Table 5.10.2 Comparison of Alternative Plans

Intersection : Rama IV/Kasemrat Rd. (No. 035)

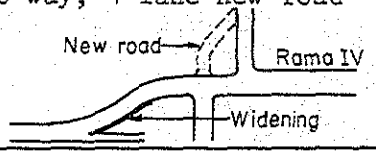
Alternatives		(Recommended improvement)		
Improvement Plan		Two-way, 4-lane new road 		
Project Cost (Million Baht)	Construction Cost	30.1		
	Land Acq. Cost	6.4		
	Total	36.5		
	Maintenance Cost per annum	0.6		
Construction Period		1 year		
Evaluation	Improvement Effect (Morning peak)	Saturation degree 1.036 ⟶ 0.815 Max. Queue length (EB) 550 m ⟶ 50 m Max. Stopped delay (EB) 7 min. ⟶ 40 sec.		
	Major Constraints	Both sides of Rama IV Rd. already built-up.		
	Advantage/ Disadvantage	Area of new road is mainly in open spaces. Land acquisition required for lane increase.		

Table 5.10.3 Economic Analysis (in 10 years)

Item	Result
Initial Cost	36 Mil.B.
Cost in Present Value (C)	41 Mil.B.
Benefit in Present Value (B)	105 Mil.B.
Net Benefit (B-C)	64 Mil.B.
B/C	2.58
IRR	0.272

The net benefit is reasonably high, the B/C is more than 2.0 and the IRR is 0.272. Therefore, the new road plan is recommended for the future execution.

5.11 Dindaeng - Asok Rd., No.900

(1) General description (Figure 5.11.1)

This intersection is located at the south end of Middle Ring Rd. (or Ratchadaphisek Rd.). The traffic volume coming here is not large compared with those of other intersections. One of the reasons is that an east road called Samsen Khlong-side Road has not been completed nor connected to east Ramkhamhaeng Road. If the road is connected to the east road, the traffic volume will increase significantly.

(2) Traffic flow

As Samsen Khlong-side road has not been completed, traffic volume to/from the road accounts only 300 - 500 PCU/hr. Therefore, traffic diagram shows almost like a 3 - leg intersection instead of actural 4 - leg one. (Figure 5.11.2). When the road is completed, the traffic flow will change drastically.

(3) Constraints (Figure 5.11.1)

Dindaeng - Asok road in the south has only 6 lanes at standard section in comparison with 8 lanes of Middle Ring road in the north. Along the Dindaeng - Asok road, concrete buildings are already built-up and the sidewalk has only about 3 m width. For the widening of the road from 6 - lane to 8 - lane, large land acquisition will be required.
A bridge at Khlong Samsen has also only 6 lanes. If the widening of the road is required, the bridge widening, the land acquisition and shifting of the sidewalk are also required. Around the bridge, building demolition will be small because the buildings are already set back around there.

(4) Degree of congestion (existing)

Existing conditions are summarized in Table 5.11.1.

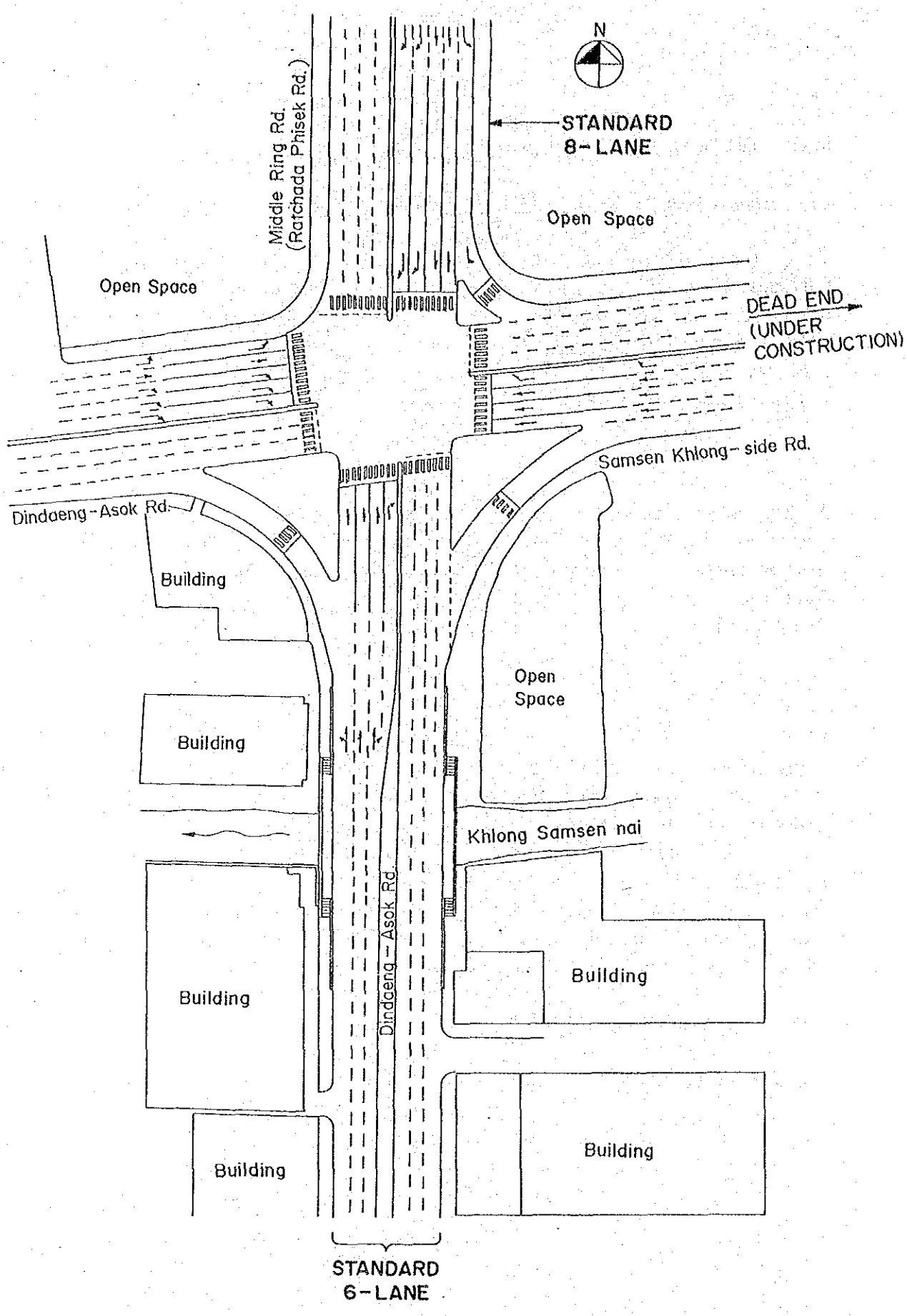


Figure 5.11.1 Dindaeng–Asok Intersection

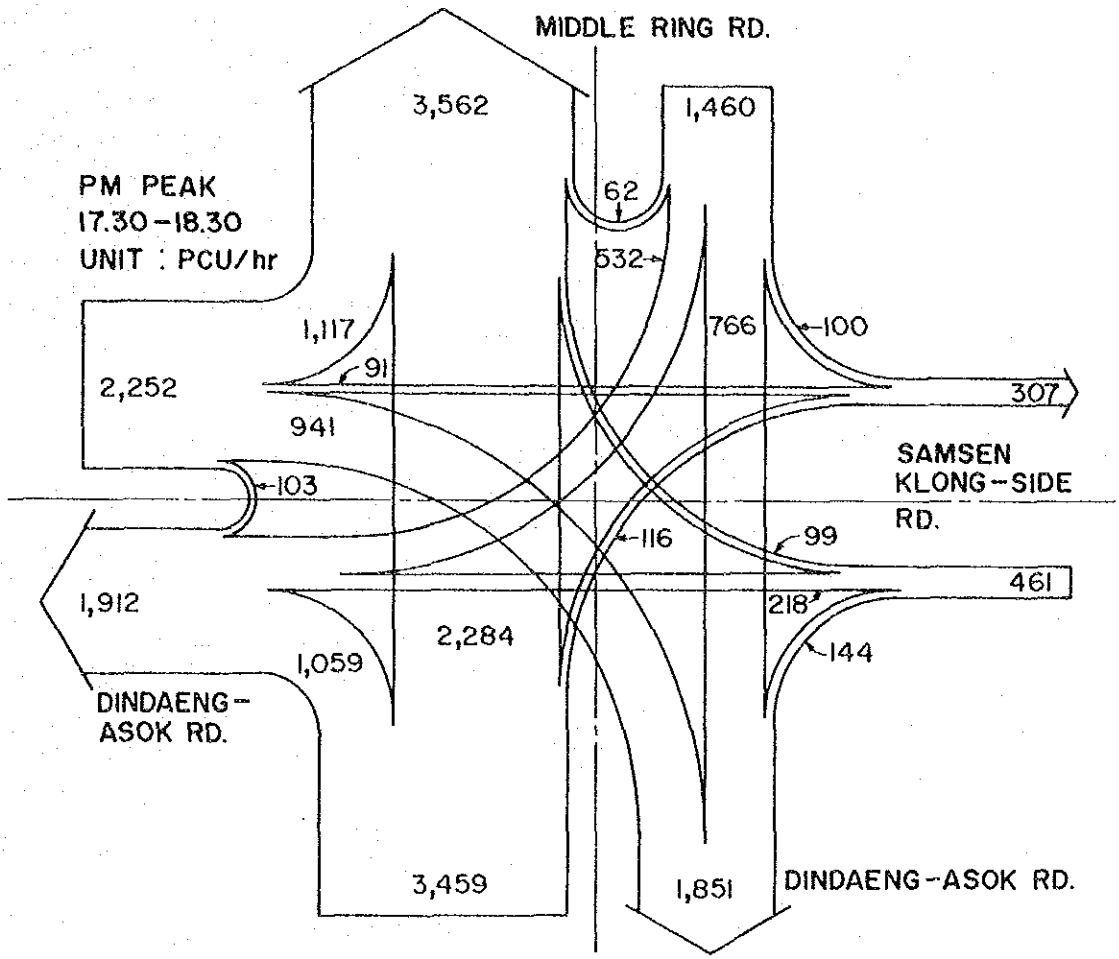


Figure 5.11.2 No. 900
Traffic Volume at Dindaeng–Asok Rd.

Table 5.11.1 Existing Condition of Intersection

Item	Characteristics
1) Morning peak hour	09:00 - 10:00
Max. Traffic	2,649 PCU/hr, north bound
2) Evening peak hour	17:00 - 18:30
Max. Traffic	3,562 PCU/hr, north bound
3) Saturation degree of intersection	
Morning	1.007
Evening	1.144
4) Queue length	
Morning	400 - 600m, 07:30 - 08:00 south bound
	400 - 600m, 07:45 - 08:00 west - south bound
Evening	200 - 400m, 16:30 - 18:30 north bound and west - south, north bound
5) Stopped delay	
Evening	7 min. west - south, north bound
6) Cycle length	
Morning	291 sec. (irregular)
Evening	219 sec. (regular)

(5) Cycle time analysis

- Green time is properly arranged to each direction.
- Cycle length is long and irregularly controlled in the morning.

(6) Planning of improvement alternatives

1) Points of planning

As mentioned in General description of this intersection, the improvement plan at this location should be closely coordinated with that of Middle Ring Road. Furthemore, Samsen Khlong-side road, which is an east leg of the intersection, has been under construction. When the road is completed, traffic from east of Bangkok will come to the intersection and its traffic volume will increase significantly. The traffic condition will be much different from the existing one.

Therefore, the basic direction of the improvement plan at this intersection must be clarified in order to realize a balanced and integrated improvement of the road network concerned, based on a comprehensive and long term perspects in consideration of future traffic demand. The studies carried out here was confined to analyse the existing conditions and to present the effects on them in case of widening the road from 6-lane to 8-lane which is stretched on the adjacent segment of Middle Ring Road.

(7) Improvement effects

If south Dindaeng - Asok road was widened to 8 - lane, the saturation degree of the intersection will decrease from existing 1.144 to around 0.8. It is still a little congested.

5.12 Petburi Rd./Soi Asok, No.220

(1) General description (Figure 5.12.1)

This intersection is a 4-leg one and located at Petburi Rd. with a flyover above it. Crossing roads are Dindaeng-Asok Rd. and Soi Asok. Those two roads will form Middle Ring Rd. in future. The existing road width and the number of lanes from the north road are shown in Table 5.12.1 and Figure 5.12.1.

Table 5.12.1 Road Width along Middle Ring Rd.

Road Name	Road Width	Number of Lanes
Middle Ring Rd.	40 m	8
Dindaeng-Asok Rd.	30 m	6
Soi Asok	20 m	4
Middle Ring Rd. extension (Under construction)	40 m	8

In the table, existing Dindaeng - Asok Rd. (30 m in width) and Soi Asok (20 m) are narrower than both sides of Middle Ring Rd. (40 m)

Middle Ring Rd. is a major road surrounding the Bangkok city. Therefore, the improvement of the intersection which is located on the future Middle Ring Rd. should be considered with that of Middle Ring Rd.

Then, for this intersection, at-grade improvement plan without land acquisition is proposed and analyzed Overall improvement of Middle Ring Rd. is expected to be studied in future.

(2) Traffic flow (Figure 5.12.2)

Petburi Rd. in the west is one way except a contra bus lane. Petburi Rd. in the east is dual way but its east bound traffic is relatively small (about 800 PCU/hr) due to the flyover of east bound. Traffic volume in the evening is analyzed here because its saturation ratio is bigger than that in the morning.

Queue length is 200 - 400 m between 16:30 and 18:00 on Petburi Rd.

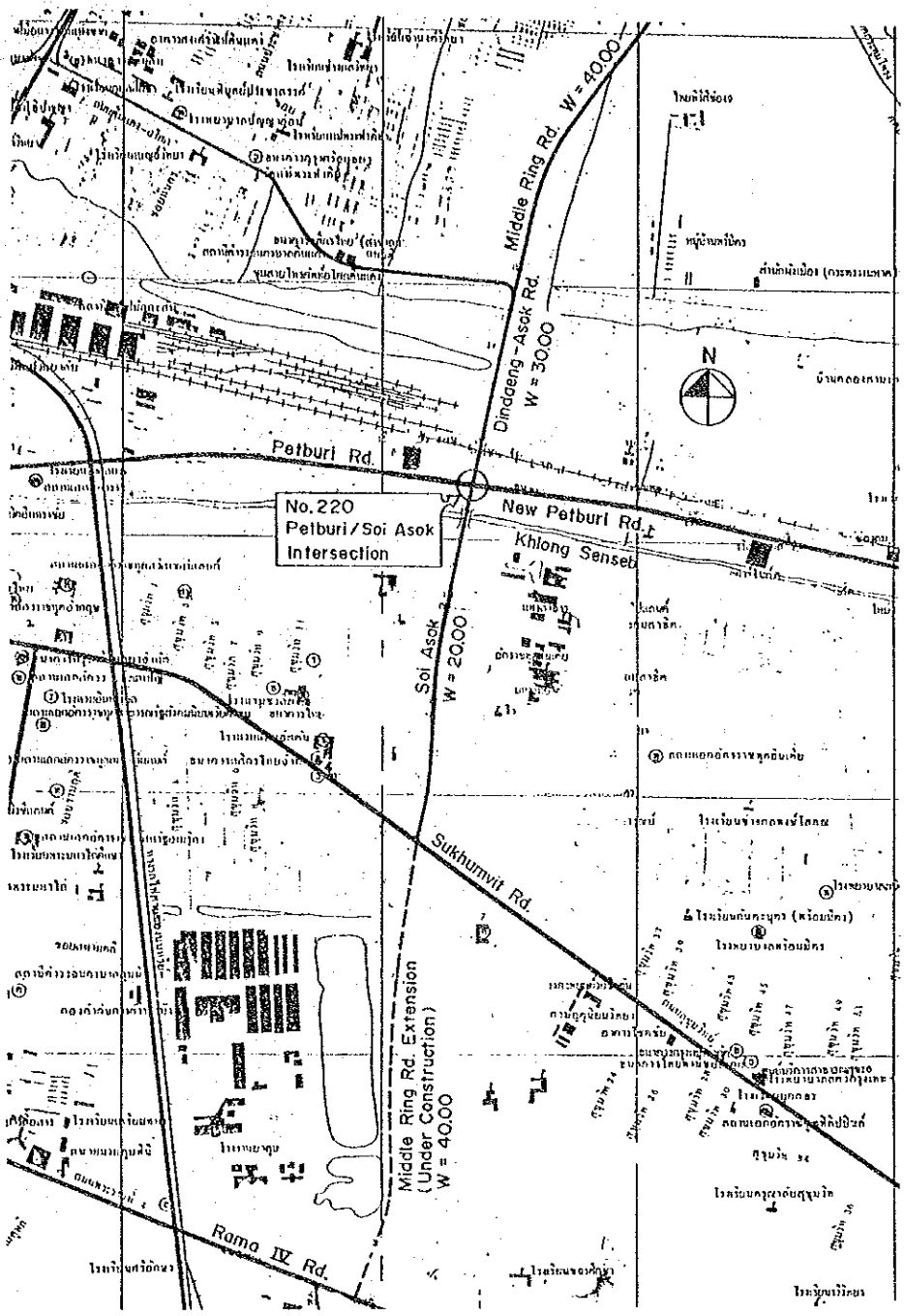


Figure 5.12.1 Petburi Rd./Soi Asok

(3) Constraints (Figure 5.12.3)

- At north west side of the intersection, commercial buildings are located. Therefore, road widening for left-turn is difficult.
- Traffic island in the north west of the intersection is disturbing the traffic flow of the left-turn.
- Soi Asok and the bridge above khlong Sen Sab has only 4 lanes.

(4) Degree of congestion (existing)

Existing conditions are summarized in Table 5.12.2.

Table 5.12.2 Existing Condition of Intersection

Item	Characteristics
1) Morning peak hour	09:00 - 10:00
Max. Traffic	2,311 PCU/hr, west-south bound
2) Evening peak hour	17:00 - 18:00
Max. Traffic	1,955 PCU/hr, west-north bound
3) Saturation degree of intersection	0.897 (Evening)
4) Queue length	
Morning	500 - 600 m, 07:15 - 07:45 south bound
	300 - 600 m, 07:15 - 07:45 west bound
Evening	200 - 400 m, 16:30 - 18:00 west bound
5) Stopped delay	
Evening	5 min. 30 sec. west bound
6) Cycle length	
Morning	300 sec.
Evening	120 sec.

Saturation degree is 0.897 and stopped delay is more than 5 min. The improvement of the intersection is required.

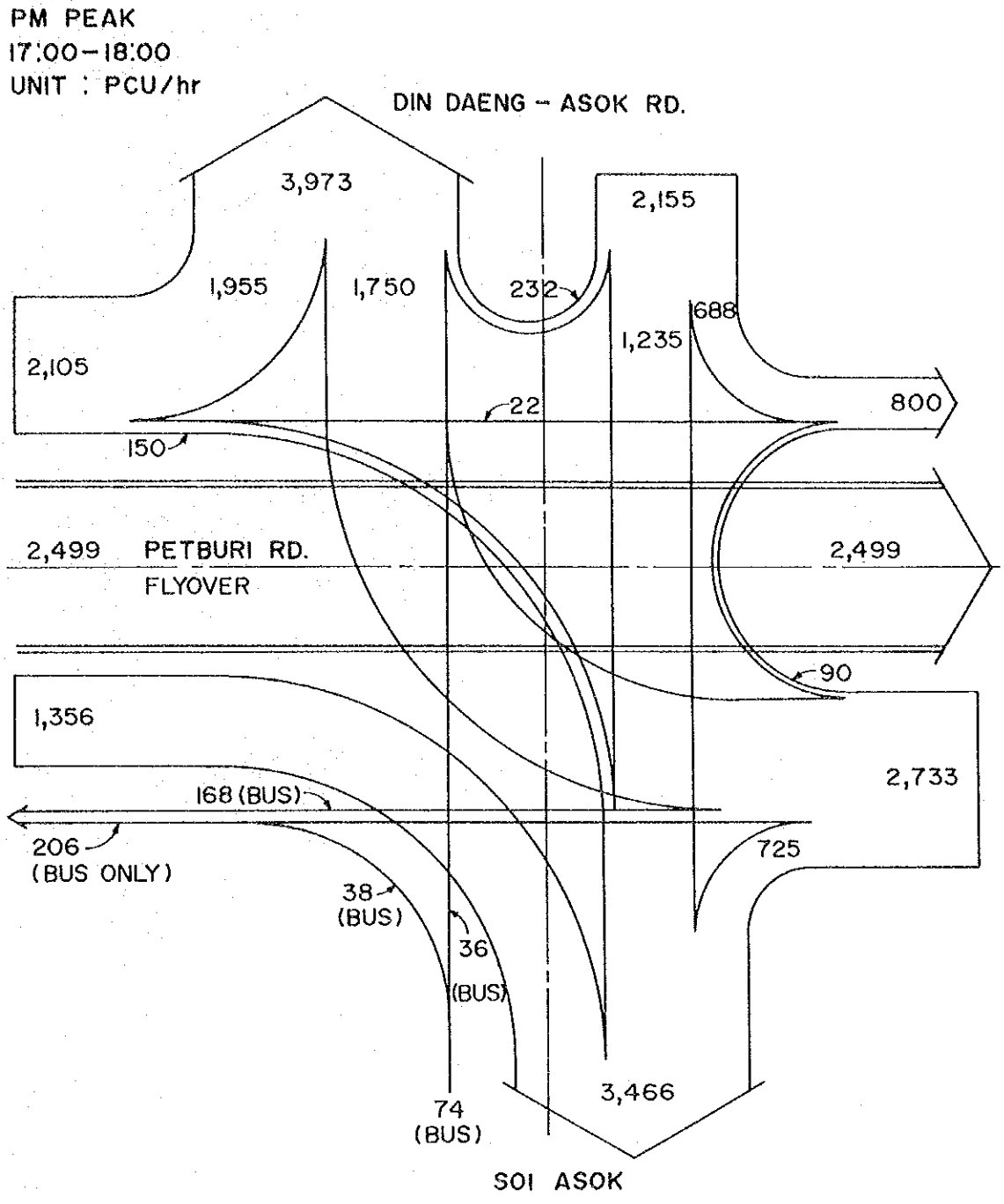


Figure 5.12.2 No. 220
Traffic Volume at Petburi Rd./Soi Asok

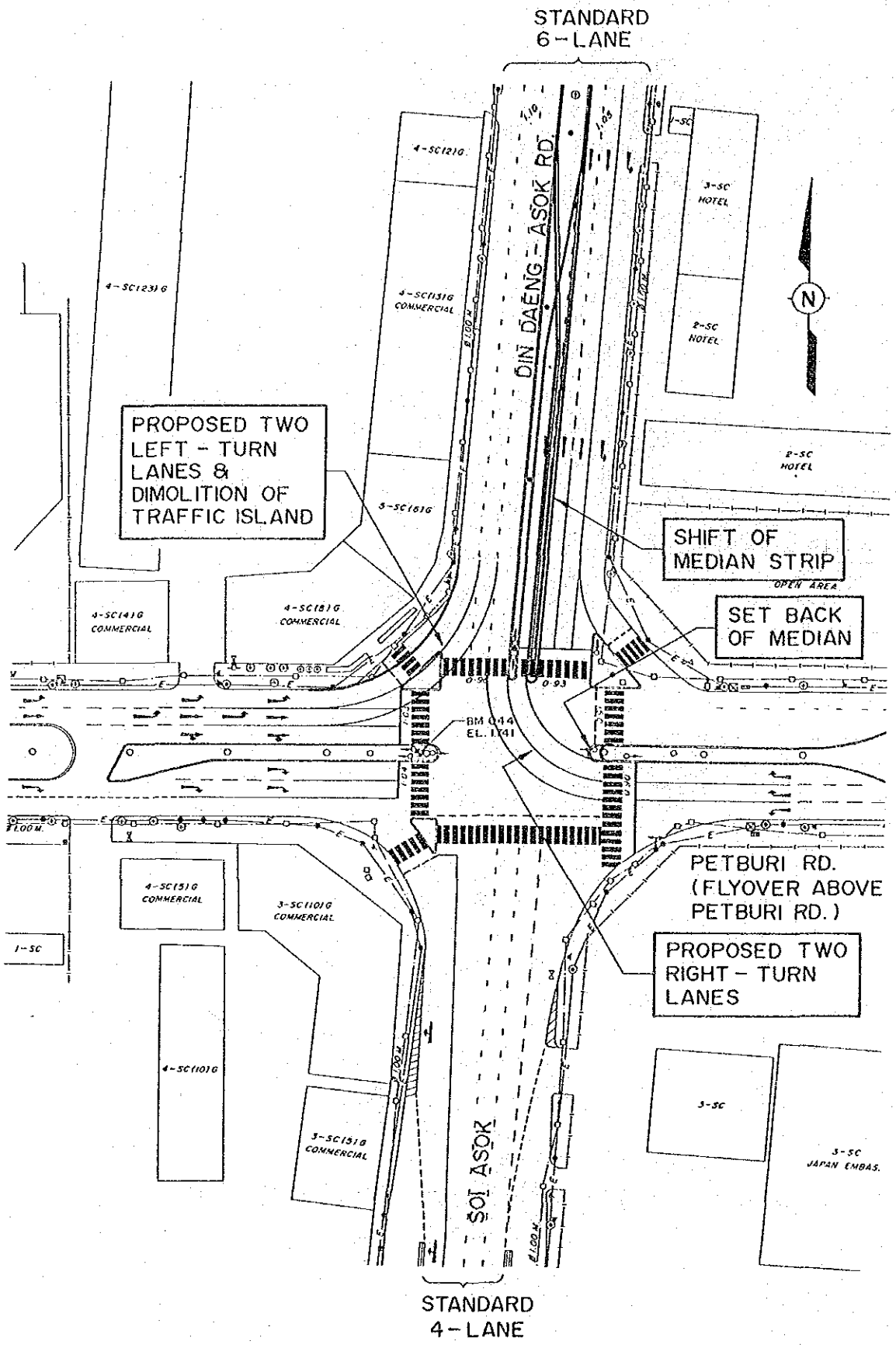


Figure 5.12.3 Proposed Improvement at Petburi/Soi Asok

(5) Cycle time analysis

- Green time is properly arranged to each direction.
- Cycle time in the morning is long, 300 sec.

(6) Planning of improvement alternatives

1) Points of planning

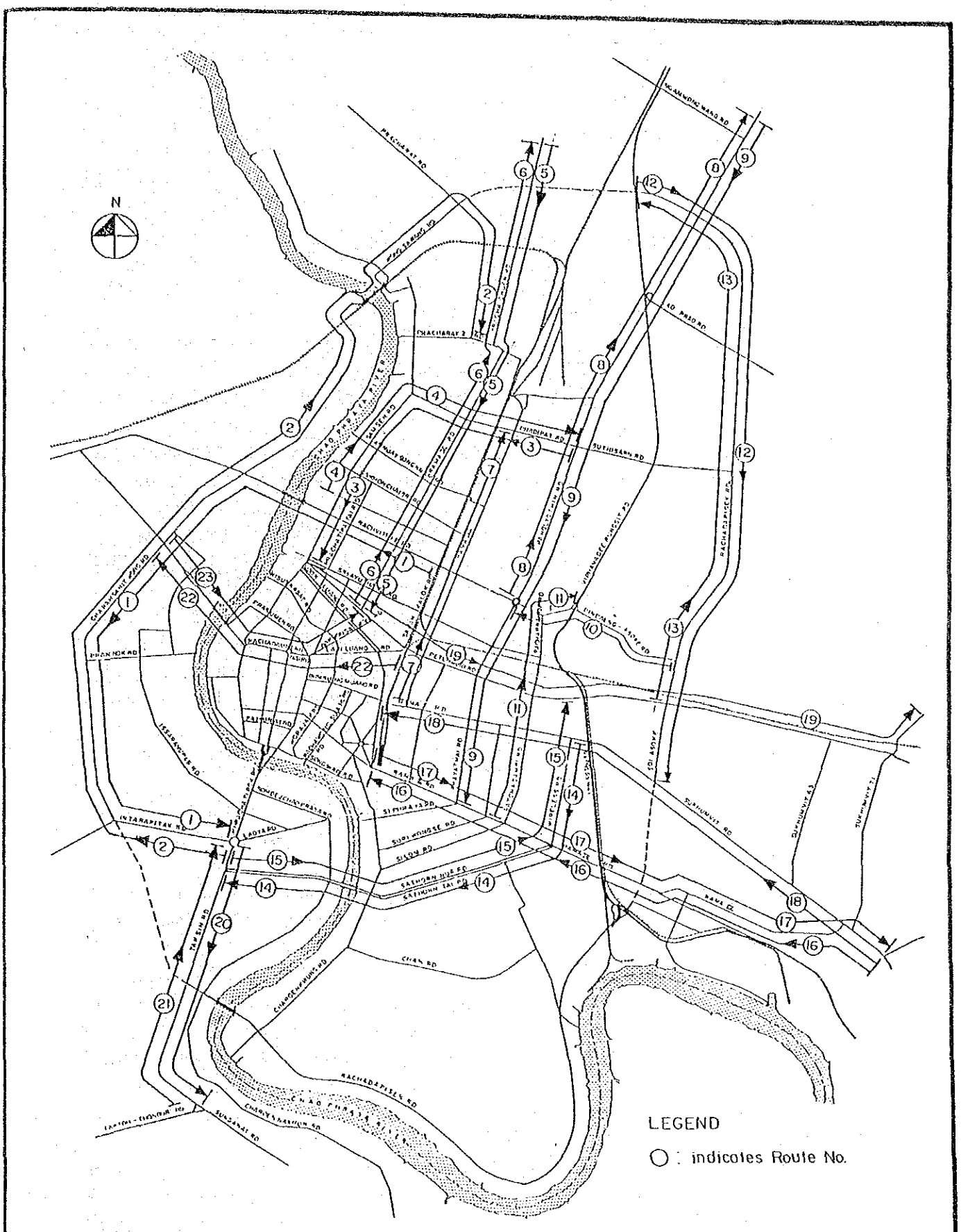
As described in general description, this intersection's improvement should be with that of Middle Ring Road. Therefore, at-grade improvement without land acquisition is planned in this section. A flyover is adready constructed above the intersection.

2) Improvement plan

The problem of this intersection is that two turning movements are interfered each other, left-turn from the west and right-turn from the east (Figure 5.12.2).

To accommodate the two large turning traffics, the west side lane of Dindaeng-Asok road is proposed to be increased from existing 3-lane to 4-lane at the intersection (Figure 5.12.3). For the widening, its median strip is to be shifted to east side. The east through lane is reduced from 3 to 2 but the capacity of traffic is enough. The Dindaeng-Asok road has 6 lanes in standard section. It has enough capacity for the present traffic volume from/to the intersection.

APPENDICES



Routes of Travel Speed Survey

Measurement of Travel Speed

(1) Equipments

Necessary equipments are as follows

1) Passenger car

A usual passenger car is needed as a sample car to measure the travel speed. Any type of car, a truck or a small bus, can be used as far as it is equipped with an accurate odometer and can carry at least one person (preferably two persons) in addition to the driver. However, a passenger car is preferable because it can be driven at the average speed of the circumstantial traffic more easily than other types of motor vehicle.

2) Wrist watch with a second hand

A wrist watch is used to measure the travel time. The watch has to have a second hand so that the travel time can be measured to the accuracy of seconds. A stop watch can be used instead a wrist watch. In this case, time (of the day) of the measurement should be recorded for the later reference.

(2) Measurement

1) Travel speeds should be measured in the section of roads on the both sides of the suspected traffic bottleneck.
2) Travel speed can be obtained by measuring the length of the measurement section, D and the time spent for travelling the measurement section, t.
3) The section of measurement of travel speed should be designed in such a manner that it has a reference point at one end and the suspected bottleneck on the other. When a suspected bottleneck can not be identified or measurement of travel speed is planned over a certain route of the road network, measurement section can be simply set to coincide with road segments between the intersections. The length of the measurement section should be less than 1.5km.
4) Measurement should be carried out during morning and/or evening peak hours so that the suspected bottleneck can be evaluated at its severest traffic congestion.

Fluctuation of Measured Travel Speed and Its Statistical Meaning

(1) Fluctuation of measured travel speed

Condition of traffic congestion in Bangkok greatly varies every day. Therefore, it is desirable to measure travel speed as many times as possible. In this study, however, limitation of time was also important factors to be considered in the planning of the travel speed survey. As the result, travel speeds were measured six times for morning and evening peak hours, respectively, on each route of survey.

In the early stage of the travel speed, travel speeds on a certain route were intensively (approximately 30 times) measured.

As a result, 356 speed data were obtained. Assuming that these speed data are normally distributed, the standard deviation, was calculated to be 10.02 (Km/h). Given this standard deviation, maximum deviation of the mean value of six samples (measured speeds) from the mean value of the population was estimated to be $\pm$ 7.5 Km/h with confidence level of 85%. This implies that if travel speed are measured six times and the average value is calculated, the "true" average value is within the range of (average of six measurement) $\pm$ 7.5 Km/h. (This expression may not be correct in a strictly statistical (or mathematical) sense. However, the authors' intention is to give the better picture of the situation.

(2) Significance of difference of speed between before and after passing intersections

As the measured speeds fluctuate significantly, speed increments (or decrements) should be examined to see if they are meaningful.

The result of statistical examination is shown in Figure 1. According to the figure, the boundary between "significant" and "non-significant" seems to be somewhere between 15 Km/h and 20 Km/h. Hence, if the difference of speeds between before and after passing an intersection is larger than 20 Km/h (or 15 Km/h), this difference can be said not to be due to "fluctuation".

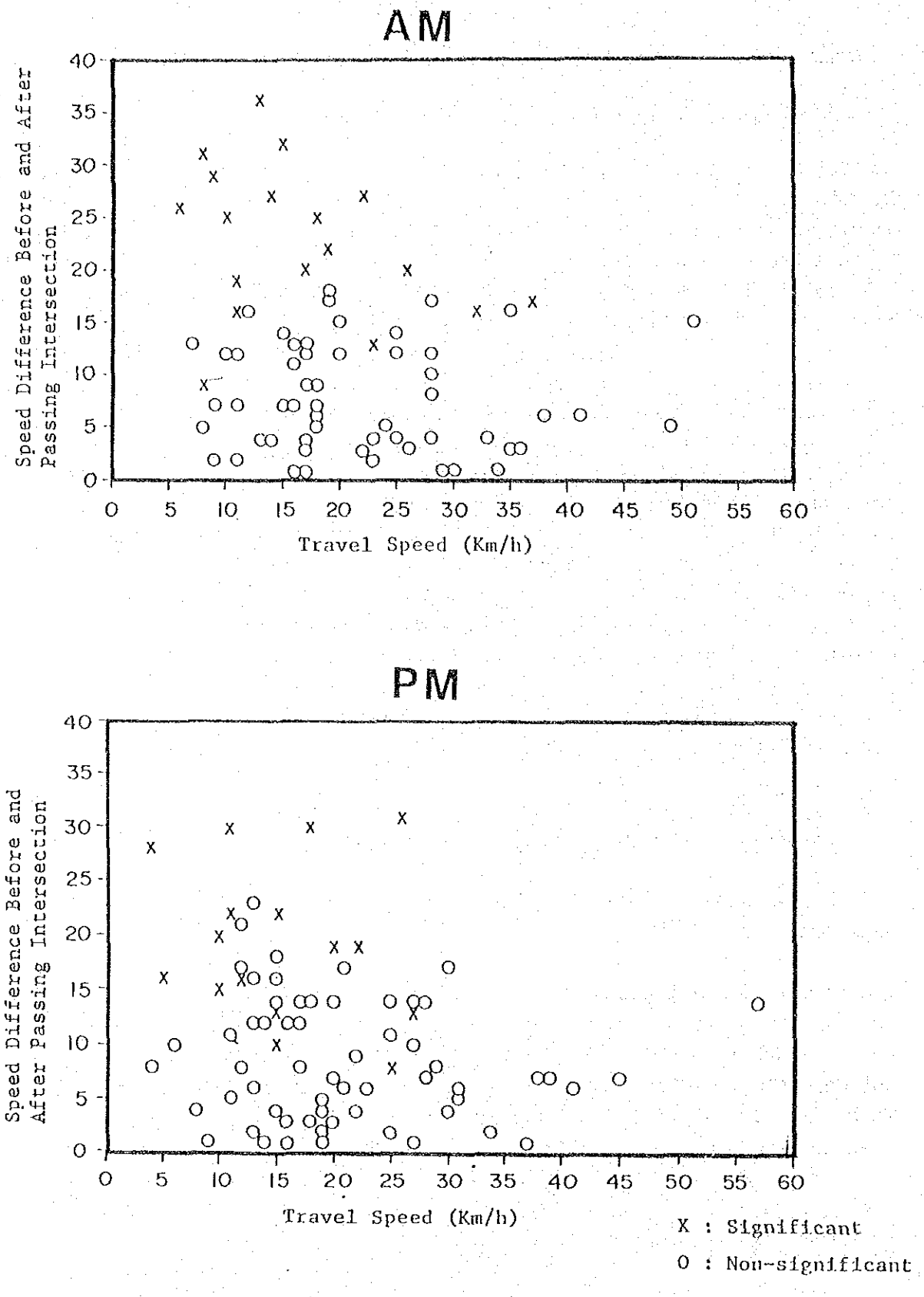


Figure 1 Significant Speed Difference

Correction for measurement section length

In this study, travel speed was measured between major intersections along the survey routes.

The distances of these intersection (hereinafter referred as "measurement section length") range from 0.15 km to 2.2 km as shown in Figure 1.

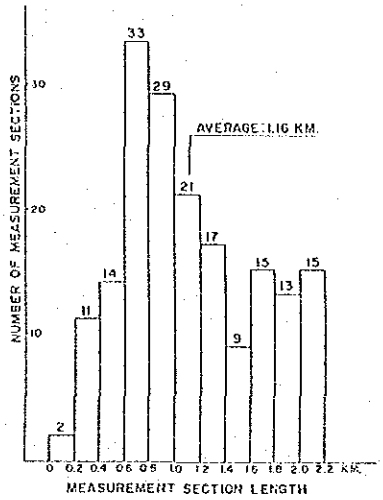


Figure 1 Histogram of Measurement Section Length

This variation of measurement section length give a problem to the proposed rating system, as illustrated in Figure 2.

Let us assume two measurement sections with same length of congestion. In the measurement section with short section length, average travel speed over the measurement section is mainly governed by the travel speed in the congested section, and is measured to be low. On the other hand, in the measurement section with long section length, the average travel speed is measured to be fairly high because of the high speed at non-congested section.

Thus, congestion in the long measurement section has possibility of not being picked up as bottlenecks.

This shortcoming can be compensated by the following procedure.

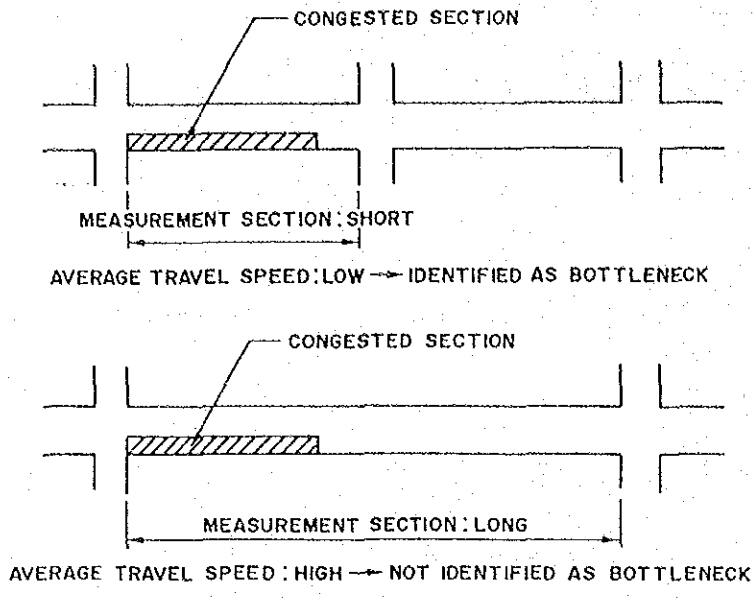


Figure 2 Effect of Difference of Measurement Section Length

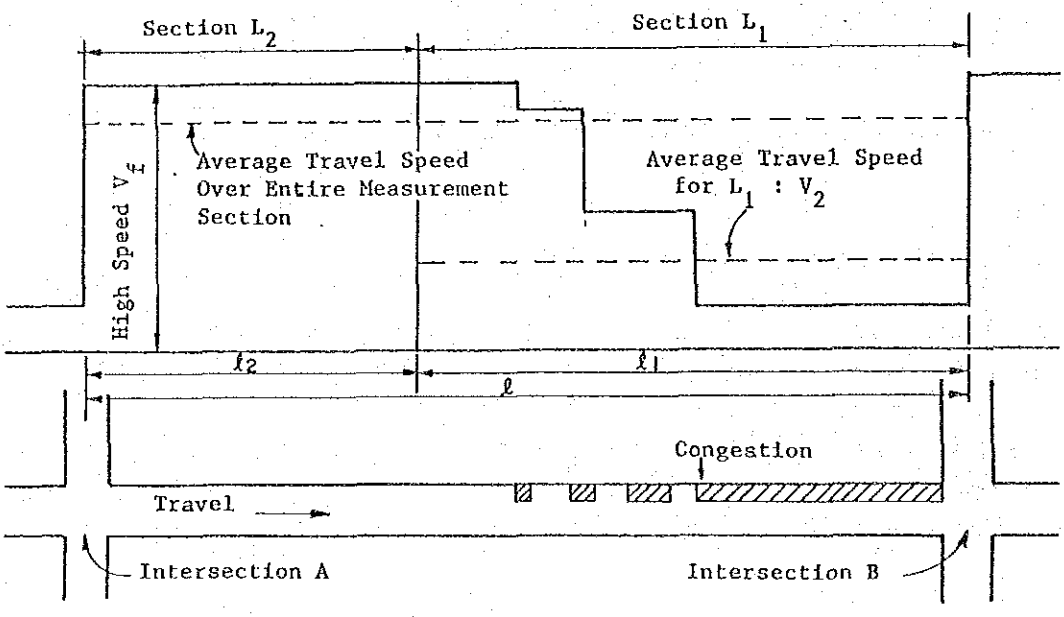


Figure 3 Schematic Curve of Travel Speed

Figure 3 shows the schematic curve of travel speed between intersections. After passing Intersection A, running speed of the vehicle increases to V_f which is usually equal to or close to the "free flow speed" defined in HCM, 1985. Because of this high speed, V_f, the average travel speed is calculated to be relatively high, as shown in the figure. Average travel speed over the section L_1 adjacent to the Intersection B, including congested section, can be calculated as follows,

$$V_c = \frac{\ell_1}{t_{L1}} \qquad \text{.....(1)}$$

Where l_1 is the length of the section including congested section and t_{L1} is the time to travel L_1 section.

Hence,

$$t_{L1} = t - t_{L2}$$
$$= t - \frac{\ell_2}{V_f}$$
$$= t - \frac{\ell - 1}{V_f} \qquad \text{.....(2)}$$

where t is total travel time from Intersection A to Intersection B,
t_{L2} is travel time for L section,
l_2 is length of L section and
V_f is high speed observed immediately after passing Intersection A.

Substituting Equation (2) into (1), we get

$$V_c = \frac{\ell 1}{t - \frac{\ell 2}{V_f}} \qquad \text{.....(3)}$$

In this equation, t is already measured. l_1 can be chosen as such a way as to be close to average measurement section length (1.16 km). Only V_f is unknown. By determining V_f by some method, V_c can be calculated.

For this reason V_f of long measurement length (longer than 1.5 km) were measured.

V_f was measured by recording time and distance at short intervals until the vehicle reach the tail of congested section. V_f thus measured are shown in Table 1 and 2, together with V_c values calculated by assuming l_1 = 1.0 km. Using these V_c values as V_i in the proposed rating method, additional three and four bottlenecks are identified for the morning and evening peak hour, respectively. Those additionally identified bottlenecks are shown in

Figure 4 with asterisk.

The Figure 4 also shows comparison of bottlenecks with police officer's opinion. If more than one officer identified the same congested intersections, they are round marked in the figure. It shows good conincidence with the result of the rating system.

The additional bottlenecks identified here are not included among the locations for preparing improvement plans.

On the contrary to above-described situation, the average travel speed is measured to be low where the measurement section length may be short, even if the congested section is not long. This occurs because the significance of congested section relative to the entire measurement section increases as the measurement section length becomes short, and the average travel speed calculated over the measurement section tends to be governed by the speed in the congested section rather than the high speed before entering the congested section.

This problem, however, is rather easy to handle, compared to the problem seen in the long measurement section. If it is found that a certain bottleneck was identified because of the shortness of the measurement section length, the identified bottlenecks can be discarded.

Table 1 Vf and Vc in Long Measurement Sections (AM)

Rt. No.	Measure-ment Section Sta.- Sta.	Length (Km)	Vf (Km/h)	V_c (Km/h)	Average Travel Speed Over Enter Section V_A (Km/h)
1	3 - 4	1.66	49.1	32.6	38.8
	4 - 5	1.87	38.2	19.1	25.5
2	6 - 7	1.87	48.2	8.29	17.0
	7 - 8	3.68	53.3	6.3	20.2
	9 -10	1.78	55.5	60.8	58.2
5	1 - 2	2.25	49.7	32.6	42.0
	2 - 3	1.67	52.1	27.9	39.7
	3 - 4	1.82	53.3	28.6	37.6
6	7 - 8	1.82	42.7	49.2	48.9
	8 - 9	1.67	47.7	28.9	40.7
	9 -10	2.25	40.2	38.3	40.6
8	5 - 6	1.84	51.9	29.9	40.1
	6 - 7	1.89	37.6	37.5	39.7
9	3 - 4	1.89	45.0	8.28	20.4
	4 - 5	1.84	43.3	29.9	37.4
12	2 - 3	2.77	60.0	21.8	48.1
	3 - 4	1.71	60.9	39.2	48.2
	5 - 6	2.79	60.5	13.8	41.6
13	2 - 3	2.79	61.0	25.8	43.4
	4 - 5	1.71	57.0	23.5	34.9
	5 - 6	2.77	71.7	30.8	51.0
14	6 - 7	1.87	74.8	39.2	54.2
15	1 - 2	1.87	71.1	31.0	45.5
19	10-11	2.35	49.8	32.4	41.4
20	2 - 3	2.01	49.1	41.0	46.3
21	3 - 4	2.01	42.7	30.8	36.5
22	6 - 7	1.53	52.7	27.7	41.3
23	2 - 3	1.63	56.6	12.5	20.1

Table 2 Vf and Vc in Long Measurement Sections (PM)

Rt. No.	Measurement Section Sta. - Sta.	Length (Km)	Vf (Km/h)	V_c (Km/h)	Average Travel Speed Over Enter Section, V_A (Km/h)
1	3 - 4	1.66	49.1	14.6	20.9
	4 - 5	1.87	38.2	19.9	27.0
2	6 - 7	1.87	48.2	10.2	17.9
	7 - 8	3.68	53.3	12.9	32.3
	9 -10	1.78	55.5	31.1	39.2
5	1 - 2	2.25	49.7	38.5	44.6
	2 - 3	1.67	52.1	34.7	40.1
	3 - 4	1.82	53.3	35.1	42.1
6	7 - 8	1.82	42.7	30.8	37.0
	8 - 9	1.67	47.7	22.1	31.6
	9 -10	2.25	40.2	20.7	30.7
8	5 - 6	1.84	51.9	15.6	26.9
	6 - 7	1.89	37.6	32.4	36.5
9	3 - 4	1.89	45.0	11.8	22.4
	4 - 5	1.84	43.3	36.7	41.8
12	2 - 3	2.77	60.0	20.3	37.6
	3 - 4	1.71	60.9	30.0	44.4
	5 - 6	2.79	60.5	30.7	47.4
13	2 - 3	2.79	61.0	26.43	47.0
	4 - 5	1.71	57.0	13.9	26.3
	5 - 6	2.77	71.71	40.3	57.5
14	6 - 7	1.87	74.82	12.3	39.5
15	1 - 2	1.87	71.1	46.7	61.9
19	10-11	2.35	49.8	8.75	22.7
20	2 - 3	2.01	49.05	15.4	22.0
21	3 - 4	2.01	42.67	31.1	38.6
22	6 - 7	1.53	52.67	31.3	38.8
23	2 - 3	1.63	56.64	27.5	40.9

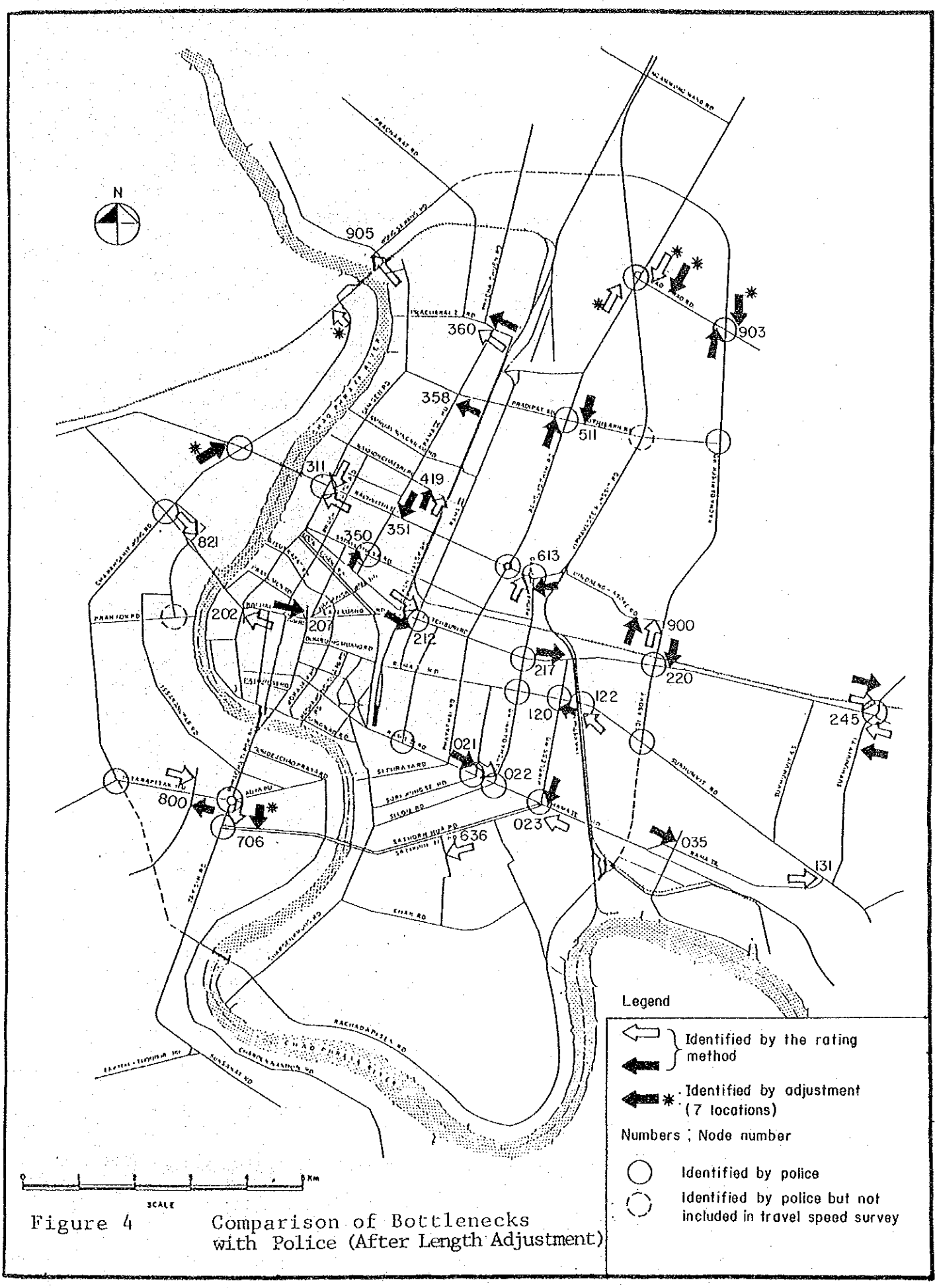


Figure 4 Comparison of Bottlenecks with Police (After Length Adjustment)

Reasons of "Un-selected" 17 intersections

Group D

Characteristics: Improvement plan already exists or under study (5 locations).

12) Sathon/Taksin Rd. (No.706)
The extension of Sathon Rd. to Middle Ring Rd. and Outer Ring Rd. has been planned by PWD. The study includes the improvement of the intersection.

13) Ratchawithi/Sam Sen Rd. (No.311)
An existing 2-lane bridge at Khlong Sam Sen to the north of the intersection is one of the north of the intersection is one of the causes of traffic congestion. Widening of the bridge to 4-lane one is under planning by BMA.

14) Sathon Rd./Soi St. Louis (No.636)
BMA has a plan of widening and realignment of Soi St. Louis, from existing 2-lane to 4-lane.

15) Phetchakasem/Thoet Thai Rd. (No.800)
BMA has already planned to widen the existing bridge at Khlong Bangkok Yai from existing 4-lane to 6-lane. When the missing link of Middle Ring Rd. between Phetchakasem and Taksin Rd. is constructed, the traffic volume will decrease.

16) Wongsawang/Pibul Songkhram Rd. (No.905)
The congestion is considered to be caused by the existing 2-lane Rama VI bridge. A new Rama VI bridge of 6-lane is now under detail design and the construction is expected to be completed in 1990.

Group E

Characteristics: The intersections are located beside Khlong with each arch-shaped bridge, along Rama V Rd. (3 locations).

17) Thahan/Rama V Rd. (No.358)

18) Ratchawithi/Rama V Rd. (No.351) and

19) Si Ayutthaya/Rama V Rd. (No.350)
Benefit/Cost ratio is estimated small and policy coordination with DDS is required.

Group F

Characteristics: At the time of traffic survey, the construction was in progress at the site or near the site (2 locations).

20) New Arun Ammarin/Arun Ammarin Rd. (No.821)
Widening of approach lanes by two were completed by BMA in February 1986.

21) Nakhonchaisi/Swankhalok Rd. (No.419)
At the time of traffic survey, this intersection was used as a detour road for the construction of a bridge at Khlong Sam Sen in Rama VI Rd. The bridge was completed and the bottleneck was solved.

Group G

Characteristics: One of continuous intersections are selected for planning. The others can be planned according to the typical plan (2 locations).

22) Rama IV/Suriwong Rd. (No.021) and

23) Rama IV/Silom Rd. (No.022)
The Sathon Rd. intersection is selected for detail planning. The above two will be studied together because they are closely located, but excluded from the detail planning for the Sathon is selected as a typical.

Group H

Characteristics: Due to other various reasons, the intersections are not selected.

24) Lat Phrao/Middle Ring Rd. (No.903)
Existing traffic volume is not so much compared with other intersections.

25) Ratchadamnoen Klang/Ratchadamnoen Nok Rd. (No.207)
Existing 8-lane bridge seems to have not enough capacity for a big traffic volume. But the bridge is a historical one and needs longer study time due to its complexity.

26) Sukhumvit/Witthayu Rd. (No.120)

27) Sukhumvit/Expressway Ramp (No.122) and

28) Petburi/Witthayu Rd. (No.217)
The three intersections were located near the Expressway on and off ramps and SRT railway. Coordination with other agencies necessitates a longer study period.

Overhead, Profit and Tax as a percentage of Construction Cost

No.	Net Construction Cost (Baht)	OPT (%)
1	downwards 50,000	33.77
2	50,000 – 100,000	30.64
3	100,000 – 300,000	27.52
4	300,000 – 500,000	24.40
5	500,000 – 800,000	23.36
6	800,000 – 1,000,000	22.32
7	1,000,000 – 2,000,000	21.28
8	2,000,000 – 5,000,000	20.23
9	5,000,000 – 10,000,000	19.19
10	10,000,000 – 20,000,000	18.15
11	20,000,000 – 40,000,000	17.11
12	40,000,000 – 60,000,000	16.38
13	60,000,000 – 100,000,000	15.55
14	upwards 100,000,000	14.51

Source: Cost Estimation Section, Engineering Design Sub-Division, Design Division, Department of Public Works, BMA

Unit Construction Cost			
Item	Unit	Cost (Baht)	Remarks
Flyover			
- Main Span $50^{m} < L \leqq 60^{m}$	m^2	21,000	Continuous Box Girder
$40 < L \leqq 50$	m^2	18,000	- ditto -
$30 < L \leqq 40$	m^2	16,000	- ditto -
$20 < L \leqq 30$	m^2	8,000	Prestressed Concrete Pretension Girder
- Side Span	m^2	8,000	RC continuous slab girder
- Approach Structure	m^2	4,200	
Underpass			
- Tunnel	* m^3	2,500	Facilities are included
- Depressed Structure	* m^3	1,500	- ditto -
- Basin	* m^3	2,200	- ditto -
- Pedestrian underpass	m	150,000	4 m. wide
Bridge	m^2	8,000	
- River Crossing $L \leqq 25^{m}$	m^2	8,000	
- Pedestrian Bridge	m	55,000	3 m. wide
Pavement			
- Carriageway	m^2	600	$t = 0.25^{m}$
- Sidewalk	m^2	300	Interrock surface
Pedestrian Island	m^2	50	
Demolition			
- Existing Flyover	m^2	1,100	
- Buidling	m^2	200	
- Wooden House	m^2	50	
- Pedestrian Bridge	m^3	2,000	
- Sidewalk	m^2	200	
Traffic Signal	set	400,000	

Note : *excavated Volume

Unit Rate of Land Acquisition Cost

Node No.	Name of Intersection	Name of Road	Unit Rate (Baht/m^2)	Land Use
202	Ratchadamnoen Klang/ Ratchadamnoen Nai Rd.	Rachini	10,000	Government Institution Area
613	Dindaeng/ Ratchaprarop Rd.	Dindaeng	7,500	Residential/ Commercial Area
511	Pradipat/ Phahon Yothin Rd.	Phahon Yothin	10,000	Commercial Area
212	Petburi/ Rama VI Rd.	Rama VI	10,000	Commercial Area
630	Pracharat II/ Pracha Chuen Rd.	Khan Khlong Prapa	2,000	Residential Area
131	Sukhumvit/ Rama IV Rd.	Sukhumvit (within 40 m from R/W)	8,750	Commercial Area
		Sukhumvit (beyond 40 m)	2,000	
245	New Petburi/ Ramkhamheng Rd.	Phatthanakan/ Ramkhamheng (within 40 m from R/W)	8,750	Commercial Area
		Phatthanakan/ Ramkhamheng (beyond 40 m)	2,000	
035	Rama IV/ Kasemrat Rd.	Rama IV (within 40 m from R/W)	7,000	Residential Area
		Rama IV (beyond 40 m)	2,000	

Unit Rate of Compensation Cost

Unit : Baht per sq.m.

1-2 Storey, wood, residential, poor condition	1,500
Brick/concrete, commercial or residential (multi family) good condition	3,000
Brick/concrete, commercial or residential (multi family) poor condition	2,000
Wood, commercial, industrial or warehouse, poor condition	1,500
Brick/concrete, commercial industrial or warehouse, good condition	3,000
Brick/concrete, commercial, industrial or warehouse, poor condition	2,000
1-2 Storey, concrete/brick, residential, poor condition	2,000

Land Acquisition Cost

Description		Unit Rate (Baht per sq.m)	Area (sq.m)	Acquisition Cost (Million Baht)
Ratchadamnoen Klang/ Ratchadamnoen Nai	Alt - 3	10,000	480	4.8
Dindaeng/Ratchaprarop	Alt - 1 Alt - 2	7,500	330	2.5
Pradipat/Phahon Yothin	Alt - 1	10,000	1,780	17.8
Petburi/Rama VI	Alt - 1	10,000	2,180	21.8
Pracharat II/ Pracha Chuen	Alt - 1	2,000	2,810	5.6
	Alt - 2	2,000	11,880	23.8
Sukhumvit/Rama IV	Alt - 1	8,750	3,360	29.4
		2,000	12,570	25.1
		TOTAL	15,930	54.5
	Alt - 2	8,750	3,600	31.5
		2,000	10,200	20.4
		TOTAL	13,800	51.9
Petburi/Ramkhamheng	Alt - 1	8,750	210	1.8
		4,500	430	1.9
		TOTAL	640	3.7
	Alt - 2	8,750	180	1.6
		4,500	550	2.5
		TOTAL	730	4.1
Rama IV/Kasemrat		7,000	2,100	14.7
		2,000	3,540	7.1
		TOTAL	5,640	21.8

Compensation Cost

Description		Wooden, residential bldg. (sq.m.)	Brick/concrete commercial or residential bldg. poor condition (sq.m.)	Brick/concrete commercial or residential bldg. good condition (sq.m.)	Total (Million Baht)
Unit rate (Baht per sq.m)		1,500	2,000	3,000	
Pradipat/Phahon Yothin	Alt - 1	-	-	43,000	129.0
Petburi/Rama VI	Alt - 1	-	-	8,500	25.5
Pracharat II/ Pracha Chuen	Alt - 1	4,220	130	-	6.6
	Alt - 2	5,700	650	-	9.9
Sukhumvit/Rama IV	Alt - 1	670	3,570	6,420	27.4
	Alt - 2	330	5,130	14,520	54.4
Rama IV/Kasemrat		-	-	1,850	5.6

Construction Quantity (1)

	Item	Unit	Alt 1	Alt 2	Alt 3
Rama IV/Siphraya -Sathon	Flyover				
	Main span (L=60 m)	m^2	-	6,800	6,800
	Main span (L=50 m)	m^2	-	-	1,240
	Side span	m^2	-	6,400	9,260
	Approach structure	m^2	-	1,770	1,620
	Pedestrian underpass	m	-	160	160
	Pavement				
	Carriageway	m^2	-	680	930
	Island	m^2	-	7,000	9,570
	Demolition				
	Sidewalk	m^2	-	260	260
	Traffic signal	set	-	4	6
Ratchadamnoen Klang/ Ratchadamnoen Nai	Underpass				
	Tunnel	$*m^3$	-	-	19,400
	Depressed structure	$*m^3$	-	-	21,000
	Basin	$*m^3$	-	-	480
	Pedestrian underpass	m	-	35	25
	Pavement				
	Carriageway	m^2	1,900	1,560	3,250
	Sidewalk	m^2	-	-	380
	Island	m^2	2,150	2,700	2,960
	Demolition				
	Sidewalk	m^2	55	85	320
	Traffic signal	set	5	4	5
Dindaeng/Ratchaprarop	Flyover				
	Mainspan (L=50 m)	m^2	-	960	-
	Mainspan (L=40 m)	m^2	640	-	-
	Side span	m^2	1,920	1,600	-
	Approach structure	m^2	620	760	-
	Underpass				
	Tunnel	$*m^3$	3,080	3,080	-
	Depressed structure	$*m^3$	17,280	17,280	-
	Basin	$*m^3$	400	400	-
	Pavement				
	Carriageway	m^2	2,280	1,820	-
	Sidewalk	m^2	410	590	-
	Island	m^2	4,730	4,810	-
	Demolition				
	Sidewalk	m^2	410	870	-
	Traffic signal	set	2	3	-

Note : * excavated volume

Construction Quantity (2)

	Item	Unit	Alt 1	Alt 2	Alt 3
Pradipat/Phahon Yothin	Flyover				
	Main span (L=50 m)	m^2	-	990	1,240
	Side span	m^2	-	2,880	3,600
	Approach structure	m^2	-	850	1,060
	Pedestrian bridge	m	110	-	-
	Pavement				
	Carriageway	m^2	1,590	450	450
	Sidewalk	m^2	1,780	-	-
	Island	m^2	-	2,750	3,410
	Demolition				
	Building	m^3	43,000	-	-
	Pedestrian bridge	m^2	73	-	-
	Sidewalk	m^2	1,590	-	-
	Traffic signal	set	4	2	2
Petburi/Rama VI	Flyover				
	Main span (L=35 m)	m^2	-	280	-
	Side span	m^2	-	3,580	-
	Approach structure	m^2	-	250	-
	Pedestrian bridge	m	64	-	-
	Pavement				
	Carriageway	m^2	1,810	-	-
	Sidewalk	m^2	1,620	-	-
	Island	m^2	450	2,970	-
	Demolition				
	Flyover	m^3	-	1,230	-
	Pedestrian bridge	m^2	12	-	-
	Building	m^2	8,370	-	-
	Sidewalk	m^2	1,030	-	-
	Traffic signal	set	2	1	-
Pracharat II/Prachachuen	Bridge	m^2	290	920	-
	Pavement				
	Carriageway	m^2	3,800	9,890	-
	Sidewalk	m^2	3,890	7,710	-
	Island	m^2	-	1,870	-
	Demolition				
	Building	m^2	130	650	-
	Wooden house	m^3	4,220	5,700	-
	Pedestrian bridge	m	19	19	-
	Traffic signal	set	4	3	-

Construction Quantity (3)

	Item	Unit	Alt 1	Alt 2	Alt 3
Sukhumvit/Rama IV	Flyover				
	Main span (L=34 m)	m^2	-	-	580
	Side span	m^2	-	-	5,420
	Approach structure	m	-	-	950
	Pavement				
	Carriageway	m^2	9,290	8,140	40
	Sidewalk	m	5,520	4,780	-
	Island	m^2	1,330	1,150	3,810
	Demolition				
	Sidewalk	m^2	220	340	40
	Traffic signal	set	4	4	-
Petburi/Ramkhamheng	Flyover				
	Main span (L=35 m)	m^2	-	320	-
	Side span	m^2	-	2,160	-
	Approach structure	m	-	900	-
	Bridge				
	River crossing	m^2	640	640	-
	Pedestrian bridge	m	185	-	-
	Pavement				
	Carriageway	m^2	2,520	1,270	-
	Sidewalk	m	1,040	790	-
	Island	m^2	920	3,080	-
	Demolition				
	Sidewalk	m^2	2,050	970	-
	Signal	set	4	5	-
Rama IV/Kasemrat	Pavement				
	Carriageway	m^2	4,580	-	-
	Sidewalk	m	1,670	-	-
	Island	m^2	510	-	-
	Demolition				
	Building	m^2	1,850	-	-
	Sidewalk	m	460	-	-
	Traffic signal	set	2	-	-
Petburi/ Soi Asok	Pavement				
	Carriageway	m^2	124	-	-
	Sidewalk	m	22	-	-
	Island	m^2	94	-	-

Construction Cost (1)

Unit : 1,000 Baht

	Item	Alt 1	Alt 2	Alt 3
Rama IV/Siphraya - Sathon	Flyover			
	Main span (L=60 m)	-	142,800	142,800
	Main span (L=50 m)	-	-	22,320
	Side span	-	51,200	74,080
	Approach structure	-	7,420	6,800
	Pedestrian underpass	-	24,000	24,000
	Pavement			
	Carriageway	-	410	660
	Island	-	350	480
	Demolition			
	Sidewalk	-	50	50
	Traffic signal	-	1,600	1,200
	TOTAL	-	227,830	272,290
Ratchadamnoen Klang/ Ratchadamnoen Nai	Underpass			
	Tunnel	-	-	48,500
	Depressed structure	-	-	31,500
	Basin	-	-	1,060
	Relocation of utilities	-	-	6,250
	Pedestrian underpass	-	5,250	3,750
	Pavement			
	Carriageway	1,140	940	1,950
	Sidewalk	-	-	110
	Island	110	130	150
	Demolition			
	Sidewalk	10	20	60
	Traffic signal	2,000	1,600	2,000
	TOTAL	3,260	7,940	95,330
Dindaeng/Ratchaprarop	Flyover			
	Main span (L=50 m)	-	17,280	-
	Main span (L=40 m)	7,680	-	-
	Side span	15,360	12,800	-
	Approach structure	2,600	3,190	-
	Underpass			
	Tunnel	7,700	7,700	-
	Depressed structure	25,920	25,920	-
	Basin	880	880	-
	Pavement			
	Carriageway	1,370	1,090	-
	Sidewalk	180	180	-
	Island	240	240	-
	Demolition			
	Sidewalk	80	170	-
	Traffic signal	800	1,200	-
	TOTAL	62,810	70,650	-

Construction Cost (2)

Unit : 1,000 Baht

	Item	Alt 1	Alt 2	Alt 3
Pradipat/Phahon Yothin	Flyover			
	Main span (L=50 m)	-	17,980	22,320
	Side span	-	23,040	28,800
	Approach structure	-	3,570	4,450
	Pedestrian bridge	6,050	-	-
	Pavement			
	Carriageway	950	270	270
	Sidewalk	530	-	-
	Island	-	140	170
	Demolition			
	Building	8,600	-	-
	Pedestrian bridge	510	-	-
	Sidewalk	320	-	-
	Traffic signal	1,600	800	800
	TOTAL	18,560	45,640	56,810
Petburi/Rama VI	Flyover			
	Main span (L=35 m)	-	2,240	-
	Side span	-	28,640	-
	Approach structure	-	1,050	-
	Pedestrian bridge	350	-	-
	Pavement			
	Carriageway	1,090	-	-
	Sidewalk	490	-	-
	Island	20	150	-
	Demolition			
	Flyover	-	1,350	-
	Pedestrian bridge	20	-	-
	Building	1,670	-	-
	Sidewalk	210	-	-
	Traffic signal	800	400	-
	TOTAL	4,650	33,830	-
Pracharat II/Prachachuen	Bridge	2,320	7,360	-
	Pavement			
	Carriageway	2,280	5,930	-
	Sidewalk	1,160	2,310	-
	Island	-	90	-
	Demolition			
	Building	30	130	-
	Wooden house	210	290	-
	Pedestrian bridge	40	40	-
	Traffic signal	1,600	1,200	-
	TOTAL	7,640	17,350	-

Construction Cost (3)

Unit : 1,000 Baht

	Item	Alt 1	Alt 2	Alt 3
Sukhumvit/Rama IV	Flyover			
	Main span (L=34 m)	-	-	4,640
	Side span	-	-	43,360
	Approach structure	-	-	3,990
	Pavement			
	Carriageway	5,570	4,880	20
	Sidewalk	1,660	1,430	-
	Island	70	60	190
	Demolition			
	Sidewalk	40	70	10
	Traffic signal	1,600	1,600	-
	TOTAL	8,940	8,040	52,210
Petburi/Ramkhamheng	Flyover			
	Main span (L=35 m)	-	2,560	-
	Side span	-	17,280	-
	Approach structure	-	3,780	-
	Bridge			
	River crossing	5,120	5,120	-
	Pedestrian bridge	10,180	-	-
	Pavement			
	Carriageway	1,510	760	-
	Sidewalk	310	240	-
	Island	50	150	-
	Demolition			
	Sidewalk	410	190	-
	Signal	1,600	2,000	-
	TOTAL	19,180	32,080	-
Rama IV/Kasemrat	Pavement			
	Carriageway	2,750	-	-
	Sidewalk	500	-	-
	Island	30	-	-
	Demolition			
	Building	370	-	-
	Sidewalk	90	-	-
	Traffic Signal	800	-	-
	TOTAL	4,540	-	-
Petburi/ Soi Asok	Pavement			
	Carriageway	74.4	-	-
	Sidewalk	6.6	-	-
	Island	4.7	-	-
	TOTAL	86	-	-

Vehicle Operating Costs (Baht/1000 kms)

Speed Kph	Motor-cycle	Car	Pick-Up	Taxi	Truck	Bus	Weighted average
5	860	3459	2518	1962	6590	9326	2680
10	791	3095	2252	1734	5356	7455	2357
15	685	2721	1938	1528	4692	6306	2052
20	617	2471	1753	1410	4293	5639	1861
25	568	2282	1621	1325	4067	5198	1724
30	533	2142	1525	1268	3878	4881	1624
35	513	2040	1473	1233	3770	4684	1559
40	495	1955	1433	1204	3684	4530	1505
45	482	1892	1404	1185	3664	4439	1468
50	475	1849	1390	1180	3632	4367	1445
55	470	1811	1374	1175	3627	4366	1426
60	465	1814	1364	1174	3635	4370	1424
65	468	1824	1364	1179	3676	4385	1430
70	468	1827	1362	1179	3720	4501	1436
75	472	1840	1372	1190	3807	4590	1450
80	480	1850	1392	1204	3951	4728	1470
85	486	1880	1418	1220	-	-	-
90	496	1910	1451	1242	-	-	-
Vehicular Composition	0.250	0.341	0.218	0.133	0.024	0.034	1.000

Source: SSES Study, 1986

Remarks: Weighted Average; estimated by weighted average of vehicular composition

Road Improvement Plan

Summary of Economic Evaluation

(Unit: Cost & Benefit; Baht in million)

Plan No.	Imp. Alt. No.	Improvement Location (Intersection)	Const. Period (Year)	Initial Cost	O/M Cost (per year)	Evaluation Period: 10 Years							Evaluation Period: 20 Years						
						Cost (C)	Benefit (B)			Evaluation			Cost (C)	Benefit (B)			Evaluation		
							Time Saving	VOC Saving	Total Benefit	Net Benefit (B-C)	B/C	IRR		Time Saving	VOC Saving	Total Benefit	Net Benefit (B-C)	B/C	IRR
P-1	#2	Rama IV / Si Phraya - Sathon	2	302.5	3.7	318.07	771.51	68.66	840.17	522.10	2.64	0.235	336.49	1395.37	124.19	1519.56	1183.07	4.52	0.269
P-1	3	Rama IV / Si Phraya - Sathon	2	361.7	3.9	377.09	912.86	81.24	994.10	617.01	2.64	0.233	396.51	1651.03	146.94	1797.97	1401.46	4.53	0.268
P-2	3	Rachadamnoen Klang / Nai	3	134.4	4.2	150.14	133.83	12.58	146.41	-3.74	0.98	0.031	171.05	260.75	24.51	285.26	114.21	1.67	0.107
P-3	2	Din Daeng / Rachaprarop	3	98.5	3.7	113.30	212.52	39.74	252.26	138.96	2.23	0.189	131.72	414.07	77.43	491.50	359.78	3.73	0.234
P-4	3	Pradipat / Phahon Yothin	2	76.7	1.1	81.64	168.40	64.50	232.90	151.25	2.85	0.255	87.12	304.57	116.65	421.22	334.10	4.83	0.287
P-5	#1	Petburi / Rama VI	1	58.2	0.9	64.60	75.34	25.77	101.11	36.51	1.57	0.139	69.08	128.10	43.81	171.91	102.83	2.49	0.186
P-5	2	Petburi / Rama VI	2	45.6	1.2	51.90	179.47	61.38	240.85	188.94	4.64	0.397	57.87	324.59	111.01	435.60	377.73	7.53	0.415
P-6	1	Pracharat II / Pracha Chuen	1	24.1	0.5	27.65	26.86	10.50	37.36	9.71	1.35	0.107	30.14	45.67	17.85	63.52	33.38	2.11	0.160
P-7	3	Sukhumvit / Rama IV	2	70.4	1.5	77.96	156.17	20.30	176.47	98.51	2.26	0.207	85.42	282.45	36.71	319.16	233.74	3.74	0.245
P-8	1	Petburi / Ramkhamheng	1	30.5	1.0	37.61	288.87	121.04	409.91	372.30	10.90	0.951	42.59	491.16	205.80	696.96	654.37	16.37	0.952
P-9	1	Rama IV / Kasemrat	1	36.5	0.6	40.76	73.27	32.10	105.37	64.60	2.58	0.272	43.75	124.59	54.57	179.16	135.41	4.09	0.299

Source: JICA Team Estimation

Remarks:
1. Costs and Benefits are calculated at 1986 price.
2. Rate of discount: 5% per annum.
3. Traffic flow and volume are set at 1986 level.
4. Improvement alternative number (Imp. Alt. No.) marked with (#) indicates the alternative whose economic evaluation is made for comparative purpose.
5. Weighted average time value: 22.1 Baht per vehicle-hour.
6. VOC stands for vehicle operating cost, comprising the costs of fuel, oil, tyres, depreciation, maintenance for parts and labour, interest and age depreciation.
7. PV: Present Value.

(2) Benefit/Cost Calculation

(Road Improvement Plan)

Plan No. : P-1 #(2)

Location : Rama IV/Surawongse-Silom

Bo (Mil.Baht/Y) = 136.49 Cost (Mil.Baht) = 302.50 Discount Rate = 0.05 Unit = Benefit & Cost : Baht in million

Year	Cost				Benefit				Net Benefit	B/C	IRR
	Gross			PV	Gross			PV			
	Const.	O/M	Total		T. Save	V.O.C	Total				
1	151.25	0.00	151.25	151.25	0.00	0	0.00	0.00	-	-	-
2	151.25	0.00	151.25	144.05	0.00	0	0.00	0.00	-	-	-
3	0.00	3.70	3.70	3.36	125.34	11.15	136.49	123.80	-	-	-
4	0.00	3.70	3.70	3.20	125.34	11.15	136.49	117.91	-	-	-
5	0.00	3.70	3.70	3.04	125.34	11.15	136.49	112.29	-	-	-
6	0.00	3.70	3.70	2.90	125.34	11.15	136.49	106.95	-	-	-
7	0.00	3.70	3.70	2.76	125.34	11.15	136.49	101.85	-	-	-
8	0.00	3.70	3.70	2.63	125.34	11.15	136.49	97.00	-	-	-
9	0.00	3.70	3.70	2.50	125.34	11.15	136.49	92.38	-	-	-
10	0.00	3.70	3.70	2.39	125.34	11.15	136.49	87.98	-	-	-
SUB	302.50	29.60	332.10	318.07	1002.70	89.24	1091.94	840.17	522.10	2.64	0.235
11	0.00	3.70	3.70	2.27	125.34	11.15	136.49	83.79	-	-	-
12	0.00	3.70	3.70	2.16	125.34	11.15	136.49	79.80	-	-	-
13	0.00	3.70	3.70	2.06	125.34	11.15	136.49	76.00	-	-	-
14	0.00	3.70	3.70	1.96	125.34	11.15	136.49	72.38	-	-	-
15	0.00	3.70	3.70	1.87	125.34	11.15	136.49	68.94	-	-	-
16	0.00	3.70	3.70	1.78	125.34	11.15	136.49	65.66	-	-	-
17	0.00	3.70	3.70	1.70	125.34	11.15	136.49	62.53	-	-	-
18	0.00	3.70	3.70	1.61	125.34	11.15	136.49	59.55	-	-	-
19	0.00	3.70	3.70	1.54	125.34	11.15	136.49	56.72	-	-	-
20	0.00	3.70	3.70	1.46	125.34	11.15	136.49	54.01	-	-	-
TOTAL	302.50	66.60	369.10	336.49	2256.07	200.79	2456.86	1519.56	1183.07	4.52	0.269

Source; JICA Team Estimation

Remarks are the same as Appendix 4.4.9 (1)

(3) Benefit/Cost Calculation

(Road Improvement Plan)

Plan No. : P-1 (3)

Location : Rama IV/Siphraya-Silom

Bo (Mil.Baht/Y) = 161.50 Cost (Mil.Baht) = 361.70 Discount Rate = 0.05 Unit = Benefit & Cost : Baht in million

Year	Cost				Benefit				Net Benefit	B/C	IRR
	Gross			PV	Gross			PV			
	Const.	O/M	Total		T. Save	V.O.C	Total				
1	180.85	0.00	180.85	180.85	0.00	0.00	0.00	0.00	-	-	-
2	180.85	0.00	180.85	172.24	0.00	0.00	0.00	0.00	-	-	-
3	0.00	3.90	3.90	3.54	148.30	13.20	161.50	146.48	-	-	-
4	0.00	3.90	3.90	3.37	148.30	13.20	161.50	139.51	-	-	-
5	0.00	3.90	3.90	3.21	148.30	13.20	161.50	132.87	-	-	-
6	0.00	3.90	3.90	3.06	148.30	13.20	161.50	126.54	-	-	-
7	0.00	3.90	3.90	2.91	148.30	13.20	161.50	120.51	-	-	-
8	0.00	3.90	3.90	2.77	148.30	13.20	161.50	114.77	-	-	-
9	0.00	3.90	3.90	2.64	148.30	13.20	161.50	109.31	-	-	-
10	0.00	3.90	3.90	2.51	148.30	13.20	161.50	104.10	-	-	-
SUB	361.70	31.20	392.90	377.09	1186.41	105.59	1292.00	994.10	617.01	2.64	0.233
11	0.00	3.90	3.90	2.39	148.30	13.20	161.50	99.15	-	-	-
12	0.00	3.90	3.90	2.28	148.30	13.20	161.50	94.43	-	-	-
13	0.00	3.90	3.90	2.17	148.30	13.20	161.50	89.93	-	-	-
14	0.00	3.90	3.90	2.07	148.30	13.20	161.50	85.65	-	-	-
15	0.00	3.90	3.90	1.97	148.30	13.20	161.50	81.57	-	-	-
16	0.00	3.90	3.90	1.88	148.30	13.20	161.50	77.68	-	-	-
17	0.00	3.90	3.90	1.79	148.30	13.20	161.50	73.98	-	-	-
18	0.00	3.90	3.90	1.70	148.30	13.20	161.50	70.46	-	-	-
19	0.00	3.90	3.90	1.62	148.30	13.20	161.50	67.11	-	-	-
20	0.00	3.90	3.90	1.54	148.30	13.20	161.50	63.91	-	-	-
TOTAL	361.70	70.20	431.90	396.51	2669.42	237.57	2906.99	1797.97	1401.46	4.53	0.268

Source; JICA Team Estimation

Remarks are the same as Appendix 4.4.9 (1)

(4) Benefit/Cost Calculation

(Road Improvement Plan)

Plan No. : P-2 (3)

Location : Rachadamnoen Klang/Nai

Bo (Mil.Baht/Y) = 27.90 Cost (Mil.Baht) = 134.40 Discount Rate = 0.05 Unit = Benefit & Cost : Baht in million

Year	Cost				Benefit				Net Benefit	B/C	IRR
	Gross			PV	Gross			PV			
	Const.	O/M	Total		T. Save	V.O.C	Total				
1	44.80	0.00	44.80	44.80	0.00	0.00	0.00	0.00	-	-	-
2	44.80	0.00	44.80	42.67	0.00	0.00	0.00	0.00	-	-	-
3	44.80	0.00	44.80	40.63	0.00	0.00	0.00	0.00	-	-	-
4	0.00	4.20	4.20	3.63	25.50	2.40	27.90	24.10	-	-	-
5	0.00	4.20	4.20	3.46	25.50	2.40	27.90	22.95	-	-	-
6	0.00	4.20	4.20	3.29	25.50	2.40	27.90	21.86	-	-	-
7	0.00	4.20	4.20	3.13	25.50	2.40	27.90	20.82	-	-	-
8	0.00	4.20	4.20	2.98	25.50	2.40	27.90	19.82	-	-	-
9	0.00	4.20	4.20	2.84	25.50	2.40	27.90	18.88	-	-	-
10	0.00	4.20	4.20	2.71	25.50	2.40	27.90	17.98	-	-	-
SUB	134.00	29.40	163.80	150.14	178.49	16.78	195.27	146.41	-3.74	0.98	0.031
11	0.00	4.20	4.20	2.58	25.50	2.40	27.90	17.13	-	-	-
12	0.00	4.20	4.20	2.46	25.50	2.40	27.90	16.31	-	-	-
13	0.00	4.20	4.20	2.34	25.50	2.40	27.90	15.53	-	-	-
14	0.00	4.20	4.20	2.23	25.50	2.40	27.90	14.79	-	-	-
15	0.00	4.20	4.20	2.12	25.50	2.40	27.90	14.09	-	-	-
16	0.00	4.20	4.20	2.02	25.50	2.40	27.90	13.42	-	-	-
17	0.00	4.20	4.20	1.92	25.50	2.40	27.90	12.78	-	-	-
18	0.00	4.20	4.20	1.83	25.50	2.40	27.90	12.17	-	-	-
19	0.00	4.20	4.20	1.75	25.50	2.40	27.90	11.59	-	-	-
20	0.00	4.20	4.20	1.66	25.50	2.40	27.90	11.04	-	-	-
TOTAL	134.40	71.40	205.80	171.05	433.48	40.75	474.23	285.26	114.21	1.67	0.107

Source; JICA Team Estimation

Remarks are the same as Appendix 4.4.9 (1)

(5) Benefit/Cost Calculation

(Road Improvement Plan)

Plan No. : P-3 (2)

Location : Dindaeng/Rachaprarop

Bo (Mil.Baht/Y) = 48.06 Cost (Mil.Baht) = 98.50 Discount Rate = 0.05 Unit = Benefit & Cost : Baht in million

Year	Cost				Benefit				Net Benefit	B/C	IRR
	Gross			PV	Gross			PV			
	Const.	O/M	Total		T. Save	V.O.C	Total				
1	32.83	0.00	32.83	32.83	0.00	0.00	0.00	0.00	-	-	-
2	32.83	0.00	32.83	31.27	0.00	0.00	0.00	0.00	-	-	-
3	32.83	0.00	32.83	29.78	0.00	0.00	0.00	0.00	-	-	-
4	0.00	3.70	3.70	3.20	40.49	7.57	48.06	41.52	-	-	-
5	0.00	3.70	3.70	3.04	40.49	7.57	48.06	39.54	-	-	-
6	0.00	3.70	3.70	2.90	40.49	7.57	48.06	37.66	-	-	-
7	0.00	3.70	3.70	2.76	40.49	7.57	48.06	35.87	-	-	-
8	0.00	3.70	3.70	2.63	40.49	7.57	48.06	34.16	-	-	-
9	0.00	3.70	3.70	2.50	40.49	7.57	48.06	32.53	-	-	-
10	0.00	3.70	3.70	2.39	40.49	7.57	48.06	30.98	-	-	-
SUB	98.50	25.90	124.40	113.30	283.45	53.00	336.45	252.26	138.96	2.23	0.189
11	0.00	3.70	3.70	2.27	40.49	7.57	48.06	29.51	-	-	-
12	0.00	3.70	3.70	2.16	40.49	7.57	48.06	28.10	-	-	-
13	0.00	3.70	3.70	2.08	40.09	7.57	48.06	26.76	-	-	-
14	0.00	3.70	3.70	1.96	40.49	7.57	48.06	25.49	-	-	-
15	0.00	3.70	3.70	1.87	40.49	7.57	48.06	24.28	-	-	-
16	0.00	3.70	3.70	1.78	40.49	7.57	48.06	23.12	-	-	-
17	0.00	3.70	3.70	1.70	40.49	7.57	48.06	22.02	-	-	-
18	0.00	3.70	3.70	1.61	40.49	7.57	48.06	20.97	-	-	-
19	0.00	3.70	3.70	1.54	40.49	7.57	48.06	19.97	-	-	-
20	0.00	3.70	3.70	1.46	40.49	7.57	48.06	19.02	-	-	-
TOTAL	98.50	62.90	161.40	131.72	688.37	128.73	817.10	491.50	359.78	3.73	0.234

Source; JICA Team Estimation

Remarks are the same as Appendix 4.4.9 (1)

(6) Benefit/Cost Calculation

(Road Improvement Plan)

Plan No. : P-4 (3)

Location : Pradipat/Phahon Yothin

Bo (Mil.Baht/Y) = 37.84 Cost (Mil.Baht) = 76.70 Discount Rate = 0.05 Unit = Benefit & Cost : Baht in million

Year	Cost				Benefit				Net Benefit	B/C	IRR
	Gross			PV	Gross			PV			
	Const.	O/M	Total		T. Save	V.O.C	Total				
1	38.35	0.00	38.35	38.35	0.00	0.00	0.00	0.00	-	-	-
2	38.35	0.00	38.35	36.52	0.00	0.00	0.00	0.00	-	-	-
3	0.00	1.10	1.10	1.00	27.36	10.48	37.84	34.32	-	-	-
4	0.00	1.10	1.10	0.95	27.36	10.48	37.84	32.68	-	-	-
5	0.00	1.10	1.10	0.90	27.36	10.48	37.84	31.13	-	-	-
6	0.00	1.10	1.10	0.86	27.36	10.48	37.84	29.65	-	-	-
7	0.00	1.10	1.10	0.82	27.36	10.48	37.84	28.23	-	-	-
8	0.00	1.10	1.10	0.78	27.36	10.48	37.84	26.89	-	-	-
9	0.00	1.10	1.10	0.74	27.36	10.48	37.84	25.81	-	-	-
10	0.00	1.10	1.10	0.71	27.36	10.48	37.84	24.39	-	-	-
SUB	76.70	8.80	85.50	81.64	218.86	83.83	302.69	232.90	151.25	2.85	0.255
11	0.00	1.10	1.10	0.68	27.36	10.48	37.84	23.23	-	-	-
12	0.00	1.10	1.10	0.64	27.36	10.48	37.84	22.12	-	-	-
13	0.00	1.10	1.10	0.61	27.36	10.48	37.84	21.07	-	-	-
14	0.00	1.10	1.10	0.58	27.36	10.48	37.84	20.07	-	-	-
15	0.00	1.10	1.10	0.56	27.36	10.48	37.84	19.11	-	-	-
16	0.00	1.10	1.10	0.53	27.36	10.48	37.84	18.20	-	-	-
17	0.00	1.10	1.10	0.50	27.36	10.48	37.84	17.33	-	-	-
18	0.00	1.10	1.10	0.48	27.36	10.48	37.84	16.51	-	-	-
19	0.00	1.10	1.10	0.46	27.36	10.48	37.84	15.72	-	-	-
20	0.00	1.10	1.10	0.44	27.36	10.48	37.84	14.97	-	-	-
TOTAL	76.70	19.80	96.50	87.12	492.44	188.60	681.04	421.22	334.10	4.83	0.287

Source; JICA Team Estimation

Remarks are the same as Appendix 4.4.9 (1)

(7) Benefit/Cost Calculation

(Road Improvement Plan)

Plan No. : P-5#(1)

Location : Patburi/Rams VI (at grade)

Bo (Mil.Baht/Y) = 14.22 Cost (Mil.Baht) = 58.20 Discount Rate = 0.05 Unit = Benefit & Cost : Baht in million

Year	Cost				Benefit				Net Benefit	B/C	IRR
	Gross			PV	Gross			PV			
	Const.	O/M	Total		T. Save	V.O.C	Total				
1	58.20	0.00	58.20	58.20	0.00	0.00	0.00	0.00	-	-	-
2	0.00	0.90	0.90	0.86	10.60	3.62	14.22	13.55	-	-	-
3	0.00	0.90	0.90	0.82	10.60	3.62	14.22	12.90	-	-	-
4	0.00	0.90	0.90	0.78	10.60	3.62	14.22	12.29	-	-	-
5	0.00	0.90	0.90	0.74	10.60	3.62	14.22	11.70	-	-	-
6	0.00	0.90	0.90	0.71	10.60	3.62	14.22	11.15	-	-	-
7	0.00	0.90	0.90	0.67	10.60	3.62	14.22	10.61	-	-	-
8	0.00	0.90	0.90	0.64	10.60	3.62	14.22	10.11	-	-	-
9	0.00	0.90	0.90	0.61	10.60	3.62	14.22	9.63	-	-	-
10	0.00	0.90	0.90	0.58	10.60	3.62	14.22	9.17	-	-	-
SUB	58.20	8.10	66.30	64.60	95.40	32.62	128.02	101.11	36.51	1.57	0.139
11	0.00	0.90	0.90	0.55	10.60	3.62	14.22	8.73	-	-	-
12	0.00	0.90	0.90	0.53	10.60	3.62	14.22	8.32	-	-	-
13	0.00	0.90	0.90	0.50	10.60	3.62	14.22	7.92	-	-	-
14	0.00	0.90	0.90	0.48	10.60	3.62	14.22	7.54	-	-	-
15	0.00	0.90	0.90	0.45	10.60	3.62	14.22	7.18	-	-	-
16	0.00	0.90	0.90	0.43	10.60	3.62	14.22	6.84	-	-	-
17	0.00	0.90	0.90	0.41	10.60	3.62	14.22	6.52	-	-	-
18	0.00	0.90	0.90	0.39	10.60	3.62	14.22	6.21	-	-	-
19	0.00	0.90	0.90	0.37	10.60	3.62	14.22	5.91	-	-	-
20	0.00	0.90	0.90	0.36	10.60	3.62	14.22	5.63	-	-	-
TOTAL	58.20	17.10	75.30	69.08	201.39	68.88	270.27	171.91	102.83	2.49	0.186

Source; JICA Team Estimation

Remarks are the same as Appendix 4.4.9 (1)

(8) Benefit/Cost Calculation

(Road Improvement Plan)

Plan No. : P-5 (2)

Location : Petburi/Rams Vi (Flyover)

Bo (Mil.Baht/Y) = 39.13 Cost (Mil.Baht) = 45.60 Discount Rate = 0.05 Unit = Benefit & Cost : Baht in million

Year	Cost				Benefit				Net Benefit	B/C	IRR
	Gross			PV	Gross			PV			
	Const.	O/M	Total		T. Save	V.O.C	Total				
1	22.80	0.00	22.80	22.80	0.00	0.00	0.00	0.00	-	-	-
2	22.80	0.00	22.80	21.71	0.00	0.00	0.00	0.00	-	-	-
3	0.00	1.20	1.20	1.09	29.16	9.97	39.13	35.49	-	-	-
4	0.00	1.20	1.20	1.04	29.16	9.97	39.13	33.80	-	-	-
5	0.00	1.20	1.20	0.99	29.16	9.97	39.13	32.19	-	-	-
6	0.00	1.20	1.20	0.94	29.16	9.97	39.13	30.66	-	-	-
7	0.00	1.20	1.20	0.90	29.16	9.97	39.13	29.20	-	-	-
8	0.00	1.20	1.20	0.85	29.16	9.97	39.13	27.81	-	-	-
9	0.00	1.20	1.20	0.81	29.16	9.97	39.13	26.48	-	-	-
10	0.00	1.20	1.20	0.77	29.16	9.97	39.13	25.22	-	-	-
SUB	45.60	9.60	55.20	51.90	233.25	79.77	313.02	240.85	188.94	4.64	0.397
11	0.00	1.20	1.20	0.74	29.16	9.97	39.13	24.02	-	-	-
12	0.00	1.20	1.20	0.70	29.16	9.97	39.13	22.88	-	-	-
13	0.00	1.20	1.20	0.67	29.16	9.97	39.13	21.79	-	-	-
14	0.00	1.20	1.20	0.64	29.16	9.97	39.13	20.75	-	-	-
15	0.00	1.20	1.20	0.61	29.16	9.97	39.13	19.76	-	-	-
16	0.00	1.20	1.20	0.58	29.16	9.97	39.13	18.82	-	-	-
17	0.00	1.20	1.20	0.55	29.16	9.97	39.13	17.92	-	-	-
18	0.00	1.20	1.20	0.52	29.16	9.97	39.13	17.07	-	-	-
19	0.00	1.20	1.20	0.50	29.16	9.97	39.13	16.26	-	-	-
20	0.00	1.20	1.20	0.47	29.16	9.97	39.13	15.48	-	-	-
TOTAL	45.60	21.60	67.20	57.87	524.81	179.48	704.29	435.60	377.73	7.53	0.415

Source; JICA Team Estimation

Remarks are the same as Appendix 4.4.9 (1)

(9) Benefit/Cost Calculation

(Road Improvement Plan)

Plan No. : P-6 (1)

Location : Precharat II/Prachachuen

Bo (Mil.Baht/Y) = 5.26 Cost (Mil.Baht) = 24.10 Discount Rate = 0.05 Unit = Benefit & Cost : Baht in million

Year	Cost				Benefit				Net Benefit	B/C	IRR
	Gross			PV	Gross			PV			
	Const.	O/M	Total		T. Save	V.O.C	Total				
1	24.10	0.00	24.10	24.10	0.00	0.00	0.00	0.00	-	-	-
2	0.00	0.50	0.50	0.48	3.78	1.48	5.26	5.01	-	-	-
3	0.00	0.50	0.50	0.45	3.78	1.48	5.26	4.77	-	-	-
4	0.00	0.50	0.50	0.43	3.78	1.48	5.26	4.54	-	-	-
5	0.00	0.50	0.50	0.41	3.78	1.48	5.26	4.32	-	-	-
6	0.00	0.50	0.50	0.39	3.78	1.48	5.26	4.12	-	-	-
7	0.00	0.50	0.50	0.37	3.78	1.48	5.26	3.92	-	-	-
8	0.00	0.50	0.50	0.36	3.78	1.48	5.26	3.74	-	-	-
9	0.00	0.50	0.50	0.34	3.78	1.48	5.26	3.56	-	-	-
10	0.00	0.50	0.50	0.32	3.78	1.48	5.26	3.39	-	-	-
SUB	24.10	4.50	28.60	27.65	34.01	13.30	47.31	37.36	9.71	1.35	0.107
11	0.00	0.50	0.50	0.31	3.78	1.48	5.26	3.23	-	-	-
12	0.00	0.50	0.50	0.29	3.78	1.48	5.26	3.07	-	-	-
13	0.00	0.50	0.50	0.28	3.78	1.48	5.26	2.93	-	-	-
14	0.00	0.50	0.50	0.27	3.78	1.48	5.26	2.79	-	-	-
15	0.00	0.50	0.50	0.25	3.78	1.48	5.26	2.65	-	-	-
16	0.00	0.50	0.50	0.24	3.78	1.48	5.26	2.53	-	-	-
17	0.00	0.50	0.50	0.23	3.78	1.48	5.26	2.41	-	-	-
18	0.00	0.50	0.50	0.22	3.78	1.48	5.26	2.29	-	-	-
19	0.00	0.50	0.50	0.21	3.78	1.48	5.26	2.18	-	-	-
20	0.00	0.50	0.50	0.20	3.78	1.48	5.26	2.08	-	-	-
TOTAL	24.10	9.50	33.60	30.14	71.80	28.07	99.87	63.52	33.38	2.11	0.160

Source; JICA Team Estimation

Remarks are the same as Appendix 4.4.9 (1)

(10) Benefit/Cost Calculation

(Road Improvement Plan)

Plan No. : P-7 (3)

Location : Sukhumvit/Rama IV

Bo (Mil.Baht/Y) = 28.67 Cost (Mil.Baht) = 70.40 Discount Rate = 0.05 Unit - Benefit & Cost : Baht in million

Year	Cost				Benefit				Net		
	Gross			PV	Gross			PV	Benefit	B/C	IRR
	Const.	O/M	Total		T. Save	V.O.C	Total				
1	35.20	0.00	35.20	35.20	0.00	0.00	0.00	0.00	-	-	-
2	35.20	0.00	35.20	33.52	0.00	0.00	0.00	0.00	-	-	-
3	0.00	1.50	1.50	1.36	25.37	3.30	28.67	26.00	-	-	-
4	0.00	1.50	1.50	1.30	25.37	3.30	28.67	24.76	-	-	-
5	0.00	1.50	1.50	1.23	25.37	3.30	28.67	23.59	-	-	-
6	0.00	1.50	1.50	1.18	25.37	3.30	28.67	22.46	-	-	-
7	0.00	1.50	1.50	1.12	25.37	3.30	28.76	21.39	-	-	-
8	0.00	1.50	1.50	1.07	25.37	3.30	28.76	20.37	-	-	-
9	0.00	1.50	1.50	1.02	25.37	3.30	28.76	19.40	-	-	-
10	0.00	1.50	1.50	0.97	25.37	3.30	28.76	18.48	-	-	-
SUB	70.40	12.00	82.40	77.96	202.96	26.39	229.35	176.47	98.51	2.26	0.207
11	0.00	1.50	1.50	0.92	25.37	3.30	28.67	17.60	-	-	-
12	0.00	1.50	1.50	0.88	25.37	3.30	28.67	16.76	-	-	-
13	0.00	1.50	1.50	0.84	25.37	3.30	28.67	15.96	-	-	-
14	0.00	1.50	1.50	0.80	25.37	3.30	28.67	15.20	-	-	-
15	0.00	1.50	1.50	0.76	25.37	3.30	28.67	14.48	-	-	-
16	0.00	1.50	1.50	0.72	25.37	3.30	28.67	13.79	-	-	-
17	0.00	1.50	1.50	0.69	25.37	3.30	28.67	13.13	-	-	-
18	0.00	1.50	1.50	0.65	25.37	3.30	28.67	12.51	-	-	-
19	0.00	1.50	1.50	0.62	25.37	3.30	28.67	11.91	-	-	-
20	0.00	1.50	1.50	0.59	25.37	3.30	28.67	11.35	-	-	-
TOTAL	70.40	27.00	97.40	85.42	456.67	59.36	516.03	319.16	233.74	3.74	0.245

Source; JICA Team Estimation

Remarks are the same as Appendix 4.4.9 (1)

(11) Benefit/Cost Calculation

(Road Improvement Plan)

Plan No. : P-8 (1)

Location : Patburi/Ramkhamheng

Bo (Mil.Baht/Y) = 57.67 Cost (Mil.Baht) = 30.50 Discount Rate = 0.05 Unit = Benefit & Cost : Baht in million

Year	Cost				Benefit				Net Benefit	B/C	IRR
	Gross			PV	Gross			PV			
	Const.	O/M	Total		T. Save	V.O.C	Total				
1	30.50	0.00	30.50	30.50	0.00	0.00	0.00	0.00	-	-	-
2	0.00	1.00	1.00	0.95	40.64	17.03	57.67	54.92	-	-	-
3	0.00	1.00	1.00	0.91	40.64	17.03	57.67	52.31	-	-	-
4	0.00	1.00	1.00	0.86	40.64	17.03	57.67	49.82	-	-	-
5	0.00	1.00	1.00	0.82	40.64	17.03	57.67	47.45	-	-	-
6	0.00	1.00	1.00	0.78	40.64	17.03	57.67	45.19	-	-	-
7	0.00	1.00	1.00	0.75	40.64	17.03	57.67	43.03	-	-	-
8	0.00	1.00	1.00	0.71	40.64	17.03	57.67	40.98	-	-	-
9	0.00	1.00	1.00	0.68	40.64	17.03	57.67	39.03	-	-	-
10	0.00	1.00	1.00	0.64	40.64	17.03	57.67	37.17	-	-	-
SUB	30.50	9.00	39.50	37.61	365.77	153.26	519.03	409.91	372.30	10.90	0.951
11	0.00	1.00	1.00	0.61	40.64	17.03	57.67	35.40	-	-	-
12	0.00	1.00	1.00	0.58	40.64	17.03	57.67	33.72	-	-	-
13	0.00	1.00	1.00	0.56	40.64	17.03	57.67	32.11	-	-	-
14	0.00	1.00	1.00	0.53	40.64	17.03	57.67	30.58	-	-	-
15	0.00	1.00	1.00	0.51	40.64	17.03	57.67	29.13	-	-	-
16	0.00	1.00	1.00	0.48	40.64	17.03	57.67	27.74	-	-	-
17	0.00	1.00	1.00	0.46	40.64	17.03	57.67	26.42	-	-	-
18	0.00	1.00	1.00	0.44	40.64	17.03	57.67	25.16	-	-	-
19	0.00	1.00	1.00	0.42	40.64	17.03	57.67	23.96	-	-	-
20	0.00	1.00	1.00	0.40	40.64	17.03	57.67	22.82	-	-	-
TOTAL	30.50	19.00	49.50	42.59	772.18	323.55	1095.73	696.96	654.37	16.37	0.952

Source; JICA Team Estimation

Remarks are the same as Appendix 4.4.9 (1)

(12) Benefit/Cost Calculation

(Road Improvement Plan)

Plan No. : P-9 (1)

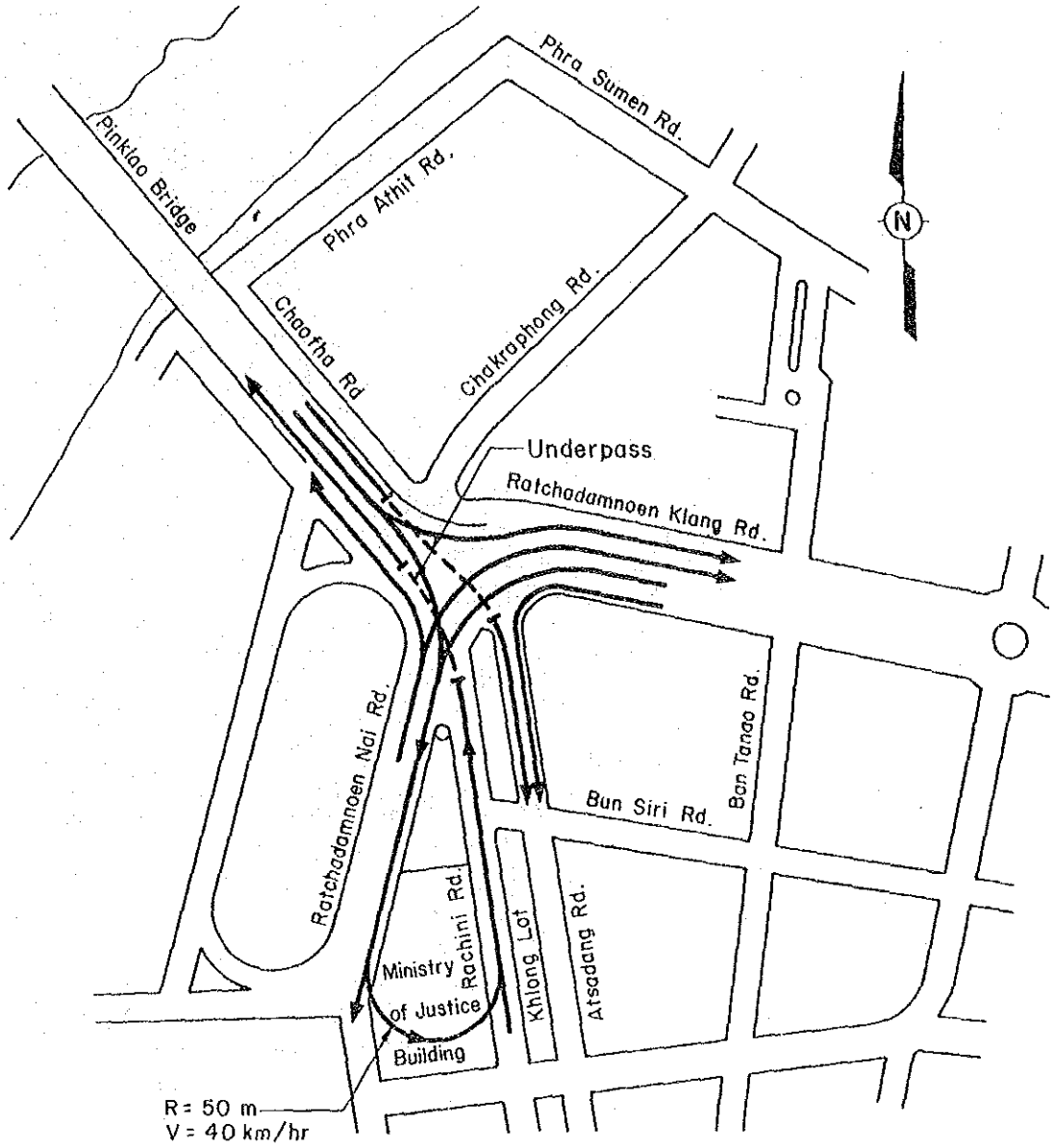
Location : Rama IV/Kasemrat

Bo (Mil.Baht/Y) = 14.82 Cost (Mil.Baht) = 36.50 Discount Rate = 0.05 Unit = Benefit & Cost : Baht in million

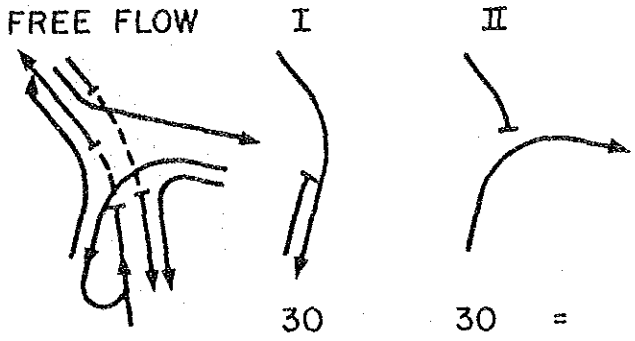
Year	Cost				Benefit				Net Benefit	B/C	IRR
	Gross			PV	Gross			PV			
	Const.	O/M	Total		T. Save	V.O.C	Total				
1	36.50	0.00	36.50	36.50	0.00	0.00	0.00	0.00	-	-	-
2	0.00	0.60	0.60	0.57	10.31	4.51	14.82	14.12	-	-	-
3	0.00	0.60	0.60	0.54	10.31	4.51	14.82	13.45	-	-	-
4	0.00	0.60	0.60	0.52	10.31	4.51	14.82	12.81	-	-	-
5	0.00	0.60	0.60	0.49	10.31	4.51	14.82	12.20	-	-	-
6	0.00	0.60	0.60	0.47	10.31	4.51	14.82	11.62	-	-	-
7	0.00	0.60	0.60	0.45	10.31	4.51	14.82	11.06	-	-	-
8	0.00	0.60	0.60	0.43	10.31	4.51	14.82	10.54	-	-	-
9	0.00	0.60	0.60	0.41	10.31	4.51	14.82	10.03	-	-	-
10	0.00	0.60	0.60	0.39	10.31	4.51	14.82	9.56	-	-	-
SUB	36.50	5.40	41.90	40.76	92.78	40.64	133.42	105.37	64.60	2.58	0.272
11	0.00	0.60	0.60	0.37	10.31	4.51	14.82	9.10	-	-	-
12	0.00	0.60	0.60	0.35	10.31	4.51	14.82	8.67	-	-	-
13	0.00	0.60	0.60	0.33	10.31	4.51	14.82	8.25	-	-	-
14	0.00	0.60	0.60	0.32	10.31	4.51	14.82	7.86	-	-	-
15	0.00	0.60	0.60	0.30	10.31	4.51	14.82	7.49	-	-	-
16	0.00	0.60	0.60	0.29	10.31	4.51	14.82	7.13	-	-	-
17	0.00	0.60	0.60	0.27	10.31	4.51	14.82.	6.79	-	-	-
18	0.00	0.60	0.60	0.26	10.31	4.51	14.82	6.47	-	-	-
19	0.00	0.60	0.60	0.25	10.31	4.51	14.82	6.16	-	-	-
20	0.00	0.60	0.60	0.24	10.31	4.51	14.82	5.87	-	-	-
TOTAL	36.50	11.40	47.90	43.75	195.87	85.79	281.86	179.16	135.41	4.09	0.299

Source; JICA Team Estimation

Remarks are the same as Appendix 4.4.9 (1)



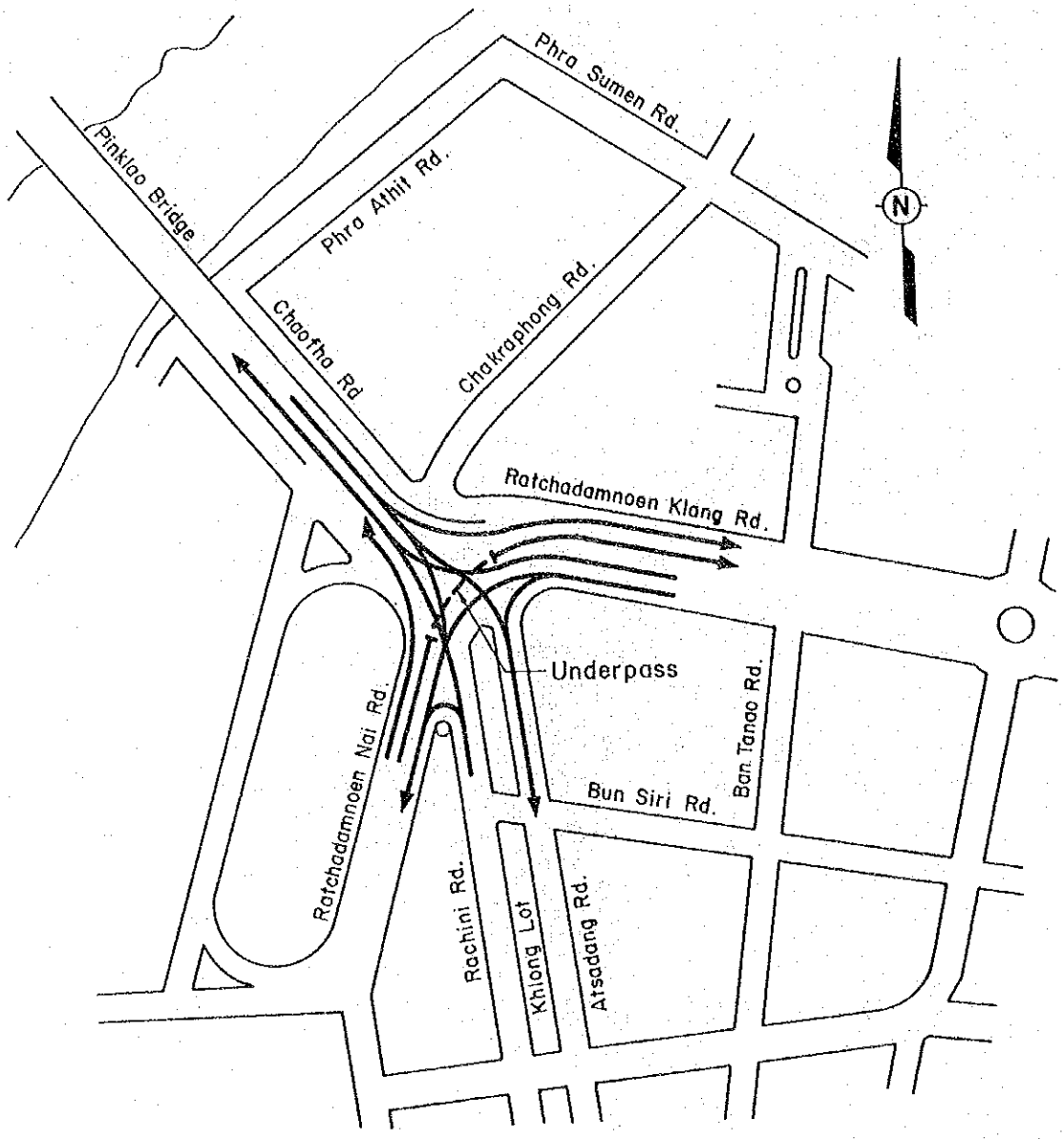
SIGNAL PHASE

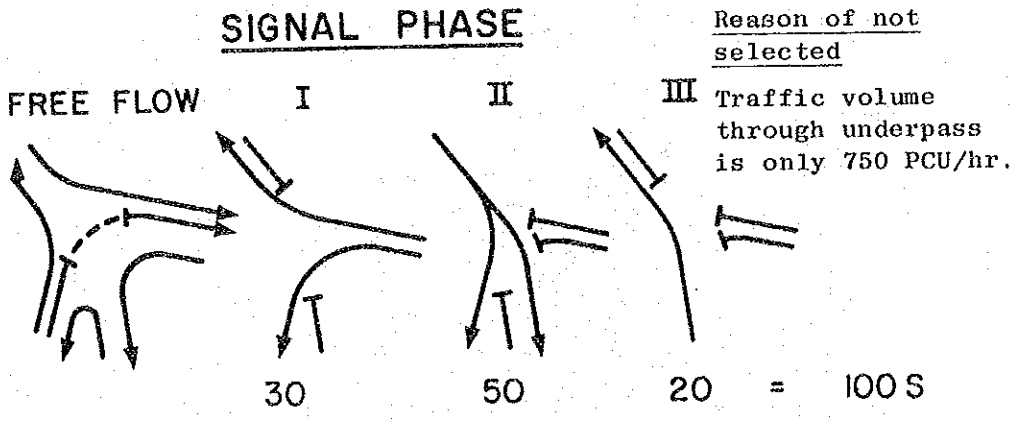


Reason of not selected

Circular is located under Ministry of Justice building.

Figure 1 Ratchadamnoen Klang / Ratchadamnoen Nai Rd. Intersection, (Studied but not selected measure)





Reason of not selected

Traffic volume through underpass is only 750 PCU/hr.

Figure 2 Ratchadamnoen Klang / Ratchadamnoen Nai Rd. Intersection, (Studied but not selected measure)