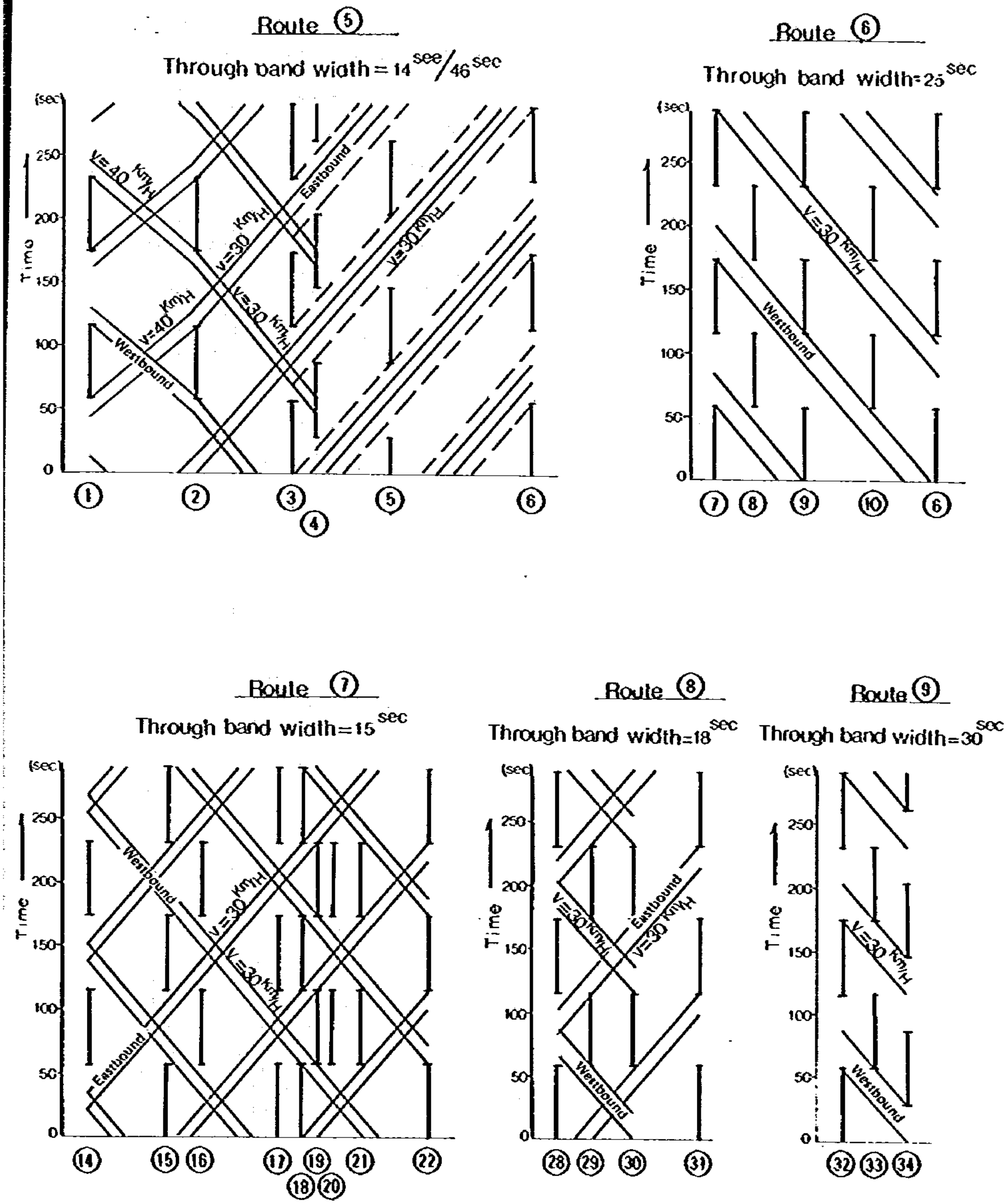

Fig. 7.3.13 Inter-Related Offsetting Through and Diagram by Route (Route 5 ~ Route 9)

signal cycle time on intersecting roads is set up so that there is no time lag between traffic light changes on intersecting routes. So that the length of time of the "through band" is as long as possible, other signals on the various roads are adjusted by shifting them one quarter of a cycle time unit. The inter-related offsetting through bands of the various routes are illustrated in Fig. 7.3.12 to Fig. 7.3.13.

(3) Parking

As for the parking system in Medan City, it is substantially favorable to provide public parking spaces off roads in the CBD. However, some difficulties can be seen presently to find open spaces for this purpose and it is evident that a heavy financial burden seems to be expected on the municipal Government to provide those open spaces. Judging from those facts, followings are the proposed items of Short Term Solution for parking system.

i) The counter-measure for parking system in case of Re-examination of One-Way System.
ii) The counter-measure for parking system on whole area in Medan City.

Both items described above are closely related each other, and it is necessary to prohibit the roadside parking on those roads to increase the traffic capacity of roads on which a partial one-way system is re-examined.

Fig. 7.3.14 shows the road sections where the road side parking is to be prohibitted. By the application of such parking regulation, some counter-measure has to be considered for the parking demand of approximate 290 vehicles in capacity. Such a counter-measure as increasing the present parking charge is considered to be effective and it seems also to be applicable to the case of the CBD in Medan City. The parking charge proposed is variable according to parking hours as follows:

Duration of Parking Time	Parking Charge per Vehicle
Within 1 hour	100 Rps.
1 - 1.5 hours	200 "
1.5 - 2 hours	400 "
2 - 3 hours	600 "
3 -	1000 "

At present owner drivers, especially of sedans, are ranked as comparatively high social status and it is not unreasonable to levy those owner drivers rather higher parking charge for the purpose to utilize the road spaces effectively. Such a measure is expected to control the progress of motorization in Medan City and to help a part of financing of providing public parking spaces of off-roads in future. However, such a regulation should be enforced not on trucks but mainly on sedans because if this regulation is applied to trucks, commercial prices of commodities might be affected by such an increase in parking charge.

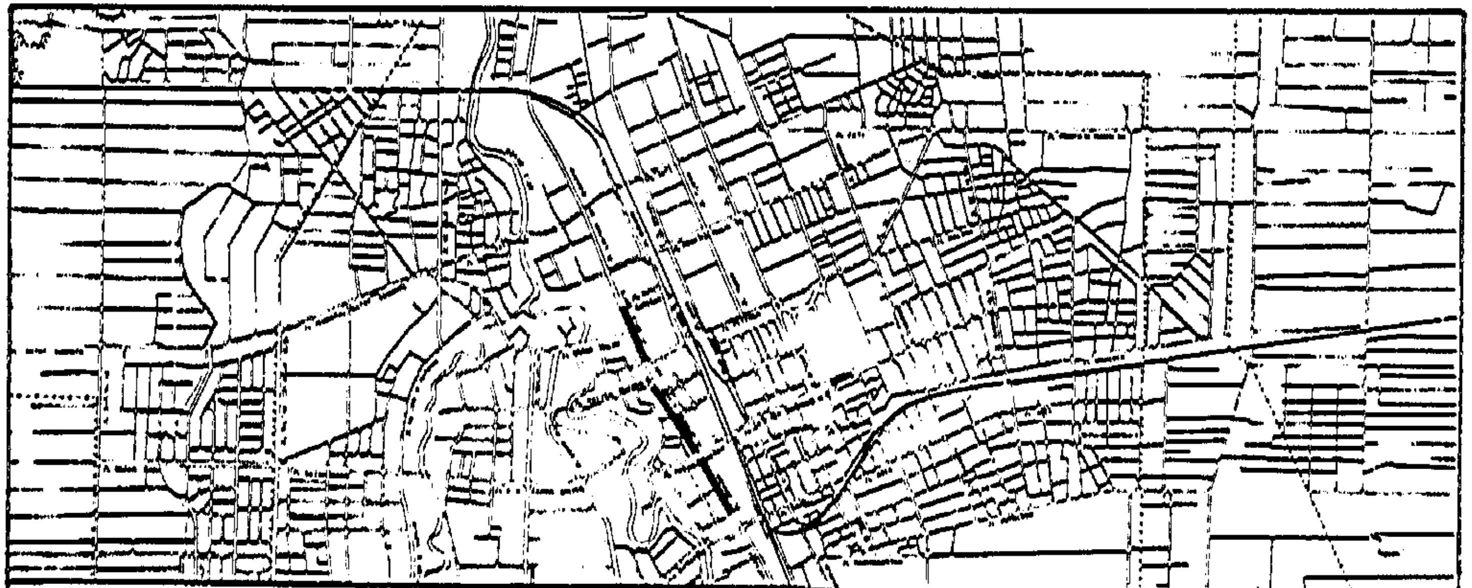

Fig. 7.3.14
Proposed Off-Limit Road Side
Parking

Legend

Locations where road side parking is to be prohibitted

7.3.3. Road Betterments and Others

As for road betterments and new constructions the following items are summarized to be studied:

i) Review on road betterments and new constructions under implementation/ planning;
ii) Additional necessary road betterments/constructions;
iii) Road improvements to cope with re-examination of traffic control system;
iv) Adjustment necessary to keep consistency with affiliated development plans.

Followings are the explanation on those items.

(a) Review on Betterments and Construction under Implementation/ Planning

Road maintenace is dominant in the first year of Third-year Plan in Medan city. However, during the period of following four years, some road construction plans will be involved. The section listed in Table 7.3.4. are the main categories, among which only Jl. Gang Warni is the new construction and the rest ones are betterment of the exicting roads.

(b) Additionally necessary Road Constructions and/or Road Betterments

The objectives of this item are the routes which indicate presently conspicuously high congestion ratio and seem to be effective by their improvements. The congestion ratio of each road is shown in Fig. 7.3.8. Judging from this situation, the following road sections are proposed for improvement alternatives.

i) Jl. Sudarso, Stretching north to the direction of Belawan
ii) Jl..Prof. Yamin, Stretching to the east
iii) Jl. Singamangaraja, a section of a raod for Tg. Morawa; and
iv) Roads inside the CBD, near Pasar Sambu

(c) Road Improvements to Cope with Re-examination of Traffic Control System

Road widening and overlaying on the following road sections seem to be necessary to cope with the re-examination of one-way traffic system.

i) Jl. Jenderal A. Yani
ii) Jl. Sudarso
iii) Jl. Gajahmada and Jl. Zainul Arifin
iv) Jl. Pemuda
v) Jl. Balai Kala
vi) Jl. Sudarso

(d) Adjustement Necessary to keep Consistency with Other Affiliated Development Plans

As Belawan-Medan-Tg. Morawa Tollway is expected to be opened for traffic in 1983 A.D., it is necessary to provide the access roads between the central district in Medan and interchanges of this toll way prior to its opening. The following streets are proposed on this reason.

i) Jl. Prof. Yamin
ii) Jl. Pembalagian

7.3.4. Improvement of Sambu Bus Terminal

(a) Outline

Pasar Sambu Bus Terminal, situated at the center of CBD, is the core of present public transportation where 70% of all the buses and 90% of Bemos come in and out every day. Its area covers Jl. Sambu and some city streets crossing it, and the usable area extends considerably. Yet its potential capacity is not fully at work because of the unclarified flows of pedestrians and vehicles. In this short-term period that expires in 1985/86 it is suggested that some points be considered instead of launching a large-scale re-modelling along the following basic objectives, so that a large benefit shall result in from the least additional investment.

(b) Basic Objectives

i) To provide sufficient sidewalks, and separate pedestrians from buses and Bemos.
ii) To separate bus lanes from bemo lanes, and consequently simplify the traffic conflicting points.
iii) To assign sufficient number of bus berth & drive routes to buses and Bemo separately and secure enough terminal space for each route according to its number of vehicles operating.
iv) To eliminate obstacles in traffic flows by regulating vehicles on the roadways and pedestrians on sidewalks.

Table 7.3.4 Proposed Betterments and New Construction of Roads in Medan City as Short-Term Solutions

Route No.	Name of Street	Length	Work Items
R-1	JL. Pembalagian Paved width (W=6m)	4,000m	(i) Widening up to 4 lanes (ii) Improvement of 5 intersections
R-2	JL. Prof. Yamin SH (W=6m)	3,900m	(i) Widening up to 4 lanes (ii) Construction of a new bridge (span 12m, width 10m) (iii) Improvement of 3 intersections
R-3	JL. Gajah Mada (W=8m)	600m	(i) Widening up to 4 lanes (ii) Improvement of 2 intersections
	JL. Zainul Aritin	900m	(i) Widening up to 4 lanes, 500m long (ii) Overlaying 400m long (iii) Construction of a new bridge (span 35m, width 10m) (iv) Improvement of 2 intersections
	JL. Palang Merah (W=15m)	600m	(i) Overlaying (ii) Construction of a new bridge (span 46m, width 10m) (iii) Improvement of 2 intersections
R-4	JL. Pemuda (W=20m)	400m	(i) Overlaying (ii) Improvement of an intersection
	JL. A. Yani (W=12m)	520m	(i) Widening up to 4 lanes (ii) Improvement of an intersection
	JL. Balai Kota (W=20m)	460m	(i) Overlaying (ii) Improvement of 2 intersections
	JL. Sudarso (W=11m)	300m	(i) Widening up to 4 lanes (ii) Improvement of 2 intersections
R-5	New Street along JL. Gang Warni	950m	Construction of a 2-laned including a bridge (span 40m, width 10m) and improvement of 2 intersections

(c) Number of Vehicles & Size of Bus Berths

(i) Number of Buses

Table 7.3.5 Projected Number of Buses Entering Pasar Sambu Bus Terminal (1985)

Route No.	Vehicles/ day	Vehicles/ Peak hour
1	537	47
4	284	25
6	202	18
7	271	24
8	188	17
9	223	20
10	112	10
11	155	14
12	195	17
Total	2,167	192

Note: Peak hour rate is 8.87% over the average figure per hour.

(ii) Number of Bemo

Table 7.3.6 Projected Number of Bemos by Route Entering Pasar Sambu Bus Terminal (1985)

Route No.	Vehicles/ day	Vehicles/ Peak hour	Route No.	Vehicles/ day	Vehicles/ Peak hour
2	219	22	23	302	30
3	533	53	24	723	72
4	1,074	106	25	413	41
5	533	53	26	299	30
7	751	74	27	583	58
9	294	29	28	700	69
10	509	50	29	296	29
11	248	25	31	204	20
12	1,340	133	33	832	82
13	326	32	35	618	61
14	482	48	36	228	23
15	534	53	37	787	78
16	424	42	40	972	96
17	535	53	41	268	27
18	748	74	42	180	18
19	439	43	43	267	26
20	448	44	44	630	62
21	517	51	Total	18,256	1,807

Note: "Peak hour rate is 9.9% over the average figure per hour.

(iii) Major Dimensions of New Berths

a) Bus Berth:

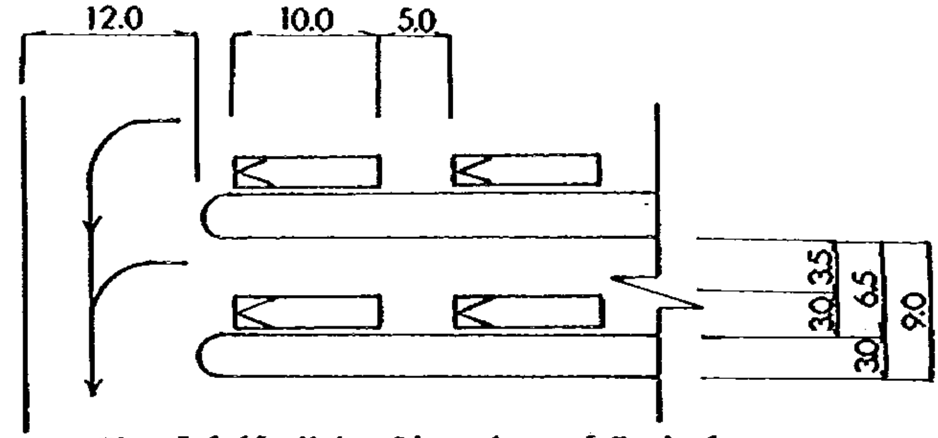

Fig. 7.3.15 Major Dimensions of Typical Bus Berths

b) Bemo Berth:

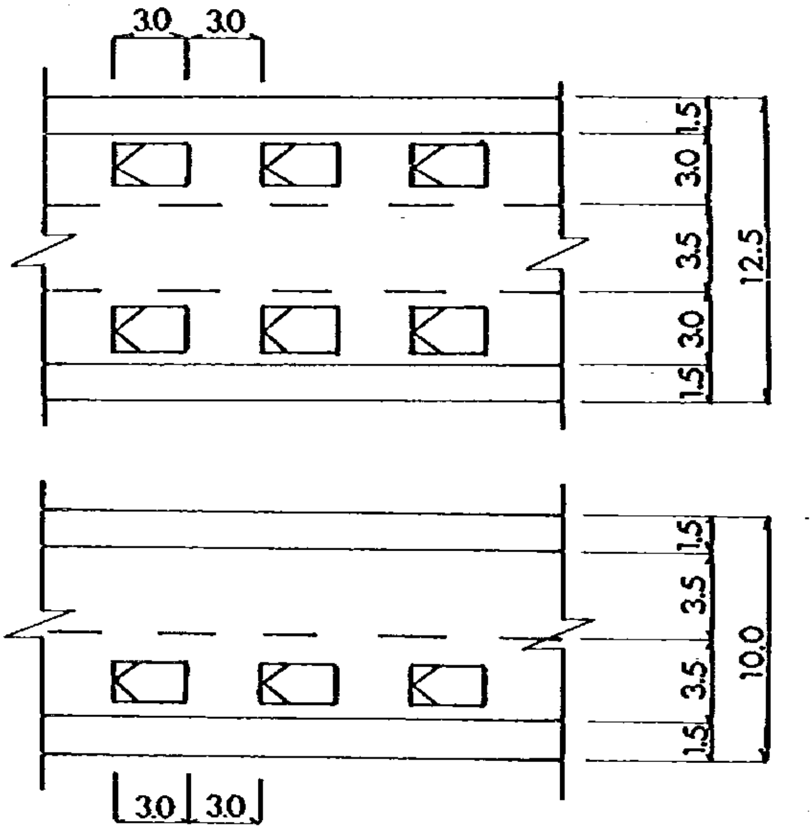

Fig. 7.3.16 Major Dimensions of Typical Bemo Berths

(iv) Capacity

Under the assumption that buses and bemo stop for 5 minutes at the terminal in peak hours, the hourly capacity to be handled is around 220 buses and 2,160 bemos respectively. Judging from these analyses, Pasar Sambu Bus Terminal is expected to be able to handle the present bus and Bemo fleets smoothly by such a improvement.

Table 7.3.7 Present Bemo Operating Routes

Route No.	Streets to be Served
# 2	Proyek Air Minum Sunggal-Sei. Sikambing-Psr. Peringgan-Pusat Pasar Pasar P.P.
# 3	Pekan Sunggal-Kp. Lalong-Pusat Pasar P.P.
# 4	Sei. Sikambing-Pusat Pasar P.P.
# 5	Kelambir Lima Batas Kota-Kp. Lalang-Pusat Pasar P.P.
# 7	Perumnas Helvetia-Pusat Pasar P.P.
# 9	Jln. Ayahanda Ujung-Pusat Pasar P.P.
#10	Sambu Baru-Pusat Pasar P.P.
#11	Jln. Karya Ujung-Pusat Pasar P.P.
#12	Jln. Pertempuran Pulau Berayan-Jln. K.L. Yos Sudarso-Pusat Pasar P.P.
#13	Jln. Krakatau Ujung/Tanjung Mulio-P. Brayan-Pusat Pasar P.P.
#14	Jln. Krakatau Ujung/Tanjung Mulia-Jln. Sutomo Ujung-Pusat Pasar Pasar P.P.
#15	Jln. Cemara Dekat Jembatan Parit Busuk-Pusat Pasar P.P.
#16	Jln. Suratman Glugur Derat-Pusat Pasar P.P.
#17	Pasar III Ujung-Pusat Pasar P.P.
#18	Jln. Perjuangan Ujung-Pusat Pasar P.P.
#19	Saentis Jln. Ke Percut Batas Kota-Pusat Pasar P.P.
#20	Jln. Gurilla Dekat Pajak Sentosa Baru-Pusat Pasar P.P.
#21	Tembung Dekat Titi Sewa-Pusat Pasar P.P.
#23	Perumnas Medan II-Prof. M.M. Yamin SH-Pusat Pasar P.P.
#24	Jln. Negara-Pusat Pasar P.P.
#25	Jln. Mandala by Pass-Jln. Denai-Pusat Pasar P.P.
#26	Jln. Denai Ujung-Pusat Pasar P.P.
#27	Sukaramai-Pusat Pasar P.P.
#28	Jln. Aksara-Pusat Pasar P.P.
#29	Jln. H.M. Joni Ujung/Kp. Binjai-Pusat Pasar P.P.
#31	Kampung Martoba Batas Kota-Pusat Pasar P.P.
#33	Simpang Mariendal-Pusat Pasar P.P.
#35	Pasar Senen-Pusat Pasar P.P.
#36	Titikuning-Pusat Pasar P.P.
#37	Jln. Mongonsidi Kp. Anggrung-Pusat Pasar P.P.
#40	Padang Bulan/Gudang Mesiu-Pusat Pasar P.P.
#41	Jln. Sembada Ujung/Kompleks Koserna-Pusat Pasar P.P.
#42	Tuntungan Batas Kota-Pusat Pasar P.P.
#43	Tanjung Rejo-Pusat Pasar P.P.
#44	Belawan-Pusat Pasar P.P.

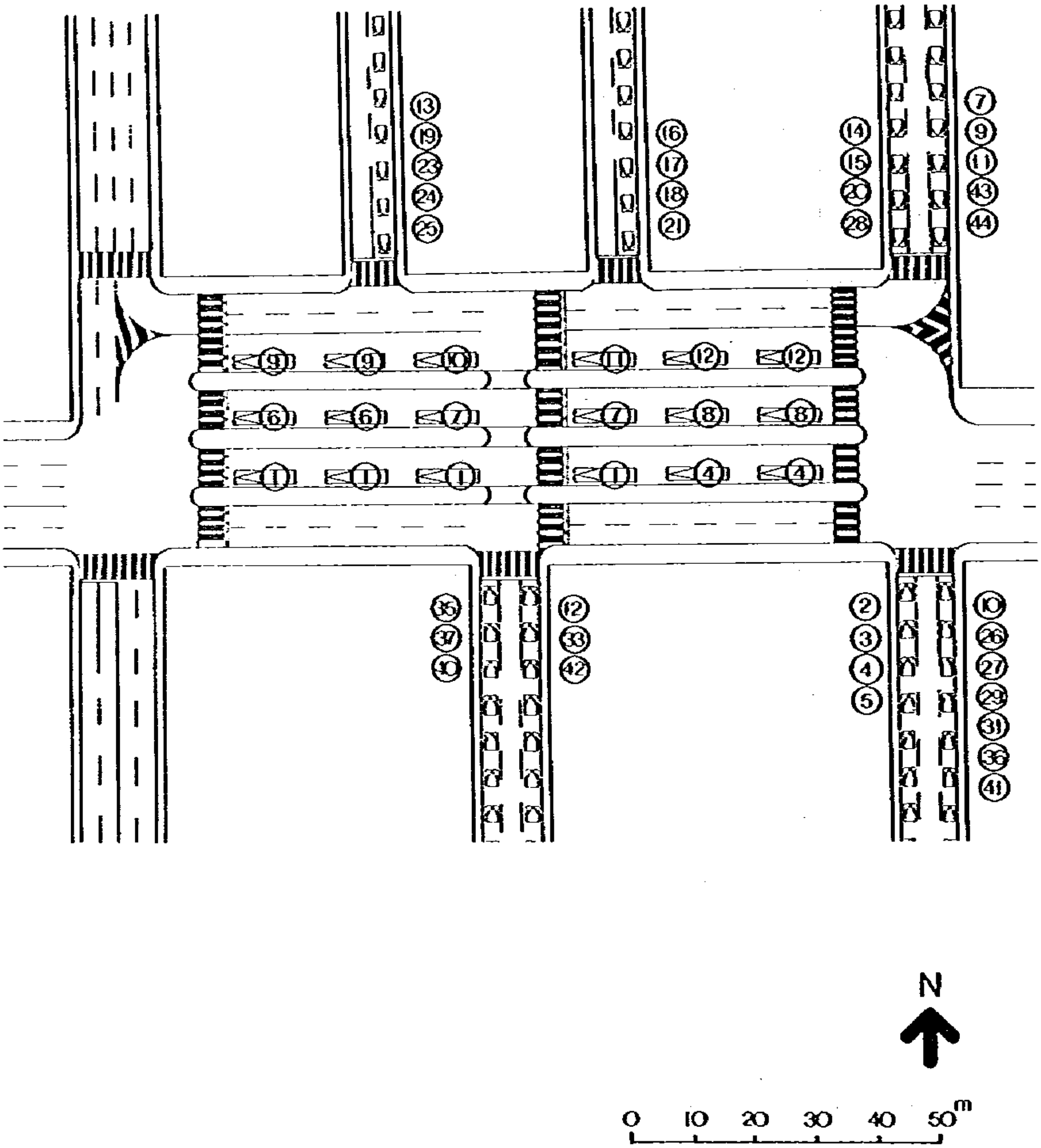

Fig. 7.3.17
Proposed Improvement Plan of Pasar Sambu Bus Terminal

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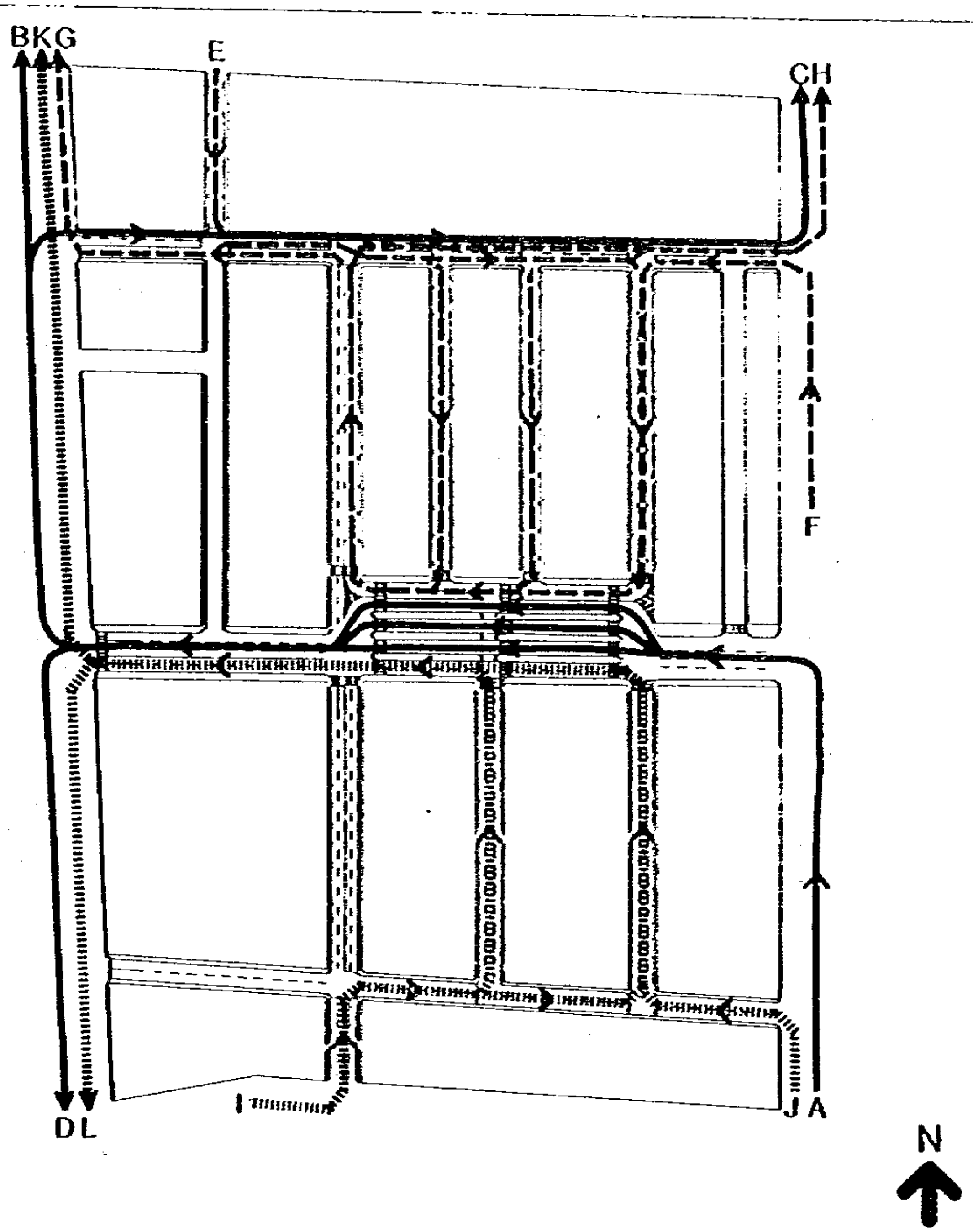
Legend

(bus symbol)	Bus
(bemo symbol)	Bemo
ⓝ	Route number



	Route number
A	1 4 6 7 8 9 O 11
B	1 9 10 11
C	7
D	4 6 8
E	13 14 15 16 17 18 19 20 21 23 24 25
F	7 9 11 28 43 44
G	13 43

	Route number
H	7 9 11 14 15 16 17 18 19 20 21 23 24 25 28 44
I	2 3 4 5 10 12 31 33 35 36 37 40 41 42
J	26 27 29
K	3 4 5 10 12
L	2 26 27 29 31 33 35 36 37 40 41 42

Fig. 7.3.18
Proposed Improvement Plan of Bus and Bemo Routes in and around Pasar Sambu Bus Terminal

Medan Area Transportation Study

Legend

Bus route

Bemo route

Bemo route

7.3.5 Intersections

(1) Evaluation of the Present Situation

Many complicated elements intertwine in inducing the present serious crowded road conditions of Medan. The main problems are the following:

(a) Drivers do not completely keep to their own lanes because traffic lanes are not marked. The congestion is worsened because of slow moving vehicles (bicycles, Becak, etc.) mixed with faster vehicles, especially because there is no channeling of vehicles that are making left or right turns at intersections, and then it is complicating conditions are caused by vehicles that are turning interfere with vehicles going straight, and vice versa.

(b) Pedestrians cross the road wherever they want since cross-walks are not marked and is another factor disturbing the smooth flows of traffic at intersections.

(c) Due to the lack of and or poor maintenance of drainage facilities, roads are frequently covered with water after a rain. This is also a cause of traffic stagnation and decrease the strength of pavement.

(d) Since there are many restrictions on directions that a driver can take at a intersection in the CBD, due to the present one-way traffic control, the route one must take to arrive at there aren't enough traffic signals nor traffic signs, it is difficult for the drivers unfamiliar with Medan to make a proper and instant decision.

A significant result cannot be achieved solely by concentrating upon engineering improvements in an effort to solve these problems. It is also very important thoroughly to educate drivers on traffic regulations and how to punish traffic offenders.

(2) Congestion Ratios of Intersections

The congestion at an intersection is different from that in the approach road section because it is a function of intersections that how large traffic volume of different approach road section can handled. The degree of congestion at intersection can be determined by comparing its traffic volume with its traffic capacity at the approach road section.

Thus,

The integrated congestion ratio of an intersection

$$= \Sigma \frac{\text{traffic volume of approach}}{\text{traffic capacity of approach}}$$

Referring to actual survey data in Japan, the traffic capacity per lane of approach route at a signalized intersection expressed in PCU is as follows:

On a lane for through traffic	2000 PCU/GH
On a lane for left or right turn traffic	1850 PCU/GH

When the through traffic mixes with the left or the right turn traffic, the capacity of through traffic lane can be modified by following coefficients shown in Table 7-3-8.

Table 7-3-8 Coefficient to be Applied to Modify Through Lane Capacity According to Left or Right Turn Traffic Percentage

Percentage of left or right turn traffic (%)	Modification by left turn traffic		Modification by right turn traffic	
	One lane	More than two lanes	One lane	More than two lanes
0	1.000	1.000	1.000	1.000
5	0.915	0.975	0.885	0.955
10	0.835	0.950	0.770	0.910
15	0.790	0.930	0.690	0.865
20	0.750	0.905	0.655	0.820
25	0.730	0.880	0.635	0.795
Over 30	0.710	0.855	0.615	0.775

Source: Highway Capacity Manual 1965, National Academy of Sciences, National Research Board, Special Report No. 87

Calculation results of the integrated congestion ratio of 47 important intersections in Medan City (See Fig. 7.3.20) according to the traffic volume by direction under present situation and under one-way traffic system Case-1 or Case-2, are shown in Table 7-3-9.

The number as well as the average value of congestion ratio intersections where the values are over 0.9 (Namely where one cannot pass through an intersection within at least one signal cycle time during peak hours.) are shown in Table 7-3-10.

Table 7-3-9 Number and Their Average Integrated Congestion Ratio of Intersections where the Ratios are more than 0.9

Alternatives		Integrated Congestion Ratio of more than 0.9	
		Number	Average Ratio
Present situation		20	1.22
One-way system Case-1	Localized release from present one-way control system	21	1.35
One-way system Case-2	Advanced release from present one-way control system	26	1.36

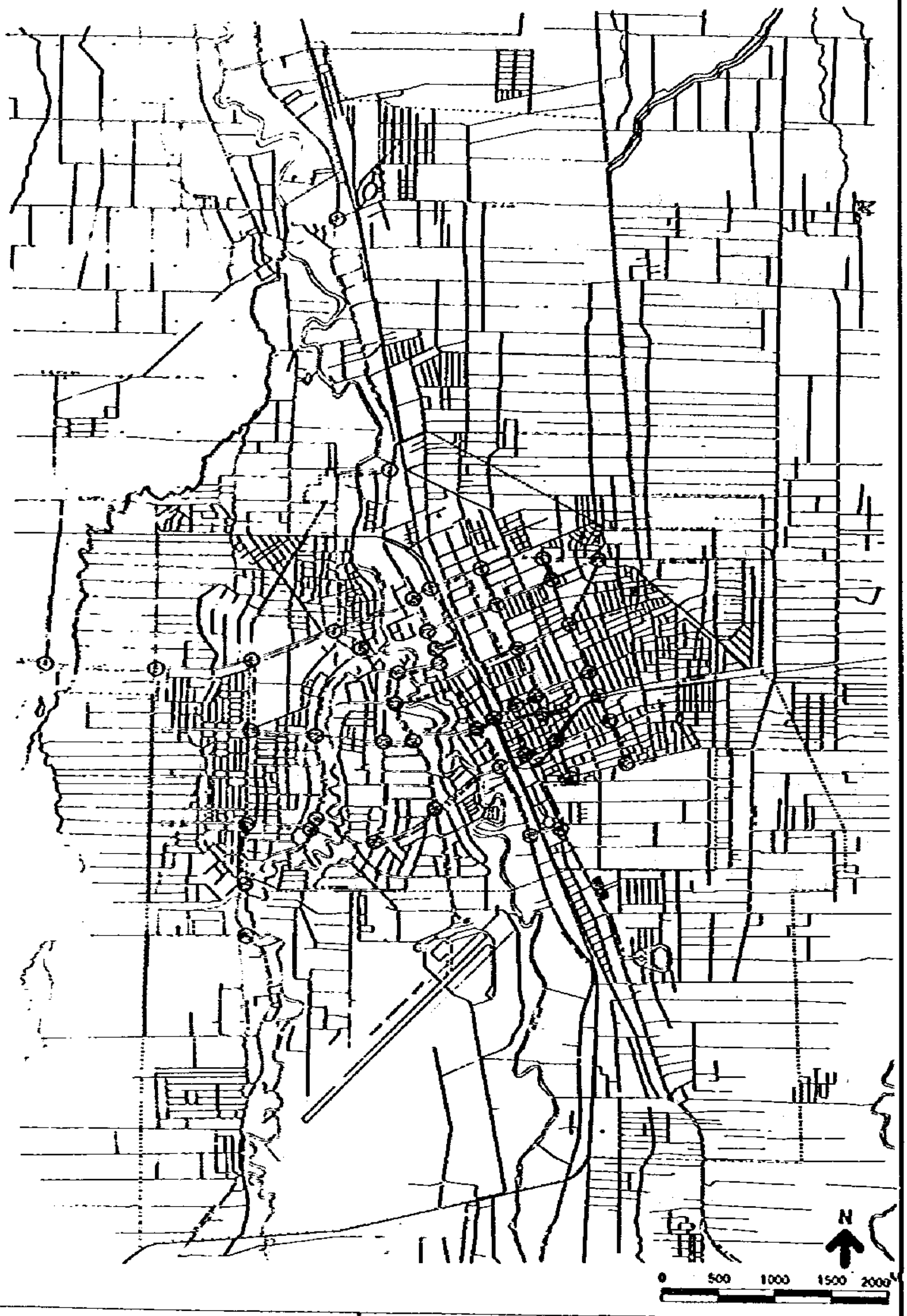


Fig. 7.3.19
Location Map of Intersections where Integrated Congestion Ratios are Calculated (1979)

Legend

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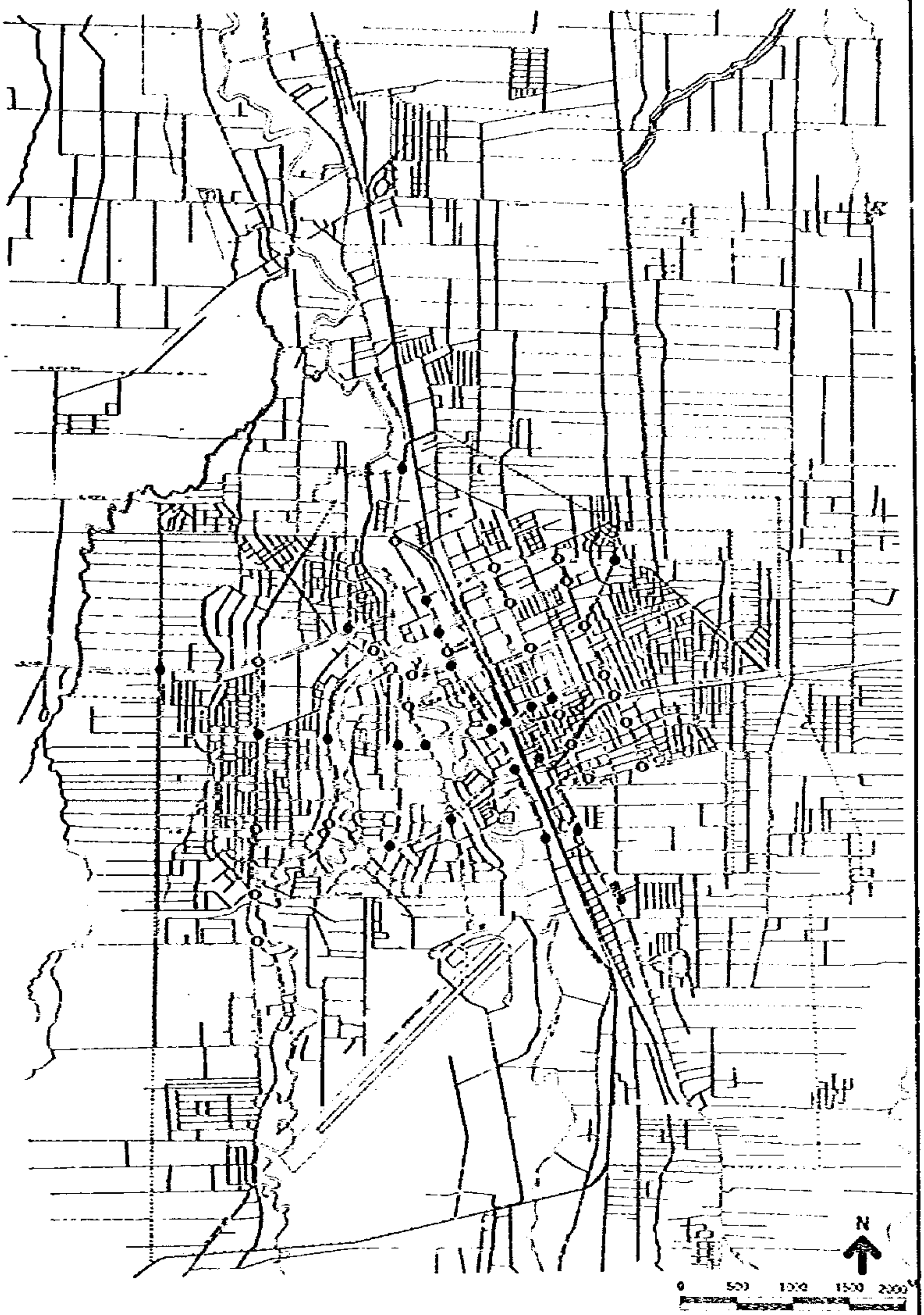

Fig. 7.3.20
Integrated Congestion Ratio of Intersections (1979)

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o – less than 1.0

● – more than 1.0

Table 7.3.10 Integrated Comparison of Congestion Ratios, of Intersections Between Existing and Partially Improved One-Way Traffic Control Systems

No.	Node No.	Intersection Situation: Crossing Street Name	Integrated Congestion Ratio: Control Method	Existing Situation	Case-I	Case-II
1	103	Jl. Helvetia Raya – Jl. Sudarso	Yield	0.815*	0.817*	0.222*
2	111	Jl. Gelugur Bypass – Jl. Sudarso	Rotary	1.128*	1.040*	1.069*
3	116	Jl. Sudarso – Jl. Gudang	Yield	0.627	0.780	0.687*
4	122	Jl. Gatot Subroto – Jl. Kapten Muslim	Signal	0.797	0.797	0.797
5	123	Jl. Gatot Subroto – Jl. Darsalam	Signal	0.999	1.012	0.973
6	125	Jl. Gatot Subroto – Jl. Iskandar Muda	Signal	0.930	0.840	0.865
7	128	Jl. Gatot Subroto – Jl. Gelugur Bypass	Signal & Rotary	1.838	1.457	1.580
8	130	Jl. Sudarso – Jl. Guru Patimpus	Signal	1.734	1.672	1.343
9	134	Jl. Jati – Jl. Sutomo	Signal	0.884	0.773	1.564
10	136	Jl. Jati – Jl. Thamrin	Signal	0.676	0.445	0.722
11	137	Jl. Taji – Jl. Yamin	Yield	1.233*	1.239*	1.277*
12	141	Jl. Palai Kota – Jl. Yamin	Yield	0.776*	1.072*	1.010*
13	145	Jl. Sutomo – Jl. Yamin	Signal	0.870	0.840	1.848*
14	147	Jl. Thamrin – Jl. Yamin	Yield	0.583*	0.438*	1.045*
15	148	Jl. Gatot Subroto – Jl. S. Parman	Rotary	0.622	0.644	0.770*
16	150	Jl. Raden Saleh – Jl. Iman Brijol	Yield	0.681	0.831*	0.893*
17	151	Jl. Raden Saleh – Jl. Balai Kota	Yield	1.330*	1.263*	1.212*
18	160	Jl. Sutomo – Jl. Veteran	Rotary	0.550	0.774*	1.048*
19	162	Jl. Thamrin – Jl. Veteran	Yield	0.850*	0.894*	1.286*
20	168	Jl. Imam Bajol – Jl. Sutoyo S.	Rotary	0.744*	0.599*	0.623*
21	177	Jl. Iskandar Muda – Jl. Gajah Mada	Signal	0.788	0.939	1.009
22	180	Jl. Gajah Mada – Jl. S. Parman	Signal	0.934	1.482	1.220
23	181	Jl. Zainul Arifin – Jl. Diponegoro	Signal	0.682	0.910	0.851
24	182	Jl. Zainul Arifin – Jl. Imam Bonjol	Signal	0.885	1.007	0.912
25	183	Jl. A. Yani – Jl. Palang Merah	Yield	1.023*	2.347*	2.336*
26	184	Jl. Haryono – Jl. Kereta Api	Yield	0.925*	0.913*	1.501*
27	187	Jl. Haryono – Jl. Pandan	Diverging	1.149	1.563*	1.343*
28	188	Jl. Haryono – Jl. Sutomo	Signal	1.116	1.391	1.432
29	190	Jl. Thamrin	Signal	0.893	0.859	1.193
30	195	Jl. Sutomo – Jl. Merbaru	Signal	0.796	0.598	0.829
31	196	Jl. Thamrin – Jl. Merbaru	Yield	0.951*	0.461*	0.769*
32	210	Jl. ABD. Lubis – Jl. Iskandar Muda	Signal	0.616	0.748	0.821
33	212	Jl. ABD. Lubis – Jl. Kapten Patimura	Yield	0.623*	0.692*	0.635*
34	213	Jl. S. Parman – Jl. Sudirman	Yield	0.717*	0.712*	0.670*
35	214	Jl. Diponegaro – Jl. Sudirman	Signal	0.953	0.928	0.897
36	215	Jl. Imam Bonjol – Jl. Sudirman	Rotary	1.088*	0.982*	0.940*
37	217	Jl. Suprapto – Jl. Pemuda	Signal	1.771	2.385	2.356
38	219	Jl. Pandu – Jl. Singamangaraya	Yield	1.346*	2.055*	2.059*
39	220	Jl. Pandu – Jl. Sutomo	Yield	1.171*	0.870*	1.142*
40	222	Jl. Thamrin – Jl. Asia	Yield	0.712*	0.587*	0.895*
41	224	Jl. Sutomo – Jl. Sutrisno	Yield	0.670	0.884*	0.728*
42	226	Jl. Thamrin – Jl. Sutrisno	Yield	0.540	0.704*	0.655*
43	232	Jl. Katamso – Jl. Mesjid Raya	Signal	1.060	1.032	1.065
44	233	Jl. Singamangaraja – Hesjid Raya	Signal	1.697	1.561	1.544
45	239	Jl. Patimura – Jl. Iskanda Muda	Rotary	0.878	0.844*	0.841*
46	250	Jl. Patimura – Jl. Mansur	Signal	0.864	0.867	0.869
47	276	Jl. Balai Kota – Jl. Bukit Barisan	Rotary	0.776	0.881*	0.891*

Note: * Traffic signals are additionally required

(3) Intersection Improvement Plan

One can generally divide the causes of the problem of the present traffic congestion in Medan into two categories, namely: the insufficient road capacity and the insufficient intersection capacity. In the former category one cannot relieve the problem of traffic congestion merely by improving intersections, but one must wait for route improvement. In the latter category, one cannot expect good results simply by improving a certain intersection.

In order to make a progress in improving intersections, one must keep in mind the above-mentioned two facts.

(a) Separation of Slow Moving Vehicles in Central Business Districts

Current, slow moving vehicles (Becaks, bicycles etc.) occupy fully one fourth of total number of vehicles on central Medan streets. They interfere with the smooth flow of fast moving vehicles especially since there is no regulation of keeping lanes. In addition at intersections, since such slow moving vehicles have a low capacity for acceleration, they interfere with traffic when they begin to move forward from a standing position and especially affect other traffic on making right turns.

As one can see from the existence of a great numbers of such vehicles, they play an important role in the urban transport system for daily life of Medan citizens. Therefore, in addition to the prevention of traffic accidents, they must be preserved, but be separated from fast moving vehicles in order to raise the overall efficiency of the road traffic system.

Fig. 7.3.21 is a plan of model intersection planned keeping in mind all of the observations stated above. In this type of intersection, right turns directly at an intersection by slow moving vehicles are forbidden and only proceeding straightly or left turns are allowed. In order to prevent traffic accidents with fast moving vehicles which are going straight or turning left, slow moving vehicles should be separated by a traffic island. It is planned that their crossing be channelized to the place in the intersection by which fast moving vehicles of left turn can get good visibility.

This kind of improvement is effective on streets in the CBD which can be attained by road widening and one can expect a reduction in traffic accidents and consequently an increase in efficiency. However, on streets which are not wide enough, one must pay attention to the fact that this would result in increased friction with the flow of high speed traffic.

(b) Concrete Proposals for Intersection Improvements

Intersections where one can expect the effects of their improvements are those where road capacity is wide enough and also a successive intersections in the area are not crowded. From this point of view an improvement plan for the following two intersections are proposed. They seem to be urgent solutions by which favorable effects can be expected.

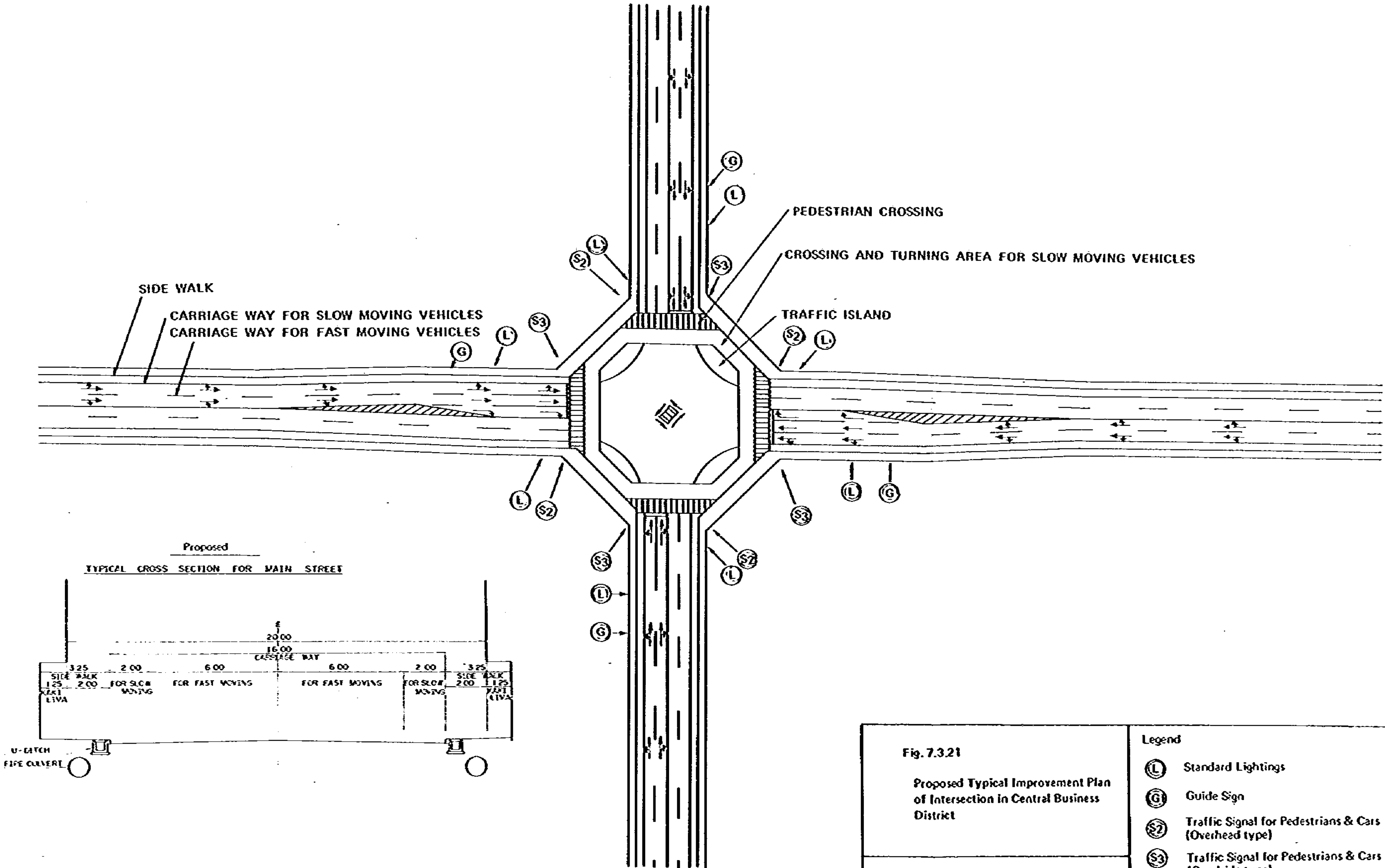


Fig. 7.3.21

Proposed Typical Improvement Plan of Intersection in Central Business District

Medan Area Transportation Study

Legend

- (L) Standard Lightings
- (G) Guide Sign
- (S2) Traffic Signal for Pedestrians & Cars (Overhead type)
- (S3) Traffic Signal for Pedestrians & Cars (Roadside type)

i) The Intersection at Jl. Gator Subroto and Jl. Gelugur Bypass

This intersection is of five legs, signalized and faces on the Jl. Gatot Subroto which is presently the arterial road connecting Bingei with Medan and Jl. Gelugun Bypass which is one of the arterial road connecting Belawan with Medan.

In morning and evening-peak hours, there takes place such a serious traffic jam, and air pollution by exhaust gas, etc. Of five legged roads, both southern parts of Jl. Gelugur Bypass and of Jl. Raden Saleh are controlled by one-way traffic system. The main directions of traffic flow are from Jl. Gatot Subroto to Jl. Raden Saleh and from Jl. Guru Patimpus to Jl. Gatot Subroto. Fig. 7.3.22 show traffic volume in each direction under present situation and also partially improved one-way traffic system in Case-1. Fig. 7.3.23 is a comparison chart of improvement plans which have been studied for this intersection.

The improvement plan of the alternative II is proposed as shown in Fig. 7.3.24. By adopting the alternative II, one can expect the improvement that the congestion rate at this intersection during peak hours decreases from 1.84 down to 0.87 under present situation and it is also estimated that the congestion rate by the traffic volume in 1985, when Bedawan-Medan - Tg. Morawa Highway is to be opened will be 1.05. The direct construction cost of this improvement plan is estimated 298 million Rupiah in the price level of January 1980. Breakdowns of construction cost are shown in Table 8.1.14 of Chapter 8.

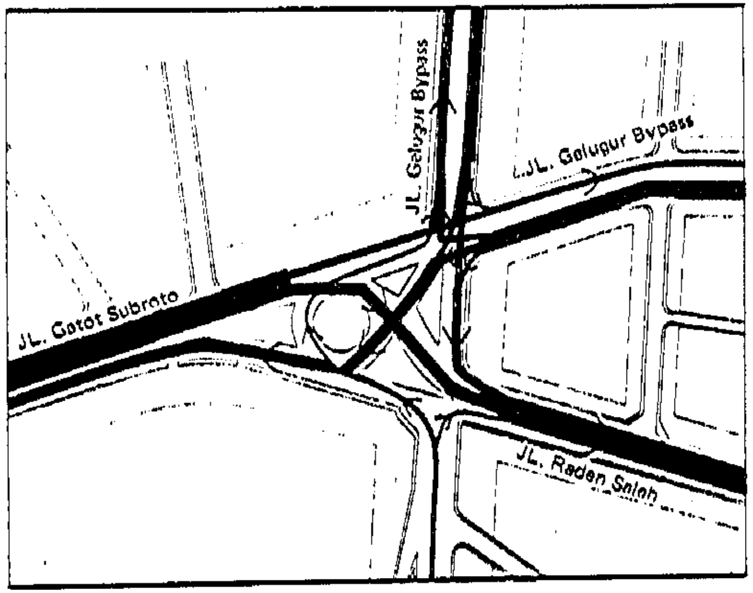
ii) The Intersection of Jl. Prof. Yamin SH and Jl. Jati

This intersection is of six legs, non-signalized and located at the crossing of Jl. Prof. Yamin SH which is the main road to Percut and Jl. Jati which continues to Jl. Gatot Subroto. Furthermore, after Belawan-Medan-Tg. Morawa Highway will be opened in 1985, Jl. Prof. Yamin SH will play an important role as an access road to that highway. Of six legged roads, both Jl. Mabar and Jl. Tirto are narrow streets whose traffic volume is at a level that may be negligible. Presently western portion of Jl. Prof. Yamin SH is controlled by one-way traffic system and Jl. Jati is proposed to become one-way traffic route Case-1. Fig. 7.3.25 shows traffic volume by direction under the present situation and the partially improved one-way traffic system Case-1. The main directions of traffic flow are from Jl. Jati to Jl. Prof. Yamin SH and toward Medan City through Jl. Prof. Yamin SH.

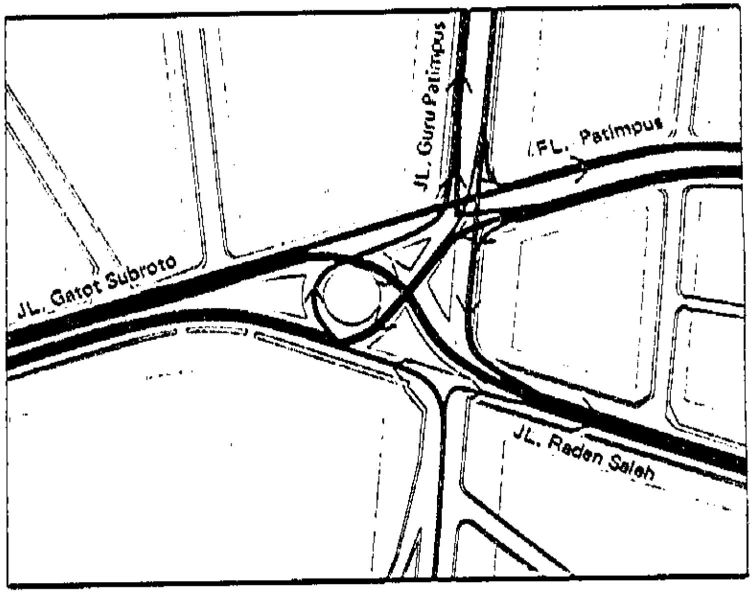
Fig. 7.3.26 is a comparison of improvement plans which have been studied for this intersection.

The improvement plan of the alternative II is proposed shown in Fig. 7.3.27.

By adopting the alternative-II, one can expect that the congestion rate at this intersection will be decreased considerably because there exist merely a merging and a diverging-areas.



Existing Situation



Case - 1

N

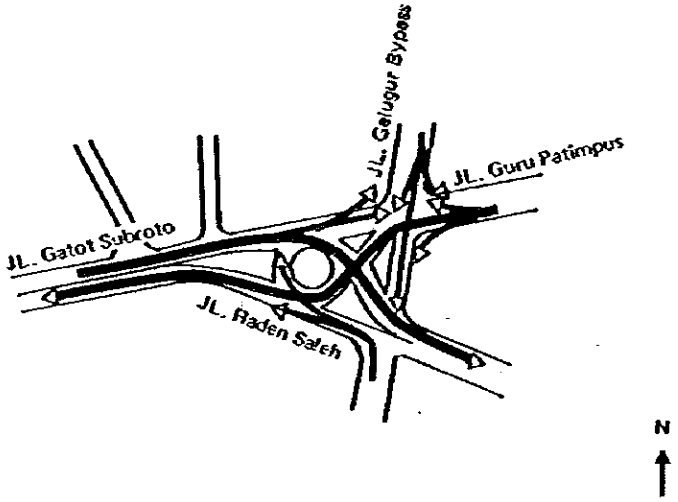
Fig. 7.3.22
Traffic Flows Comparison at Intersection

Medan Area Transportation Study

Legend

Fig. 7.3.23 Traffic Flow Comparison at Intersection by Improvements Intersection at JL. Gatot Subroto and at JL. Gelugur Bypass

Existing

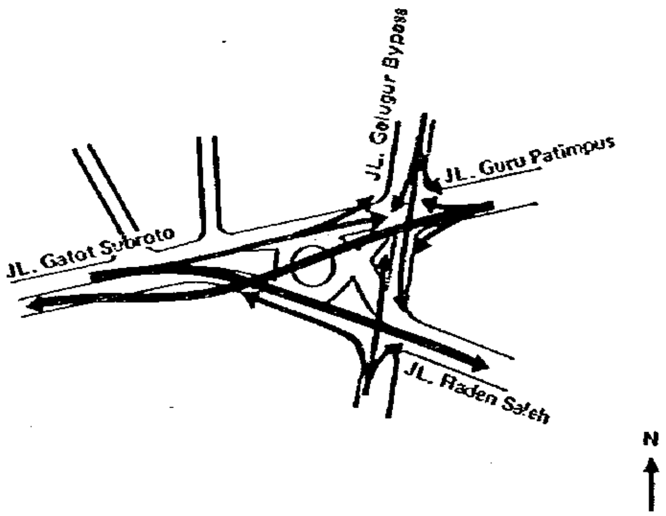


i) Alignments in direction of main traffic flows are unfavorable with poor visibility.

ii) Traffic-flow crossing points are scattered throughout the intersection, reducing the intersection capacity.

iii) Vehicles, which are stopped in the intersection, are apt to obstruct crossing traffic flows by forming a situation so-called "interrocking".

Alternative-I

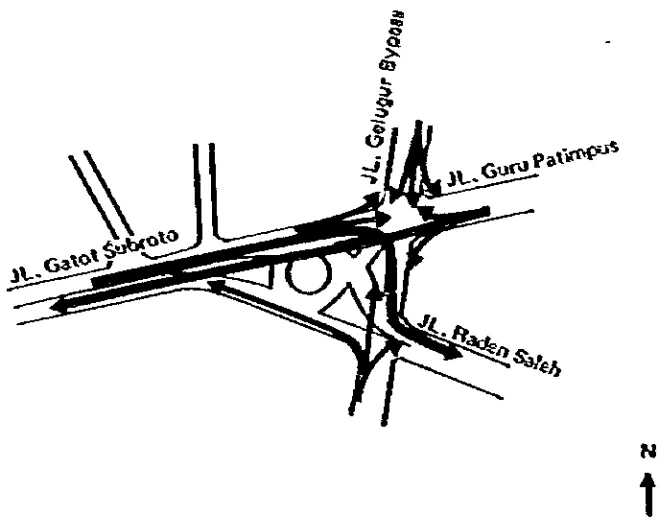


i) Alignments of main traffic flows are better, with good visibility.

ii) The alignment of northbound traffic flow proceeding straight through the intersection on JL. Gelugur Bypass is improved.

iii) Although there will be an enough length of waiting lanes to prevent forming "interrocking", but it still looks as if these intersections are existing in a square, by which the traffic capacity of intersection is considerably reduced.

Alternative II



i) Since the traffic is funneled trough a compact intersection, the traffic capacity of intersection is improved.

ii) The alignment of northbound traffic flow on JL. Gelugur Bypass is improved same as in Alternative-I.

iii) A large traffic island is to be created in the middle of the intersection which could be used for many purposes.

iv) The alignment of the largest traffic flow, namely, that from JL. Guru Patimpus to JL. Gatot Subroto, is better than in Alternative-I, but that from JL. Gatot Subroto to JL. Raden Saleh is unfavorable although the actual traffic in this direction is not so large.

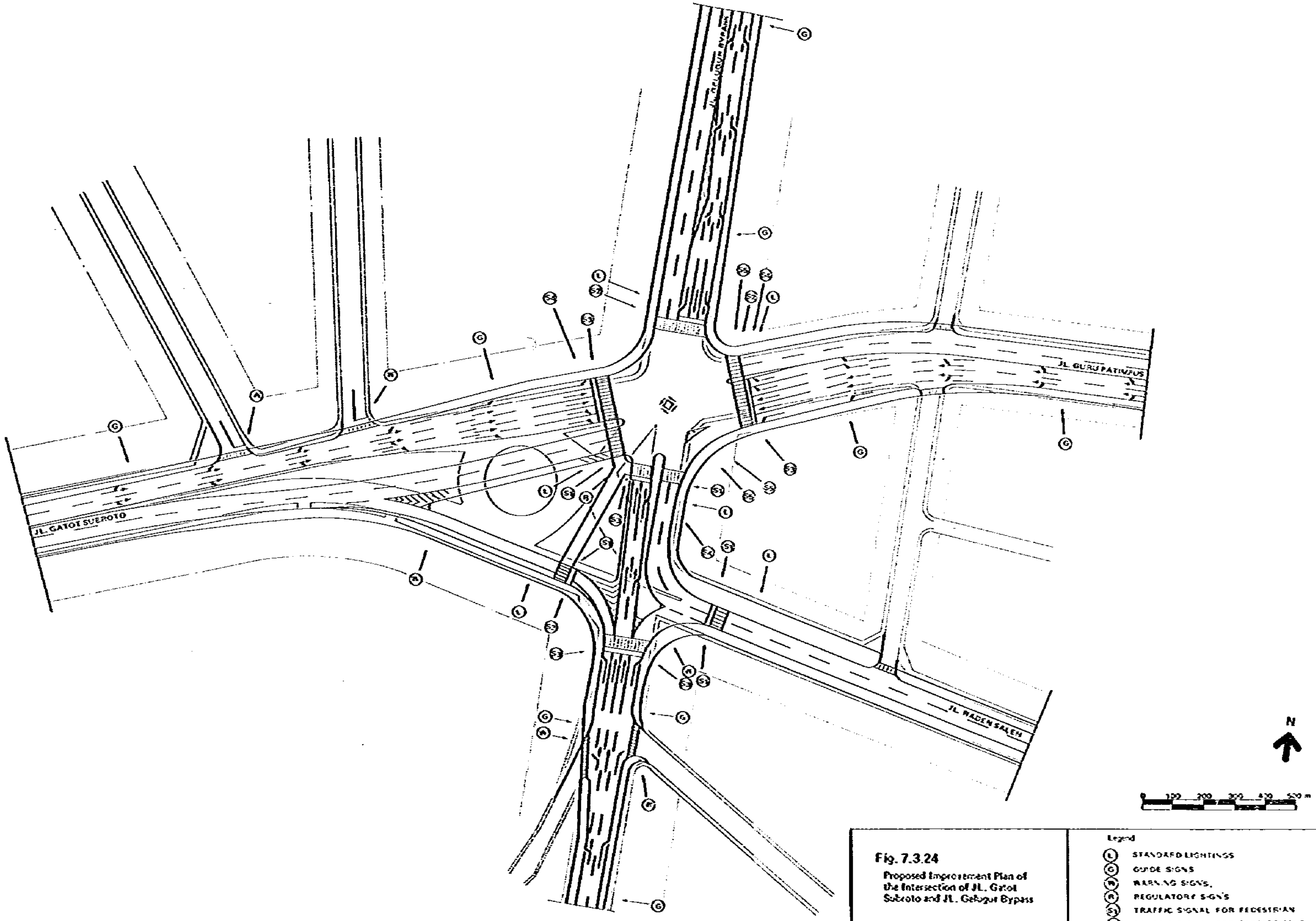


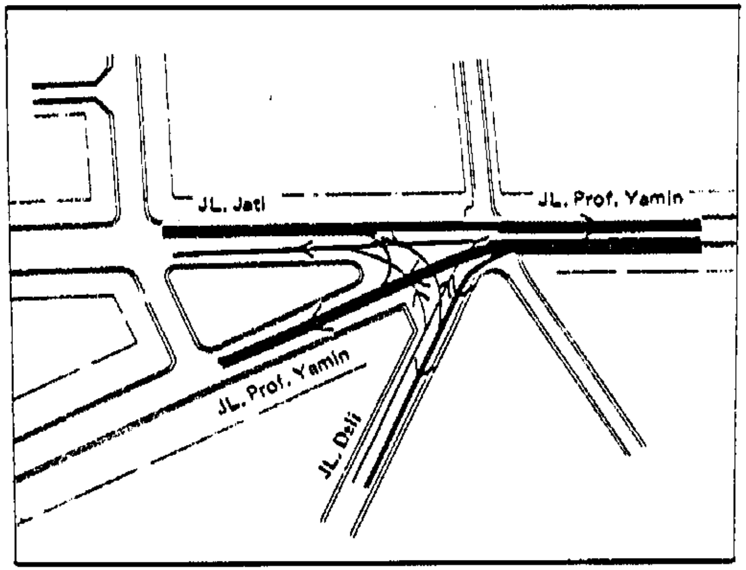
Fig. 7.3.24

Proposed Improvement Plan of the Intersection of JL. Gatot Subroto and JL. Gelugur Bypass

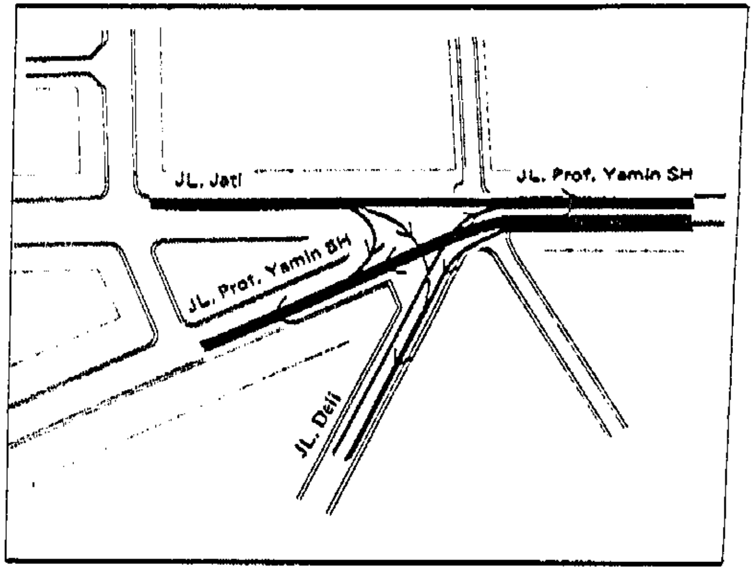
Medan Area Transportation Study

Legend

- (L) STANDARD LIGHTINGS
- (G) GUIDE SIGNS
- (W) WARNING SIGNS,
- (R) REGULATORY SIGNS
- (S1) TRAFFIC SIGNAL FOR PEDESTRIAN
- (S2) TRAFFIC SIGNAL FOR PEDESTRIAN & CAR, OVERHEAD TYPE
- (S3) TRAFFIC SIGNAL FOR PEDESTRIAN & CAR, ROAD SIDE TYPE
- (S4) TRAFFIC SIGNAL FOR CAR, ROAD SIDE TYPE
- (S5) TRAFFIC SIGNAL FOR CAR, OVERHEAD TYPE



Existing Situation of Traffic Flows



Improved Traffic Flows in Case – 1

N

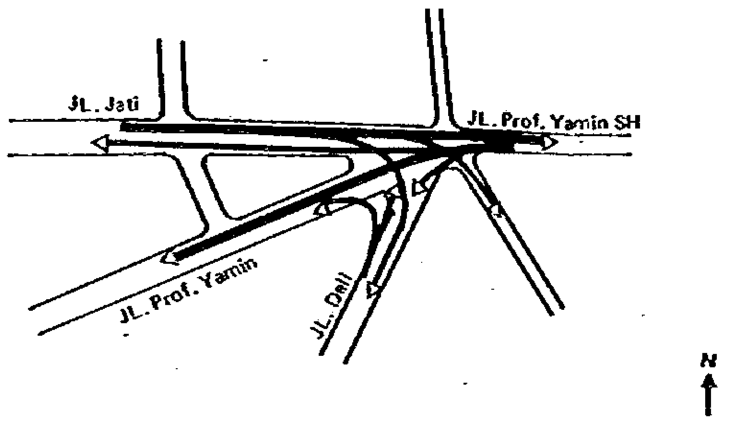
Fig. 7.3.25
Traffic Flow Diagrams at Intersection

Medan Area Transportation Study

Legend

Fig. 7.3.26 Proposed Improvement of Traffic Flows of the Intersection at JL. Jati and JL. Prof. Yamin SH

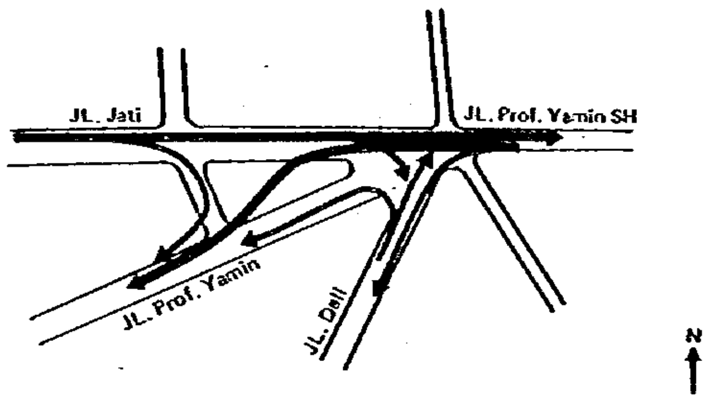
Existing Flows



i) The alignments of main traffic flows are good with good visibility but there are many crossings of traffic flows.

ii) The traffic handling capacity at intersection is low because of the complicated crossings of non-signalized traffic flows.

Alternative-I

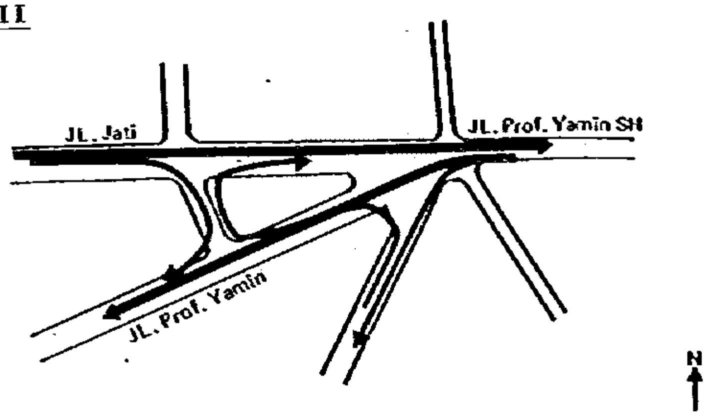


i) There is a reduction in the number of traffic flow crossings because JL. Jati is controlled by one-way traffic system.

ii) The route on JL. Yamin going toward the city center becomes worse.

iii) It is necessary to make the intersection more compact one and to control traffic flows by traffic signals and to widen approach portion of JL. Yamin.

Alternative-II



i) Right-turn traffic from JL. Jati to JL. Deli is forbidden at this intersection because it can make U-turn at the next intersection.

ii) Since there is no traffic flow crossing traffic flows consist only of marging and diverging traffic, and consequently there is no need to signalize the intersection.

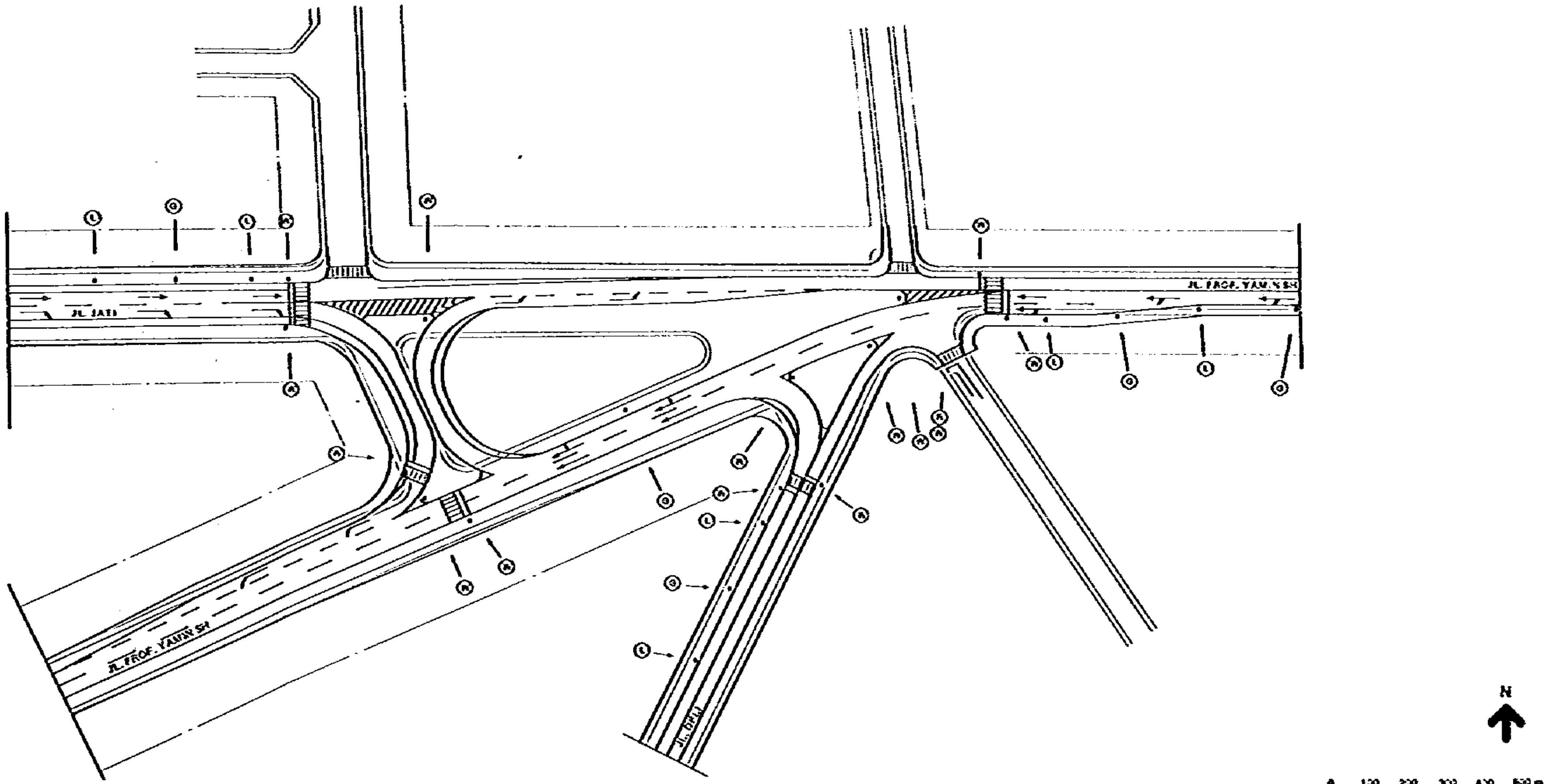


Fig. 7.3.27
Proposed Improvement Plan of the Intersection of JL. Jati and JL. Prof. Yamin SH

Medan Area Transportation Study

- Ⓛ STANDARD LIGHTINGS
- Ⓖ GUIDE SIGNS
- Ⓦ WARNING SIGNS
- Ⓡ REGULATORY SIGNS

Until Belawan-Medan-Tg. Morawa Highway will be opened in 1985, Jl. Prof. Yamin SH will be widened as an access road. This improvement plan canbe easily adjusted to the necessary widening plan.

The direct construction cost of this improvement is estimated to be 191 million Rupiah in the price level of January, 1980 and its breakdowns are tabulated in Table 8.1.15 of Chapter 8.

7.3.6 Public Transport

(1) The Aim of Planning

Bus routes are presently provided on almost all the roads which have such a width in which buses can be operated, as explained in Sec. 6.3.2. "Bus Service Network".

In or around zones Nos. 12, 22, 25 and 36, mainly due to the comparative narrow road widths, all users are using Bemo. However, the transportation of many passengers by Bemo seems to be ineffective. So, it is basically desirable to substitute Bemo with bus transportation. In view of these circumstances and the radial formation of the present bus routes, it is hoped the establishment of an intermediate loop route to be realized to serve such intermediate zones. Fig. 7.3.28 shows a new bus loop route to be established. For reference, see Table 7.3.11 which shows the rate of users of bus and Bemo is those four zones.

Table 7.3.11 Estimated Numbers of Passengers of Bus & Bemo (1979)

Zone No.	No. of Passengers			
	Bemo	Ratio	Bus	Ratio
12	74	0.85	13	0.15
22	6,665	1.00	0	0
25	634	0.72	249	0.28
36	6,417	0.92	542	0.08

(2) Forecast of Numbers of Bus Users

When applying the modal split curve for bus transport prepared from the results of the present O-D survey, around 8,500 passengers are expected to be transported on this proposed loop bus route, in which 7 buses will be required. For reference, the bus user modal split curve for bus transport is as shown in Fig. 7.3.29.

In Fig. 7.3.29 a modal split curve between bus and other modes except railway in Medan City is shown. This curve was obtained based on the O-D survey results conducted in the city, the travel time characteristics in the city much affected by the existing road network and bus routes. The curve presents the relation between the ratio of minimum travel time by bus to that by other modes between said zones and the sharing rate by bus.

The rank of factor in the Fig. 7.3.29 is expressed in the following formula:

$$\text{Rank of factor} = \frac{\text{Travel time by bus between said zones}}{\text{Travel time by other modes between said zones}}$$

For instance, if the rank of factor between zones A and B is 1.0 - 1.2 the curve shows that the sharing percentage by bus is around 38% and consequently the rest is that by other modes, which is 62%.

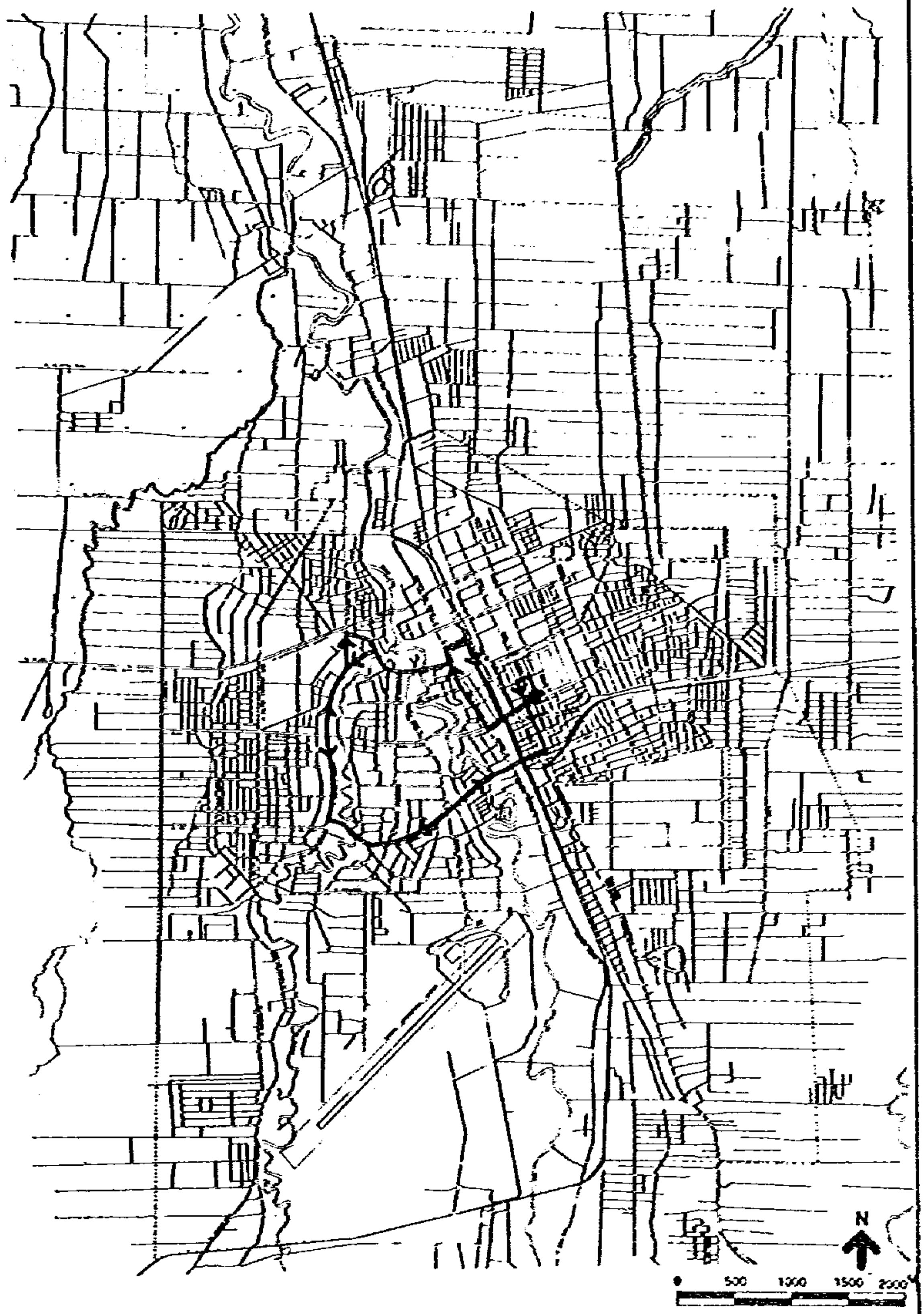


Fig. 7.3.28
Proposed New Bus Loop Route

Legend

Medan Area Transportation Study

In the Fig. the modal split curve of bus system of Medan City is shown, in which the radius of each circle means the number of data calculated whose values are indicated by the coordinate values of center of circle. The regression curve of those data is drawn so as to make the distance from the circle centers to the curve inversely proportionate to their radii. This curve can be also applicable to the railway system. The detailed explanation on this curve will appear in the Draft Final Report on the Long-Term Master Plan.

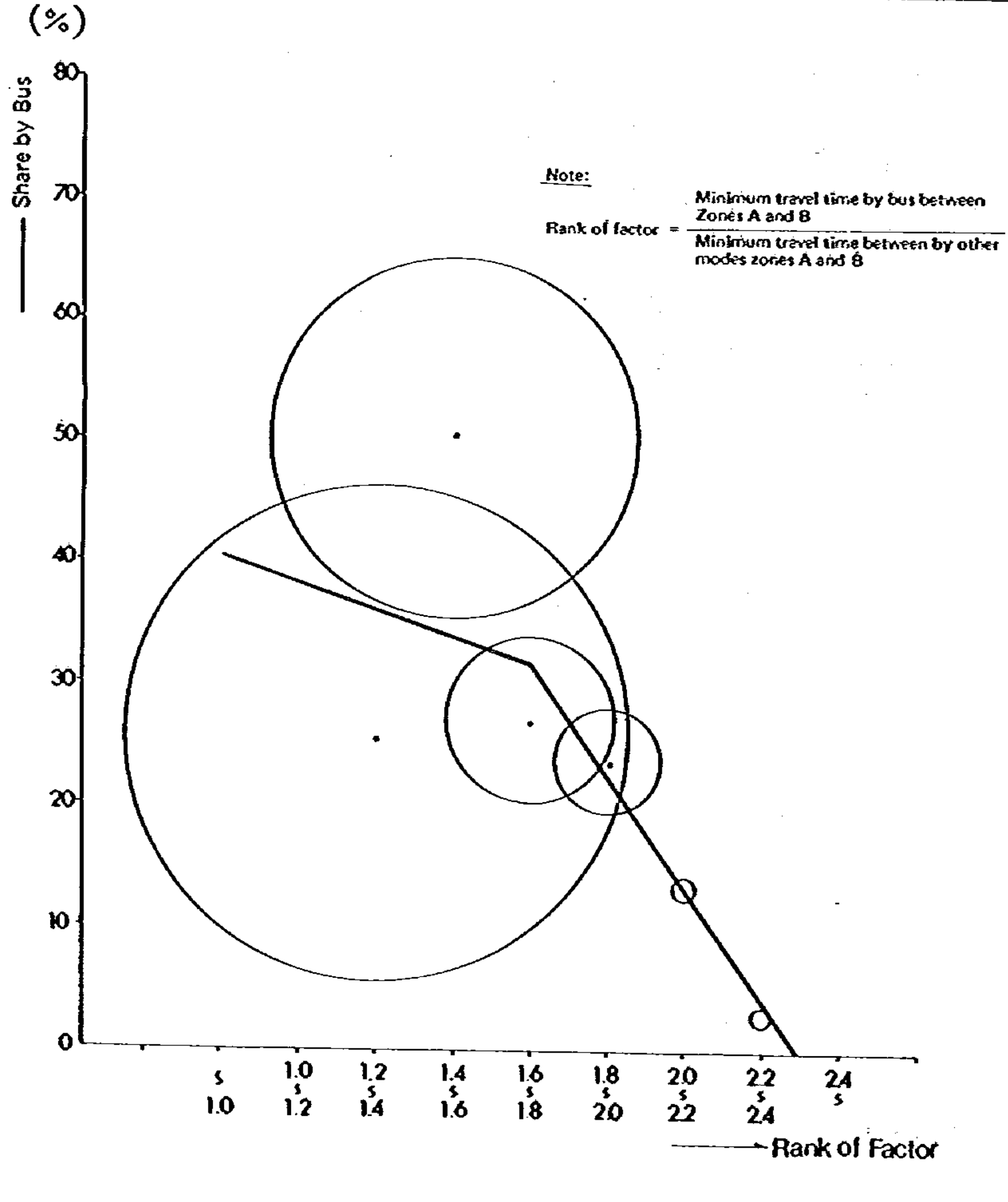


Fig. 7.3.29 Modal Split Curve for Bus Transport

7.3.7 Measures for Pedestrians

At present, facilities for pedestrians in Medan City are not favorable. Future measures for them may be enumerated as shown below:

(1) Separation of Pedestrians from Vehicle Traffic

This category relates to both ordinary road facilities and Pasar Sambu Bus Terminal. Concerning inside of the bus terminal it will be improved according to the method proposed as is described in other section. As for road facilities, it is necessary to separate the side walks from the vehicle lane clearly especially in the CBD. By this improvement securing the safety for pedestrians and an increase of road capacity will be expected. However, such a improvement depends mainly on road betterments or new constructions.

(2) Arrangement of Pedestrian Crossings

In case of intersection improvements described in another section, installation of pedestrian crossings is proposed.

7.4 Administration and Others

Engineering procedure is not a sole way to solve the prevailing traffic problems in Medan City. In some cases legislative and administrative steps seem to be effective for urban transportation planning especially for short term improvements. The followings are the items to be considered in such point of view from the evaluation on present condition of urban transportation system in Medan City and the experiences in the past studies carried out in other motorized countries.

i) To encourage to lag office hours of workers and schooling hours of students so as to reduce the peak ratio of the urban transport.

ii) To carry out social education or special training for drivers to observe the traffic regulation strictly.

iii) To enforce strict periodical inspection for vehicles by authorized vehicle inspectors in order to reduce traffic accidents occuring by the reason of imperfect maintenance of vehicles.

iv) To construct necessary numbers of additional pasars, by which pasars on road should be prohibited.

v) To establish a certain agreement among Ministry of Communication, Ministry of Public Works and Medan City should be made on sharing the public investment for main transportation facilities such as bus terminals, railway crossings and others.

Chapter 8.

ECONOMIC ANALYSIS OF SHORT TERM IMPROVEMENT PLANS

Chapter 8. ECONOMIC ANALYSIS OF SHORT TERM IMPROVEMENT PLANS

8.1 Cost Estimates

8.1.1 Introduction

Cost estimates for all short-term improvement plans of Medan Area consist of the following five items:

- Construction cost;
- Cost of Rolliing Stock, vehicles and traffic signals;
- Land acquistion and compensation cost;
- Operation cost; and
- Maintenance cost

Unit costs of those items are established mostly based on prevailing unit costs of labor, materials, equipment and supplies which the study team obtained during the site investigation in September - November 1979, but those of several items were estimated referring to actual cost data of similar construction in Japan.

Construction costs were calculated in accordance with the following criteria.

(a) Calculation is based on the cost level in North Sumatra in January 1980, when the exchange rates are assumed as follow:

Rp.625 = US$1.00 = ¥240.

(b) The cost is classified into the foreign currency and the local currency components. Foreign currency component comprises following items:

- Cost of imported equipment, materials and supplies;
- Wage of expatriate personnel;
- Overhead and profits of foreign firms; and
- Taxes and import duty.

Local currency component consists of following items:

- Cost of domestic equipment, materials and supplies;
- Wage of local personnel;
- Overhead cost and profit of local firms; and
- Taxes.

However, in foreign currency components of diesel rail-cars and imported devices such as traffic signals etc. Indonesian taxes and duty are excluded.

(c) Overhead cost and profit are assumed to be 30% of direct unit cost.

(d) Physical contingency is assumed to be 15% of the total of construction cost and land acquisition and compensation costs.

(e) The final engineering, supervision fees and administration cost are assumed to be 10% of direct construction cost.

8.1.2 Financial Cost

(1) Unit Costs of Major Materials and Labors

The unit costs of major material items are shown in Table 8-1-1.

Table 8-1-1 Unit Costs of Major Materials

Material	Unit	Domestic Supply Cost	Foreign Supply Cost
Fuel (Diesel oil)	Rp./Lit.	35	-
Reinforcing Bars	Rp./Ton	-	275,000
Portland Cement	Rp./Ton	56,400	-
Asphalt	Rp./Ton	-	104,500
Coarse Aggregates	Rp./m^3	3,760	-
Fine Aggregates	Rp./m^3	1,220	-

Source: RBO-SU Tg. Morawa-T. Tinggi Road Betterment Project.

Unit costs of labors are shown in Table 8-1-2.

Table 8-1-2 Unit Costs of Labors

Class	Hourly Cost
Foreman	430 Rp./h
Heavy plant operator	420 Rp./h
Light plant operator, Driver, Skilled labor	300 Rp./h
Common labor	150 Rp./h

Source: RBO-SU Tg. Morawa-T. Tinggi Road Betterment Project

(2) Land Acquisition and Compensation Costs

About land acquisition cost, whole area of Medan City is classified into 6 classes based on the land price map obtained from Medan AGRARIA Office and unit costs of land acquisition and compensation by class are assumed as follows:

Class - 1	20,000 Rp./m^2
" - 2	12,000
" - 3	8,000
" - 4	4,700
" - 5	2,400
" - 6	1,700

Unit costs of compensation for buildings with land acquisition are estimated as below according to the types of the building.

Class - 1	Permanent	40,000	Rp./m^2
" - 2	Semi-Permanent	27,500	"
" - 3	Low Cost Construction	10,300	"
" - 4	Barracks	5,500	"

Based on these unit costs, compensation costs are assumed to be 25% to 100% of land acquisition costs taking into account types and density of buildings where land acquisition is to be carried out.

(3) Operation Cost

Railway operation cost is divided into personnel costs and energy costs, personnel costs include the cost of operating staff, personnel costs of workshops and the signals and the telecommunication. Energy costs are the fuel cost of vehicles and the fuel and electricity cost of station and workshops. Reopening the commuter service between Medan and Belawan is assumed to need 21.2 million Rp./year for personnel costs and 14.5 million Rp./year for energy costs. Operation costs of eastside station building of Medan is also assumed to be 2.6 million Rp./year for personnel and energy costs, while road operation costs include the cost of electricity for lightings, traffic signals and other facilities. The annual cost of lighting is assumed to be 2.5 million Rp./km/year and that of one signalized intersection is assumed to be 1.83 million Rp./each/year.

(4) Maintenance Cost

The maintenance works are devided as follows:

i) Routine maintenance work;
ii) Periodic maintenance work.

Items of routine maintenance work for railway and roadway are considered as follows:

i) Railway

- Inspection,minor repairs and cleaning of diesel rail-cars;
- Inspection and minor repairs of tracks, signals and telecommunication system;
- Cleaning and minor repairs of railway stations.

ii) Roadway

- Cleaning of road surface;
- Patching of cracked portions on bituminous surface;
- Vegetation control of green belts and traffic islands;
- Cleaning and reshaping ditches and other drainage facilities; and
- Minor repairs of structures.

Periodic maintenance works are performed at an interval of at least a year.

Following items are considered as the main periodic maintenance work for railway and roadway:

i) Railway

- Change of parts of diesel rail-cars, signal and telecommunication system.

ii) Roadway

- Resurfacing with bituminous concrete;
- Repainting marking on resurfaced road; and
- Inspection of structures and affiliated repairs.

The annual maintenance cost which include both routine and periodic maintenance costs are estimated tentatively as much as 0.5 ∿ 3.0% of the initial investment cost for railway facilities except for that of diesel railcars and that for roadway which is as much as 0.5 ∿ 1.0% of its initial investment. The annual maintenance cost of 12 diesel rail-cars is assumed to be 108 million Rp.

(5) Financial Costs of Improvement Plans

Financial project costs of improvement plans are calculated for 4 cases in railway concerned and 11 cases in roadway concerned and are shown in Table 8-1-3 through Table 8-1-16. The summary of improvement costs are shown in Table 8-1-18.

Table 8.1.3 Costs of Improvement of Railway Crossing Facilities

(Unit: Rp x 10^3)

Item	Unit	Q'ty	Unit Cost	Foreign Currency: Devices without taxes and duty	Foreign Currency: Others	Local Currency	Total
1) Automatic Warning devices of train approaching	set	10	24,700	210,100	0	36,900	247,000
2) Crossing gate improvement	lo-cation	12	3,380	34,188	0	6,372	40,560
3) Construction of gateman's cabins	lo-cation	5	1,300	0	55	6,445	6,500
4) Improvement of crossing pavement	lo-cation	17	2,956	0	23,881	26,368	50,249
Total				244,288	23,936	76,085	344,364

Table 8.1.4 Costs of Reopening Railway Passenger Service between Belawan and Medan

(Unit: Rp x 10^3)

Item	Q'ty	Unit Cost	Foreign currency	Local Currency	Total
1) Rehabilitation of Titipapan Station		Lump sum	-	50,082	50,082
2) Installation of a additional telephone system	4 locs.	110	440	440	440
3) Construction of an inspection pit at Medan Loco, Depot	1 loc.	28,261	-	28,261	28,261
4) Procurement of diesel railcars	12 units	260,672	3,007,685	120,379	3,128,064
Total			3,007,685	199,162	3,206,847

Table 8.1.5 Cost of Reconstruction of Deck and Resurfacing of Pedestrian Bridge in Medan Station

(Unit: Rp x 10^3)

Item	Unit	Quan-tity	Unit cost	Foreign currency	Local currency	Total
1) Reconstruction of Deck and Resurfacing	Sq.m	240	45.6	2,608	8,333	10,941
Total				2,608	8,333	10,941

Table 8.1.6 Costs of Opening Eastside Station Building of Medan Station

(Unit: Rp x 10^3)

Item	Unit	Quantity	Unit cost	Foreign currency	Local currency	Total
1) Relocation of PJKA lodgings	house unit	3	64,725	6,721	187,455	194,176
2) Extension of under-pass in Medan Station	lump-sum			170,575	49,752	220,327
3) Construction of Station Building	Sq.m	770	281	21,896	194,453	216,349
4) Construction of Station plaza	Sq.m	1,689	34	14,134	43,277	57,411
Total				213,326	474,937	688,263

Table 8.1.7 Cost of Partial Improvement of One-Way Traffic Control System

(Unit: Rp x 10^3)

Item	Unit	Quantity	Unit Cost	Foreign currency	Local currency	Total
1) New Signal Installation at						
4-legged intersect.	location	11	16,790	176,748	7,942	184,690
3-legged "	"	6	13,830	79,412	3,568	82,980
2) Additional Signal Installation at Signalized Intersections	"	9	2,410	20,757	933	21,690
3) New Traffic Signs	"	11	336	3,463	227	3,690
Total				280,380	12,670	293,050

Note: Quantities are based on Fig. 8.1.1. Location Map of Traffic signals and Signs Required according to One-Way Traffic Control System Improvement.

Table 8.1.8 Costs of Installation of Route-Coordinated Traffic Signal System

(Unit: Rp x 10^3)

Intersection Number	Name of Streets	Type	Foreign Currency	Local Currency	Total
4	Jl. Gudang - Jl. Jati	4-legged	under planning		
7	Jl. Sudarso - Jl. Yamin	4-legged	16,067	723	16,790
8	Jl. Gaharu - Jl. Yamin	4-legged	13,762	618	14,380
11	Jl. Balaikota - Jl. Raden Saleh	3-legged	under planning		
12	Jl. Sutomo - Jl. Veteran	4-legged	13,762	618	14,380
13	Jl. Thamrin - Jl. Veteran	4-legged	14,872	668	15,540
17	Jl. A.Yani - Jl. Palang Merah	4-legged	under planning		
18	Jl. Palang Merah - Jl. Kereta Api	4-legged	15,762	708	16,470
19	Jl. Haryone - Jl. Irian Barat	4-legged	under planning		
20	Jl. Haryono - Jl. Surabaya	4-legged	12,939	581	13,520
23	Jl. Cirebon - Jl. Bandung	4-legged	13,762	618	14,380
25	Jl. Thamrin - Jl. Merbaru	4-legged	14,872	668	15,540
26	Jl. Cirebon - Jl. Bogor	4-legged	13,762	618	14,380
27	Jl. Sutomo - Jl. Bogor	3-legged	12,489	561	13,050
29	Jl. Cirebon - Jl. Pandu	4-legged	under planning		
30	Jl. Pandu - Jl. Sutomo	4-legged	under planning		
31	Jl. Thamrin - Jl. Asia	4-legged	14,872	668	15,540
32	Jl. Sutomo - Jl. Sutriso	3-legged	13,219	611	13,830
33	Jl. Sunyatsen - Jl. Sutriso	4-legged	15,762	708	16,470
34	Jl. Thamrin - Jl. Sutriso	3-legged	13,219	611	13,830
35	Jl. S.M.Raja - Jl. Rakhmadsyah	3-legged	13,219	611	13,830
Total			212,340	9,590	221,930

Note:
i) Intersection Number corresponds to that of Fig. 8.1.1. Coordinated Route Map.

ii) "Under Planning" means the intersection where Medan City has a separate plan of traffic signal installation.

iii) Traffic signals which have been already installed at intersections are not mentioned in the table.

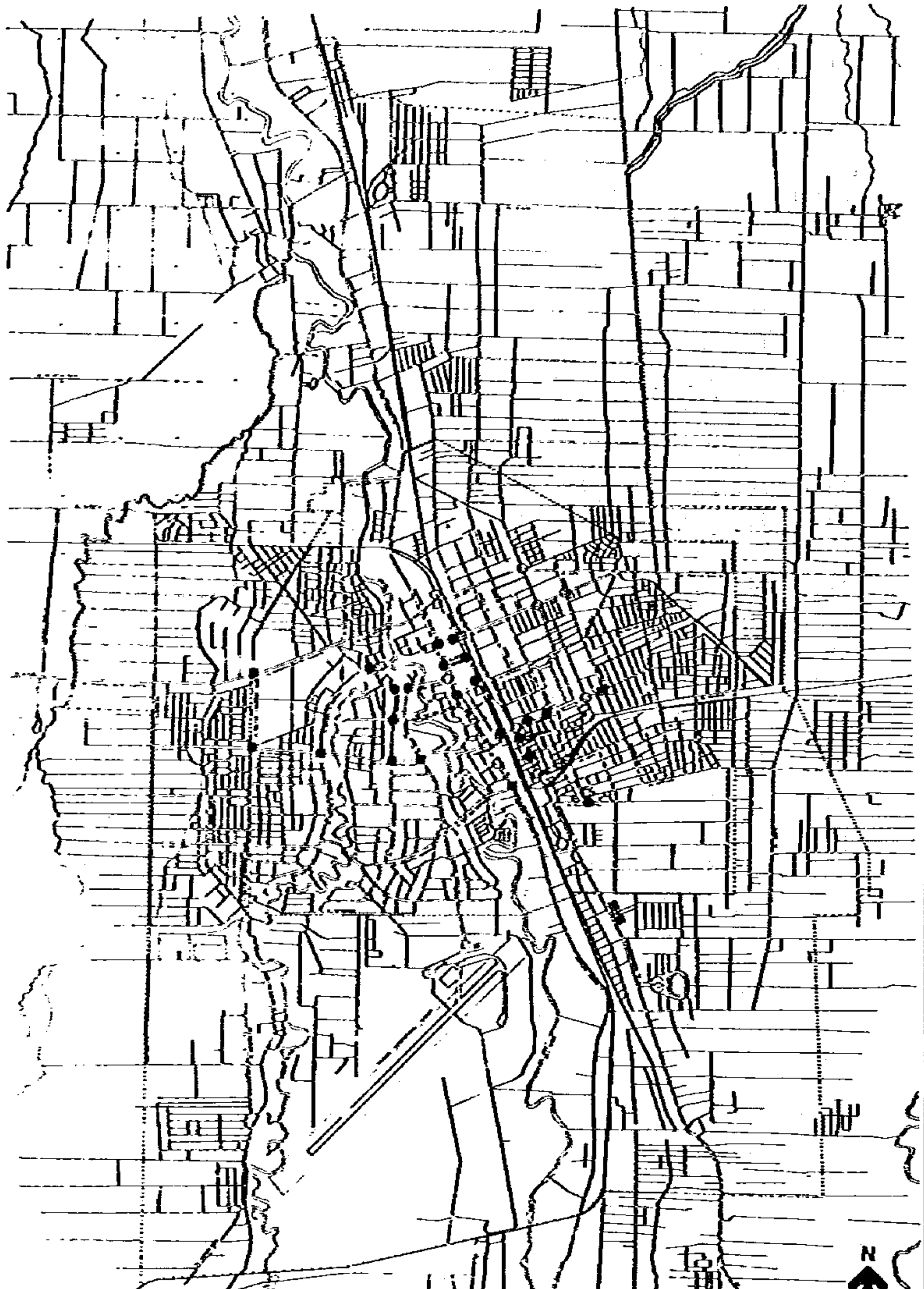


Fig. 8.1.1
Location Map of Traffic Signals and Signs Required According to Partially Improved One-Way Traffic Control System.

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Legend
○ Under construction/planning of traffic signal installation
● New traffic signal installation
■ Additional traffic signal installation
□ New traffic sign installation

Table 8.1.9 Costs of Improvement of Jl. Pembalagian

(Unit: $RP \times 10^6$)

Work item	Unit	Q'ty	Unit cost (Rp)	Foreign Currency: devices without taxes and duty	Foreign Currency: Others	Local currency	Total
1) Road section	m	3,750	298,200	341.1	342.2	435.0	1,118.3
2) Intersections				167.6	49.1	44.7	261.4
- Jl. Cemara	lump-sum			41.1	12.1	11.0	64.2
- Jl. Takari	lump-sum			19.5	5.7	5.2	30.4
- Jl. Karantina	lump-sum			19.5	5.7	5.2	30.4
- Jl. Persatasan	lump-sum			41.1	12.1	11.0	64.2
- Jl. Jati	lump-sum			46.4	13.5	12.3	72.2
Total of Construction Cost				508.7	391.3	479.7	1,379.7
3) Land acquisition and compensation	Sq.M	23,400	18,000	0	0	421.2	421.2

Note: Each cost includes the cost of mobilization and others which is assumed 15% of direct construction cost.

Table 8.1.10 Costs of Improvement of Jl. Prof. Yamin SH

(Unit: $Rp \times 10^6$)

Work item	Unit	Q'ty	Unit cost (Rp)	Foreign Currency: devices without taxes and duty	Foreign Currency: Others	Local currency	Total
1) Road section	m	3,738	298,200	340.0	341.1	433.6	1,114.7
2) Intersections				52.4	15.4	14.0	81.8
- Jl. Jati	lump-sum			13.4	4.0	3.6	21.0
- Jl. Sei Pengas	lum-sum			19.5	5.7	5.2	30.4
- Jl. Adlin Prawira	lum-sum			19.5	5.7	5.2	30.4
3) Bridge	Sq.m	120	437,000	0	36.6	15.8	52.4
Total of Construction Cost				392.4	393.1	463.4	1,248.9
4) Land acquisition and compensation cost	Sq.M	62,400	14,985	0	0	935.0	935.0

Note: Each cost includes the cost of mobilization and others which is assumed 15% of the direct construction cost.

Table 8.1.11 Costs of Improvements of Jl. Gajah Mada, Jl. Zainul Arifin and Jl. Palang Merah

(Unit: Rpx10^6)

Work item	Unit	Q'ty	Unit Cost (Rp)	Foreign Currency		Local currency	Total
				devices without taxes and duty	Others		
1) Road sections				118.2	118.7	150.9	387.8
- Jl. Palang Merah	m	500	80,945	12.3	12.4	15.8	40.5
- Jl. Zainul Arifin	m	300	80,945	7.3	7.5	9.5	24.3
	m	500	323,070	49.3	49.4	62.8	161.5
- Jl. Gajah Mada	m	500	323,070	49.3	49.4	62.8	161.5
2) Intersections				194.2	57.0	51.8	303.0
- Jl. Penuda	lump-sum			58.6	17.2	15.6	91.4
- Jl. Mesjid	lump-sum			26.4	7.8	7.0	41.2
- Jl. Imam Bonjol	lump-sum			27.3	8.0	7.3	42.6
- Jl. Dipone-goro	lump-sum			27.3	8.0	7.3	42.6
- Jl. S. Parman	lump-sum			27.3	8.0	7.3	42.6
- Jl. Iskandar Muda	lump-sum			27.3	8.0	7.3	42.6
3) Bridges				0	309.1	133.1	442.2
- Deli River	Sq.m	460	499,100	0	160.5	69.1	229.6
- Babura River	Sq.m	426	499,100	0	148.6	64.0	212.6
Total of Construction Cost				312.4	484.8	335.8	1,133.0
4) Land acquisition and compensation costs	Sq.m	4,650	18,000	0	0	83.7	83.7

Note: Each cost includes the cost of mobilization and others which is assumed 15% of the direct construction cost.

Table 8.1.12 Costs of Improvement of Jl. Pemuda, Jl. A. Yani, Jl. Balai Kota and Jl. Sudarso

(Unit:x RP 10^6)

Work item	Unit	Q'ty	Unit cost (Rp)	Foreign Currency: devices without taxes and duty	Foreign Currency: Others	Local currency	Total
1) Road sections				76.4	76.7	97.4	250.5
- Jl. Pemuda	m	350	80,945				28.3
- Jl. A. Yani	m	410	323,070				132.5
- Jl. Balai Kota	m	310	80,745				25.1
- Jl. Sudarso	m	200	323,070				64.6
2) Intersections				267.2	78.4	71.3	416.9
- Jl. Pemuda	lump-sum			31.1	9.1	8.3	48.5
- Jl. Palang Merah	lump-sum			58.6	17.2	15.7	91.5
- Jl. Yani VII	lump-sum			19.5	5.7	5.2	30.4
- Jl. Raden Saleh	lump-sum			34.5	10.1	9.3	53.9
- Jl. Bukit Barison	lump-sum			18.5	5.5	5.0	29.0
- Jl. Yamin	lum-sum			58.6	17.2	15.7	91.5
- Jl. Jati	lump-sum			46.4	13.6	12.1	72.1
Total of Construction Cost				343.6	155.1	168.7	667.4
3) Land acquisition and compensation costs	Sq.m	4160	40,000	0	0	166.4	166.4

Note: Each cost includes the cost of mobilization and others which is assumed 15% of the direct construction cost.

Table 8.1.13 Costs of Improvement of Sambu Bus Terminal

(Unit: Rpx10^3)

Work item	Unit	Q'ty	Unit cost (Rp)	Foreign Currency: devices without taxes and duty	Foreign Currency: Others	Local currency	Total
1) Direct construction cost				211,521	280,088	329,601	821,210
- Pavement (overlay)	Sq.m	24,980	4,289	0	68,890	38,249	107,139
- Traffic marking	Sq.m	1,000	3,061	0	2,997	64	3,061
- Side walk	Sq.m	7,190	4,198	0	6,640	23,544	30,184
- Concrete curb	l.m.	4,970	10,494	0	23,351	23,764	52,115
- Drainage	l.m.	4,110	68,361	0	63,217	217,747	280,964
- Lighting location		110	2,061,000	211,521	0	15,190	226,711
- Guardrail	l.m.	770	37,914	0	27,238	1,956	29,194
- Berth	Sq.m	770	119,275		82,755	9,087	91,842
2) Mobilization and others	lump-sum			31,728	42,013	49,440	123,181
Total				243,249	322,101	379,041	944,391

Table 8.1.14 Costs of Improvement of Intersection on Jl. Gatot Subroto and Jl. Gelugur Bypass

(Unit: Rp x 10^3)

Work item	Unit	Q'ty	Unit cost	Foreign Currency		Local currency	Total
				devices without taxes and duty	Others		
1) Direct Construction Cost				60,391	76,449	121,859	258,699
- Pavement (new construction)	Sq.m	1,430	8,747	0	7,517	4,991	12,508
(overlay)	Sq.m	10,840	4,289	0	29,854	16,638	46,492
- Traffic marking	Sq.m	798	3,061	0	2,390	51	2,441
- Side walk	Sq.m	4,305	4,198	0	3,976	14,096	18,072
- Concrete curb	l.m.	2,020	10,494	0	11,532	9,666	21,198
- Drainage	l.m.	1,337	68,361	0	21,180	72,953	94,133
- Lighting	location	6	2,061,000	11,537	0	829	12,366
- Traffic signal	lump-sum			32,418	0	1,457	33,875
- Guide sign	location	9	1,891,890	15,886	0	1,141	17,027
- Traffic sign	location	7	83,890	550	0	37	587
2) Mobilization and others	lump-sum			9,059	11,467	18,279	38,805
Total				69,450	87,916	140,138	297,505

Table 8.1.15 Costs of Improvement of the Intersection on Jl. Jati and Jl. Prof. Yamin SH

(Unit: Rpx10^3)

Work item	Unit	Q'ty	Unit Cost (Rp)	Foreign Currency		Local currency	Total
				devices without taxes and duty	Others		
1) Direct Construction cost				21,542	52,407	92,442	166,391
- Pavement (new construction)	Sq.m	380	8,747	0	1,998	1,326	3,324
(overlay)	Sq.m	7,046	4,289	0	19,431	10,789	30,220
- Traffic marking	Sq.m	483	3,061	0	1,447	31	1,478
- Side walk	Sq.m	4,283	4,198	0	3,956	14,024	17,980
- Concrete curb	l.m.	1,570	10,494	0	8,963	7,513	16,476
- Drainage	l.m.	1,080	68,361	0	16,612	57,218	73,830
- Lighting	location	6	2,061,000	11,537	0	829	12,366
- Guide sign	location	5	1,891,890	8,826	0	633	9,459
- Traffic sign	location	15	83,890	1,179	0	79	1,258
2) Mobilization and others	lump-sum			3,231	7,861	13,866	24,958
Total				24,773	60,268	106,308	191,349

Table 8.1.16 Cost of Opening a Bus Loop Route Operation

(Unit: Rpx10^6)

Work item	Unit	Q'ty	Unit cost	Foreign currency	Local currency	Total
1) Procurement of Buses	unit	7	20.0	0	140.0	140.0
Total				0	140.0	140.0

Table 8.1.17 Costs of Improvement of Jl. Gang Warni

(Unit: Rpx10^6)

Work item	Unit	Q'ty	Unit cost Rp	Foreign Currency		Local currency	Total
				device without taxes and duty	Others		
1) Road section	m	850	405,830	105.2	105.6	134.2	345.0
2) Interesection				86.8	25.4	23.2	135.4
- JL. Katamuso	lump-sum			43.4	12.7	11.6	67.7
- JL. Imani Bonjol	lump-sum			43.4	12.7	11.6	67.7
3) Bridge	Sq.m	400	499,100	0	139.5	60.1	199.6
Total Construction Cost				192.0	270.5	217.5	680.0
4) Land acquisition & Compensation	Sq.m	8,740	7,050	0	0	61.6	61.6

Note: Each cost includes the cost of mobilization and others which is assumed 15% of direct construction cost.

8.1.3 Economic Cost

The economic cost for economic evaluation derives from the financial cost which in described in paragraph 8.1.2 minus taxes and duty. Taxes included in the local currency portion consist of business tax, municipal tax and income tax. The tax rate of the local currency portion is estimated to be 7.8% in this project, referring to the report on Jakarta Intra Urban Toll-way project in 1979. Concerning the foreign currency portion, it can be considered that there is an additional import duty to taxes mentioned above. Import duties to materials or equipment which are to be used for the construction of public investments are assumed to be 5% to 20% respectively. Thus, duty rate to foreign currency portion is estimated to be 15% in this project. However, the foreign currency portion of diesel railway cars and imported devices such as traffic signal, lighting etc. do not include these taxes and duty.

Economic costs of each improvement plans are tabulated in Table 8-1-18.

Table 8-1-18 Summary of Financial and Economic Costs of Improvement Plans in the Value of January, 1983

(Unit: Rp.10[3])

Improvement Plan		Construction: Civil Construction Cost: Foreign Currency: Devices without tax and duty	Construction: Civil Construction Cost: Foreign Currency: Others	Construction: Civil Construction Cost: Local Currency	Construction: Land Acquisition and Compensation	Construction: Physical contingencies	Construction: Field Engineering services	Construction: Total*	Mechanical Cost*: Foreign Currency	Mechanical Cost*: Local Currency	Mechanical Cost*: Total	Grand Total	Annual operation cost	Annual maintenance cost
Improvement of railway crossing [illegible]	Financial Cost	0	23,936	32,813	0	8,512	5,635	70,936	244,288	43,272	287,560	358,496	0	12,154
	Economic Cost	0	18,479	30,255	0	7,310	6,873	62,916	244,288	39,857	284,145	345,191	0	11,706
Expanding passenger service between [illegible] and Medan	Financial Cost	0	0	78,343	0	11,751	7,834	97,928	3,007,655	120,919	3,128,574	3,226,502	37,000	110,363
	Economic Cost	0	0	72,232	0	10,835	7,223	90,290	3,007,655	111,355	3,119,010	3,209,300	34,118	86,203
Reconstruction of [illegible] of pedestrian bridge in Medan station	Financial Cost	0	2,609	8,333	0	1,641	1,093	13,676	0	0	0	13,676	0	235
	Economic Cost	0	2,073	7,683	0	1,457	971	12,184	0	0	0	12,184	0	221
Opening outside station building of Medan	Financial Cost	0	213,326	474,937	0	203,239	69,826	961,328	0	0	0	961,328	2,597	3,936
	Economic Cost	0	164,658	437,892	0	90,387	60,258	753,225	0	0	0	753,225	2,394	3,601
Partial improvement of railway traffic control	Financial Cost	0	0	0	0	0	0	0	280,380	12,670	293,050	293,050	31,110	2,930
	Economic Cost	0	0	0	0	0	0	0	280,380	11,680	292,060	292,060	28,653	2,704
Installation of centralized signal system	Financial Cost	0	0	0	0	0	0	0	212,340	9,590	221,930	221,930	27,450	2,220
	Economic Cost	0	0	0	0	0	0		212,340	8,840	221,180	221,180	25,309	2,047
Improvement of Jl. [illegible]	Financial Cost	508,700	391,300	479,700	421,200	270,100	135,000	2,209,000	0	0	0	2,209,000	18,500	9,700
	Economic Cost	508,700	302,100	442,300	388,300	245,200	125,300	2,012,900	0	0	0	2,012,900	17,057	8,953
Improvement of Jl. [illegible]	Financial Cost	392,400	393,100	453,400	935,000	327,600	124,900	2,636,400	0	0	0	2,636,400	14,500	8,700
	Economic Cost	332,400	303,500	437,300	852,100	297,810	112,300	2,395,400	0	0	0	2,395,400	13,645	9,031
Improvement of Jl. Gajah Mada, Jl. [illegible] and Jl. [illegible]	Financial Cost	312,400	454,800	335,800	83,700	182,500	113,300	1,512,500	0	0	0	1,512,500	14,200	7,920
	Economic Cost	312,400	374,300	309,650	77,200	161,050	59,600	1,334,100	0	0	0	1,334,100	13,092	7,254
Improvement of Jl. [illegible]	Financial Cost	343,600	155,100	168,700	166,400	125,100	56,700	1,015,600	0	0	0	1,015,600	14,200	6,700
	Economic Cost	343,600	119,700	155,500	153,400	115,800	61,900	949,900	0	0	0	949,900	13,092	6,333
Improvement of Sambu bus terminal	Financial Cost	243,249	322,101	379,041	0	141,659	94,439	1,180,489	0	0	0	1,180,489	31,250	6,610
	Economic Cost	243,490	245,662	359,476	0	126,244	85,163	1,052,035	0	0	0	1,052,035	28,813	6,094
Improvement of the intersection on Jl. [illegible] and Jl. [illegible]	Financial Cost	69,450	87,916	140,338	0	45,626	29,150	372,480	0	0	0	372,480	4,860	1,725
	Economic Cost	69,450	67,871	129,207	0	29,979	26,653	323,160	0	0	0	323,160	4,451	1,590
Improvement of the intersection on Jl. [illegible] and Jl. [illegible]	Financial Cost	24,773	60,768	106,308	0	28,702	19,135	239,686	0	0	0	239,686	1,300	1,339
	Economic Cost	24,773	45,527	98,816	0	25,397	16,932	211,445	0	0	0	211,445	1,156	1,235
Opening a bus [illegible] operation	Financial Cost	0	0	0	0	0	0	0	0	140,000	140,000	140,000	67,600	
	Economic Cost	0	0	0	0	0	0	0	0	129,000	129,000	129,000	57,717	
Improvement of Jl. [illegible]	Financial Cost	192,000	270,500	217,500	61,600	102,000	68,000	911,600	0	0	0	911,600	5,800	5,131
	Economic Cost	192,000	208,800	200,500	56,800	93,700	65,100	816,900	0	0	0	816,900	5,348	4,755

* Costs of railway rolling stock, bus coaches and other mechanical devices.

8.2 Benefit Analysis

8.2.1 Methodology

The benefit analysis is carried out under the following conditions.

- It is assumed that the direct benefits consist of savings in vehicle operating costs, and travel time costs.
- Indirect benefits are observed in some cases however, it is not included in benefit calculations in this study.
- Direct benefits are calculated by comparing them between the existing road network with and without the short-term improvements which are described more in detail in Sec. 8.2.3.
- Direct benefits are calculated by using economic benefit cost.
- Benefits are calculated from the first year to be opened to the year 1990 A.D.
- Sensitivity analysis is not performed in the short-term improvement.

8.2.2 Unit Costs

(1) Time Value

According to 'INTERIM STRATEGIC PLAN AND FEASIBILITY REPORT', Medan Urban Development, Housing, Water Supply and Sanitation Project, 1979, the average monthly household expenditure in 1978 is approximately Rp.37,300. Applying the average number of household members, 6.2 persons/household, the average yearly expenditure per one person is figured out, 72,194 Rp./yr.

Assuming that the average working hours for an employed person is 2,000 hours/yr. and that the economic participation rate (employed person/residential population) is 28%*) in 1978, the average hourly wage is figured out as 128.9 Rp./hr.

Notes: *) From 'LAPORAN PEMBANGUNAN, DAERAH TK. II, KOTAMADYA MEDAN, SELAMA PELITA II', Walikota Daerah Tk. II Medan, 1979.

Here, an assumption is made that the time value during non-working hours is 25% of during working hours. Also, another assumption is made that the time value of car owners and non car owners are 150% and 25% respectively, of average hourly wage obtained above.

- Car Owner:

  Working Hours : 128.9 x 1.5 x 1.0 = 193.4 (Rp./hr)
  Non-working Hours: 128.9 x 1.5 x 0.25 = 98.3 (Rp./hr)

- Non-Car Owner:

  Working Hours : 128.9 x 0.75 x 1.0 = 96.7 (Rp./hr)
  Non-working Hours: 128.9 x 0.75 x 0.25 = 24.2 (Rp./hr)

Based on the result of the O-D survey by Bina Marga in 1978, the percentage of the number of trips made during working hours is estimated to be approximately 40%. The average daily time value for a car owner and a non-car owner are estimated as shown in the following Table.

Table 8-2-1 Average Time Value

	Time Value (Rp./hr.)		Percentage of Trips(%)		Average Time Value (Rp./hr.)
	Working Hours	Non-Working Hours	Working Hours	Non-Working Hours	
Car Owner	193.4	48.3	40	60	106.3
Non-Car Owner	96.7	24.2	40	60	53.2

Here, it should be remembered that about 85% of car owners are those of motorcycles. Then, the average time value of a car owner in the above table is rather close to that of motorcycle. 'SURABAYA AREA TRANSPORTATION STUDY', Halcrow Fox and Associates, 1977, estimates the time value of a sedan owner 2.7 times of that of a motorcycle owner. Taking these conditions into account, the time values of a passenger by vehicle type in 1978 are estimated as follows:

- Sedan : 287 Rp./passenger.hr.
- Motorcycle, Becak Mesin : 106 Rp./passenger.hr.
- Bus, Bemo : 53 Rp./passenger.hr.
- Bicycle : 42 Rp./passenger.hr.

Applying the average number of passengers per motor vehicle confirmed in Bina Marga's O-D survey to the above time value, the time value per vehicle-hr. can be obtained. The time value per vehicle-hr. for truck is estimated based on that by 'FEASIBILITY STUDY OF JAKARTA RING ROAD PROJECT', Japan International Cooperation Agency, 1978. Then, the time values by vehicle type are escalated with the future growth rate of per capita regional income.

Table 8-2-2 Time Value by Vehicle Type

(Unit: Rp./vehicle-hr.)

	Average No. of Passengers per vehicle excluding Driver	Time Value by Vehicle Type		
		1978	1985	2000
- Sedan	1.8	545	737	1,160
- Motorcycle, Becak Machine	1.6	170	231	362
- Bus	32.8	1,749	2,376	3,762
- Bemo	5.6	297	403	638
- Truck	-	2,125	2,878	4,527
- Becak	1.6	67	90	89
- Bicycle	1.2	50	67	107

For the reference purpose the time value estimated in other projects are as presented below:

- 'SURABAYA AREA TRANSPORTATION STUDY', Halcrow Fox and Associates, 1977:

  - Sedan : 518 Rp./vehicle.hr.
  - Motorcycle : 192 Rp./vehicle.hr.

- 'FEASIBILITY STUDY OF JAKARTA OUTER RING ROAD PROJECT', Japan International Cooperation Agency, 1978:

  - Sedan 832 Rp./vehicle.hr.
  - Bus : 2,797.7 Rp./vehicle.hr.
  - Truck : 3,231.7 Rp./vehicle.hr.

- 'THE CONSULTING ENGINEERING SERVICES FOR JAKARTA INTRA URBAN TOLLWAY', Pacific Consultants International, 1979:

  - Sedan (1,200 cc) : 787 Rp./vehicle.hr.
  - Sedan (2,000 cc) : 1,050 Rp./vehicle/hr.
  - Sedan (2,600 cc) : 1,692 Rp./vehicle.hr.
  - Bus : 3,594 Rp./vehicle.hr.
  - Truck : 2,886 Rp./vehicle.hr.

(2) Vehicle Operating Costs

(a) Road Vehicle Operating Cost

Road vehicle operating costs in this study are adopted from the results analized in Padang-Medan Highway Study modifying them by the characteristics of Medan City and annual price escalation.

However, those of some transport modes such as motorcycles and Bemo are calculated by the results of Surabaya Area Transport Study due to insufficient data in the Padang-Medan Highway Study, but some modifications are made by same reasons mentioned above.

With regards to the operating cost of bicycle, the calculation method used in Japan is applied although depreciation of tire and tube costs are its main items. Table 8-2-3 shows the results of calculation of road vehicle operating cost to be applied in this study and 1980 A.D. value is utilized for the analysis using annual escalation rate of 10%. In this case, devaluation held in 1979 is take into consideration.

Table 8-2-3 Operating Cost by Speed and by Type of Vehicle

(unit: Rp/km)

Speed (km/h)	Bicycle*	Motor Cycle	Bemo	Passenger Car	Bus	Truck
5	8.5			60	150	155
10	8.5	14.8	46.61	58	138	139
15	8.5	14.17	45.41	56	127	126
20	8.5	13.53	44.2	55	117	114
25	8.5	13.03	42.3	53	108	104
30		12.55	41.0	51	101	96
35		12.11		50	95	89
40		11.66	39.4	49	90	83
45		11.17		48	87	79
50		10.67	38.3	47	84	76
55		10.34		46	83	75
60		10.01	36.1	45	83	74
65		10.0		44	84	75
70		10.0	35.9	44	87	77
75		9.75		44	90	81
80		9.5	34.2	44	95	85
85		9.3		44	100	91
90		9.1	33.6	44	107	97
95		9.1		44	115	105
100		9.0	33.4	45	124	114

Notes: It is assumed that the operating cost of bicycle does not change year by year.

8.2.3 Benefits of Improvement Plans

Calculating method of the benefits of short term improvement plans is different in each alternative. Detailed procedures by each improvement category are as follows:

(1) Improvement of Railway Crossings

Concerning this category, benefits as time travel savings for road vehicles are taken into consideration. 57 minutes per day of reduction in the closed time are expected by the improvement plan in which automatic warning devices of train approaching are to be installed. Such devices are to be installed at 10 railway crossings, and the expected benefits are calculated in total of vehicle time saving eventually.

(2) Railway Passenger Service between Belawan and Medan

The benefits of this project are considered as follows:

- Travel time savings by railway passengers who are expected to divert from bus and Bemo to railway after reopening Belawan-Medan passenger trains.

- Cost savings by comparing the bus operating cost with that of diesel rail-car train.

(3) Opening Eastside Gate of Medan Railway Station

As far as this project is concerned, travel time savings are considered as benefit. Personal time saving is estimated as 4 minutes per passenger from the eastside.

(4) Localized Change of One-Way System

Benefits in this category depend mainly on the saving in vehicle-time. Vehicle-kilometers and vehicle-hours were counted in the central district of Medan City.

Table 8-2-4 shows the present figures and this estimated figures after the improvement. Total reductions of both items are estimated as 71 thousand vehicle-kms per day and 2.7 thousand vehicle-hours per day respectively.

Table 8-2-4 Total Vehicle-Kms, Vehicle-Hours

		Vehicle-km/day	Vehicles.Time (Vehicle-hour/day)
1	Present Network	920,447	42,241.7
2	Partially improved One-Way System (Alternative Case I)	849,468	39,505.5
	Savings by Improvement	70,979	2,736.2

(5) Benefits of Route-Coordinated Signal Control

In order to fully comprehend the benefits due to this category of improvement let us look at the case when the systematically controlled traffic system is used in comparison with a case when the systematic control system is not used, weighing the benefits of each case.

<Uninterrupted Travel Benefits>

A reduction in fuel expenses because of a lessening of the number of times vehicles to stop and start up again at traffic lights. This reduction of fuel expenses it is named as the benefit of uninterrupted travel. The amount of fuel cost expended to start is calculated as follows.

- the case without Route-Coordinated Signal Control:

$$Mr_1 = Q \times \frac{R}{C} \times N \times K_1$$

Mr_1 : fuel expenses used in starting a car from an engine-idling position along a certain length of road (Rp/day)

Q : Average daily volume of traffic on a certain length of road (number of vehicles per day)

C : the length of the cycle time = 116 seconds

R : the length of time while a traffic light is red in a cycle time of 58 seconds

N : the number of signalized intersections in a given section of road

K_1 : the weighted average amount of fuel cost expended to start a car from a engine-idling position (Rp/car per stop)

- the case with Route-Coordinated Signal Control System:

$$Mr_2 = Q \times 1 \times K_1$$

$$Mr_3 = 0.75/1.75 \times Mr_1 + 1/1.75 \times Mr_2$$

The cost of fuel K_1 expended in starting a car from a engine-idling position, differs depending on the model of car and the cruising speed of the road. Using a chart of the composition of vehicular traffic in Medan and assuming that cars will travel at 30 kilometers per hour, we can establish the difference in fuel costs Mr between the two cases.

According to this method K_1 = 6.0 cc per car x 0.1 Rp/cc = 0.6 Rp. per car.

Thus the uninterrupted travel benefits in terms of fuel cost saving and for the Route-Coordinated Signal system is as follows:

(Unit: Rp/day 1,000)

Mr_1	Mr_3
645	400

Therefore, benefits is calculated as a total of Rp.245×10^3/day per car.

<Time Benefits>

Due to the Route-Coordinated Signal system, the amount of time spent waiting on red light are drastically reduced, it is summed up such time benefits under the assumption that an average time spent waiting on red light is half of the red light time (29 seconds) of a cycle.

- the case with Route Coordinated Signal System:

$$Mt_1 = Q \times \frac{R}{C} \times N \times \frac{R}{2} \times \frac{K2}{3,600}$$

$$Mt_2 = Q \times \frac{R}{2} \times \frac{K2}{3,600}$$

$$Mt_3 = 0.75/1.75 \times Mt_1 + 1/1.75\ Mt_2$$

Thus, we obtain: K_2 = 548 Rp/vehicle hour

The following in the comparison of vehicle fuel costs at intersections.

- Comparison of Fuel Costs at Intersections

(Unit: 1,000Rps/day)

Mt_1	Mt_3
4,746	2,946

Therefore, the benefit due to savings in vehicle fuel cost calculated as a total of Rp.1,800 x 10^3/day.

Thus, the benefits of the Route-Coordinated signal system is calculated as follows:

$$(245 + 1,800) \times 10^3 \times 365 = 746^{million}\ Rp./year$$

(6) Improvement of Raod Facilities

Reductions in vehicle-km and vehicle-hour of the traffic volume passing through of the roads are calculated as benefits.

(7) Improvement of Pasar Sambu Bus Terminal

The benefits of this category is estimated as the reduction of operating cost of buses and Bemo in this bus terminal. The traffic volume is calculated by the results of traffic counts conducted by the JICA Study Team.

(8) Improvement of Intersections

The benefit is estimated as the reduction in delay of vehicles passing through those intersections. The results of calculation are shown in Table 8-2-5.

Table 8-2-5 Intersection of Jl. Tati and Jl. Yamin

Approach	Existing		Improvement Plan		Difference in Delay (Veh. hr.)	Benefit (Rp./day)
	Traffic/ day	Delay Time (Veh. hr.)	Traffic/ day	Delay Time (Veh. hr.)		
A	28,790	168	20,633	0	168	92,064
B	577	3	2,438	28	-25	-13,700
C	33,877	169	31,233	26	143	78,364
Total	63,244	340	62,304	54	286	156,728

Note: Cost per vehicle-hour is assumed as Rp.548.

(9) Loop Bus Service

It is very difficult to estimate the benefits of this category; therefore, only the financial analysis is performed in the following chapter.

The results of those benefits described above by improvement plan are summarized in Table 8-2-6.

Table 8-2-6 Summary of Economic Benefits of Improvement Plans (in value of January 1980)

(Unit: Rp. x 10^3)

Improvement Plans	Total Benefits in the period from 1982 to 1990
Improvement of Railway Crossings	1,622.50
Re-opening Commuter Service between Belawan and Medan	37.47
Opening Backside Station Building of Medan	5.77
Localized Change of One-Way Traffic Control	2,423.86
Installation of Coordinated Signal System	1,141.70
Improvement of Route 1	1,597.36
" 2	1,457.00
" 3	1,967.72
" 4	1,443.74
Improvement of Sambu Bus Terminal	171.94
Improvement of Intersection of Jl. Jl. Gotot Subrato and Jl. Geigur By-pass	58.21
Improvement of Intersection of Jl. Tuti and Jl. Yamin	85.86
Total:	Rp.12,013.13 x 10^3

8.3 Cost-Benefit Analysis

From the total economic costs which are calculated in Section 8.1.2, comprising the construction costs, the maintenance costs and the operation costs, and the total benefits, coping with the project life-span of each improvement the benefit-cost ratio and the internal rate of return of each improvement plan are calculated.

8.3.1 Calculation of Cost-Benefit Ratio and Internal Rate of Return

For each improvement plan, benefit-cost ratio and internal rate of return are calculated by using three discount rates such as 10%, 12% and 15%.

According to the results, the following four plans seem to be unfeasible, which indicate the B/C ratio below 1.0 in the case of 15% in the discount rate:

1. Re-openning the railway passenger service in the section between Belawan and Medan;

2. Opening east side gate of Medan Station.

3. Improvement of Sambu Bus Terminal.

4. Improvement of the intersection of Jl. Gotat Subroto and Jl. Gelgur By-pass.

Table 8-3-1 shows the whole results of economic analyses.

Table 8-3-1 Economic Benefit/Cost Ratios and Internal Rates of Return of Improvement Plans

	Benefit/Cost Discount Rate			I.R.R. (%)
	10%	12%	15%	
Improvement of Railway Crossings	18.3	17.0	15.4	259.7
Re-opening Commuter Service between Belawan and Medan	0.061	0.057	0.052	(A)
Opening east side gate of Medan Station	0.034	0.032	0.028	(A)
Localized change of One-Way Traffic Control	30.4	29.2	27.4	17,477.5
Installation of Route-Coordinated Signal System	14.6	13.9	12.9	312.6
Improvement of Route 1	3.9	3.6	3.2	59.4
" 2	2.8	2.7	2.4	42.0
" 3	7.1	6.5	5.8	83.5
" 4	7.2	6.7	6.0	107.3
" 5	3.2	3.0	2.7	50.8
Improvement of Pasar Sambu Bus Terminal	0.68	0.63	0.58	1.1
Improvement of the Intersection between Jl. Gotat Subrato and Jl. Gelgur By-pass	0.75	0.70	0.63	3.4
Improvement of Intersection of Jl. Tubi and Jl. Jamin	1.8	1.6	1.5	25.8

Note: (A) shows that evaluated benefit total is less than the value of evaluated financial total cost.