The applied D value is 60% peak hour ratio for the heaviest directional traffic ratio on Route 1 around Bangkok metropolitan area and the D value is only applied for multi lane roads.

(4) Method for Calculating Traffic Congestion Rate

Traffic congestion rate is calculated as follows:

$$\text{Traffic congestion rate} = \frac{Q * (1-T/100)ET * T/10}{C}$$

Where, Q : 24 hours traffic volume in pcu unit (pcu/24hours)
T : Heavy vehicles ratio (%)
ET : Heavy vehicle equivalent passenger car unit

Furthermore, the value of the heavy vehicle equivalent passenger car unit ET is 2.0 in both urban and rural areas.

3.2.2 Identification of Congested Road Sections

The DOH roads' traffic congestion rate is calculated by the methods shown in 3.2.1 using the data for 1987. The control sections which were not subjected to actual traffic volume observations were not analyzed. The roadway is broken down to road sections on the following basis:

A. Traffic volume observations which were conducted each year by DOH are carried out basically on one point in each control section. Accordingly, while only one observation point in one control section is set up, it is deemed to be one road section in one control section.

B. In case of one control section which has two and more traffic volume observation points, a central point is deemed to be a road section border.

The calculated traffic congestion rate is shown in Tables 3.2/3.4 and a cumulative graph of congestion rate versus distance is shown in Figure 3.2. The following is understandable from these tables.

A. Road sections which show a congestion rate greater than 1.0 amount to a total length of approximately 245km representing 0.7% of total length analyzed.

B. By contrast, road sections which have a congestion rate of less than 0.5 represent a total length of approximately 35,200km or 95.7% of total length analyzed.

C. Road sections which have a congestion rate of more than 1.25 total approximately 150km or about 0.4% of total length analyzed.

D. Traffic congestion rate on Primary Highways appears higher than other road types which were analyzed.

E. Division 410 (Bangkok Highway Division) and Division 430 (Lop Buri Highway Division) which are located in the central region of Thailand show a high traffic congestion rate among the regional observations.

Table 3.2 Non Intersection (roadway) Traffic Congestion Rate

Unit : m

Congestion Rate : a	Total
0 ≤ a < 0.25	31,297,205
0.25 ≤ a < 0.50	3,887,280
0.50 ≤ a < 0.75	837,541
0.75 ≤ a < 1.00	501,912
1.00 ≤ a < 1.25	92,938
1.25 ≤ a < 1.50	32,222
1.50 ≤ a	119,952
Total	36,765,050

Table 3.3 Non Intersection (Roadway) Traffic Congestion Rate (By type of road)

Unit : m

Congestion Rate : a	Primary Highway	Secondary Highway	Provincial Highway	Total
0 ≤ a < 0.25	2,659,721	4,833,936	23,753,546	31,297,205
0.25 ≤ a < 0.50	1,903,668	1,063,911	919,701	3,887,280
0.50 ≤ a < 0.75	376,598	219,951	240,992	837,541
0.75 ≤ a < 1.00	382,923	87,276	31,713	501,912
1.00 ≤ a < 1.25	63,970	6,360	22,608	92,938
1.25 ≤ a < 1.50	19,080	0	13,142	32,222
1.50 ≤ a	74,099	45,853	0	119,952
Total	5,480,059	6,307,289	24,981,702	36,765,050

Table 3.4 Non Intersection (Roadway) Traffic Congestion Rate (By region)

a : CONGESTION RATE (m)

DIVISION	0≦a<0.25	0.25≦a<0.50	0.50≦a<0.75	0.75≦a<1.00	1.00≦a<1.25	1.25≦a<1.50	1.50≦a	TOTAL
310	1,010,051	250,634	26,153	0	0	0	0	2,186,838
320	2,706,726	441,648	61,989	12,352	0	0	0	3,222,715
330	1,234,507	360,012	57,122	95,792	0	0	0	1,747,433
410	1,391,327	598,045	200,942	183,376	48,571	32,222	71,378	2,525,861
420	2,523,761	586,043	281,560	35,000	3,442	0	0	3,429,806
430	2,452,869	318,748	87,151	60,691	38,590	7,998	0	2,966,047
510	3,333,661	245,962	0	3,905	0	0	0	3,503,528
520	2,404,864	280,237	66,660	30,078	0	0	0	2,721,839
530	3,705,343	202,841	5,424	0	2,335	0	0	3,995,943
610	3,087,254	240,706	25,293	77,976	0	0	0	3,431,229
620	2,015,446	164,341	18,732	845	0	0	33,076	3,132,440
630	3,551,396	188,063	6,515	1,897	0	0	7,500	3,765,371
TOTAL	31,297,205	3,887,280	837,541	501,912	92,938	40,220	111,954	36,769,050

Region	Division	
Southern region	310	Song Khla Highway Division
	320	Nakhon Si Thammarat Highway Division
	330	Prachuap Khiri Highway division
Central region	410	Bangkok Highway Division
	420	Chachoengsao Highway Division
	430	Lop Buri Highway Division
Northern region	510	Phitsanulok Highway Division
	520	Chiang Mai Highway Division
	530	Prae Highway Division
North-eastern region	610	Nakhon Ratchasima Highway Division
	620	Khon Kaen Highway Division
	630	Ubonratchathani Highway Division

Traffic congestion rate classified by the control section of DOH roads is shown in Appendix 5.1. Identification of problem sections by traffic congestion rate was carried out reflecting the interview result in conclusion of district engineer survey.

It may be safely assumed that sections on which the congestion rate is 0.75 or more, can be identified as a problem sections. Accordingly 747km of DOH roads corresponding to 2.0% of total could be listed as problem sections.

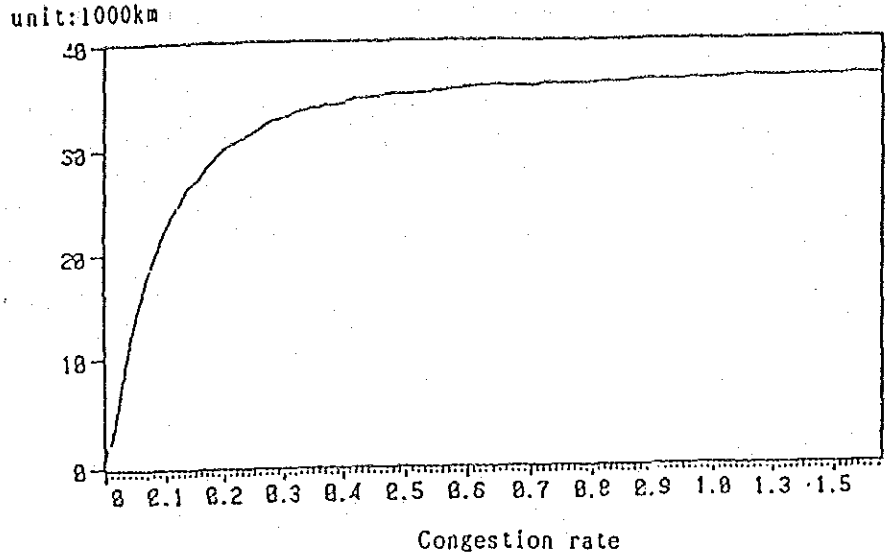


Figure 3.2 Cumulative Congestion Rate Versus Distance

3.3 IDENTIFICATION OF PROBLEM SECTIONS THROUGH TRAFFIC ACCIDENT RATE ANALYSIS

In the Study, hazardous road sections can be defined as sites where traffic accidents occur frequently or a large number of casualties exists indicating some remedial measures are required. However, "hazardous" is always defined relatively and not absolutely.

Identification methods of hazardous road locations are classified into six types as follows:

- number of accidents method
- accident density method
- accident rate method
- accident number - rate method
- accident rate - traffic volume method
- statistical method

Careful consideration to the characteristics of each method shall be paid in selecting the identification method of hazardous road locations. In the Study, accident rate - traffic volume method, which was recommended in the Phase I Study and which has been adopted at DOH, is used. In the Phase I Study which was carried out by JICA, DOH roads are separated into non intersections (roadways) and intersections. The accident rate - traffic volume method was applied to non intersections and the number of accident method was applied to intersections. However, in the Study, since the existing DOH data on intersections are unavailable, only roadways sections are analyzed through the accident rate - traffic volume method.

3.3.1 Identifying Method for Hazardous Road Locations

Identification criteria for non intersections are basically set by accident rate - traffic volume method as follows:

(1) Section Length

Application of identification approach to non intersections requires the determination of "section length". In theory, the shorter the section length, the more the uniformity of road conditions within each section can be attained, and the identified sections are easily correlated with actual "hazardous sites" on the road network. As section lengths becomes longer, the road conditions become less homogeneous and the reasons why particular road sections are identified as hazardous will become vague. This reduces the chance of finding efficient safety measures to be applied to sections. Figure 3.3 sets out the above relationship, which was obtained in the Phase I Study.

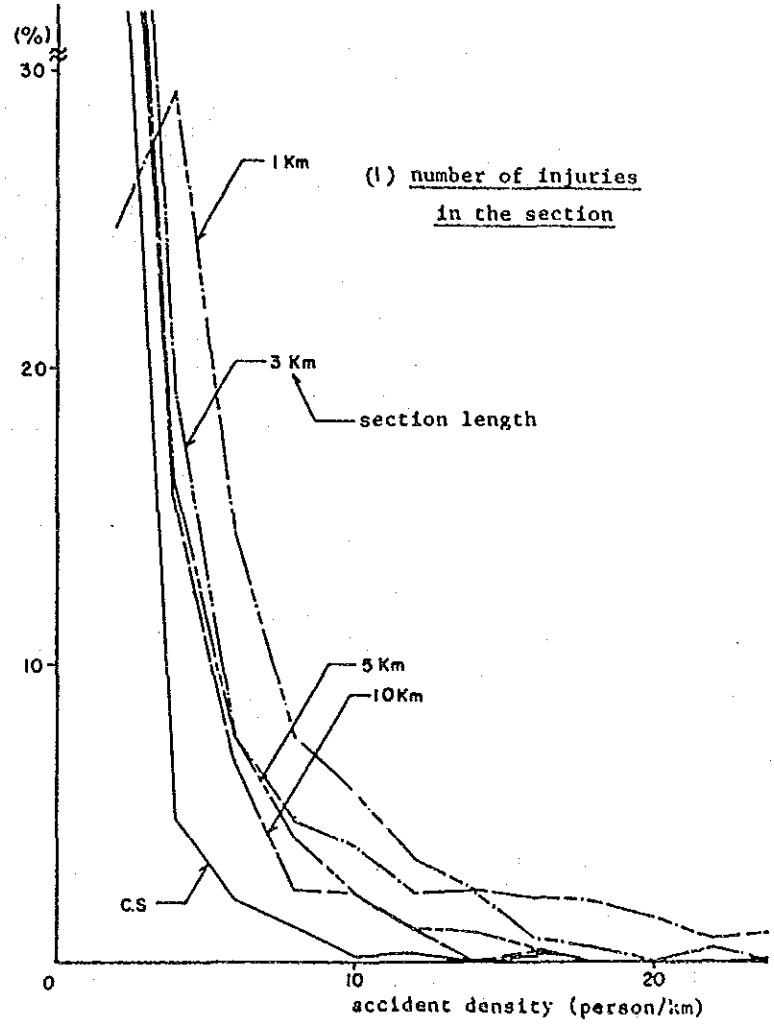


Figure 3.3 Distribution of Accident Density by Section Length

When the control unit length exceeds the length in which most of the observed data falls, the distribution property of the accident density stabilizes. Sections of too short a length also result in undue workload in data assembly and calculation.

As a result of the above Phase I Study analysis, the uniformity of road conditions over any section of 1 kilometer is basically applied for non intersection.

(2) Process of Establishing Criteria

Figure 3.4 shows the process of establishing identification criteria. This diagram describes the flow of the analytical process, data handling and processing to lead to the setting of identification criteria.

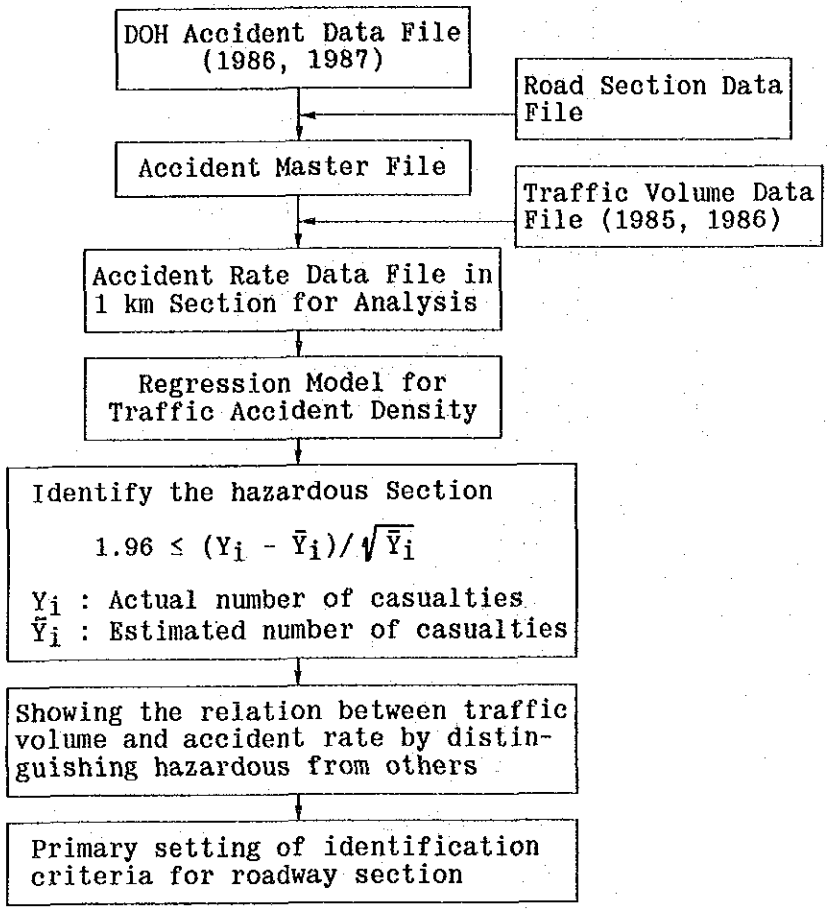


Figure 3.4 Process of Establishing Criteria for Non Intersections

(3) Regression Model

Setting of identifying criteria requires the prediction of accident indicators either as density or rate. The prediction value is usually made using regression models. Several factors such as road environment and traffic characteristics usually enter as the explanatory variables. In this analysis, however, only "traffic volume" is used in the model, since the road inventory of the Study roads was not yet completed.

The regression model used in the analysis is in the form of:

$$Y = aX^b$$

where, Y : Accident rate
X : Traffic volume (veh/day)
a, b : Parameter

DOH data for 1986 and 1987 were applied to the above

model and following relationship was established. The method of calculating the accident rate was the same as that use in the Phase I Study (i.e.: number of traffic accident death per 1 km).

$$Y = 1.18X^{0.078} \quad (R = 0.40)$$

where, Y : Accident rate (person/km)
X : Average per day traffic volume (veh/day)

For reference, result of the Phase I Study is shown as follows:

$$Y = 0.56X^{0.196} \quad (R = 0.48)$$

(4) Identify Criteria of Hazardous Road Locations

Identifying criteria of hazardous locations are generally defined as follows:

$$1.96 \leq \frac{Y1 - \bar{Y}1}{\sqrt{\bar{Y}1}}$$

Y1 : actual observation data
$\bar{Y}1$: estimated and accident rate by regression model

3.3.2 Identification of Hazardous Road Locations

Using the methods previously explained and data of 1986 and 1987 on DOH roads, hazardous sections were identified and are shown in Table 3.5 by classification of roads. Of the DOH roads, Appendix 5.2 summarizes road sections determined to be hazardous. Identification of problem sections by the accident rate method was determined comprehensively taking into account the results of interview from district engineers, and the same method as identification of problem sections by the congestion rate.

Table 3.5 Length of Hazardous Road Locations by Road Classification

Unit : km

Road Classification		1986	1987
Primary Road	Route No. 1 - 4	74.7 (25)	72.5 (24)
	Others	41.6 (14)	38.5 (13)
Secondary Road		35.9 (12)	27.2 (9)
Provincial Road		24.4 (8)	26.5 (9)
Total		176.6 (59)	164.7 (55)

Note : Numbers in parentheses mean the number of hazardous road sections.

CHAPTER 4 CASE STUDIES AND EXPERIMENTAL WORKS FOR TRAFFIC CONTROL MEASURES

CHAPTER 4 CASE STUDIES AND EXPERIMENTAL WORKS FOR TRAFFIC CONTROL MEASURES

4.1 OBJECTIVES OF CASE STUDIES AND EXPERIMENTAL WORKS

4.1.1 Objectives of Case Studies

The traffic operation problems are very complex and can be only solved through the implementation of comprehensive traffic control measures involving such parties as road administrators, road users and traffic police. Therefore, traffic control measures by road administrator should be prepared in close collaboration with parties concerned.

The traffic operation planning for engineering remedial works should be determined by effective and realistic traffic control measures on road sections experiencing problems of traffic congestion as well as traffic conflicts. For these selected locations, detailed design, cost estimation and implementation programs should be prepared.

The general procedure to prepare the engineering remedial works at a certain location is as shown below;

A. Selection of location which require remedial works.

B. Collection and analyses of data pertaining to traffic condition and road condition.

C. Identification of major problems from traffic engineering consideration.

D. Determination of traffic control measures applicable to the selected location.

E. Detailed design of traffic control measures.

F. Estimation of improvement cost.

G. Preparation of the implementation program.

In the Study, execution of case studies is planned in order to show some examples of traffic control measures for engineering remedial works prepared according to the procedures outlined above.

4.1.2 Objectives of Experimental Works

The objectives of the experimental works in the Study is to evaluate the effectiveness of the traffic control measures through before-and-after surveys of the experimental works. In the Study, the experimental works are

considered to be a part of the case study for the traffic control measures. In addition, execution of the experimental works are fully incorporated with the establishment of the traffic operation plan in DOH.

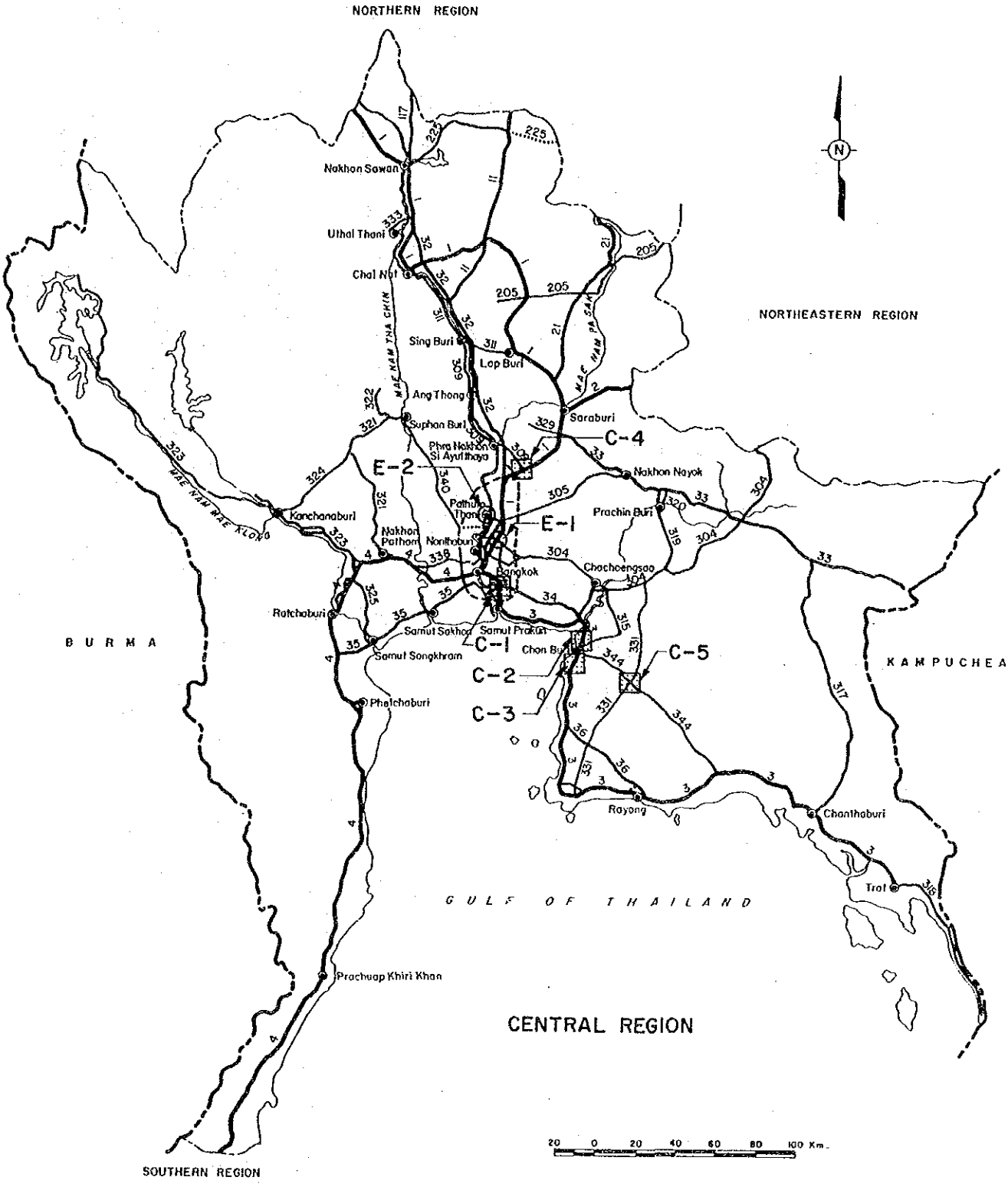


Figure 4.1 Location of Case Study and Experimental Work Sites in the Central Region

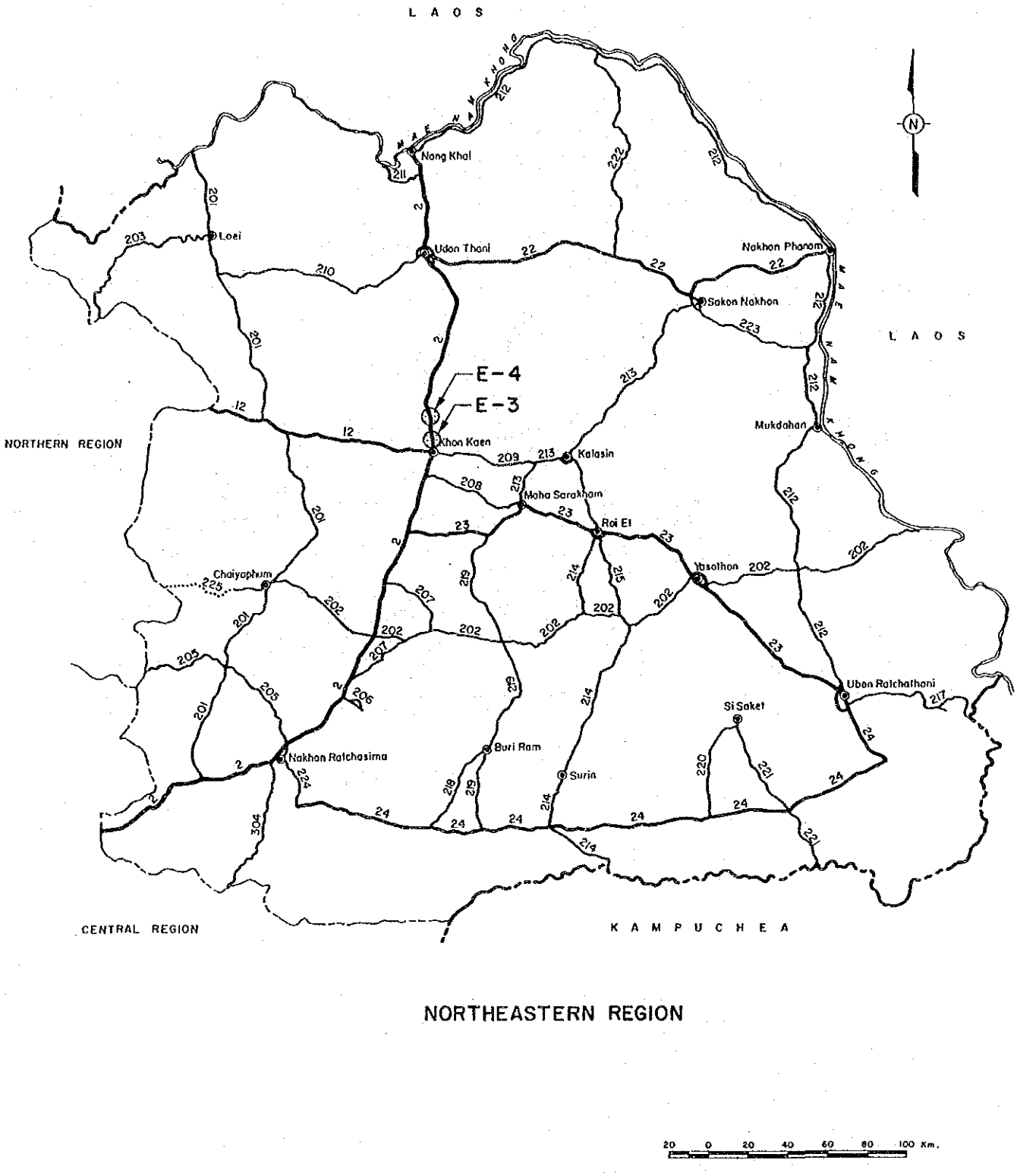


Figure 4.2 Location of Case Study and Experimental Work Sites in the North-Eastern Region

4.2 SELECTION OF LOCATIONS FOR CASE STUDIES AND EXPERIMENTAL WORKS

The case studies and the experimental works for the preparation of traffic control plan have been carried out in order to cope with the problems related to traffic congestion, traffic conflict, etc. on DOH roads. However, since it was almost impossible to pin point certain locations from the huge DOH road network, the representative areas for the Study was determined as follows and several locations from each representative area were selected for the case studies as well as experimental works.

A. Bangkok suburban area

B. Local city area

C. Intercity road section

For the selection of the road section for the case study and the experimental work, a series of discussions with the DOH were conducted and site investigations were carried out. The final selection of location was made in consideration of the following points;

A. Selected location should be a road section containing typical traffic operational problems in each representative area.

B. Since the case studies and the experimental works must be a kind of demonstration related to the traffic control measures, good effects of improvement should have been expected.

C. For the experimental work locations, it was necessary to consider the DOH's improvement program in the fiscal year 1988, because implementation of experimental works was agreed to be conducted by the DOH's own budget.

Figures 4.1 and 4.2 indicate the selected locations for the case study and the experimental work, while proposed traffic control measures are summarized in Tables 4.1 and 4.2.

Table 4.1 Summary of Case Study

Location No.	Route No.	Control Section	Section Name	Kilo Post	Area CD	Classified Area	Road Configulation	Major Countermeasure	Remark
C-1	R.34 (R.3, R.3102)	100	Bang Na	0+000-4+000	411	A	Signalized Intersection (Under elevated road)	* Rehabilitation of pavement * Improvement of visibility of signals * Modification of signal phasing * Extention of left turn lane	
C-2	R.3 (R.315, R.344)	402	Chonburi	92+000-94+100	422	B	Signalized Intersection Roadway	* Improvement of channelization * Installation of median * Modification of signal phasing	
C-3	R.3	501	Sriracha	95+100	422	B	Signalized Intersection (not operated)	* Improvement of visibility of signal * Channelization * Installation of median * Access control of frontage road	
C-4	R.1 (R.309, R.3189)	202-301	Wang Noi	65+151 - 167	413	C	Intersection (with partial frontage Rd.)	* Short term plan - Signalization - Improvement of frontage road - Channelization * Long term plan - Grade separation	
C-5	R.344 (R.331)	200	Ban Bung - Klaeng	31+506	422	C	Intersection	* Channelization * Speed control	

Classified Area. A : Bangkok suburban area
B : Local city area
C : Intercity roadways

Table 4.2 Summary of Experimental Works

Location No.	Route No.	Control Section	Section Name	Kilo Post	Area CD	Classified Area	Road Configulation	Major Countermeasure	Remark
E-1	R.1 (R.304)	100	Laksi	18+567	411	A	Roundabout	* Signalization * Channelization	
E-2	R.346 (R.3111)	100	Pathumthani	12+122	416	A	Intersection (4-leg)	* Signalization * Channelization * Installation of acceleration Lane	
E-3	R.2	1000	Khon Kaen	1+100-3+100	621	B	Roadway	* Motorcycle Lane	
E-4	R.2	1000	Khon Kaen - Nam Phong	14+25-15+500	621	C	Roadway	* Passing Lane	

Classified Area. A : Bangkok suburban area
B : Local city area
C : Intercity roadways

CLASSIFICATION OF TRAFFIC OPERATIONAL MEASURES IN E/W AND C/S

Intersection			
	a) Signalization	Laksi*, Pathumthani*, Wang Noi	3
	b) Improvement of I.S	Ban Bung-Klaeng	1
	c) Improvement of Signalized I.S	Bang Na, Chonburi, Srirach	3
	d) Grade separation	Wang Noi, Laksi	2
Roadway			
	a) Access control	Wang Noi, Sriracha	1
	b) Median	Chonburi, Sriracha	2
	c) Adding lane	Khon Kaen*, Pathumthani*	2
	d) Motorcycle treatment	Khon Kaen*	1

* means Experimental Work Sections

4.3 SUPPLEMENTAL SURVEYS

For the identification of traffic operational problems as well as for the consideration of the traffic control measures at each selected road sections for the case study and the experimental work. it was necessary to collect various data related to the site condition and traffic condition.

For this purpose, topographic surveys and traffic surveys were carried out by the Study Team. The details of each survey are described below.

4.3.1 Topographic Survey

Generally speaking, topographic maps, which are necessary for the detailed design works, are hardly available in DOH, except road sections where road improvement works had been implemented recently. In fact, after the selection of the road sections for the case study and the experimental work, the Study Team tried to find topographic maps of each selected locations. However, only a limited number of plans for two case study locations were available to the Study Team. Therefore, it was necessary to conduct topographic surveys in order to prepare detailed plans for the remaining locations.

Survey locations and types of topographic surveys carried out by the Study Team is summarized in Table 4.3.

Table 4.3 Survey Locations and Types of Topographic Surveys

Item	Location	Route No.	Survey Type
Case Study	C-2 Chonburi	R3/R315/R344	Plane-table survey
	C-3 Sriracha	R3/Surasak Rd	Plane-table survey Profile survey
	C-4 Wang Noi	R1/R309/R3189	Plane-table survey
Experimental Work	E-1 Laksi	R1/R304	Plane-table survey Cross section survey
	E-2 Pathumthani	R3111/R346	Plane-table survey Cross section survey
	E-3 Khon Kaen	R2	Plane-table survey Cross section survey
	E-4 Khon Kaen	R2	Plane-table survey Profile survey Cross section survey

Based on the results of the topographic surveys, detailed plans were prepared at a scale of 1:1000 for the uninterrupted roadway sections and a scale of 1:500 for the intersections.

4.3.2 Traffic Survey

Traffic volume is one of the most important data items to obtain in order to determine the traffic control measures at selected road sections for the case study and the experimental work.

Hence, traffic volume counting surveys were carried out by the Study Team, since traffic volume data at most of selected locations were not available from DOH. The survey locations of traffic survey is summarized in Table 4.4.

Table 4.4 Traffic Survey Locations

Item	Survey Location	Route No.	Remarks
Case Study	C-1 Bang Na C-2 Chonburi C-3 Sriracha C-4 Wang Noi C-5 Ban Bung Klaeng	R34/R3/R3102 R3/R315/R344 R3/Surasak Rd. R1/R309/R3189 R344/R331	 by DOH by DOH
Experimental Work	E-1 Laksi E-2 Pathumthani E-3 Khon Kaen (M/C Lane) E-4 Khon Kaen (Passing Lane)	R1/R304 R3111/R346 R2 (Kp. 2km) R2 (Kp. 15km)	

Traffic volume was counted for a period of 12 hours from 7 a.m. to 7 p.m. manually, while classification of vehicle type in this survey was for 4 categories as shown in Appendix 4.1. Other traffic surveys, such as a vehicle velocity survey, a queue length survey and a travel time survey, were also conducted in order to grasp the existing traffic condition at certain locations.

It should be noted that the purpose of this traffic survey was to obtain basic traffic data relating to the establishment of traffic control measures at the case study and experimental work locations. Therefore, this traffic survey differs from the before traffic survey. However some results might affect the contents of the 'before' survey. The details of the before-and-after survey is described in section 4.6 of this report.

The results of major traffic surveys are attached in Appendices 4.2 and 4.3.

4.4 OUTLINE OF EXPERIMENTAL WORK PLANS

Details of the experimental works for four (4) selected planning sites prepared by the Study Team are described in this section. The drawings of the detailed plans were based on the topographic map with scales of 1/1,000 and 1/500 for the uninterrupted roadway section and the intersection, respectively.

Through the series of site investigations, supplementary surveys and data analyses, existing conditions and major problems were identified for each planning site, and then traffic operational measures for each planning site were planned in order to cope with major traffic operational problems. For the determination of traffic operational measures, the following points were taken into consideration;

A. The proposed measures should be expected to solve the traffic operational problems at each location.

B. The proposed measures should be acceptable in each representative area.

C. The proposed measures should be applicable to other areas in Thailand, where road and traffic condition are similar.

D. The consensus for the proposed measures should easily be obtained from relevant parties, such as drivers and police.

The following sub-sections describe the details of the experimental work plans.

The detailed plans for each experimental work are combined in the Drawings. In addition, construction plans prepared by DOH for the Laksi Roundabout and the Pathumthani Intersection are also attached in the Drawings.

4.4.1 E-1 Laksi Roundabout (R1/R304)

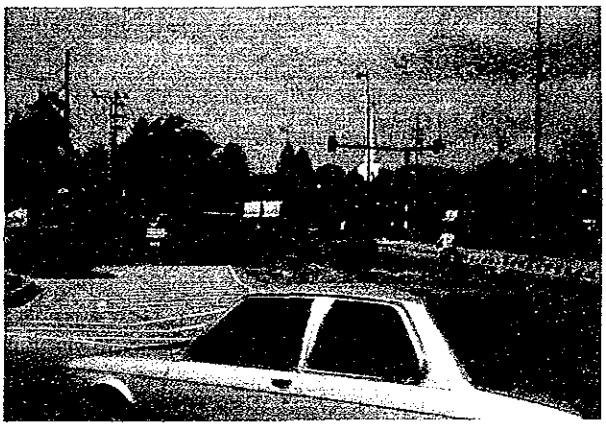
(1) Existing Conditions

A. An elliptical shaped roundabout located in the northern suburban area of Bangkok.

B. A roundabout with four major legs and three small sois.

C. The lane number in the roundabout is mostly four, except for a short section with three lanes.

Before Implementation



After Implementation
(Traffic signals are not in operation)

Photograph of Experimental Work Site
E-1 Laksi Roundabout

D. The approach sections of the roundabout are six lanes for Route 1 and four lanes for Route 304.

E. Sufficient number of street lightings are installed at the roundabout.

F. Pedestrian overpasses are installed along Route 1 at the both sides of the roundabout.

G. The fluctuation in traffic volume entering the roundabout over 24 hours is shown in Figure 4.3.

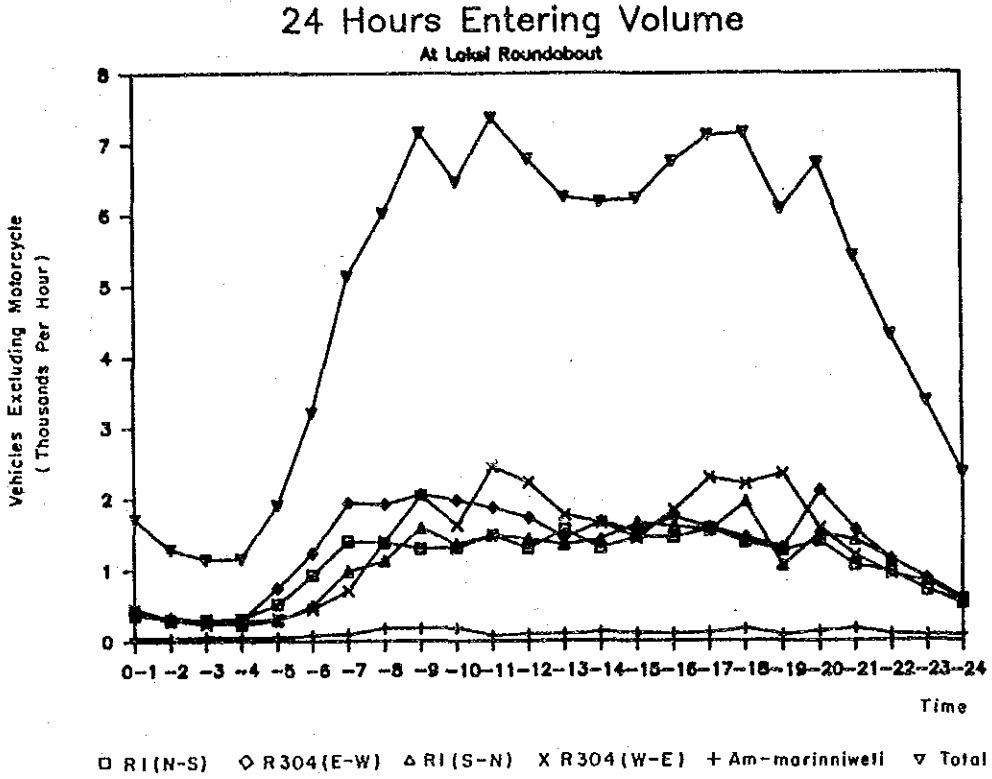


Figure 4.3 24 Hours Traffic Volume Entering Laksi Roundabout

H. The traffic flows by PCU in this roundabout in the morning and the evening peak period are illustrated in Figures 4.4 and 4.5. On the survey day, the traffic pattern between 8 a.m. and 11 a.m. was different from an ordinary day, since many traffic attending a funeral were considered to be included. The result of the second traffic volume survey as well as the DOH traffic data on Route 1 indicate the morning peak hour as between 7 a.m. and 8 a.m. In fact, there was no significant difference of traffic volume for the time range of 7 a.m. to 8 a.m. between the first and the second traffic survey results. Hence, the traffic volume in PCU between 7 a.m. and 8 a.m. is shown in this figure.

In the morning peak period, the main traffic flows are south bound traffic both from Route 304 (from east) and Route 1 (from north). While in the evening peak period, the main traffic flows are north bound and east bound traffic both from Route 304 (from west) and Route 1 (from south).

(2) Major Problems

A. Traffic volume at this roundabout is very high and between 6,000 to 8,000 vehicles per hour during daylight hours.

B. Weaving length particularly at the south-east corner of the roundabout is too short to maintain smooth traffic flow.

C. Arrival speeds of vehicles from both sides of Route 1 are very high.

(3) Proposed Traffic Operational Measures

A. Installation of coordinated traffic signals with overhang signal displays are proposed for the following reasons;

- Traffic volume at this roundabout exceeds the limit of non signalized roundabout control.

- Stop control at this roundabout cannot reduce traffic accidents and traffic conflicts due to the short weaving length at the roundabout.

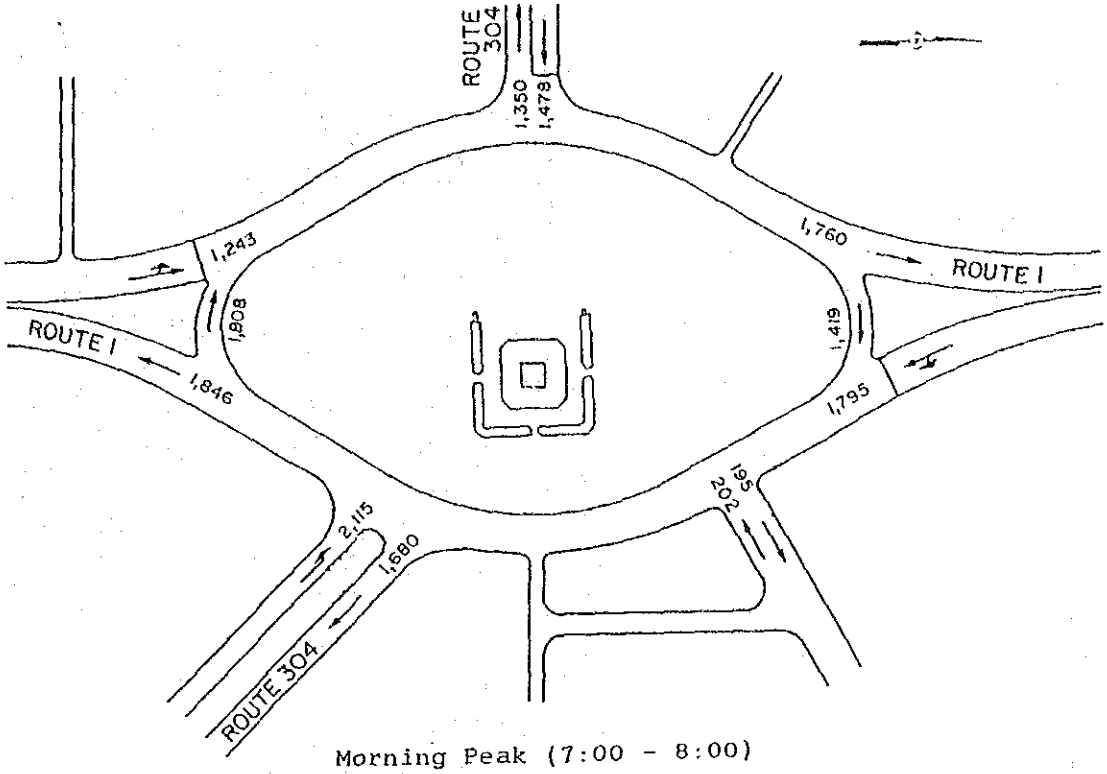
- Since the arrival speed of vehicles, especially from both sides of Route 1, are high, it is desirable to install overhang type signal displays in order to provide adequate visibility of traffic signals.

- The size of the roundabout is very large; hence it is necessary to coordinate each traffic signal installed at this roundabout.

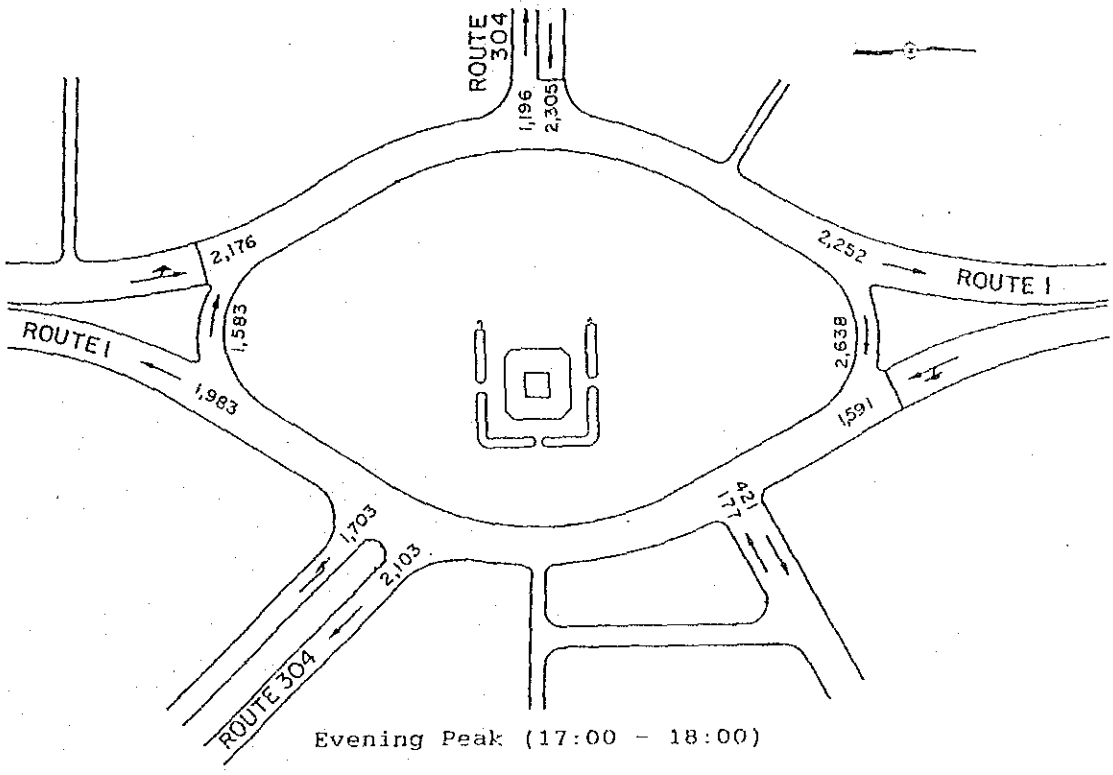
Proposed installation plan of traffic signal and its phasing plan is illustrated in Figure 4.6.

B. Installation of pedestrian signals at both approaches of Route 304 are proposed in order to provide for the safety of crossing pedestrians.

C. Provision of pavement markings are proposed to delineate the necessary number of lanes at each part of the roundabout. Figure 4.7 indicates the necessary number of lanes at this roundabout.



Morning Peak (7:00 - 8:00)



Evening Peak (17:00 - 18:00)

Figure 4.4 Traffic Flow at Laksi Roundabout

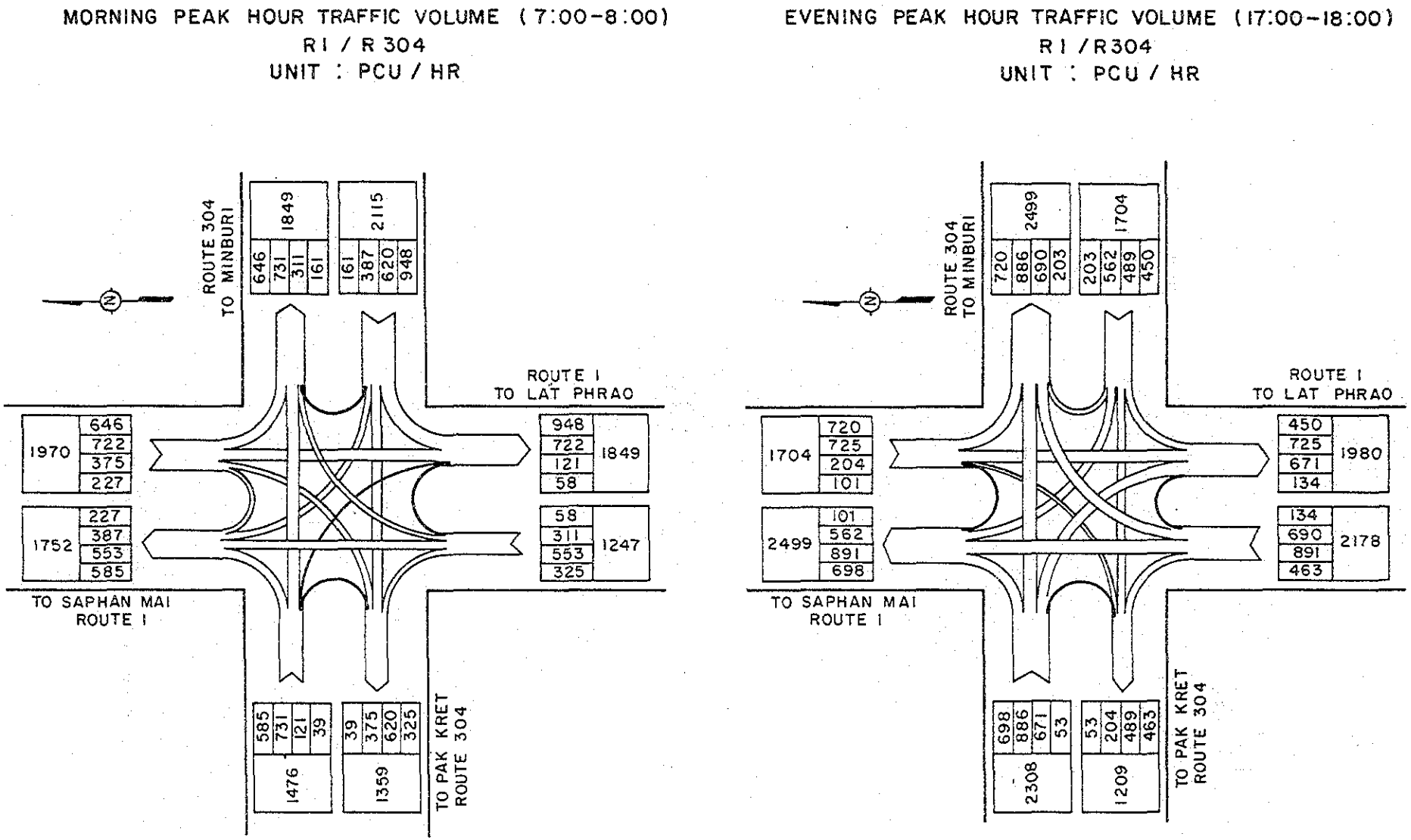
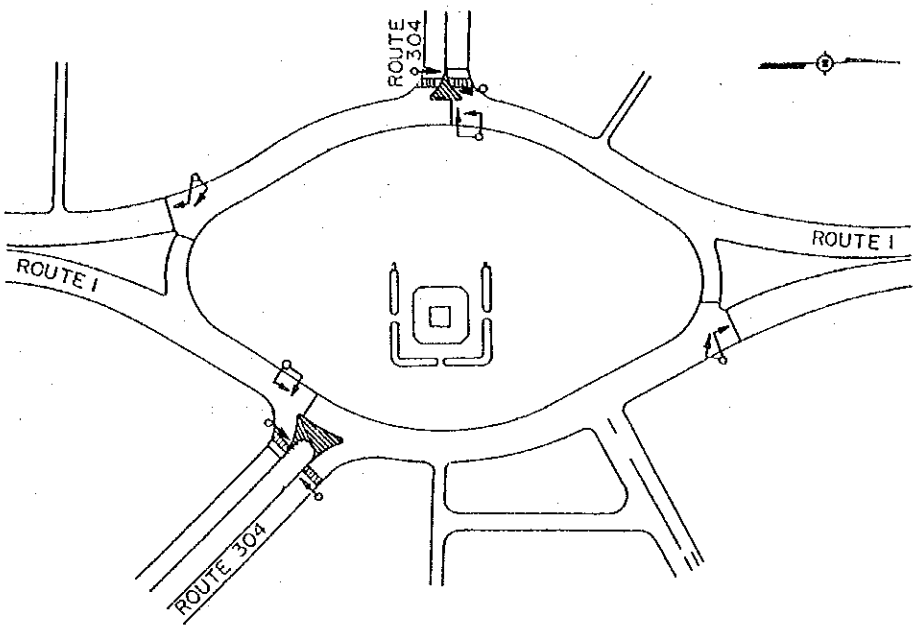
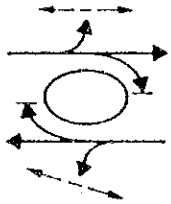
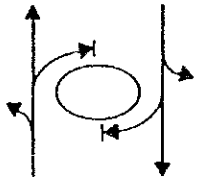


Figure 4.5 Traffic Volume at Laksi Roundabout

INTERSECTION NAME	LAKSI	LOCATION	ROUTE I / ROUTE 304



1	2	3		
				

REMARKS

a)	Traffic signals for vehicle (Overhead type)	8	set
b)	Traffic signals for pedestrian	4	set
c)	Controller	4	

Figure 4.6 Traffic Signal Installation Plan for Laksi Roundabout

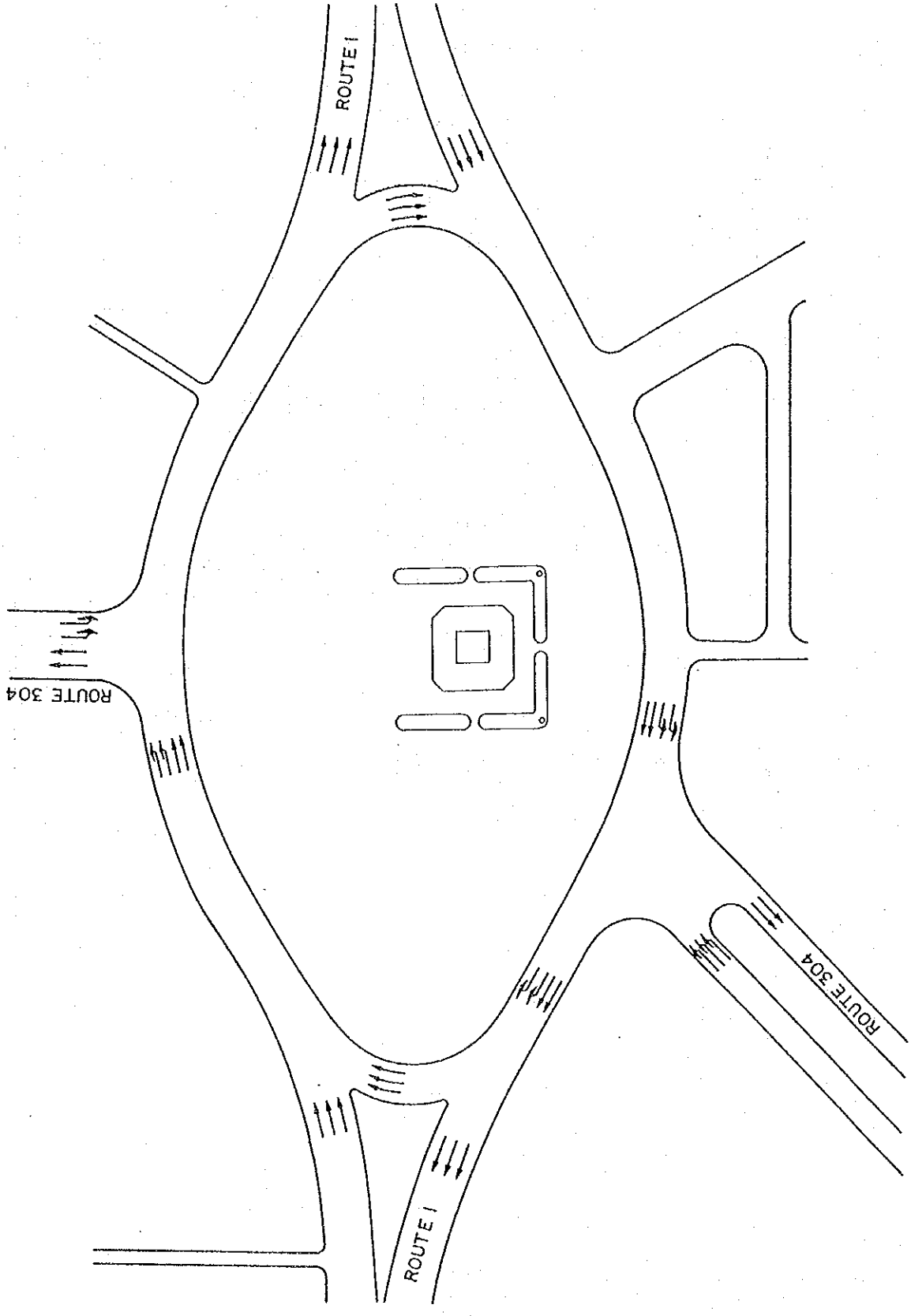


Figure 4.7 Required Lane Number at Laksi Roundabout

(4) Future Operational Measures

Even now, as a result of the queue length survey (refer to Figure 4.8) shows the queue length at both sides of Route 304, in particular west bound, are long enough to the point of being fully saturated.

Although the signalization is recommended to ameliorate the present traffic situation, a drastic improvement such as grade separation will be necessary sooner or later to handle the sharply increasing traffic volume.

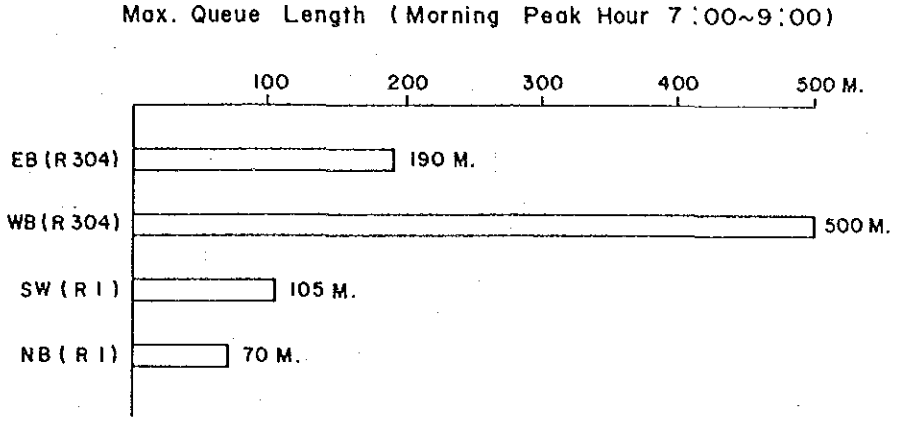


Figure 4.8 Results of Queue Length Survey at Laksi Roundabout

A. To introduce a grade separation at the roundabout with a four lane underpass on Route 1 as shown in Figure 4.9. Main reasons for the measure adopted are;

   - Traffic on Route 1, which is the main route, shall be separated from other traffic to decrease the friction in traffic.

   - The underpass, which will not disturb the people's view, is more acceptable than a flyover.

   - Route 1 is easier to accomodate an underpass structure than Route 304 from the point of existing land use situation.

B. Lane number of at grade section of Route 1 alongside the underpass is reduced from existing 3 to 2.

C. Whole roundabout is coordinatedly signalized with overhang signals.

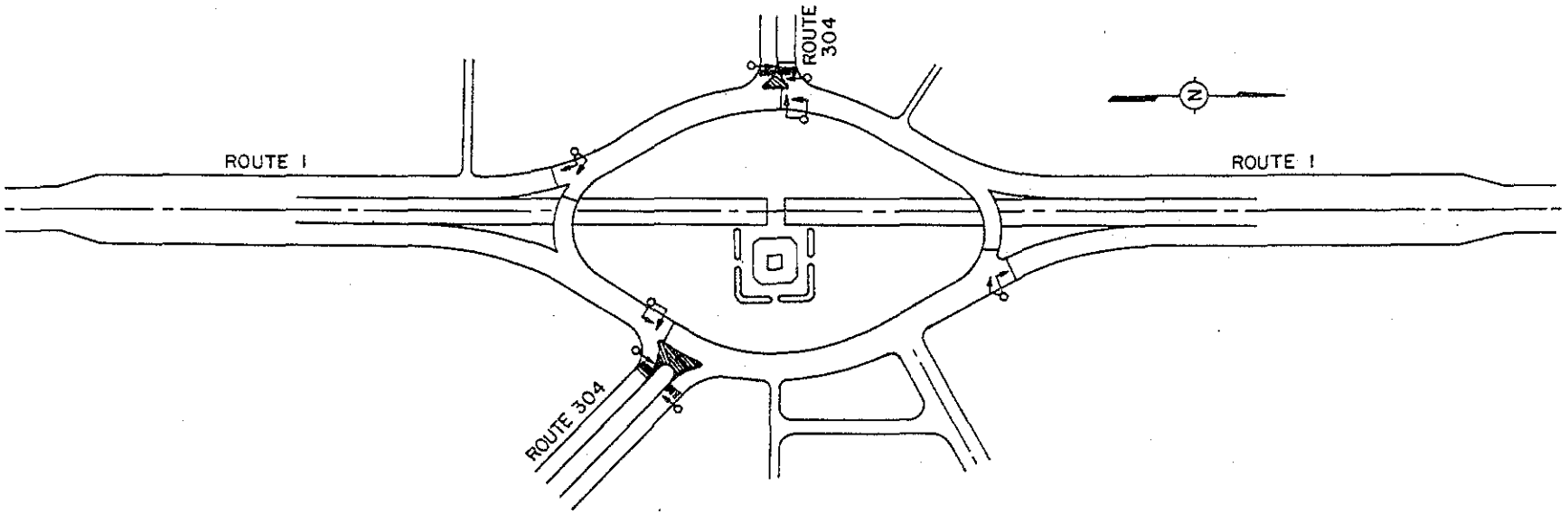
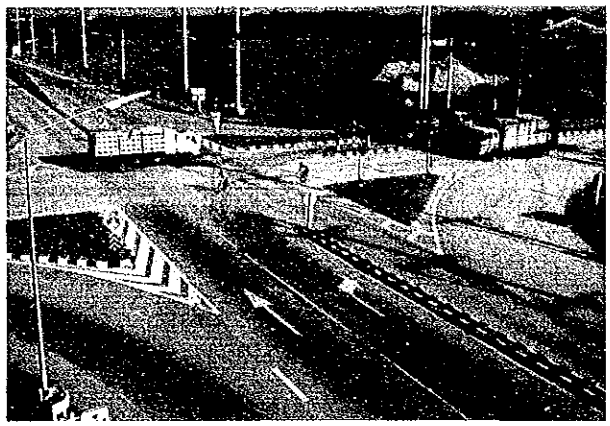
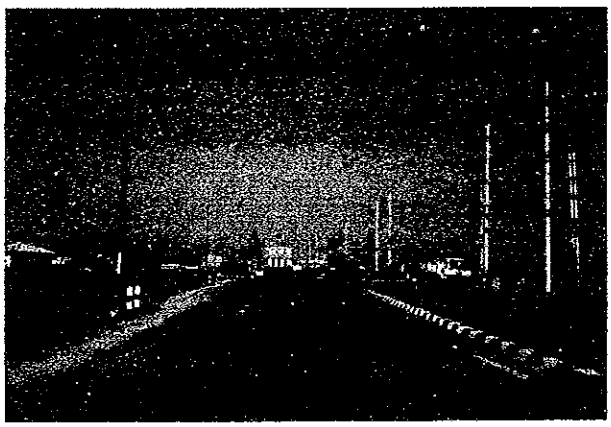
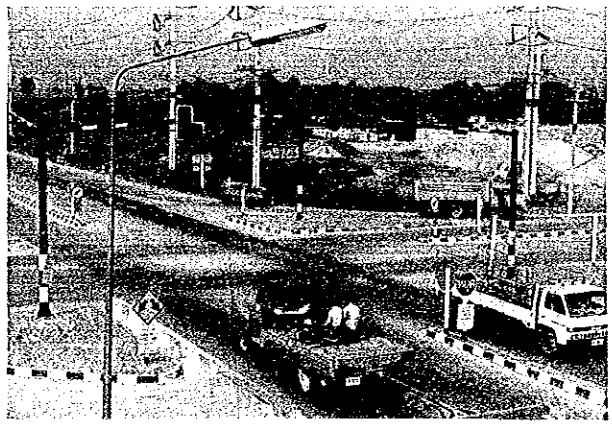


Figure 4.9 Grade Separation Plan at Laksi Roundabout



Before Implementation





After Implementation

Photograph of Experimental Work Site
E-2 Pathumthani Intersection

4.4.2 E-2 Pathumthani Intersection (R3111/R346)

(1) Existing Conditions

A. At grade intersection with 4 legs in the rural area.

B. Number of lanes on each intersecting road is two (2).

C. Right turn and left turn lanes with separators and traffic islands are installed for each approach.

D. Sufficient street lighting is installed.

E. Only a limited number of pedestrians were observed.

F. Hourly fluctuation of traffic volume entering this intersection is shown in Figure 4.10. During the daytime, traffic volume entering this intersection is almost uniform, although peak periods can be observed at 10-11 in the morning and 15-16 in the afternoon.

G. Turning movements during peak hours as well as an off-peak hour at this intersection are illustrated in Figure 4.11. The main traffic flow is the through traffic of R3111; however, right and left turn traffic volume between Rangsit and Pathumthani/Sam Khok are also high. In addition, the heavy vehicle composition is very high at 25-40% at this intersection.

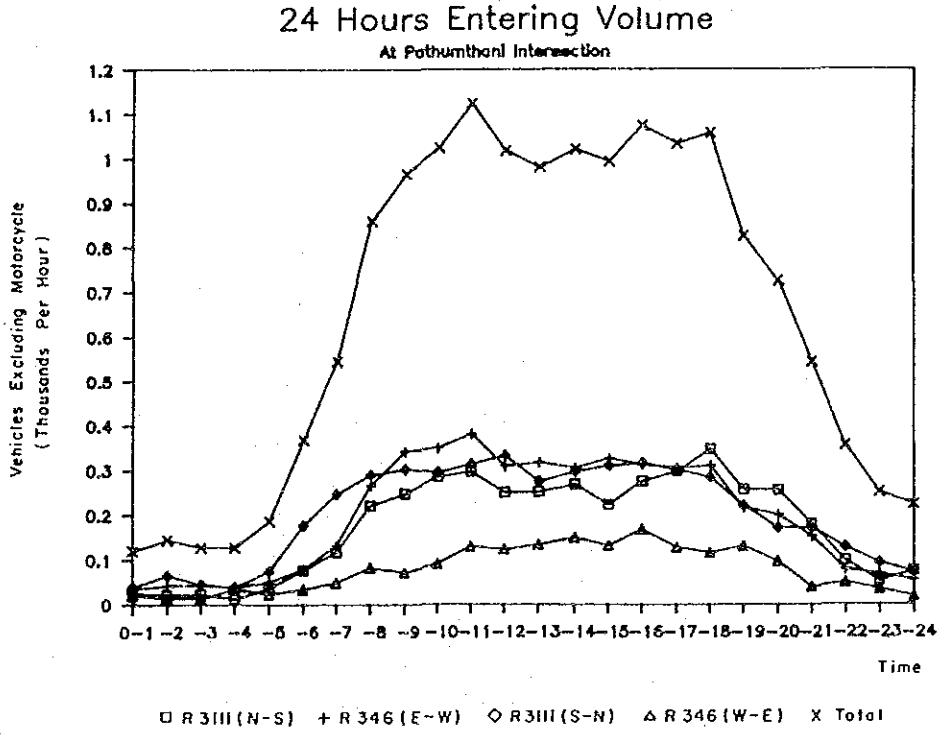


Figure 4.10 Fluctuation of Traffic Volume Entering to the Pathumthani Intersection

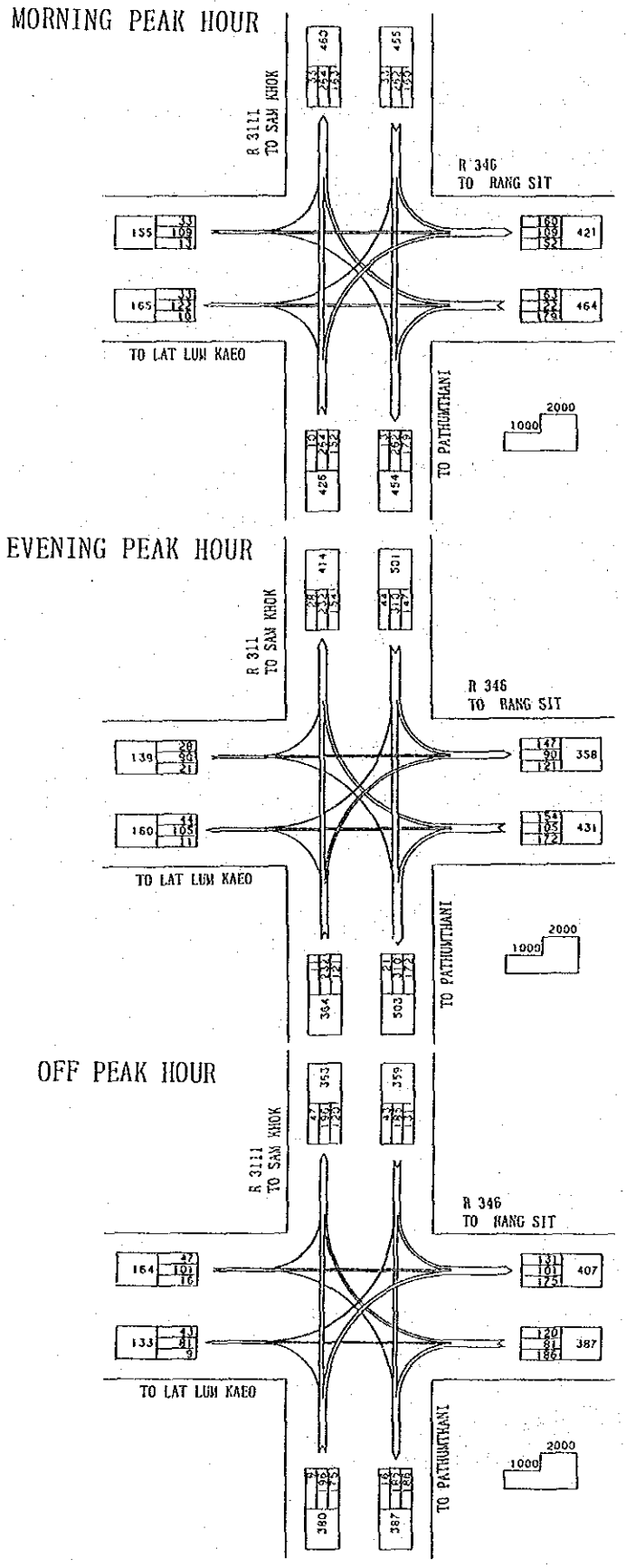


Figure 4.11 Traffic Volume at Pathumthani Intersection

(2) Major Problems

A. Priority of vehicle movements is not clear at this intersection even though yellow flushing lights are installed.

B. Stop control is difficult due to heavy traffic volume on both crossing roads and high composition rate of right turning vehicles.

C. Frequent accidents involving right turning vehicles.

D. Possibility of conflicts with through vehicles and left turning vehicles at merging sections.

E. Difficulty of right turning due to undesirable location of stop lines for right turn heavy vehicles, which may confuse the traffic flow.

(3) Proposed Traffic Operational Measures

A. Installation of traffic signals with overhang signal displays are proposed at this intersection by the following reasons;

- Even though the peak hour traffic volumes at this intersection is considered to be on the border line of warranting condition of traffic signal, almost the same traffic volumes are observed throughout the daytime.

- It is difficult to clarify the priority by stop control, since traffic volume on both crossing roads are very similar.

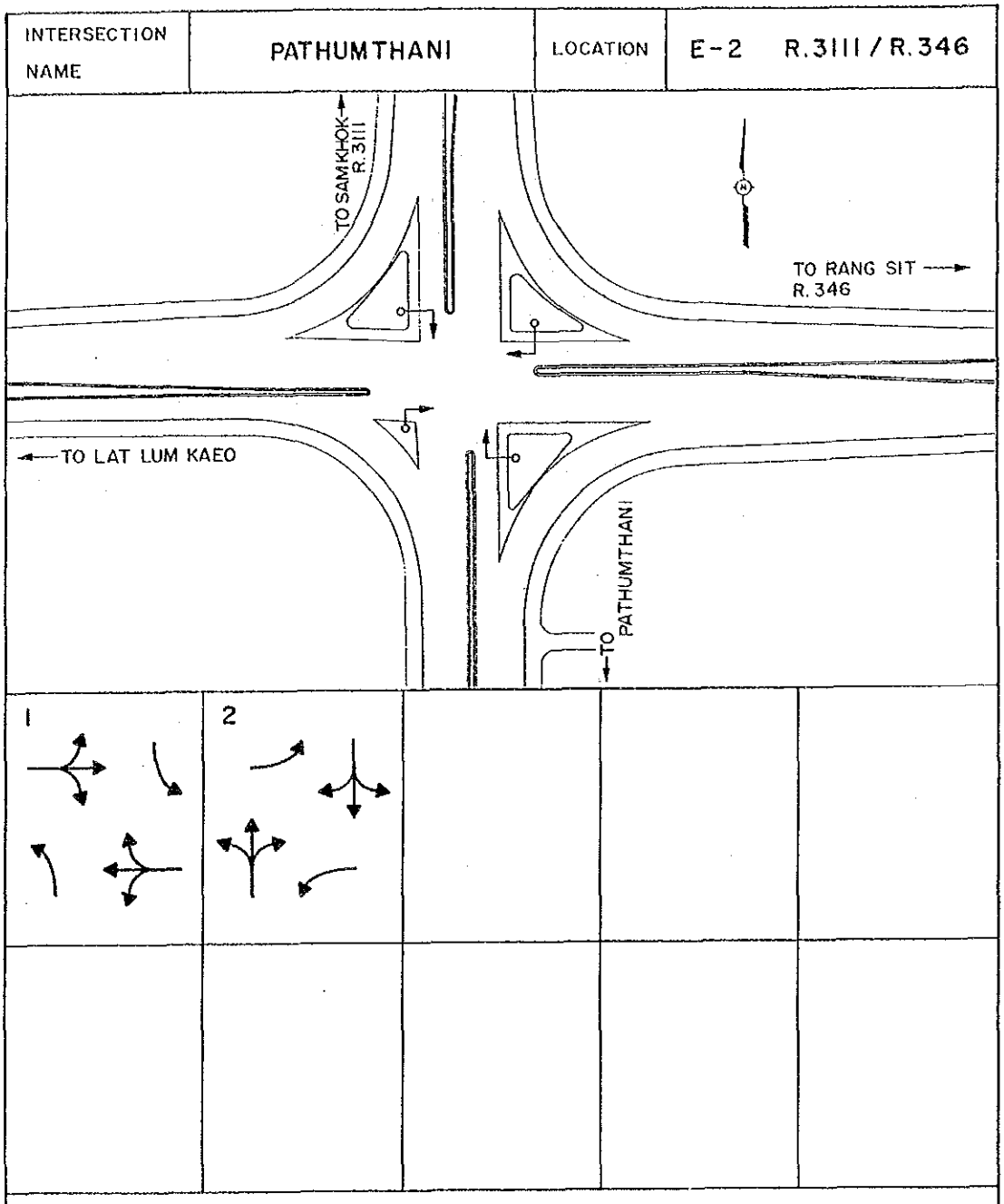
- Many traffic accidents involving crossing vehicles and right turning vehicles have occurred.

- The speed of vehicles is high and it is necessary to improve the visibility of traffic signals.

Traffic signal installation plan for this intersection is illustrated in Figure 4.12.

B. Installation of acceleration lane for the left turn lanes direction to Pathumthani from Route 346 and to Route 346 from Sam Khok are proposed in order to avoid conflicts between through traffic and left turn traffic, since the left turning traffic volume on these directions are high.

C. Relocation of stop lines are proposed to provide for smooth right turning movements.



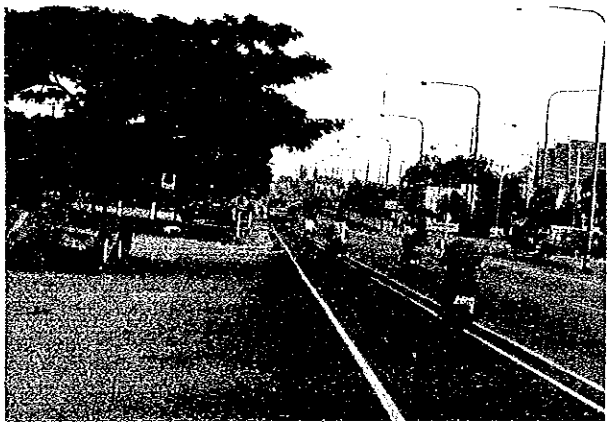
REMARKS

a) Traffic Signal for vehicle (Overhead type) 4 set

b) Controller 1 "

Figure 4.12 Traffic Signal Installation Plan for Pathumthani Intersection

Before Implementation



After Implementation

Photograph of Experimental Work Site
E-3 Motorcycle Lane in Khon Kaen

4.4.3 E-3 Motorcycle Lane in Khon Kaen (R2 kp 1.1km-3.1km)

(1) Existing Conditions

A. Route 2 is one of the most important primary highways in the North-Eastern Region connecting Saraburi and Nongkai via Khon Kaen.

B. Route 2 is a two lane dual carriageway at this section.

C. The selected road section is located in the built-up urban area, and many houses and shops are located along this road.

D. The hourly fluctuation of traffic volume and the volume of motorcycles at this road section are shown in Figure 4.13. Basically, the composition rate of motorcycle at this road section is very high at 45% during peak hours.

E. Many traffic accidents resulting in collisions with the median have occurred during the evening peak hours.

F. Sufficient street lighting is installed.

(2) Major Problems

A. Disturbance and confusion to main traffic flow is caused by motorcycles.

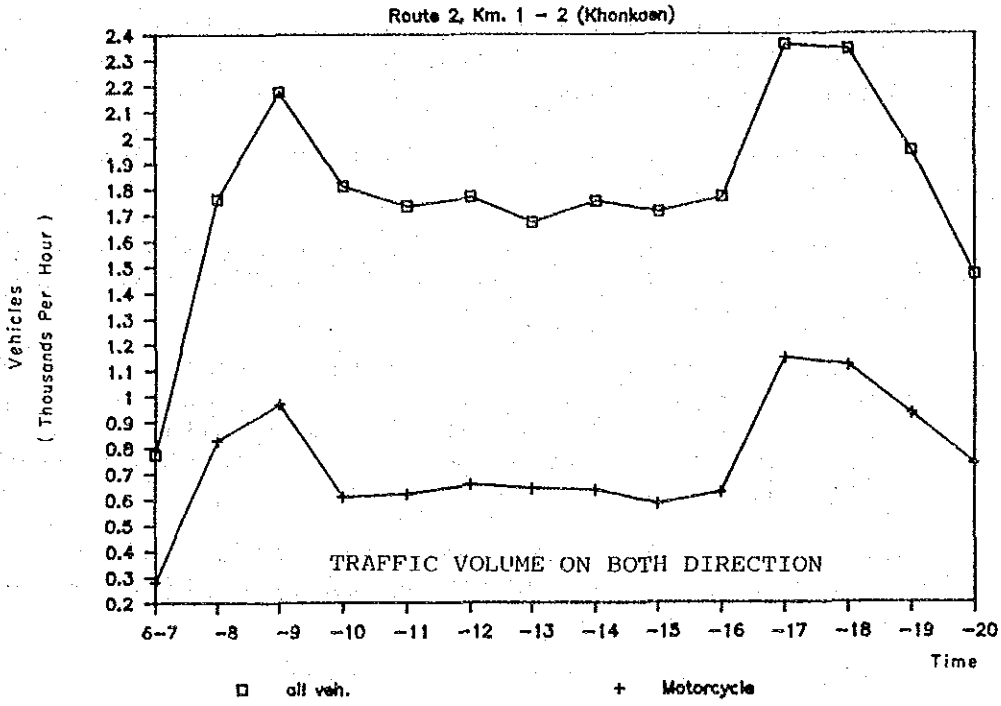
B. Numerous traffic conflicts between ordinary motor vehicles and motorcycles.

(3) Proposed Traffic Operational Measures

A. Installation of an exclusive motorcycle lane is proposed for this road section, since it is desirable to segregate ordinary motor vehicles and motorcycles, in order to achieve the smooth traffic flow on the main carriageway and to avoid conflicts between ordinary motor vehicles and motorcycles.

B. For this road section, two alternative cross section elements as shown in Figure 4.14 are proposed, since provision of an exclusive motorcycle lane is a new concept in Thailand.

- As for the width of the motorcycle lane, two alternatives w=1.5m and w=2.0m are proposed since this measure is an experiment.



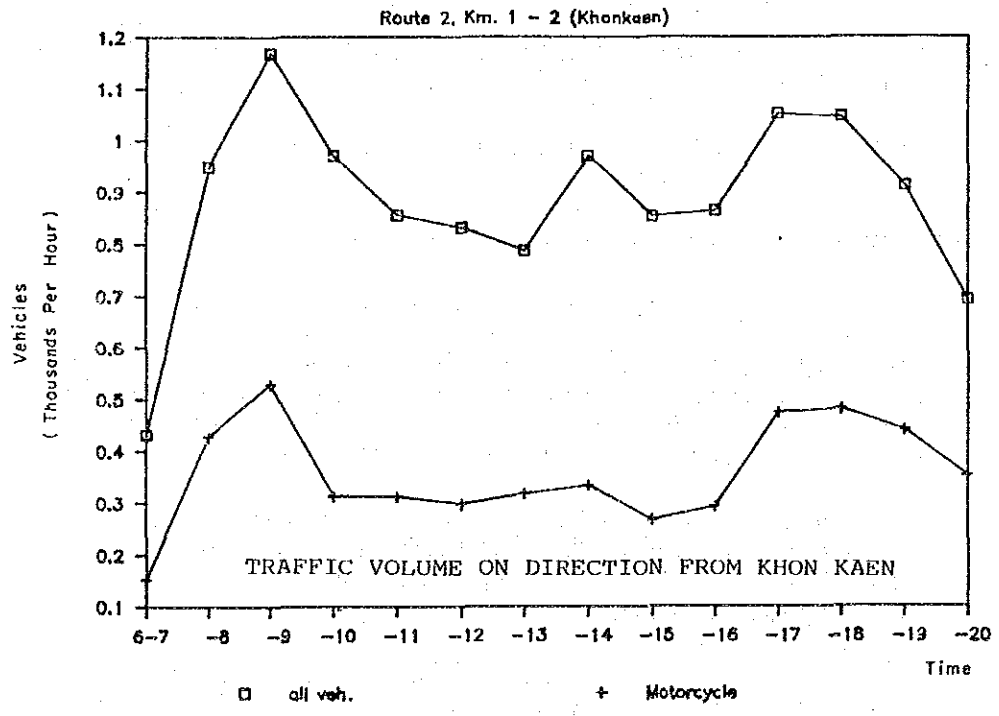


Figure 4.13 Hourly Fluctuation of Traffic Volume on Route 2 for Motorcycle Lane

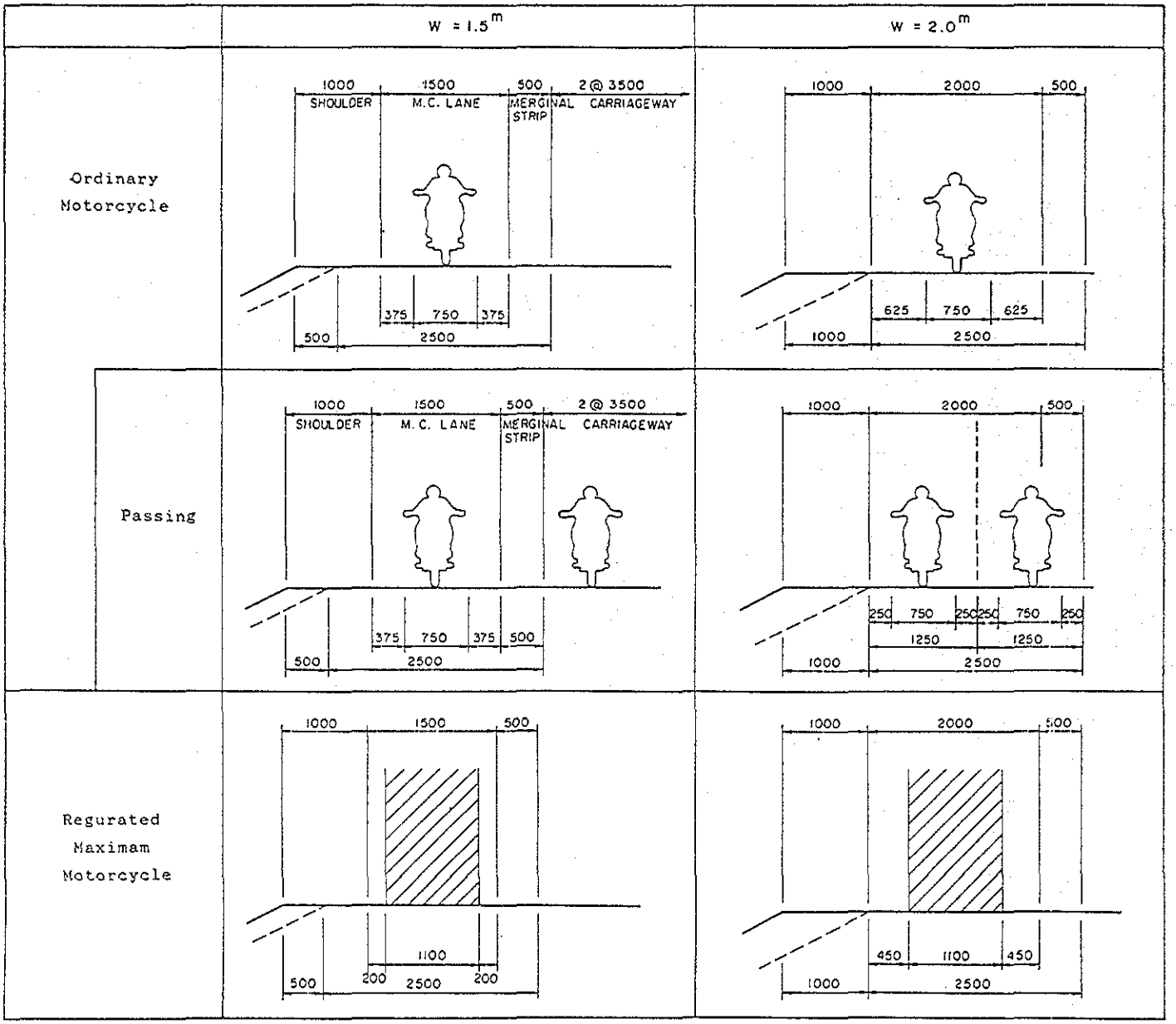


Figure 4.14 Alternative Cross Section Elements for Motorcycle Lane

- Provision of a marginal strip of 0.5m is planned in order to clearly separate the main carriageway and the motorcycle lane, and to ensure lateral clearance.

- Provision of 1.0m width shoulder is planned in order to provide space for pedestrians and to protect the road structure.

C. Installation of bus bays at three bus stops is also proposed as shown in Figure 4.15 in order to avoid conflict with the stream of motorcycle traffic as well as for the main traffic flow caused by a stopping bus.

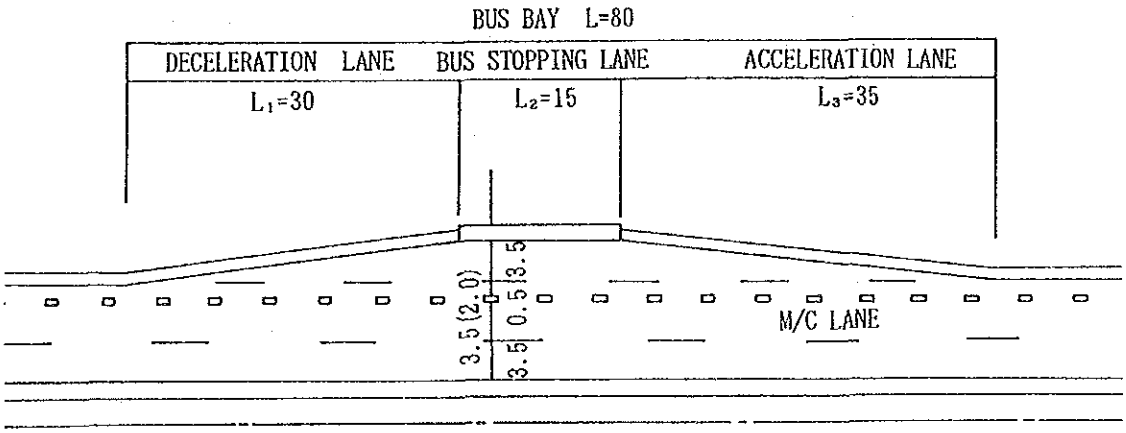
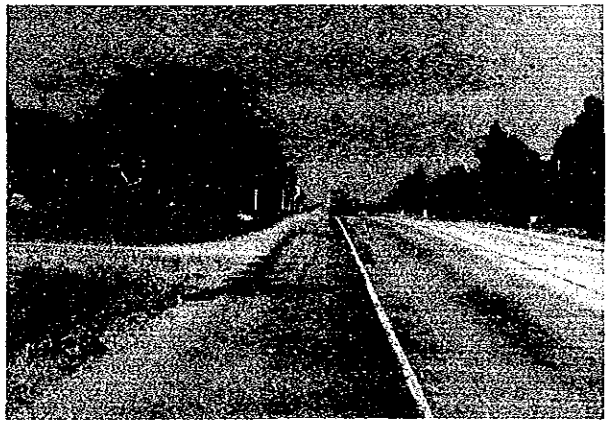


Figure 4.15 Geometry of Bus Bay

Before Impelementation



Under Construction

Photograph of Experimental Work Site
E-4 Passing Lane in Khon Kaen

4.4.4 E-4 Passing Lane in Khon Kaen (R2 kp. 14.025km-15.5km)

(1) Existing Conditions

A. The selected road section is part of a very important intercity primary highway located in the rural area.

B. This road section consists of two lanes with provision of a wide shoulder of 2.5m on each side.

C. This road section is located in the rolling terrain, although the horizontal alignment is straight.

D. Hourly fluctuation of traffic volume excluding motorcycles are shown in Figure 4.16. It is clear from this figure that the composition rate of heavy trucks at this road section is very high at about 30% in the morning peak period.

(2) Major Problems

A. Impeded speed of vehicles due to high composition rate of heavy, slow moving vehicles.

B. Difficulty of overtaking slow moving vehicles due to insufficient sight distance in rolling terrain and heavy traffic volume on the opposing lane.

C. This situation leads the reduction of the traffic capacity and driving comfortability. Also, this may lead severe traffic accidents, such as a head-on collision, caused by improper overtaking by frustrated drivers.

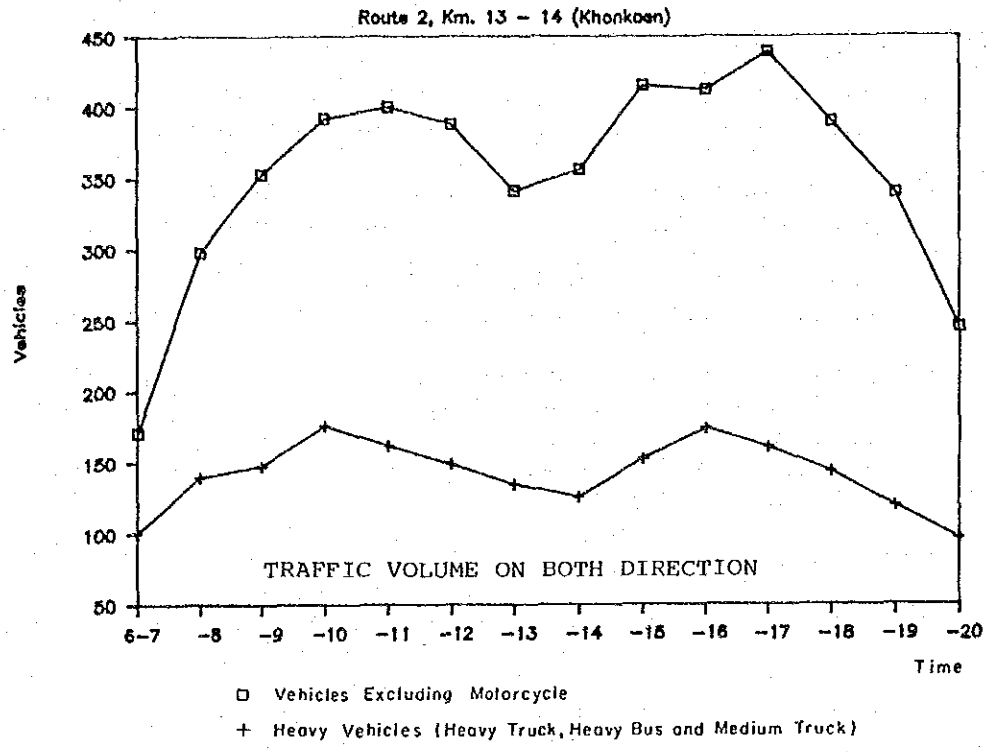
(3) Proposed Traffic Operational Measures

A. Installation of a passing lane is proposed in order to prevent accidents as well as conflicts caused by improper overtaking, and to maintain orderly traffic flows mainly for high speed vehicles.

B. Basically, it is desirable to provide passing lanes on both directions in each 5 to 7 km as described in the Technical Guideline. However, since this traffic operational measure is an experiment, provision of a passing lane only for a direction toward Khon Kaen is proposed.

C. The overtaking method is considered to be suitable at this section mainly by the following reasons;

- Vehicle speed is high; hence smooth operation, especially at the merging section, is necessary.



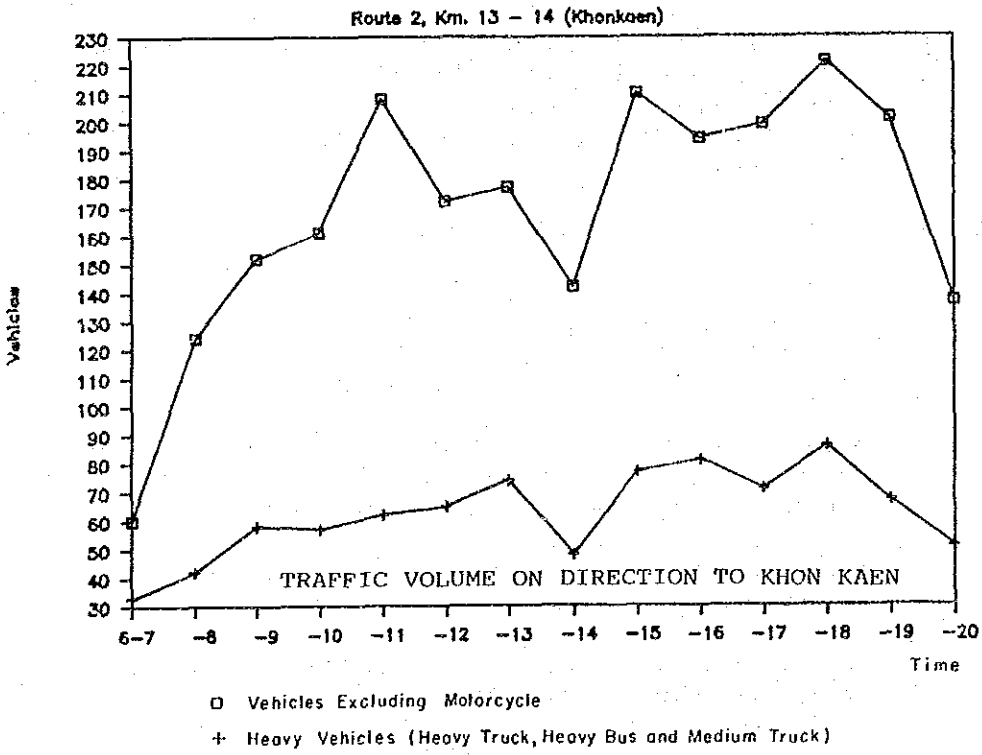


Figure 4.16 Hourly Fluctuation of Traffic Volume on Route 2 for Passing Lane

- The way of driving is as same as on an ordinary 4-lane road.
- The right of way at this section is quite wide.

D. The structure of the passing lane is illustrated in Figure 4.17.

- The outer lane is the main carriageway, while the inner lane can be used by vehicles wishing to overtake slow moving vehicles.

- The center strip which is delineated by pavement markings is provided to clearly separate the passing lane and the opposing lane, in order to avoid encroachment from the opposing lane.

E. The location of diverging and merging sections are selected by avoiding steep gradient sections.

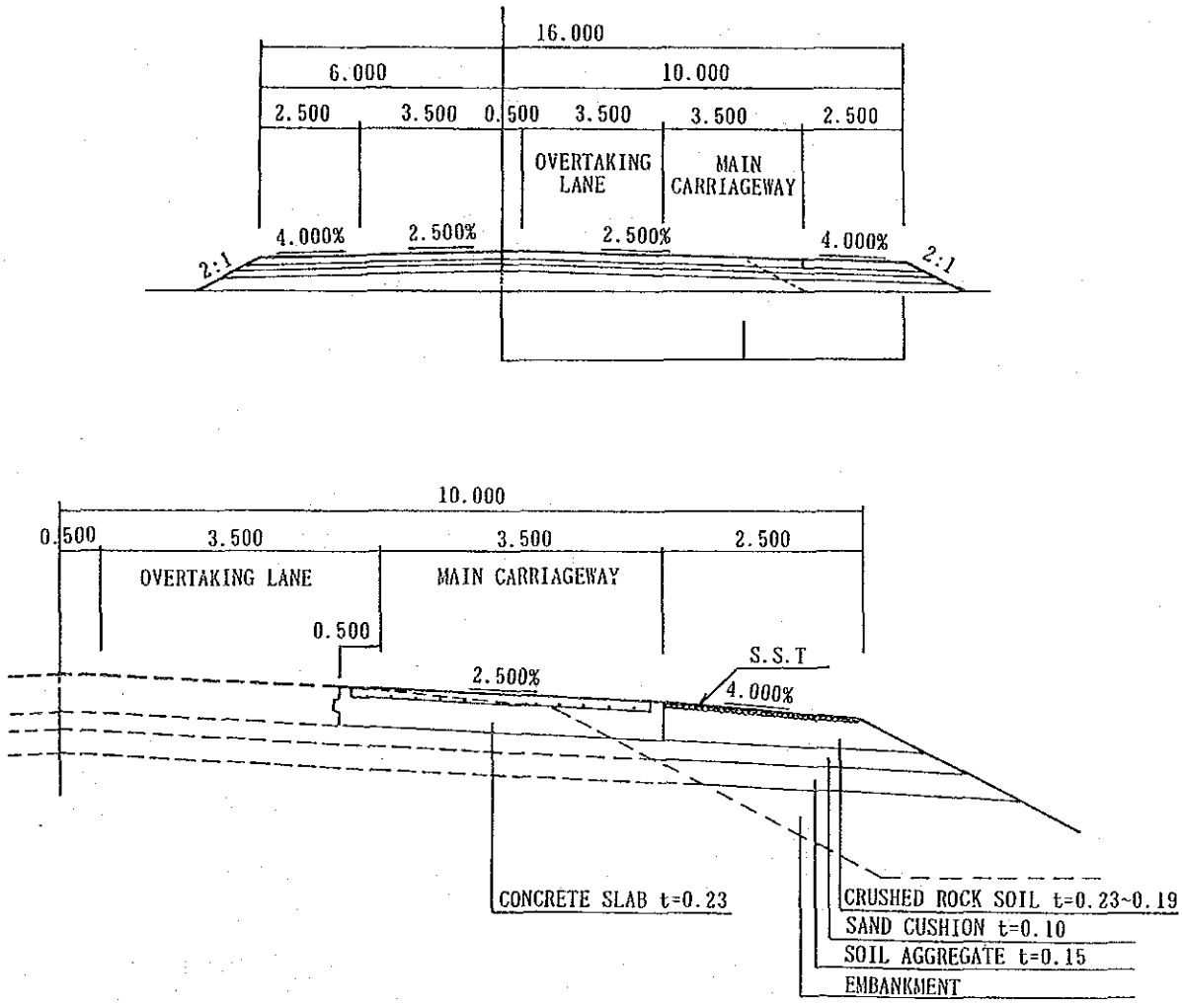


Figure 4.17 Structure of Passing Lane

4.5 IMPLEMENTATION

The experimental improvement works at four planning sites have been implementing by DOH with DOH budget.

The construction plans for the Laksi roundabout and the Pathumthani intersection were prepared by DOH based on the proposed plans prepared by the Study Team. On the other hand, the construction plans for the motorcycle lane and the passing lane in Khon Kaen were prepared by the Study Team.

The estimated quantities for the improvement works at the Laksi roundabout and the Pathumthani intersection are attached in Appendix 4.4, while those for the motorcycle lane and the passing lane in Khon Kaen are shown in the construction plans included in the Drawings.

The improvement cost for the experimental work are summarized in Table 4.5.

Table 4.5 Summary of the Improvement Cost for the Experimental Works

Location	Route No.	Traffic Operational Measures	Improvement Cost (Mill. Baht)
E-1 Laksi Roundabout	R1/R304	- Installation of Signal - Pavement Marking	3.74
E-2 Pathumthani Intersection	R346/ R3111	- Installation of Signal - Provision of Added Lane	0.70 (only signal)
E-3 Khon Kaen	R2	- Provision of Motorcycle Lane	0.55 (only W=1.5m)
E-4 Khon Kaen	R2	- Provision of Passing Lane	3.44

Among four experimental improvement works, implementation of three of them were completed by the following schedule.

- Motorcycle lane in Khon Kaen : Middle of November, 1989.
- Pathumthani Intersection : End of December, 1989.
- Laksi Roundabout : End of January, 1990.

It should be noted that only one of proposed alternatives for the motorcycle lane, i.e. width of 1.5m, was implemented in order to shorten the construction period by avoiding the embankment works.

4.6 EFFECTIVENESS EVALUATION FOR EXPERIMENTAL WORKS

4.6.1 Concept of Effectiveness Evaluation

Before and after analyses are usually designed to evaluate the effectiveness of improvement measures for highways or traffic in accordance with selected criteria. Generally, the criteria for evaluation are economic, efficiency and safety measures for the traffic flow achieved through the improvement of road sections.

Economic evaluation are always expressed as the monetary value of the benefits to the road users, the adjacent property, and the general public as well as the actual costs for improvement and operation.

Measures of efficiency are normally described by changes in speed, reduction of traffic delays, and increased compliance of drivers or pedestrians to traffic regulations and control devices.

Safety evaluation are provided by changes in type, frequency, and severity of traffic accidents or conflicts. However, other measures of traffic flow and/or safety conditions can be applied as decision making variables in a before and after study.

In the Study, the Study Team decided to adopt before- and after-surveys for the effectiveness evaluation of the experimental works by means of comparison of traffic conditions and traffic accidents between before and after implementation of planned improvement measures.

4.6.2 Method of Before- and After-Surveys

The before- and after-surveys have being conducted in 3 main categories as follows;

(1) Traffic Condition Survey

The purpose of traffic conditions surveys is to evaluate the efficiency and economic evaluation of experimental works and also to check the traffic pattern before and after their implementation.

The surveys were conducted in the periods before and after the implementation of the improvement works; however the details for each location were not same since the experimental work at each site was planned and designed with difference objectives. The major survey items are as follows;

- Running speed
- Headway
- Placement of traveling vehicle

- Conflicts
- Traffic volume

The VTR recording was applied to the traffic conditions survey in which a number of techniques were necessary. However, the traffic volume counting by using automatic counter and manual counts were still recommended for the long period surveys such as 12 hours counts, 24 hours counts and longer periods. The classification of traffic is made for four (4) vehicle types which are same as mentioned in the previous section.

In the case of passing lane analysis, a number plate survey was planned in order to determine the number of overtaking vehicle and checking their order at the point of arrival and after passing through the site.

(2) Traffic Accident Survey

The traffic accident survey aimed at effectiveness evaluation of the experimental works by comparing the difference in traffic accidents between before and after implementation of planned improvements. The comparison was made as to number, severity and causes of accidents which occurred during the survey period. Basically, traffic accident data for each 3 months before and after the implementation of the experimental works were collected from local police stations concerned with each improvement site.

However, in the case of the Laksi roundabout and the Pathumthani intersection, it seemed that many low severity accidents, which were normally not recorded in accident investigation records by policemen, occurred at these two locations. Since it was also important to measure the incidence of low severity accidents at these two sites, the Study Team carried out the traffic accident survey.

The traffic accident survey were conducted at the site for 12 hours in the day time, from 7:00 a.m. through 7:00 p.m. Appendix 4.5 shows an accident survey form used in this survey. The period of the survey was one month before and after the implementation of improvements since works' scheme was limited. The results of this traffic accident survey were used to supplement the traffic accident data obtained from local police stations.

(3) Interview Survey

The interview surveys were planned for the experimental works of the motorcycle lane and the passing lane in order to obtain the opinion of drivers regarding to the improvement works and to observe driving characteristics

which were utilized as the supporting data for the effectiveness study.

The interview surveys were carried out for only after the implementation of improvement works, while the samples were picked up from motorcyclists who utilized the motorcycle lane as well as those who did not utilize it.

The contents of before- and after-surveys at each experimental work site are summarized in Table 4.6.

4.6.3 Before-and After-Surveys

(1) Before-Survey

The before-surveys were carried out at four experimental work sites in July and August, 1989 mainly based on the proposed survey items.

The analysis of the before-survey results were completed and analyzed results were utilized for the effectiveness evaluation.

(2) After-Survey

The after-surveys had been planned to be carried out after completion of the implementation of experimental works for the proposed survey items, which were almost same as the before-surveys.

Unfortunately, the delay of the implementation of experimental works, mainly because of the budgetary procedure and lacking of contractors, also cause the delay of the after-surveys. As the result, after surveys only at two experimental work sites, i.e. the motorcycle lane in Khon Kaen and the Pathumthani Intersection, were carried out. While the after-surveys for the improvement of Laksi Roundabout and the passing lane in Khon Kaen are going to be carried out by DOH after completion of implementation works.

4.6.4 Effectiveness Evaluation on Experimental Works

The effectiveness evaluation for two experimental works of the motorcycle lane in Khon Kaen and the improvement of the Pathumthani Intersection were carried out.

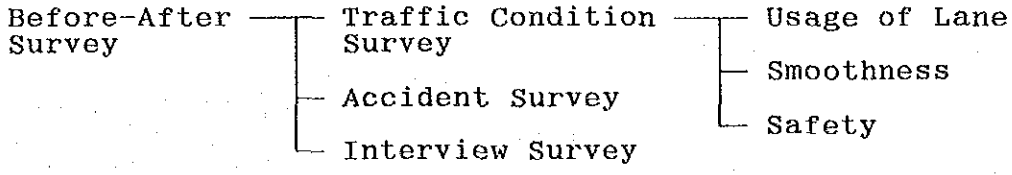
The results of the effectiveness evaluation for the motorcycle lane in Khon Kaen and the improvement of the Pathumthani Intersection are summarized below. In addition, the details of evaluation results are attached in Appendix 4.6.

Table 4.6 Before- and After-Surveys for Evaluation of Experimental Works

Location	Traffic Condition Survey	Traffic Accident Survey
Laksi Roundabout	1. VTR Recording - 2 hours each at peak and off-peak hours from 2 points. - To check running path, conflicts and entry/exit speed of vehicles. 2. Traffic Volume Counting a) By automatic traffic counter b) By traffic surveyor For 12 hours at entry and exit points of each leg or roundabout by vehicle type.	1. Accident Survey by Surveyor - 7 a.m. to 7 p.m. everyday for 1 month. - To examine the effect of accidents, including light accidents, on the traffic flow. 2. Collection of Accident Data for 2 months from Local Police Station.
Pathumthani Intersec-tion	1. VTR Recording - 2 hours each at peak and off-peak hours from 2 points. - To check running path, conflicts and entry/exit speed of vehicles. 2. Traffic Volume Counting a) By automatic traffic counter - For 1 week by vehicle type. b) By traffic surveyor - For 12 hours at entry and exit points of each leg of roundabout by vehicle type.	1. Accident Survey by Surveyor - 7 a.m. to 7 p.m. everyday for 1 month. - To examine the effect of accidents, including light accidents, on the traffic flow. 2. Collection of Accident Data for 2 months from Local Police Station.
Khon Kaen (M/C Lane)	1. VTR Recording - 1 hour each at peak and off-peak hours at 2 points. - To check running path, conflicts and running speed of vehicles. 2. Traffic Volume Counting a) By automatic traffic counter b) By traffic surveyor - For 12 hours by direction and by vehicle type. 3. Interview Survey (After Only) - Conduct interview with M/C riders and other vehicle drivers about their opinion of M/C Lane.	1. Collection of Accident Data for 2 months either from Local Police Station or Highway Police.
Khon Kaen (Passing Lane)	1. VTR Recording - 1 hour each at peak and off-peak hours at 2 points. (beginning, end and mid section of passing lane) - To check passing condition, conflicts and running speed of vehicles. 2. Number Plate Survey - 1 hour each at peak and off-peak hours. 3. Traffic Volume Counting a) By automatic traffic counter b) By traffic surveyor - For 12 hours by direction and by vehicle type. 4. Interview Survey (After Only) - Conduct interview with drivers about their opinion of Passing Lane.	1. Collection of Accident Data for 2 months either from Local Police Station or Highway Police.

(1) Motorcycle Lane in Khon Kaen

Three kinds of surveys were carried out as the before- and after-survey for the motorcycle lane, while the results of the traffic condition survey were evaluated from three aspects, i.e. the usage of lane, the smoothness and the safety. The details of evaluation results are attached in Appendix 4.6.



a) Usage of Lanes

A. The video observation result shows that the 2 hours traffic volume on the motorcycle lane was about 550 vehicles. On the other hand, the traffic volume on the first lane was decreased about 20% compared with the result of the before-survey.

B. 93% of vehicles utilizing the motorcycle lane were motorcycles, which seems to indicate that the motorcycle lane is being used for the purpose for which it is intended.

C. Before the installation of the motorcycle lane, nearly 60% of vehicles utilizing the first lane were motorcycles. But, after the installation, the percentages accounted for by motorcycles was reduced to about 30%.

D. The video observation after the installation of the motorcycle lane has found that 63% of motorcycle used the motorcycle lane, 36% the first lane, and 1 percent the second lane. The motorcycle lane is also used by 15% of "Samlor" and 5% of heavy buses, because passengers' getting on and off at bus stops.

E. Based on the result of traffic volume counting for 12 hours, about 70% of motorcycles used the motorcycle lane.

b) Evaluation of Smoothness

A. On the first lane, the average speed of all vehicle types increased from 45 km/hr to 50 km/hr after installation of the motorcycle lane. At the same time, the speed of passenger cars also increased from 53 km/hr to 56 km/hr.

B. The average running speed on the motorcycle lane was about 43 km/hr.

The facts listed above clearly indicate that the installation of the motorcycle lane has led to an increased running speed, hence improved smoothness. This tendency is evident particularly on the first lane where the motorcycle mixing percentage was as high as 60% before the installation of the motorcycle lane.

c) Evaluation of Safety

The composition of motorcycle in a platoon on the first lane before the installation of the motorcycle was compared with that after the installation to determine whether traffic safety has improved over the section where the motorcycle lane was installed. Note that a group of vehicles with a headway of 5 seconds or less is regarded as a platoon.

A. The number of motorcycles in a platoon on the first lane decreased as much as 65% from about 700 vehicles/2 hours to about 250 vehicles/2 hours.

B. On the second lane, there was no significant change in the number of vehicles in a platoon except pick-ups.

C. On the motorcycle lane, the number of vehicles in a platoon was about 300 vehicles/2 hours, which is approximately 55% of an encountered motorcycle traffic volume of about 550 vehicles per 2 hours.

The facts listed above clearly indicate that the installation of the motorcycle lane helps to substantially reduce a potential danger involved with motorcycles running between cars on the first lane. It can therefore be concluded that the installation of the motorcycle lane has contributed significantly to improve the safety.

d) Evaluation of Lane Width

The specific paths taken by motorcycles when utilizing the motorcycle lane were investigated to determine whether the lane width is appropriate.

To divide the motorcycle lane into 3 parts, the central path is most often taken (63% of motorcycles), which is followed by the first lane side path (31%). These paths, when combined together, account for 94% of use, clearly showing that only a few motorcycles run on the shoulder side. The video observation also confirmed that motorcycles were running steadily.

These findings indicate that the lane width needed for running would be 1.0m. Thus, in the absence of factors (e.g., a wall along the roadside) which hinder smooth running, it might be possible to reduce the current lane width of 1.5m.

e) Traffic Accident

The result of accident analysis shows that there was a significant reduction in the number of accidents and casualties, and it has been concluded that the motorcycle lane is serving its purpose well. The results of analysis may be summarized as follows.

A. The number of accidents decreased more than 50% from 16 to 7.

B. In terms of type of accident, the number of vehicle-versus-vehicle accidents was 14, which accounted for 90% of accidents reported, before the installation. The number, however, decreased as significantly to 4 after the installation of the motorcycle lane.

C. Casualties also decreased from 8 to 5. Motorcycle riders account for 75% of the casualties both before and after the installation of the motorcycle lane.

f) Users' Opinion

A. 95% of road users with all vehicle types involved considered that the installation of a motorcycle lane helps to improve traffic conditions.

B. Most of users think that the installation of a motorcycle lane contributes significantly to reduced travel time, improved mobility and reduced accidents. 88% of users pointed out the improved mobility.

C. 74% of motorcycle riders think the width of the motorcycle lane is adequate.

D. 95% of users think that motorcycle-related traffic problems can occur in other areas; hence installation of more motorcycle lanes is desirable.

(2) Pathumthani Intersection

For the Pathumthani Intersection, it was planned to install traffic signals and acceleration lanes, and also to improve channelization. However, due to the delay of the improvement works, only installation of the traffic signal were completed when the after-survey was carried out. Hence, the experimental work at this intersection was analyzed mainly for the effectiveness of the newly installed traffic signals focusing on the following points.

1) Traffic volume
2) Running speed
3) Traffic conflict
4) Traffic accident

Among the above items, 1) traffic volume, 2) running speed and 3) traffic conflict were analyzed using the VTR observation results. The results of the effectiveness of the signal installation on each studied item are summarized below. More detailed evaluation results are attached in Appendix 4.7.

a) Traffic Volume

A. The inflow traffic volume at the intersection was about 1,700 veh/2 hrs before the implementation. Traffic volume during the after-survey period for 2 hours increased by 500 vehicles to 2,200 veh/2 hrs.

B. The main traffic flows at this intersection both before and after implementation were as follows.

- Through traffic between Pathumthani and Sam Khok.

- Left and right turn traffic from Rangsit.

- Right turn traffic from Pathumthani.

C. Ratio of heavy vehicles increased from 24.5% before implementation to 30% after implementation. Particularly, considerably high ratio of heavy vehicles at about 60% was observed for the left turn traffic from Lat Lum Kaeo and right turn traffic from Sam Khok after implementation.

b) Running Speed

In order to identify the improvement in traffic smoothness at the intersection after installation of traffic signals, running speeds at the intersection were compared.

A. The average passing speed at the intersection increased from 25-35 km/hr before implementation to 35-40 km/hr after implementation. The results indicate the increase of running speed by 10-25% at each approach.

B. The standard deviation of passing speed at the intersection, except vehicles from minor approaches, increased from 8-13 km/hr before implementation to 10-14 km/hr after implementation. This means that more vehicles passed the intersection at higher speed.

From the above facts, it is concluded that traffic capacity at the intersection increased with faster running speed, greater traffic smoothness and reduced passing time at the intersection.

c) Traffic Conflict

In order to measure the improvement of safety level at the intersection after installation of traffic signals, traffic conflicts between vehicles at the intersection were analyzed.

A. Total number of traffic conflicts were reduced from 65 to 11 as a result of signal installation. The reduction rate was 83% in number and 87% per vehicle.

B. Because traffic flows are segregated by installation of traffic signals, traffic conflicts, which may directly lead to traffic accidents, caused by vehicles simultaneously entering the intersection, were almost prevented.

C. Before implementation, the most typical case of conflicts were between through vehicles and right turn vehicles. By provision of the exclusive right turn phase, this type of conflicts were drastically reduced.

The above results indicate that traffic conflicts were drastically reduced by installation of traffic signals, which consequently means the reduction of the potential danger of traffic accidents. Hence, it is considered that installation of traffic signals contributed to increase the safety level of the intersection.

d) Traffic Accident

Traffic accident analyses at the intersection were carried out based on the results of one-month traffic accident survey at the site before and after implementation.

According to the analysis, number of accidents, especially accidents with casualties, were reduced. Therefore, it can be said that installation of traffic signals and improvement of channelization were effective for the prevention of traffic accident and improvement of safety at the intersection.

A. Number of accidents were reduced from 5 cases to 4 cases.

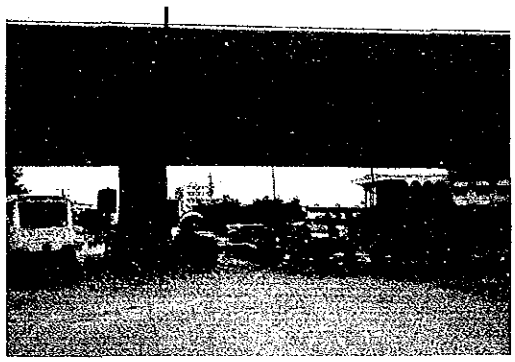
B. Number of casualties were drastically reduced from 4 persons to 1 person.

C. Damages to road facilities were also reduced.

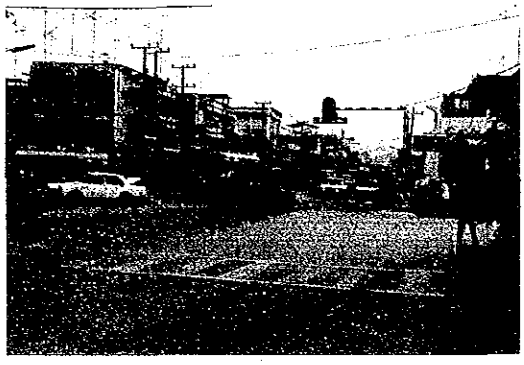
D. Every accident was vehicle vs. vehicle type.

E. Side collision during turning was reduced from 4 cases to 1 case. On the contrary, rear-end collision increased from 1 case to 4 cases, but those collisions were not severe. It is understood that increase of rear-end collisions are general tendency after installation of a traffic signal.

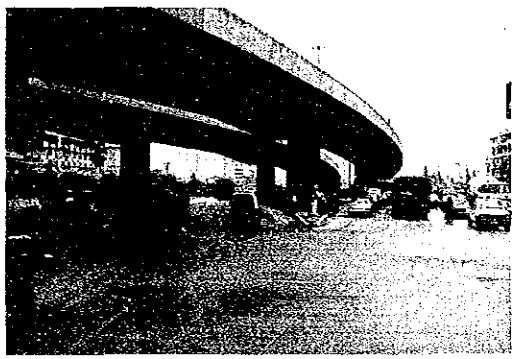
F. Regarding the types of vehicles involved in accidents, ratio of heavy vehicles was reduced from 50% to 22%.



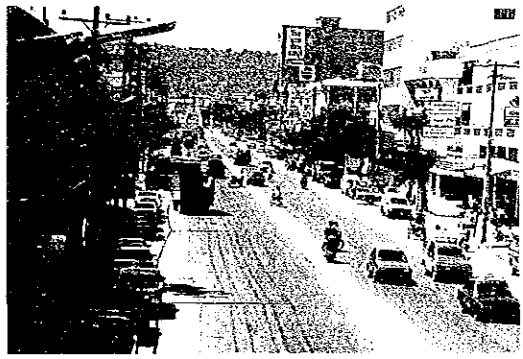
C-1 Bang Na Intersection (1)



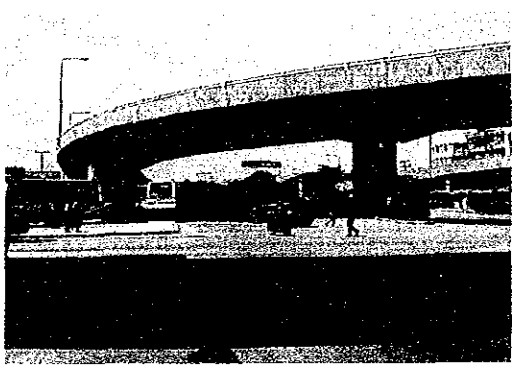
C-2 Chonburi (1)



C-1 Bang Na Intersection (2)



C-2 Chonburi (2)



C-1 Bang Na Intersection (3)

C-2 Chonburi (3)

Photograph of Case Study Site (1)

4.7 OUTLINE OF CASE STUDY PLAN

4.7.1 C-1 Bang Na Intersection (R34/R3, R3102)

(1) Existing Condition

A. This intersection is an at-grade signalized intersection under the Expressway in an urban area.

B. The Expressway is directly connected to Route 34.

C. Bus stops are located adjacent to this intersection.

D. This intersection is channelized by providing left and right turn roadways as well as traffic islands. There is an opening of the median on Route 34 for U-turn vehicles.

E. Piers of the Expressway viaduct are placed on the medians and traffic islands. The arrangement of the on and off ramps of the Expressway is illustrated in Figure 4.18.

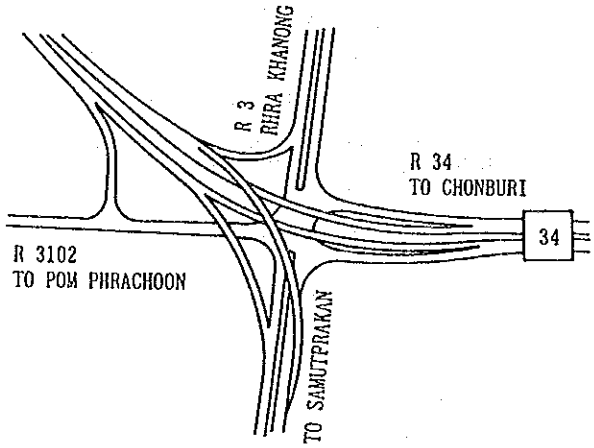


Figure 4.18 Layout of the Bang Na Interchange

(2) Major Problems

A. The traffic volume at this intersection is very heavy with high proportions of right and left turn vehicles, as shown in Figure 4.19. The hourly fluctuation of traffic volume entering this intersection is attached in Appendix 4.8.

B. The saturation degree at this intersection is very high because of the longer starting delay and the reduction of traffic capacity on lanes mainly due to the following problems as well as heavy traffic volume.

- Pavement deterioration caused by the differential settlement around the base of piers.

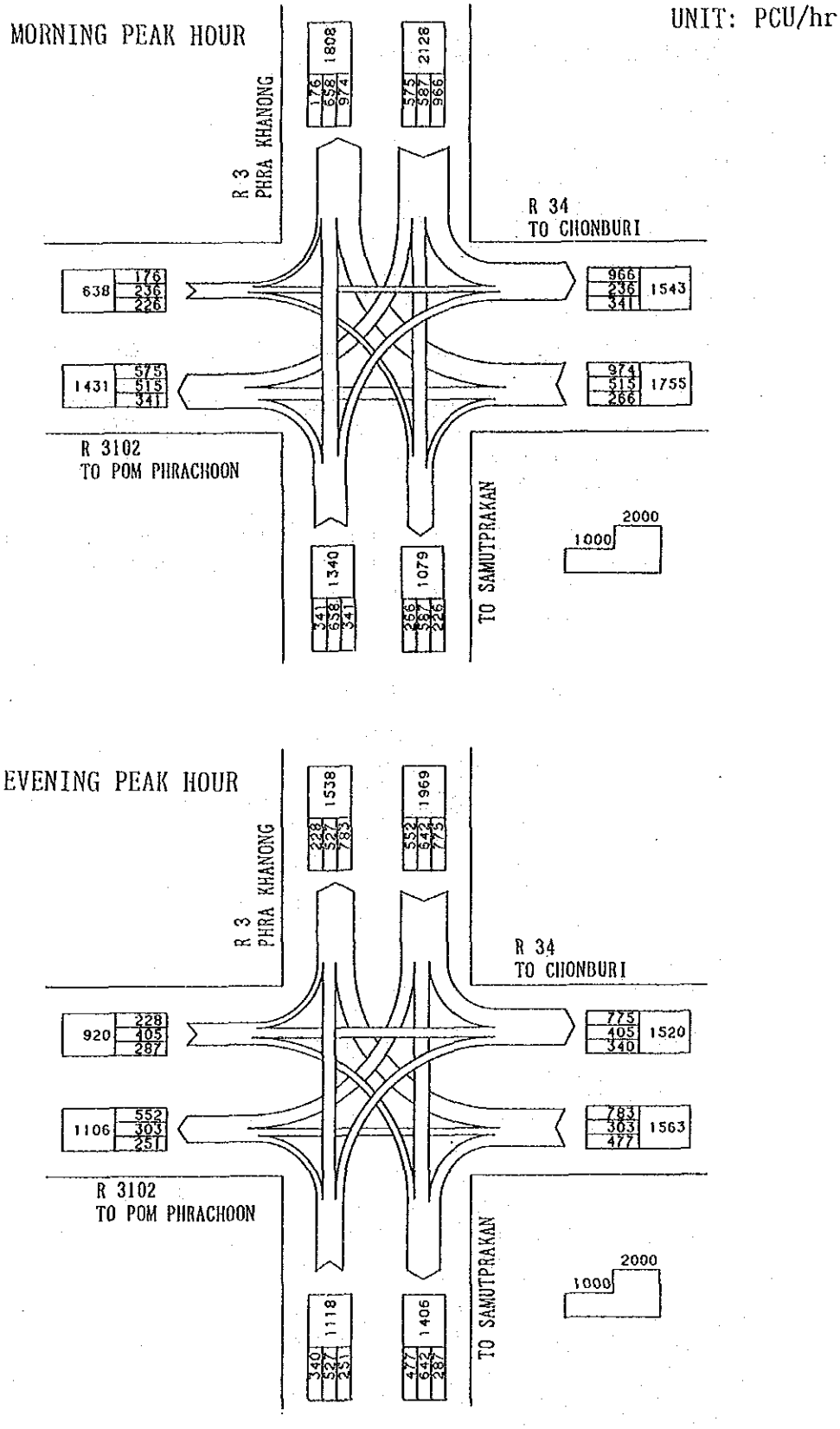


Figure 4.19 Traffic Volume at Bang Na Intersection

- Confusion caused by buses, left turn and through traffic adjacent to bus stops.

- Parked vehicles and vendors occupying the carriageway.

- Through traffic flows are often disturbed by left and right turn vehicles waiting to turn.

The saturation flow rate at this intersection was measured by using VTR and the result is attached in Appendix 4.9. The result shows lower saturation flow rate on each approach compared with the value of 2,200 PCU for the through lane studied by OCMRT.

C. The cycle length at this intersection is very long being 210 seconds in the morning peak, and this results in long intersection stopped delay and traffic queues. Observed queue length at each approach is attached in Appendix 4.8.

D. The visibility of traffic signal displays are poor due to the pedestal type of traffic signal displays.

(3) Major Traffic Operational Measures

It is difficult to widen the carriageway at each approach and to relocate bus stops to increase the traffic capacity of this intersection. Hence, the following traffic operational measures are proposed in the Study.

A. To rehabilitate the pavement.

B. To install the over-hang type traffic signal displays in order to improve the visibility.

C. To modify the signal phasing method as follows.

- To allow the right turning from Route 3 in the same signal phase for the through traffic. For this case, it is necessary to provide proper pavement marking guidance to avoid traffic accidents.

- To control left turn traffic by a traffic signal in order to avoid confusion and reduced capacity on the through lane at the merging section.

- To shorten the cycle length in order to reduce intersection stopped delay.

D. To extend the left turn lane on Sukumvit Road, where the left turn traffic volume is heavy, in order to increase the saturation flow rate on the through lane.

4.7.2 C-2 Chonburi (R3/R315, R344)

(1) Existing Condition

A. This planning section is located at the commercial area in Chonburi city, composed of two at-grade intersections and the roadway section between these two intersections. (see Figure 4.20)

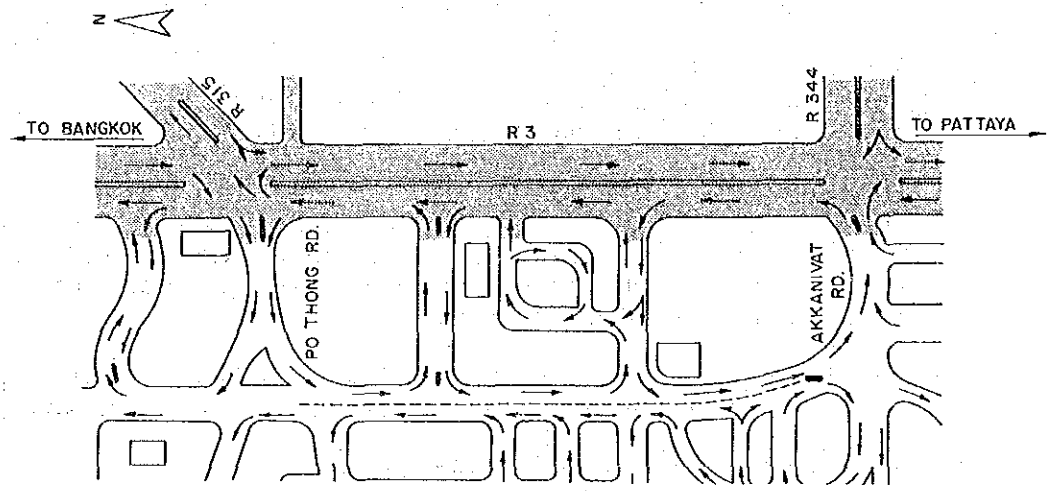


Figure 4.20 Road Network in Chonburi

B. Two intersections are controlled by the traffic signals and right turn lanes are provided on Routes 3, 315 and 344.

C. The roadway section is a four lane road divided by chatterbars, and stopping lanes and sidewalks are also installed on both sides.

D. The daily traffic volume excluding motorcycles on Route 3 is more than 30,000. The south bound traffic volume on Saturday increases by about 30% compared with Wednesday, mainly because of the holiday traffic. On the other hand, there are no difference of the north bound traffic volume between Saturday and Wednesday.

The turning movement during peak hours at these two intersections are shown in Figures 4.21 and 4.22. The hourly fluctuation of entering traffic volume at two intersections on Sunday, Saturday and Wednesday are attached in Appendices 4.10 and 4.11.

E. There is a two lane road which bypasses Chonburi City and this road is planned to be improved as a two lane dual carriageway. At present, all heavy vehicles except buses are not permitted to enter the urban area and they are directed to this bypass.

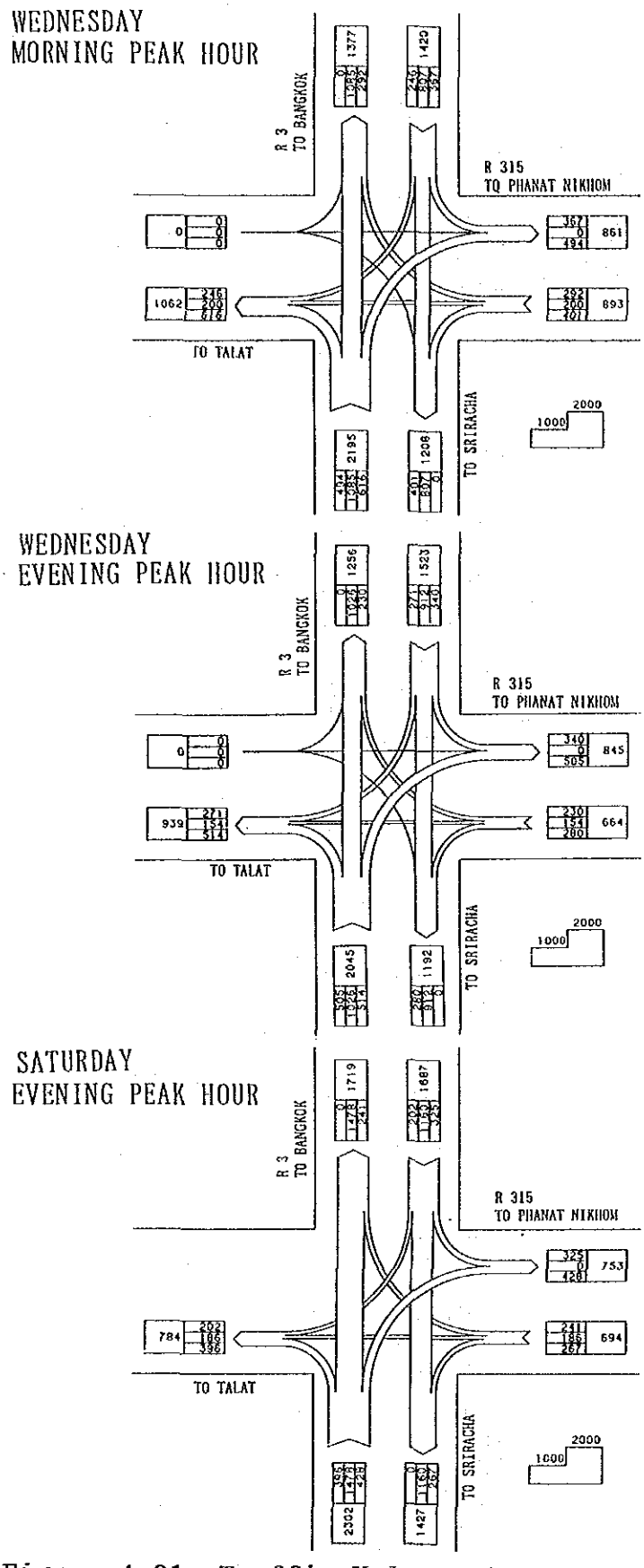


Figure 4.21 Traffic Volume at Route 3/Route 315 in Chonburi

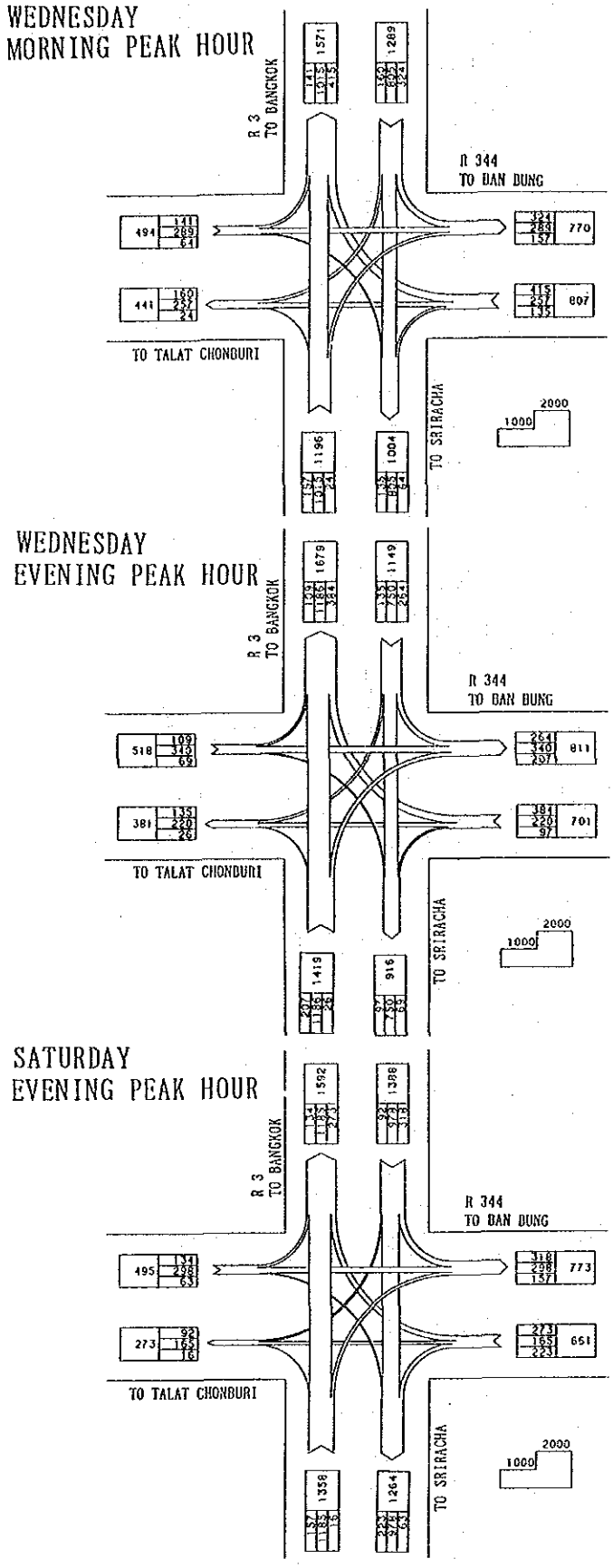


Figure 4.22 Traffic Volume at Route 3/Route 344 in Chonburi

(2) Major Problems

A. Both intersections are nearly saturated owing to the heavy traffic volume and high proportion of left and right turn traffic.

B. There are long intersection stopped delays caused by the long cycle length at these two intersections.

C. On the roadway section, reduction in traffic capacity and disorderly traffic flows are observed. This situation is mainly caused by right turn vehicles entering access roads and random right turn/U-turn manoueuvres in order to enter a roadside parking lot.

D. The above mentioned problems lead to longer delay and slower travel speed in this section. The average travel speed in this section was observed to be 14 - 24 km/h. The results of the travel speed survey and queue length survey are attached in Appendices 4.10 to 4.12.

(3) Traffic Operational Measures

The widening of the bypass is expected to commence in the near future. The majority of through traffic is then expected to use this bypass guided by the recommended information system, as described in Section 6.4.

However, Route 3 is still expected to carry heavy traffic volumes mainly due to many new developments, such as the Eastern Seaboard Development Projects. Hence, the traffic operational measures for the planning section are proposed to cope with the above mentioned problems without widening of Route 3.

a) Intersection of Route 3/Route 315

1) Geometric improvement

The following strategies are proposed to increase the traffic capacity at this intersection.

A. The center lane on an approach of Route 315 will be converted to a through/left turn lane to deal with the predominant left turn traffic volume. Instead, it is desirable to restrict the free left turn, which may cause the confusion and decrease the capacity of the through lane on Route 3 at the merging point.

B. At approaches to the intersection, it is desirable to provide a right turn roadway in order to clearly segregate the right turn traffic from the through traffic.

C. Improvement of channelization is desirable to deal with the new one-way regulation on Pho Thong Rd, as shown in Figure 4.20, in order to ensure orderly traffic flow as well as clearing parked vehicles on the approach to the intersection.

Other than these strategies, provision of a left turn lane on the south bound approach can be considered as an alternative. This alternative, however, contains the following problems.

A. The saturation degree of the intersection will not be remarkably decreased owing to heavy through traffic volume in the opposite direction.

B. Leveling pavement overlay will be required at the approach to the intersection.

2) Determination of signal phase

The optimum signal phase and cycle length are proposed taking the following points into account.

A. A three phase solution including an exclusive right turn phase is proposed to control traffic related to the one-way system on Pho Thong Rd.

B. A minimum cycle length is proposed to reduce the intersection stopped delay.

C. To ensure the minimum safe green timing for crossing pedestrians.

Based on the proposed signal phase, the saturation degree of intersection is expected to be reduced from 0.770 to 0.694 in the most critical peak period of Wednesday morning. Also, delay at the intersection is also expected to be reduced.

b) Intersection of Route 3/Route 344

1) Geometric improvement

The following strategies are proposed to deal with the traffic problems at this intersection by using the same concepts as for the intersection of Route 3/Route 315.

A. Provision of a left turn lane on an approach of Route 3 for the south bound direction and Akkanivat Rd. are desirable.

B. The center lane on the Route 344 approach would be converted to a through/left turn lane.

C. At approaches to the intersection, it is desirable to provide right turn roadways.

2) Determination of signal phase

Two alternatives are considered for the signal phase at this intersection, as shown in Figure 4.23.

A. Alternative A

This alternative is the 4-phase method having the following aspects.

- At the signalized intersection, the frequency of traffic accidents between through traffic and right turn traffic is generally high.
- Heavy right turn traffic volume with a high composition of motorcycles (36%) has a potential danger of traffic accidents.
- The saturation degree under this phasing method in the most critical peak period of Wednesday morning is expected to be decreased from 0.778 to 0.672. At the same time, the delay at the intersection is also expected to be reduced.

B. Alternative B

This alternative is a 3-phase method to provide an exclusive right turn phase only for Route 3, so the saturation degree at this intersection is less than Alternative A. This phasing method is designed mainly based on a fact that the through traffic volume on both Route 344 and Akkanivat Rd. are limited. Hence, a certain number of vehicles will be able to turn right safely when there are gaps in the through traffic flow from the opposite direction.

After consideration of the effectiveness of two alternatives, Alternative A is proposed as the phasing method for this intersection.

c) Roadway Section between Intersections

1) Installation of median

Installation of the median is proposed for this roadway section to ensure the smooth and orderly traffic flows taking the following aspects into account.

A. To avoid conflicts between vehicles in opposing directions.

B. To prevent random right turn and U-turn movements.

C. To provide refuge space for crossing pedestrians.

2) Provision of right turn lane

Provision of exclusive right turn lanes at small intersections are proposed to ensure traffic capacity and orderly traffic flow by segregating right turn vehicles from the through traffic.

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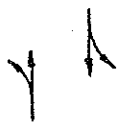
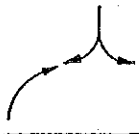
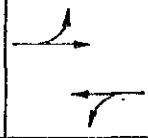
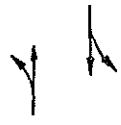
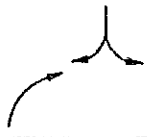
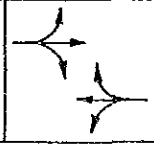
A				
B				

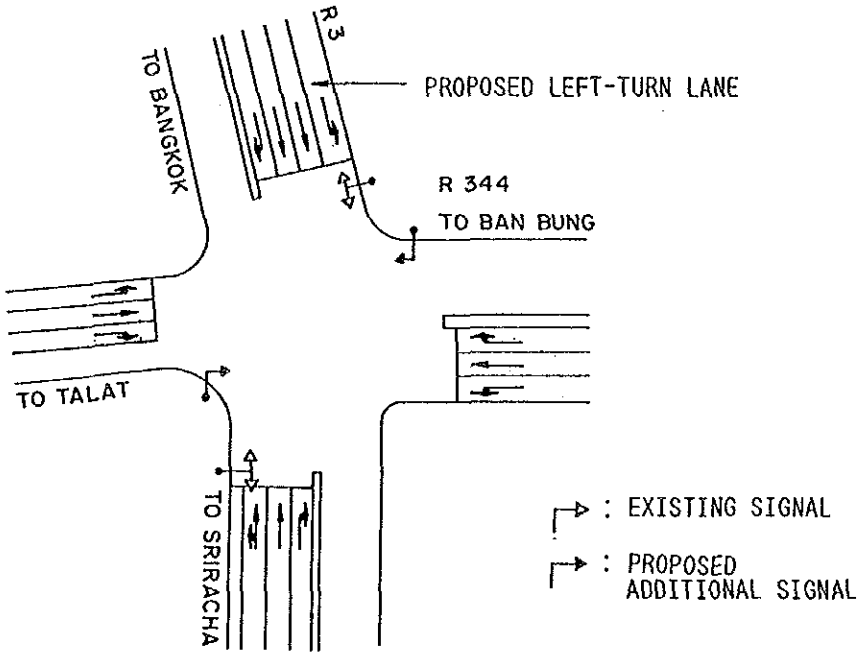
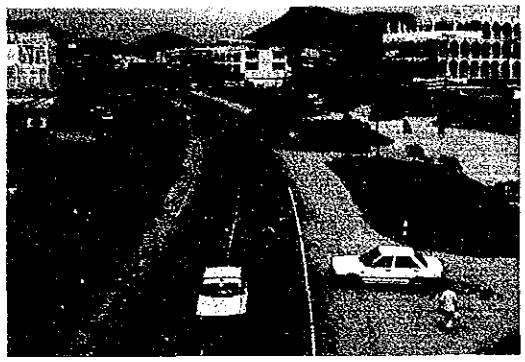


Figure 4.23 Alternatives of Signal Phasing at Route 3/Route 344

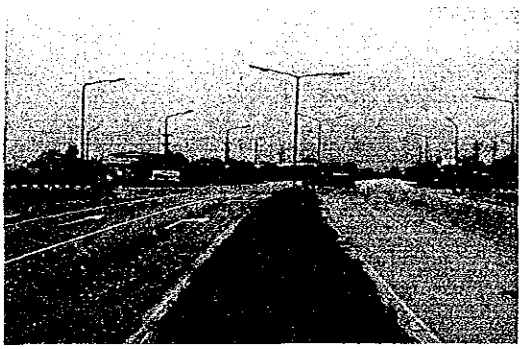
C-3 Sriracha Intersection (1)



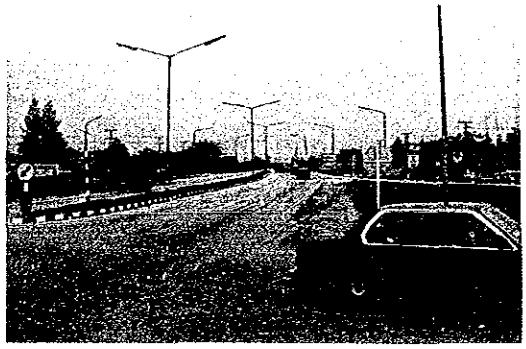
C-3 Sriracha Intersection (2)

C-4 Wang Noi Intersection (1)

C-4 Wang Noi Intersection (2)



C-5 Ban Bung-Klaeng Intersection (1)



C-5 Ban Bung-Klaeng Intersection (2)

Photograph of Case Study Site (2)

4.7.3 C-3 Sriracha Intersection (R3/Surasak Rd.)

(1) Existing Condition

A. This planning section is an at-grade intersection in an urban area. This intersection is fundamentally a 4-leg intersection; however one of approaches is closed and it operates as a T-shape intersection at present, although 4 openings connecting to Route 3 are provided from the frontage road, which is located on the closed leg side. (see Figure 4.24)

B. Right turn from Surasak Rd. is prohibited.

C. This intersection is located in a curved section with a radius of 387m. In addition, the approach section from Pattaya is on a down grade of 3% and a small size intersection with 2-lane road is located in this down grade section.

D. On Route 3, the median strip delineated by pavement markings with road studs is provided. Also, street lighting is installed.

E. Traffic signals are installed at this intersection, but are not in operation.

F. A pedestrian overpass is installed at the approach from Chonburi.

(2) Major Problems

A. Traffic volume at this intersection, as shown in Figure 4.25 and Appendix 4.13, exceed the traffic capacity of a stop control intersection. The hourly fluctuation of entering traffic volume for 12 hours is attached in Appendix 4.14.

B. The visibility of traffic signals as well as the intersection itself are very poor due to the curved alignment.

C. The approaching speed of vehicles coming from Pattaya is high, which may lead to severe traffic accidents at this intersection. The speed of passenger cars are dominant at 69 km/h as the 80 percentile speed, as shown in Appendix 4.15.

D. Many traffic conflicts and confusion are caused by vehicles coming from the 4 openings as well as road-side parking.

E. At the small size intersection on the downgrade section, traffic confusion caused by right turn and crossing vehicles are often observed.

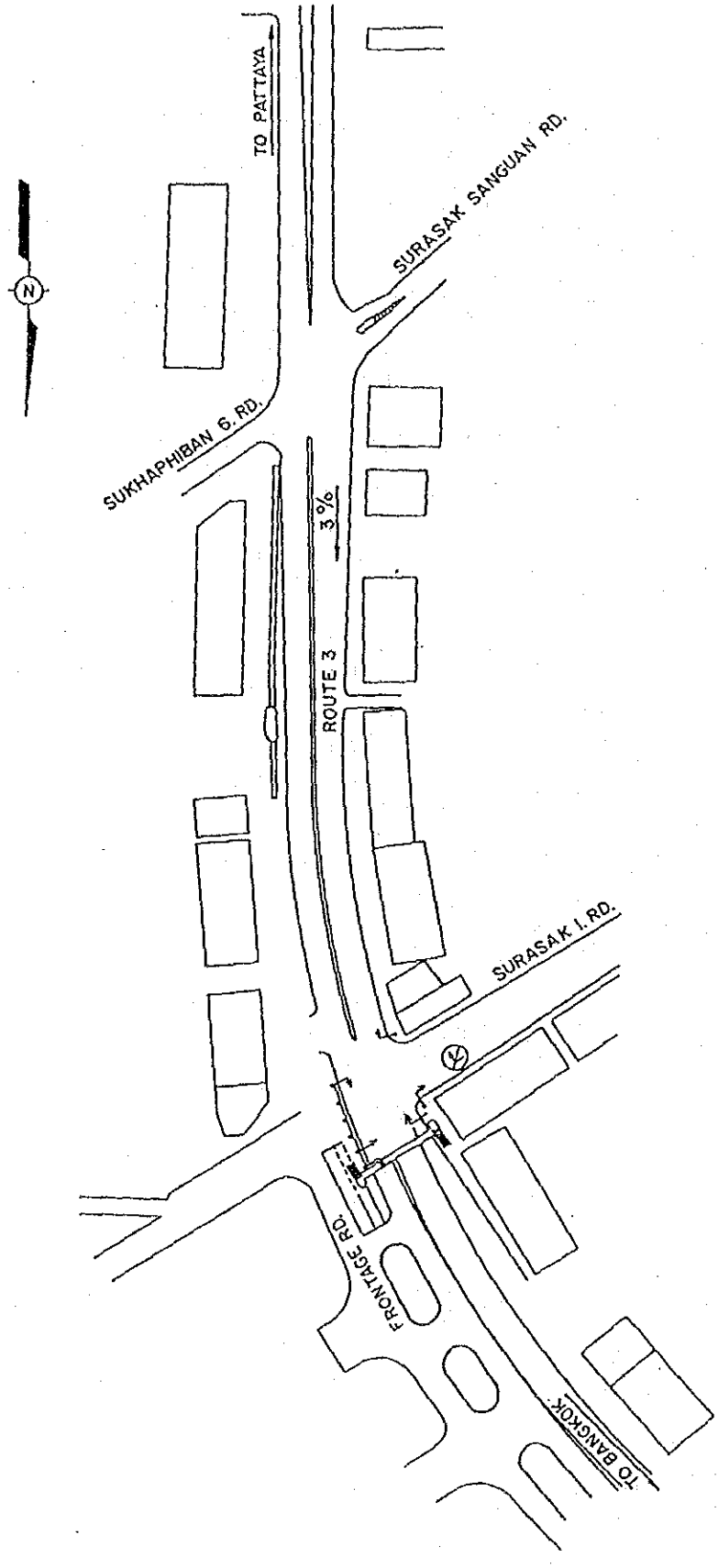


Figure 4.24 Road Configuration of Sriracha Intersection

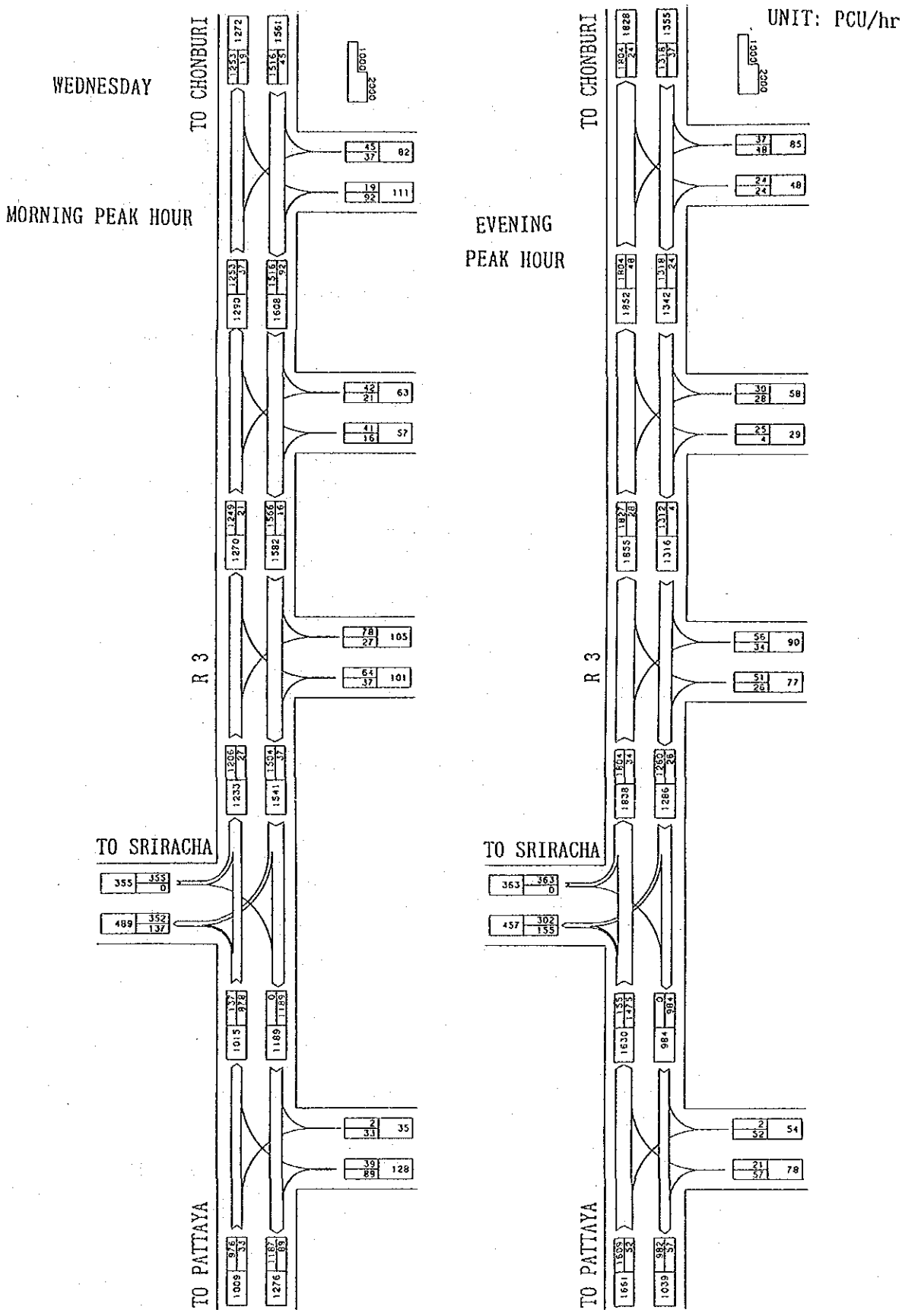


Figure 4.25 Traffic Volume on Wednesday at Sriracha Intersection

(3) Major Traffic Operational Measures

A. To re-operate the traffic signals already installed at this intersection. In this case, however, a signal display facing the curved section should be moved to a position where sufficient visibility can be obtained.

B. To close 3 openings connecting to the frontage road. Instead, it is recommended that a direct approach to the intersection is provided in order to reduce conflicts. By this measure, it is also expected to reduce the number of turning vehicles at the small size intersection.

   By applying this measure, about 50% of through and right turn traffic entering from the Surasak Sanguen Rd. are predicted to be converted to the Surasak Rd. Predicted traffic volume at this intersection are shown in Figure 4.26, while traffic volume at the intersection with the Surasak Sanguen Rd. is attached in Appendix 4.14. The calculated saturation degree of this intersection is not high being only 0.64 in the most critical peak hour on Wednesday evening.

C. To provide exclusive right turn lanes at this intersection.

D. To install a median in order to control random turnings at approaches. At one location, however, an opening in the median is provided.

Other than the above measures, an alternative plan to close every opening in order to concentrate all turning vehicles into the signalized intersection was considered. However, this alternative is not proposed at this stage for the following reasons.

A. The confusion of traffic flow might occur on the approach to the intersection from the frontage road side. This is mainly due to rather heavy traffic volume on this approach and the close proximity of a small size intersection between the approach road and the frontage road.

B. At the remaining opening, vehicles will be able to complete the turning movement within the time gaps created by the traffic signals.

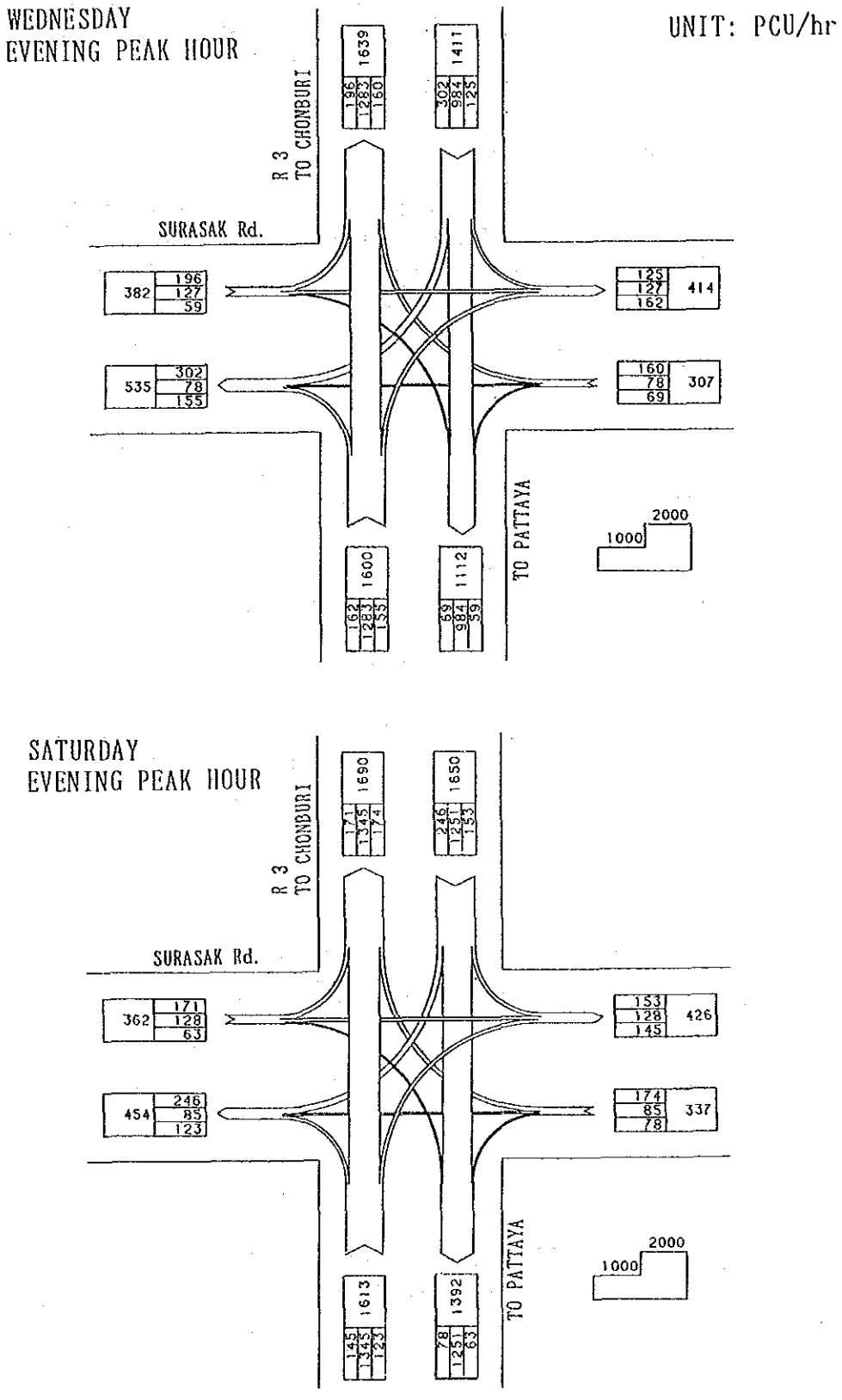


Figure 4.26 Estimated Traffic Volume at Sriracha Intersection

4.7.4 C-4 Wang Noi Intersection (R1/R309,R3189)

(1) Existing Conditions

A. This intersection is a non-signalized at-grade 4-leg intersection in a rural area

B. Route 1 carries four lanes of traffic and Route 309 and 3189 carry two lanes of traffic respectively.

C. A right turn lane is provided only on the east side on Route 1.

D. An acceleration lane is installed on Route 1 for the right turn traffic from Route 309.

E. Route 1, which carries high traffic volumes, has the frontage roads on both sides. However, when heading east on Route 1, there is no frontage road provided on the left side after the intersection.

F. The frontage road with a width of more than 10 m, is used for two-way traffic and car parking.

G. The traffic flows in the intersection are mostly on Route 1, and a peak period is observed only in the evening as shown in Figure 4.27 and Appendix 4.16.

(2) Major Problems

A. Approach speeds of vehicles to the intersection are extremely high, in particular Route 1, since the roadway alignment is almost straight both vertically and horizontally.

B. The intersection is not conspicuous to drivers.

C. Traffic flows described below are affected by the main traffic flow on Route 1.

- Right turn from Route 1 to Route 309 and 3189
- Straight flow on Route 309 and 3189
- Right and left turn from Route 309 and 3189

D. Crossing of Route 1 by pedestrians is difficult.

E. Traffic on frontage roads are not systematically controlled. In particular, traffic both on frontage roads and on Route 1 are disturbed by frequent parking and stopping of buses along the frontage road.

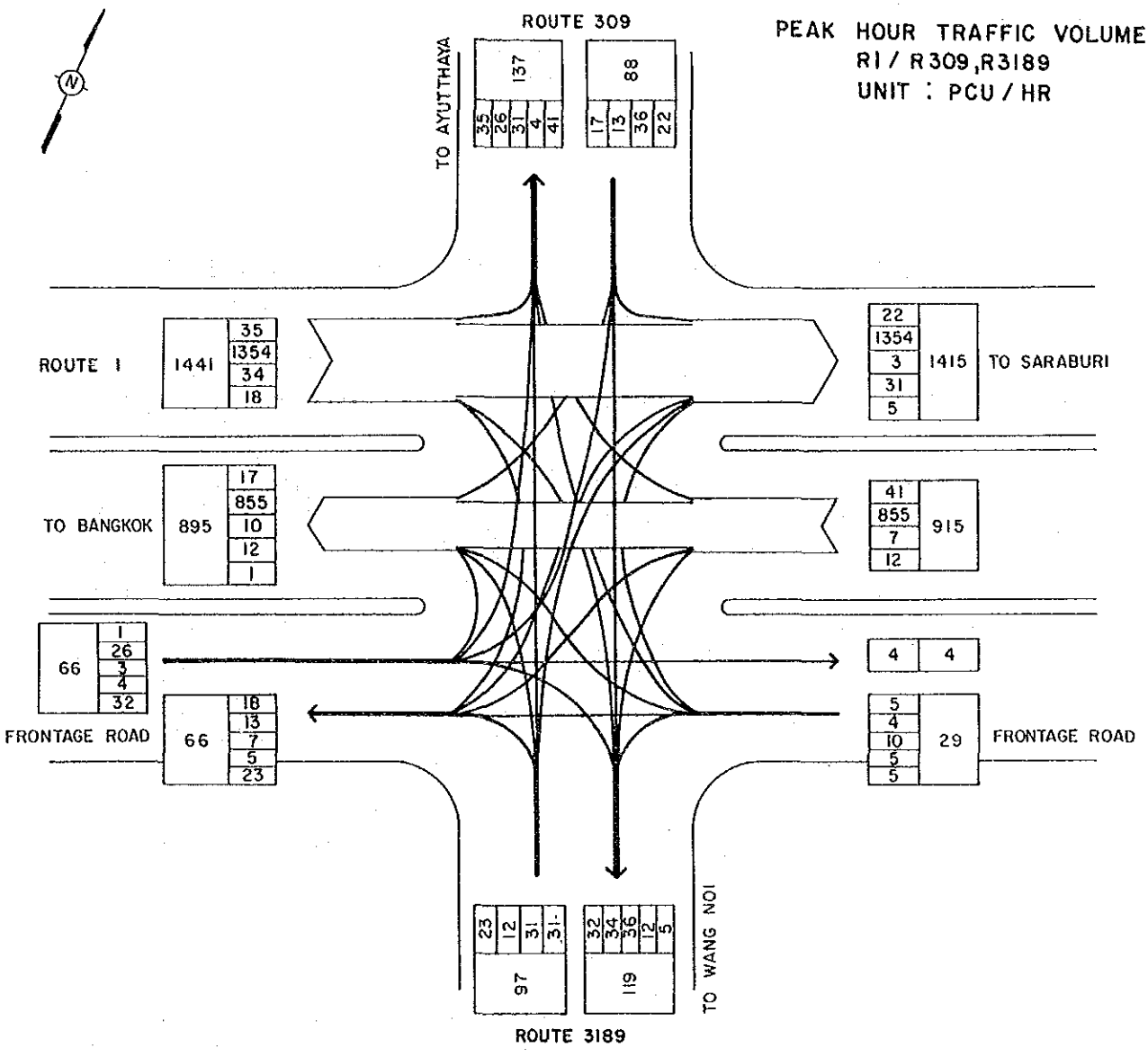


Figure 4.27 Traffic Volume at Wang Noi Intersection

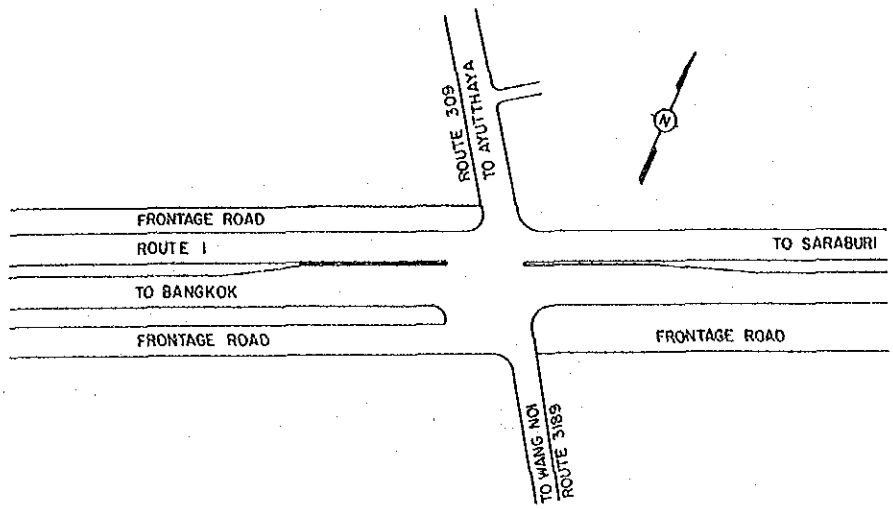


Figure 4.28 Configuration of Wang Noi Intersection

(3) Short Term Traffic Operational Measures

A. To signalize the whole intersection by installing traffic signals for vehicles and pedestrians.

B. To minimize the number of the outlets from the frontage road on Route 1 in order to reduce the traffic disturbance caused by the vehicles emerging from the frontage roads.

C. To maintain each frontage road in two-way because the frontage road is not provided with a relevant detour. However, at the intersection, the right turn from the frontage roads and left turn and diversion from the main carriageway of Route 1 to the frontage roads are not allowed, in order to mitigate the complicated traffic flow at the intersection.

D. To install a right turn lane for Route 3189 on Route 1 by removing an accelerating lane for the traffic from Route 309.

E. To install pedestrian crossings across Route 1 on both sides of the intersection.

F. To provide proper pavement markings at the intersection on the frontage roads to distinguish each traffic lanes from the parking area.

(4) Long Term Traffic Operational Measures

The measures are planned on the assumption that the expansion of Route 1 from 4 lanes to 6 lanes will be completed before the execution of the measures.

A. To construct a flyover bridge crossing Route 1. The reasons why the flyover is planned to cross Route 1 are as follows.

- To minimize the construction cost .
  When the flyover is planned along Route 1, the length and the width of the flyover will be longer and wider than the proposed one.

- Not to slow down the travel speed of vehicles on Route 1 through an arched alignment.

- It is projected that the traffic volumes on Route 309 and 3189 will not exceed the traffic capacity of the planned flyover with 2 lane and a right turn lane for a considerable period of time in the future.

Vehicles heading for Route 309 or 3189 from Route 1 need to enter the frontage road first and then take the appropriate route. Right turn vehicles from Route 309 and 3189 go on to the flyover first then take a right turn on the bridge. Left turn vehicles from Route 309 and 3189 enter the frontage road first then head for Route 1.

B. To provide a frontage road on the left side after the intersection when heading east on the Route 1 to obtain access from each other route.

C. To change the frontage road from two-way to oneway traffic.

D. To provide a grade separated pedestrian crossing attached to the flyover.

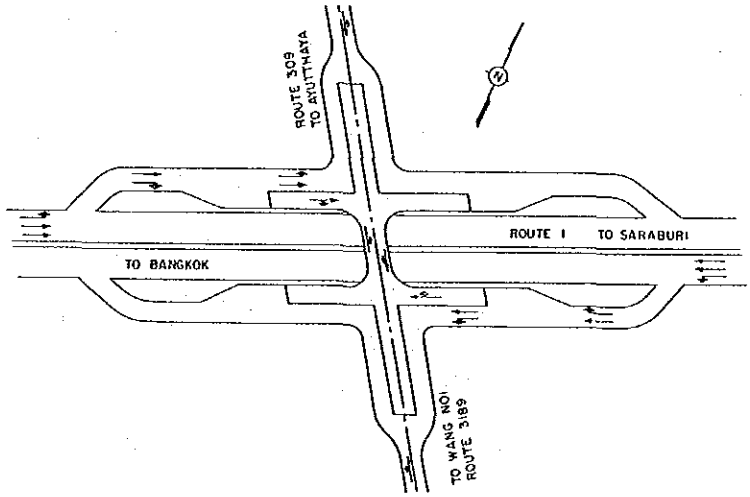


Figure 4.29 Grade Separation Plan at Wang Noi Intersection

4.7.5 C-5 Ban Bung - Klaeng Intersection (R344/R331)

(1) Existing Condition

A. This intersection is an at-grade 4-leg intersection in a rural area.

B. Both crossing roads are classified as secondary highways with 2 lanes. However, the approaches of Route 344 at this intersection have been widened to 4 lanes.

C. Left turn channels together with wide traffic islands are installed at each approach. The left turn channels at this intersection is designed to a high standard with radius of 160m - 60m.

D. On the approaches of Route 344, exclusive right turn lanes are provided as right turn roadways.

E. This intersection is a stop control intersection and the priority is given to traffic on Route 344.

F. Traffic volume at this intersection is not heavy, as shown in Figure 4.30.

(2) Major Problems

A. The approach speed of vehicles at this intersection are relatively high, especially on Route 344, since the horizontal alignment of the roadway section of both roads are good, while approaches on Route 344 are wide. The result of the vehicle speed survey is attached in Appendix 4.18.

B. Disorderly traffic flows are observed at the approach of Route 331 caused by inadequate channelization. The right turn lane is directly led from the through lane.

C. Confusion to traffic at the narrowing lane section.

D. Improper crossings and right turn movements are often observed.

E. The pavement markings at this intersection are insufficient, especially for right turn lanes.

(3) Major Traffic Operational Measures

A. To provide anti-skid pavement and proper pavement markings at each approach of the intersection, in order to encourage a reduction in the approach speed. The details of the anti-skid pavement is described in 'Pavement Treatment' of the "Technical Guidelines and

Engineering Specifications". In the Study, open graded asphaltic concrete is proposed as the anti-skid pavement.

B. To improve the channelization for the right turn lane in order to clearly segregate the right turn traffic as well as encouraging reduction in the approach speed.

C. To provide proper pavement markings at the center of the intersection to ensure smooth and orderly turning movements.

D. To provide proper pavement markings and to install necessary traffic signs at the narrowing lane section.

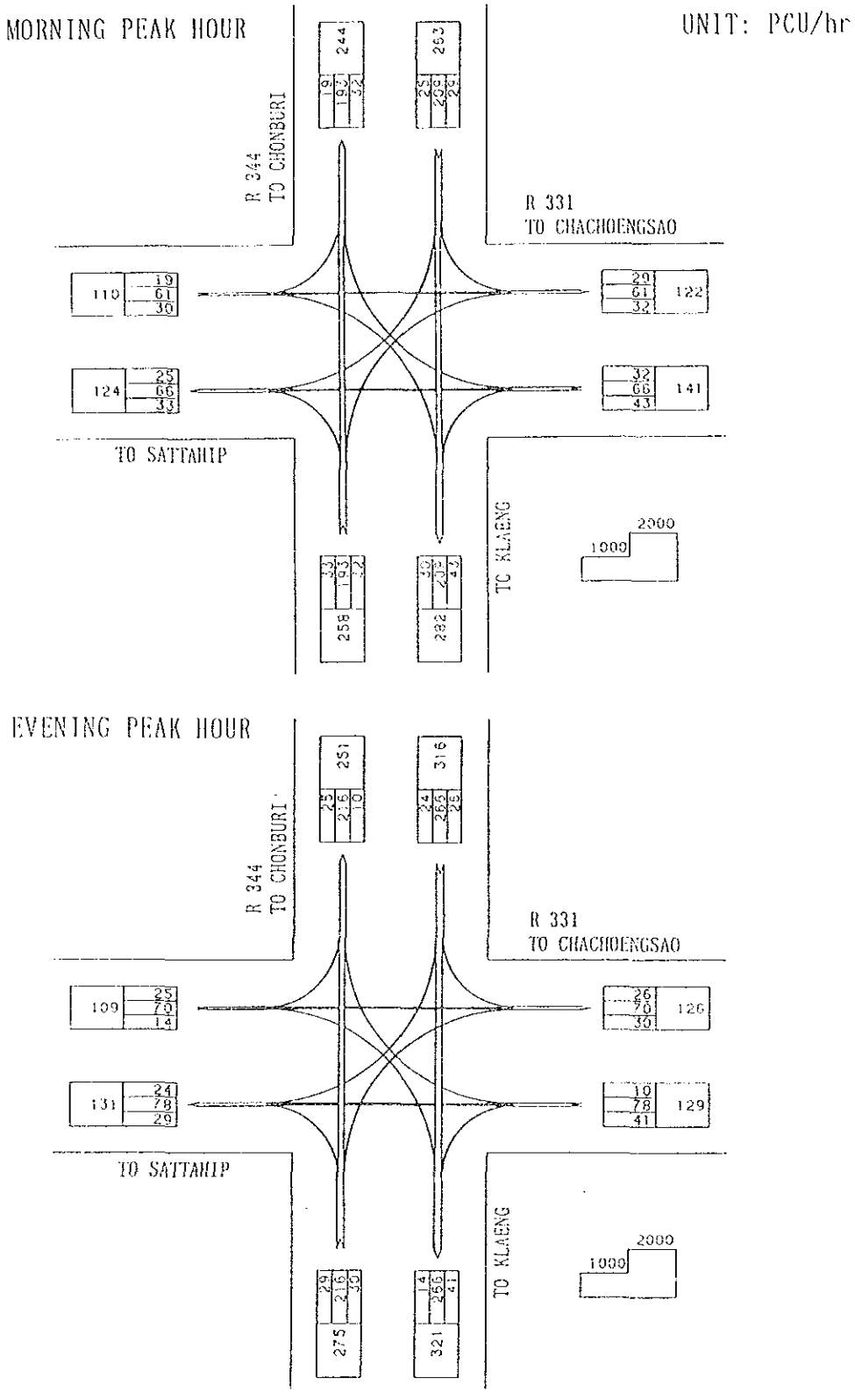


Figure 4.30 Traffic Volume at Ban Bung-Klaeng Intersection

CHAPTER 5 TRAFFIC CENSUS SYSTEM

CHAPTER 5 TRAFFIC CENSUS SYSTEM

5.1 STUDY PURPOSE AND PROCEDURE

The study described in this chapter was conducted in order to determine what kind of traffic data the DOH should collect, and to recommend the method and the setup for collecting the data needed.

Figure 5.1 gives a flow chart of the study procedure. As part of the tasks entailed in determining how to make use of the traffic data collected, the need for General Traffic Volume Survey, Motor Vehicle Origin-Destination Survey, and Continuous Traffic Volume Observation Survey were studied. In determining how to obtain the required traffic data, the method of conducting overall travel speed survey, the method of conducting motor vehicle origin-destination survey, and the method of introducing vehicle detectors were also studied.

As indicated in the flow chart, this study included a sample origin-destination survey, which was conducted in response to the DOH's request for a case study. In addition, OD Survey Manual and Traffic Forecast Manual were prepared. Implementation and compilation of sample survey were conducted by DOH based on the techniques which were transferred to the DOH.

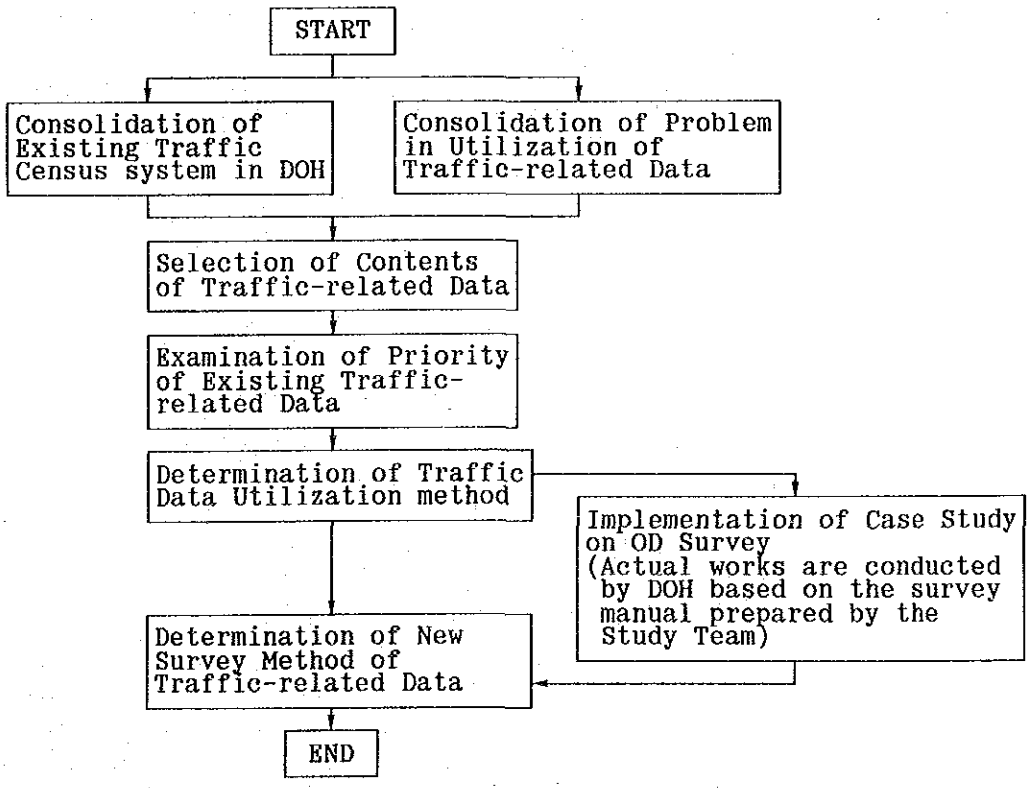


Figure 5.1 Study Flow Chart for Traffic Census System

5.2 CURRENT STATUS OF TRAFFIC SURVEY

5.2.1 Types of Traffic Survey

To draw up a road implementation plan for construction and administration, a full understanding of the current status of regional traffic and the precise prediction of future traffic demand and road construction requirements are needed. This explains why various road traffic surveys are conducted on a regular basis.

In Japan, organizational bodies such as the Road Bureau and City Bureau of the Ministry of Construction, and public corporations are conducting their own road traffic surveys. The following provides a summary of the traffic census and the continuous traffic volume observation survey conducted by the Road Bureau.

(1) Traffic Census

The traffic census consists basically of an ordinary traffic volume survey which investigates road conditions and sectional traffic volumes, and a motor vehicle origin-destination survey which examines the motor vehicle operating status (see Figure 5.2).

The motor vehicle origin-destination survey is made up of a roadside OD survey which collects necessary information by asking drivers with their vehicles stopped at the roadside, and an owner interview OD survey which collects information by visiting motor vehicle owners.

Owner interview surveys are conducted nation-wide (nation-wide OD surveys). For several designated medium and small cities, owner interview OD surveys are carried out with an increased vehicle sampling rate in smaller cities (urban OD surveys). These surveys are conducted each 5 years.

The Road Bureau is responsible for ordinary traffic volume surveys, roadside OD surveys and nation-wide OD surveys, and the City Bureau is responsible for urban OD surveys. The following describes briefly how the ordinary traffic volume survey and motor vehicle origin-destination survey are conducted.

a) Ordinary Traffic Volume Survey

1) Road condition surveys

A road condition surveys is conducted for evaluation of road servicing activities. Items to be investigated e.g., by referring to road registration records or actual counting/measurement include cross-sectional road width, sidewalks, crossroads, bus routes, roadside

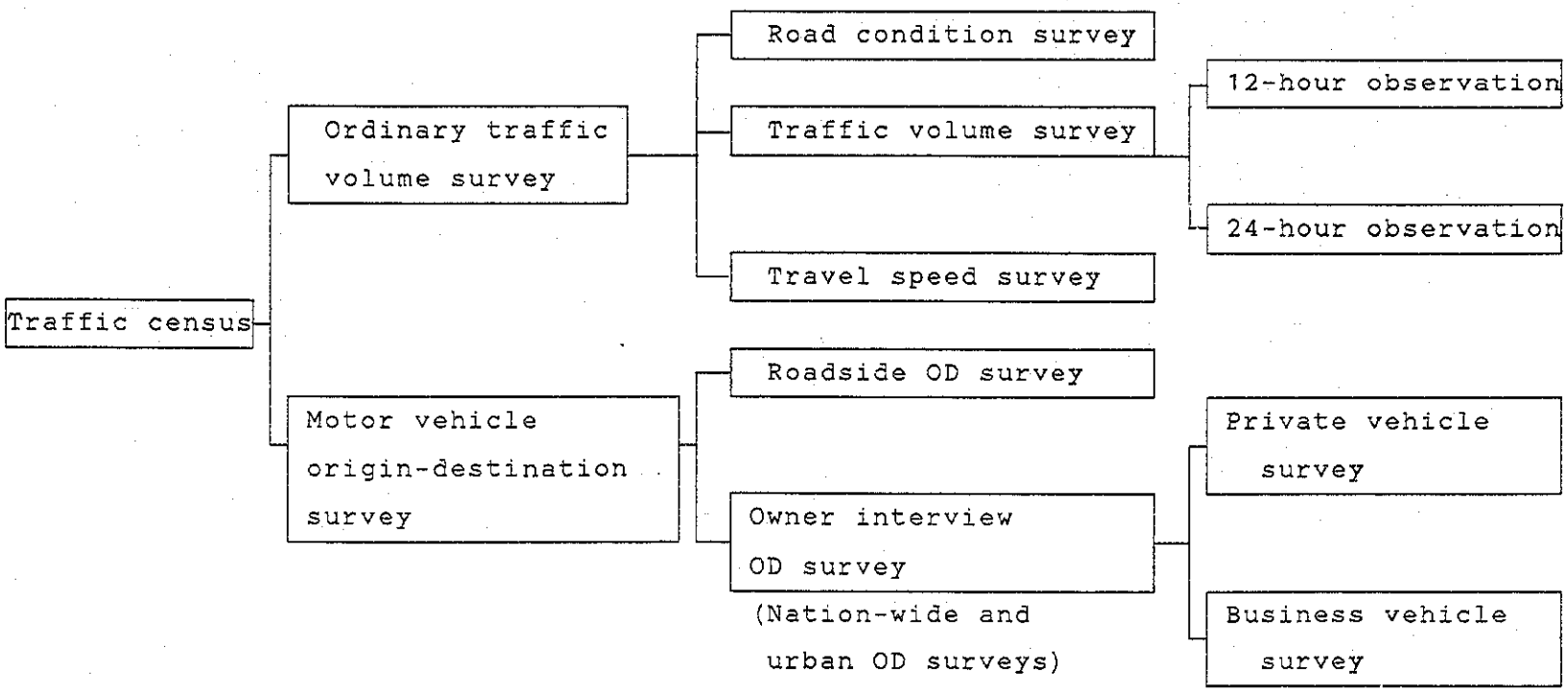


Figure 5.2 Organization of the Traffic Census

conditions, road-related regulations, and frequency of accidents.

2) Traffic volume surveys

A traffic volume survey is conducted to determine the average weekday (Tuesday, Wednesday or Thursday) traffic volume in autumn (from the end of September to the end of October). The figure obtained is assumed to be the average daily traffic volume for the year. This is because continuous traffic volume observation results have shown that the daily traffic volume during the above-mentioned period is nearly equal to the annual average daily traffic (AADT).

The observation hours are from 7 a.m. to 7 p.m. (i.e., 12 daylight hours). Additionally, a 24-hour observation is made, in case a survey of night traffic volume is needed to determine the ratio of daily traffic to daylight traffic and to ensure proper road administration (e.g., for solution of environmental issues).

3) Travel speed surveys

A travel speed survey is conducted on a weekday for principal local roads and up-graded ones by actual driving using a 1500-to-2000-cc passenger car or light van over a distance selected for the survey. The travel speed is then calculated from the travel time and the distance traveled. The travel time includes the delay time caused by signals, railroad crossings, crossing by pedestrians, traffic congestion, etc. as well as the delays caused by slow speed driving, etc. It however does not include delays caused by unexpected occurrences (e.g., traffic accidents).

b) Motor Vehicle Origin-Destination Survey

1) Roadside OD surveys

The motor vehicle origin-destination survey is generally conducted by interviewing vehicle owners. However, to ensure the accuracy required for long-distance trips, roadside OD surveys are made on routes showing relatively low through-traffic volumes and over which long-distance trips are frequently made (e.g., across cordon lines).

Routes to be surveyed are usually all prefectural roads and up-graded ones that cross cordon lines, but routes showing extremely low traffic volumes are sometimes left unsurveyed.

2) Owner interview OD survey

These surveys are basically intended for all vehicle types (except motorcycles and non-self-propelled vehicles). Vehicle owners or users are interviewed to obtain information about their activities on the day selected for survey. For truck and bus services, necessary information is collected from the motor vehicle transportation statistics (truck service records) and from the "Report on Transportation Statistics by Bus Service Route", which are prepared by the Ministry of Transportation.

(2) Continuous Traffic Volume Observation Survey

The purpose of this survey is to observe time-series variations in traffic volume through continuous observation of traffic using vehicle detectors.

The traffic volume observation system is made up of basic observation spots at which a traffic survey is conducted on a continuous basis, and auxiliary observation spots where traffic is surveyed continuously for a week in spring and autumn to obtain additional data. Auxiliary observation is conducted to observe traffic volume by vehicle type and estimate correction factors for vehicle detectors.

Basic observation spots are normally situated in the suburbs of large cities and between cities. Between basic observation spots are three to five auxiliary observation spots which coincide with the observation spots for the ordinary traffic volume survey in the road traffic census.

The continuous traffic volume observation survey ensures effective use of traffic information by providing data on time-series variations in traffic volume as well as extra data which is not available in the ordinary traffic volume survey.

The results of the survey are collected at each spot on a yearly basis, and then analyzed to provide the daily traffic volume frequency distribution, hourly traffic volumes (e.g., thirtieth highest hourly volume), time factor (e.g., peak hour factor and ratio of daily traffic to daytime traffic), day of-the-week factor and characteristics of holiday traffic.

5.2.2 Necessity of Road Traffic Data

The traffic census and the continuous traffic volume observation survey, if conducted properly, provide valuable data listed below for the identification of the current status of road traffic. The data gives the

actual conditions of roads all over the country and serves as a source of information for road servicing activities in the future. It is essential for the construction and maintenance of the roads.

1) Data obtained by the traffic census includes:
   - The current status of road traffic quantitatively and qualitatively.
   - Hourly traffic volume by purpose and classification.
   - Trip generation rates regarding vehicle traffic, and their time-series changes (e.g., hourly traffic volume).
   - Basic data for the prediction of total traffic demand that meets future socio-economic frames.

2) Data obtained by the continuous traffic volume observation survey includes:

   - Time-series variations in traffic volume.
   - Traffic census backup data.

5.2.3 The Road Traffic Census in DOH

At present, DOH is conducting traffic volume surveys at 1,834 observation spots nation-wide. However, the automatic data collection capability is available only at some 20 spots out of all observation spots; at the remaining spots, personnel from the Traffic Engineering Office are conducting surveys. This practice requires so much manpower that the Traffic Engineering Office cannot afford to assign personnel to its original duty - planning of traffic safety and control schemes.

Also, traffic data currently being collected is only concerned with sectional traffic volume on roads. This type of data is useful for the evaluation of road use at macroscopic level, but is of no service to the planning of actual traffic operation.

This situation prevails in other divisions of DOH. For instance, the Planning Division and Design Division, which are responsible for planning and designing new roads are obliged to send their personnel when a new project is implemented. In short, DOH's traffic observation activity demands too many personnel at present.

Road traffic data obtained through regular observation in the traffic census,etc. should be used to promote the construction of roads in a manner that meets socio-economic changes. This makes it necessary to identify the current status of road traffic both quantitatively and qualitatively.

Additional points to be included in the traffic volume surveys conducted by DOH are summarized below.

1) Traffic volume data

- 24-hours traffic volume data.
- Traffic volume data by classifications.

2) Road characteristics data

- Total length of road sections selected for the survey, and total length of road sections that have been improved.
- Road width, number of lanes, and total length of sidewalks installed.
- Roadside conditions, etc.

3) OD data

- OD table by vehicle type.
- Cargo OD table by commodity.
- Passenger OD table by service type, etc.

5.2.4 Basic Considerations for the Traffic Census

In Japan, the first traffic census was conducted in 1928. Continued efforts since then have resulted in the establishment of the present census system. It is often pointed out, however, that proper systematization of road traffic surveys and effective use of existing data are essential for the promotion of road construction in a manner that meets socio-economic changes and the people's needs in the future.

These developments in Japan will be considered in conducting the DOH traffic census. Implementation policies should be based on the following points:

A. The nation-wide traffic census should be conducted at the same time.

B. Traffic census should be conducted by every agency concerned with road traffic administration (e.g., DOH BMA, ETA, etc.) under the good coordination.

C. The current characteristics of road traffic by quantity and quality should be identified (e.g., trip purpose and OD of trip).

D. Motor vehicle occupancy should be identified (e.g., number of passengers and contents of cargoes).

5.3 GENERAL TRAFFIC VOLUME SURVEY

5.3.1 Existing Problems and Measures for Improvement

(1) DOH's Traffic Volume Data

Since 1962, the DOH has been conducting its traffic volume survey at 1,834 stations in the entire country using two different methods, i.e., the control count and the coverage count (Ref. Table 5.1).

The control count is intended to measure the seasonal and daily variations in traffic volume. It is conducted four times a year (January, April, July and October) for 17 consecutive days, eight hours a day (00:00-08:00 hours for three days, 08:00 - 16:00 hours for seven days, and 16:00 - 24:00 hours for seven days), at 34 stations established along major national highways.

The coverage count is aimed at estimating the average daily traffic (ADT) on each road control section, and is conducted on five consecutive days, eight hours a day (08:00 - 16:00 hours), at 446 stations on national highways and 1,438 stations on provincial highways. This survey is carried out twice a year, in April and October for national highways and in January and July for provincial highways.

The road traffic census in Japan covers all national highways and prefectural roads and part of municipal roads of designated cities. In 1988, the holiday road traffic was included in the scope of this census in addition to the weekday road traffic survey so far conducted. Table 5.2 shows a comparison of traffic volume data between the two countries with respect to the method of survey and other aspects.

(2) Improvement Measures for DOH's Traffic Volume Data

The following can be cited as improvement measures in the DOH's data.

A. Re-examine the objectives of automatic and manual traffic surveys to establish a survey system and method suited to the purpose.

B. Develop a continuous 24-hour survey method.

C. Include the pedestrian traffic in the scope of survey.

Table 5.1 Method of Traffic Counts on DOH Roads

Item	National Highway		Provincial Highway
	Control Count	Coverage Count	
Purpose	to establish seasonal and daily traffic volume characteris -tics	to estimate ADT on each road section	to estimate ADT on each road control section
Schedule	January, April, July and October	April and October	January and July
Count Period	Count period is for three weeks, and 17 daily 8-hour volume counts to form 24-hour volumes on Wednesday, Saturday and Sunday and 16-hour volumes count for other days of week[1]	5 daily 8-hour volume counts from 8:00 am to 4:00 pm. on weekdays[2]	5 daily 8-hour volume counts from 8:00 am. to 4:00 pm. on weekdays[2]
Number of Station	34 stations in 1988	446 stations in 1988 (Including road under-construction)	1438 stations in 1988 (Including road under-construction)
Type of Vehicle	1) Passenger Car, 2) Light Bus 3) Heavy Bus 4) Light Truck or Pick up 5) 6 Wheel Truck 6) 10 Wheel Truck or Trailor 7) Bi-Tricycles 8) Motorcycles		

Note 1) Control count periods are following:

	SUN	MON	TUE	WED	THU	FRI	SAT
8:00	1st day			16			17
16:00	13	2nd	15	9	4	11	6
24:00	7	14	8	3rd	10	5	12

2) Mechanical counts at the station are used to develop conversion factor for the calculation of ADT

Source : Department of Highways

Table 5.2 Comparison of Traffic Volume Data between DOH and Japanese Road Traffic Census

	Traffic volume data of DOH		Traffic volume data of road traffic census (Japan)
	Control count	Coverage count.	
Schedule	4 times a year (January, April, July, October)	Twice a year (April and October for national highways, and January and July for provincial highways)	Late september-Early October Every five years
Survey hours	8 hours a day on 17 consecutive days 00:00-08:00 hours on 3 days 08:00-16:00 hours on 7 days 16:00-24:00 hours on 7 days	8 hours a day on weekdays(07:00-19:00 hours)	12 hours on weekdays (07:00-19:00 hours) 12 hours on holidays(07:00-19:00 hours) 24 hours on weekdays(07:00-07:00 hours) 24 hours on holidays (03:00-03:00 hours)
Survey rords	Major national highways	National highways and provincial highways	National expressways, urban expressways, national highways, principal local roads, prefecturl roads, municipal roads of designated cities
Vehicle classifica	1) Passenger cars 2) Light buses 3) Heavy buses 4) Light trucks and pickups 5)6-wheel trucks 6)10-wheel trucks or trailers 7)Bi-tricycles 8)Motorcycles		1) Pedestrians 2) Bicycles 3) Motorcycles 4) Light passenger cars 5) Passenger cars 6) Buses 7) Light trucks 8) Light delivery trucks 9) Light vans 10)Heavy trucks 11)Special

motor vehicles

5.3.2 Examination of Survey Method

(1) Proposal of Road Condition Survey

a) Existing State of DOH's Road Data

Although the DOH conducted a comprehensive road inventory survey in the past, it has no information for measuring the existing road condition because the data of this survey has not been updated since. Accordingly, it is difficult to obtain updated road and roadside data from the DOH. The Programming Section of the DOH has been engaged in the collection of data of all DOH roads since 1983 to complete its road database.

The situation being such, the Phase I Study collected the road data shown in Table 5.3 in 1985. These data are made available for each 1-km road section for use in case studies of the traffic safety project.

Table 5.3 Information Available from the Road Data

Information	Remarks
1.Route No.	
2.Kilometer Post	
3.No. of Intersection	Signalized, Non-Signalized (Large, Small)
4.Land Use	High Density, Low Density, Field
5.Alignment	Straight, Curve (<25%, <50%, <75%, >75%)
6.Number of Lanes	Two Way
7.Number of Bridges	
8.Lane Line Marking	None, Exist
9.Center Line Marking	None, Exist
10.Edge Line Marking	None, Exist
11.Median Type	None, Island, Marking, Raised Pavement Marker
12.Surface of Shoulder	Paved, Unpaved
13.Sidewalk	None, One-side, Both-side
14.Street Lighting	None, At Intersection, Full
15.Guard Rail	None, Exist (<25%, <50%, <75%, >75%)

b) Proposal of Road Condition Survey

The road condition survey is intended to investigate the length and other particulars of the selected survey route by the kind and condition of road. The selected route is divided into a number of sections to conduct the survey in each individual section.

The findings of this survey are very useful in making a detailed analysis of traffic accidents that have occurred on the survey road, and also serving as important basic data for planning and implementing a traffic safety project.

It is proposed that the road condition survey be conducted to collect the following information.

1) Unit length of survey sections, and length of improved road sections.
2) Width of carriageway, lane and minimum carriageway.
3) Number of lanes.
4) Surface classification.
5) Length of freeway sections.
6) Length of traffic regulation sections.
7) Length and width of sidewalks.
8) Length and width of medians.
9) Length of road sections with green space.
10) Number of at-grade crossing with railways.
11) Number of signalized intersections.
12) Number of non-signalized intersections.
13) Number of grade separations.
14) Cycle time and green interval at signalized intersections
15) Number of intersections with right-turn lane.
16) Length of bus routes, bus priority lanes, and exclusive bus lanes.
17) Roadside condition (e.g., length of urban area, length of level terrain, and length of mountainous area).
18) Length by land use zoning (e.g., residential area, commercial area, industrial area).
19) Length of one-way traffic control sections.
20) Length of traffic control sections during abnormal weather.
21) Length of no-passing zones.

(2) Proposal for Overall Travel Speed Survey

The overall travel speed survey is conducted in parallel with the weekday traffic volume survey to measure the traveling condition and degree of traffic congestion during the peak hours of weekdays. In the overall travel speed survey conducted in Japan, however, the travel speed can be obtained only as the average in the census section. Therefore it is not possible to identify the actual bottlenecks. Since traffic congestion can be solved most effectively by smoothing the flow of the traffic in bottlenecks, it is important to identify the exact locations of bottlenecks.

The following method of overall travel speed survey is proposed based on the results of Japanese studies for improving methods.

Survey method

Passing time at origin/destination, reasons for stop, stopping time and starting time are written down for each survey section. An explanation of each of these survey items is given below.

1) Passing/stopping time

The origin/destination passing time of each vehicle, and the start and finish of the period during which the vehicle is brought to a halt, are written down.

2) Overall travel time

The travel time calculated from the origin/destination passing time is written down.

3) Stopping time

Each vehicle's stopping time obtained from the start and finish time of the period during which it is brought to a halt is written down. Total stopping time is also written down by summing up all of such stopping times.

4) Reasons for stopping

The reason or reasons for stopping are written down using the code numbers shown below.

Reason	Code No.
- Waiting for a single green interval	1
- Waiting for two or more green intervals	2
- Small road width	3
- Road construction work	4
- Traffic accident	5
- Other	6

5) Stopping places

The places where the vehicle has stopped are written down only if the cause of stopping is "waiting for green interval" or "small road width."

5.4 MOTOR VEHICLE ORIGIN-DESTINATION SURVEY

5.4.1 Necessity of Origin-Destination Survey and Its Utilization

In order to plan highway network construction, the present motor vehicle traffic pattern must be made clear, and it is desirable to understand it not as a more traffic volume but as a surface distributions of traffic between the origins and the destinations of the trips. With the data of such traffic, it is possible to formulate a highway construction plan compatible with the distribution of actual traffic volume. A traffic survey conducted for this purpose is called the OD (origin and destination) survey.

It is often the cases that the OD survey is carried out to study not only the origin and destination of the trip but also the purpose of the trip, type of vehicle, operating time, and daily operating condition. By counting and tabulating the survey data, it is possible to establish the relationship between the various zone characteristics (population, land use condition, levels of commercial and industrial activities) and the generated motor vehicle traffic. These data make it possible to probe deeper into the traffic phenomena by a detailed analysis and make a more accurate forecast of the future traffic volume. They can also be utilized extensively in, for example, the evaluation of future land use plans from a viewpoint of transportation, and are highly useful in transportation and city planning.

5.4.2 Examination of Fundamental Items

(1) Classification of Vehicles

The vehicles covered by the OD survey are classified as follows as is the case with the general traffic volume survey.

1) Passenger cars
2) Light buses
3) Heavy buses
4) Light trucks or pickups
5) 6-wheel trucks
6) 10-wheel trucks or trailers
7) Bi-tricycles
8) Motorcycles

The following vehicles are excluded from the scope of OD survey.

1) Fire engines
2) Mail cars
3) Police cars

4) Route buses
5) VIP cars
6) Road construction vehicles
7) Samlor

(2) Zoning

To indicate the locations of trip ends, the survey area needs to be divided according to the purpose of the survey, and this is called "zoning." In the OD survey sheet, the town names, the names of nearby marker buildings and stations are written down to indicate the origin and destination of trips, and the data of each trip is counted and tabulated for each zone.

The zone is the smallest unit of OD movements, and is also the unit for the future traffic forecast and traffic assignment

Zoning consists of the basic division and detailed division of the survey area. The basic division is made up of the link partition in which the survey area is divided into the central business district, urban area and suburban area, and the sector division in which the survey area is divided by considering the directions of arterial roads. In the detailed division, each unit should have approximately the same generated traffic. The zones thus delineated should be as uniform as possible in both shape and land use condition, and should preferably be made consistent with the statistical division such as administrative division so as to be able to make effective use of population and other statistical data. If the area has been covered by an OD survey in the past, it is necessary to consider the consistency with the zoning made in such a past survey.

The area not covered by the survey is zoned in a broad way. In most cases, the area surrounding the survey area is divided into municipalities, and the area extending further outside is division into prefectures.

5.4.3 Examination of Roadside Interview OD Survey

(1) Survey Method

The roadside interview OD survey is conducted in the presence of policemen from the relevant police station. All vehicles covered by the survey are stopped temporarily at the survey point where the interviewer collects the necessary information directly from each driver and record it down in the survey sheet.

The survey should cover the passing time, vehicle attributes and the details of the trip. Individual survey items are shown in Table 5.4.

Table 5.4 Survey Items of Roadside Interview OD Survey

Classification	Survey Item
1. Processing No.	1) Serial No. (by up/down trip)
2. Survey point	2) Survey point No.
	3) Distinction between up and down trip
3. Passing time	4) Passing time
4. Vehicle attributes	5) Vehicle type
	6) Ownership
	7) Name of Land Transportation Bureau
5. Contents of trip	8) Origin
	9) Destination
	10) Purpose of operation (privately owned cars only)
	11) Number of passengers
	12) Cargoes loaded (trucks only)
	13) Maximum load (trucks only)

(2) Survey Date/Hours

The survey should be conducted on a day suitable for measuring the average volume and pattern of motor vehicle traffic in the urban area covered.

The survey data should be determined by excluding Mondays, Fridays, Saturdays, Sundays, holidays, days before and after holidays, days of abnormal weather such as storms, and any other days when the traffic is likely to present phenomena differing from its usual behavior. As a rule, the survey should start at 10:00 a.m., but this can be changed according to the situation. In this case, the survey is carried out continuously for 24 hours until the same hour of the following day.

(3) Interview Stations

The roadside interview OD survey is conducted at stations set up on the cordon lines near the prefectural borders where the number of long-distance trips is large and total number of trips is small to study the trips which cannot be measured with high accuracy in an owner interview OD survey. In principle, the interview stations for this survey are established at the same spot as selected for the general traffic volume survey (24-

hour traffic survey). In this way, the general traffic survey and the roadside OD survey can be carried out on the same spots on the same day, making it possible to dispense with a separate spot traffic survey.

As a rule, the survey covers all routes of provincial highways and national highways crossing the cordon lines, but it is possible to omit the routes having an extremely small traffic volume. The survey spots are established at points near the cordon lines where the shoulder has an ample width.

5.4.4 Examination of Vehicle Owner Interview OD Survey

(1) Survey Method

In the vehicle owner interview OD survey, the survey vehicles are sampled from all registered in the country (excluding isolated, special islands), and the owner/user of each sampled vehicle is visited for an interviewer in which he is requested to answer questions regarding the operating condition of his vehicle and the contents of operation for each trip on the survey date.

The survey covers the attributes of survey vehicles, and their operating condition and details of trip-wise operation on the survey date. Individual survey items covered in Japan are shown in Table 5.5.

(2) Sampling of Vehicles

The survey vehicles are selected by random sampling by vehicle and business type from the motor vehicle registration file at a predetermined sampling ratio.

The vehicles thus sampled are arranged and sorted by municipality, vehicle type and business type to prepare the Comprehensive Table of Vehicles for Owner Interview OD Survey and the Table of Vehicle Numbers for Owner Interview OD survey.

(3) Survey Method of Privately Owned Vehicles

A. A single weekday is selected at random as the survey date of each type of vehicles. The survey covers the trips made during 24 hours from 03:00 a.m.

B. Survey vehicles are selected at a predetermined sampling ratio from the vehicles which are used mainly in the survey area.

C. The survey date is determined for each type survey vehicles. The interviewer visits the vehicle users on one or two days before the survey date, hands them the Vehicle Owner OD Survey Questionnaire with an

Table 5.5 Survey Items of Owner Interview OD Survey

	Survey item	Passengar cars	Commercial vehicles	Hired cabs/ taxis	Trucks	Leased buses	Route buses	Route trucks
A. Attributes of survey vehicles	Motor vehicle registration No.	○	○	○	○	○		
	Serial No.	○	○	○	○	○	○	
	Driver's sex	○	○					
	Driver's age	○	○					
	Prinncipal area of operation	○	○	○	○	○	○	
	Vehicle type	○	○		○			
	Vehicle ownership	○	○					
	Business type		○					
	Maximum load		○		○			
	Kind of fuel used	○	○	○	○	○		
	Operating pattern				○			
	Fixed nubeer of passengers			○		○		
B. Operating condition on the survey date	Distance traveled	○	○	○	○	○		
	Frequency of operations	○	○		○	○		○
	Oprating condition			○	○	○		
C. Contents of each trip	Origin and destination	○	○	○	○	○	○	○
	Areas crossed						○	○
	Facility classification	○	○		○			
	Starting time	○	○	○	○	○		
	Travel distance	○	○	○	○	○		○
	Purpose of operation	○	○					
	Number of passengers	○	○	○	○	○		
	Parking place	○	○					
	Type of cargo loaded		○		○			
	Superimposed load		○		○			
	Reasing for using the vehicle	○						
	Use/non=use of urban expressways	○	○	○	○	○		
	Expressways used	○	○	○	○	○		
	Route length (in km)						○	
	Daily number of operations						○	
	Annual number of transported passengers						○	
	Annual number of operating days						○	
	Annual total running distance (km)						○	
	Average transported distance per passengar						○	

instruction, and requests them to fill out the questionnaire with answers related to the operating condition of their vehicles on the survey date.

D. The interviewer visits the vehicle user again on the day after or within a few days from the survey date, and collects the questionnaires after checking the responses. If there is any question left unanswered, he asks the user for the answer, which he records.

(4) Survey Method of Commercial Vehicles

a) Business Operator Interview Survey

A. Survey vehicles are selected at a predetermined sampling rate from the vehicles used mainly in the survey area.

B. The interviewer visits the operator of survey vehicles not later than one week before the designated survey date, hands the questionnaire to him with an instruction, and requests his cooperation in filling out the questionnaire with answers related to the operating condition of his vehicles on the survey date.

C. The interviewer revisits the vehicle operator within a few days after the designated survey date, and collects the questionnaire after checking the entries made in it.

b) Route Bus Operation Survey

A. The survey is conducted to cover all buses operated along all fixed bus routes.

B. General route bus operators submit a route-wise operation report covering all existing bus routes and operated as of September 30 of each year.

5.4.5 Implementation of Case Study in Phetburi Area

A Sample OD Survey has been planned is Phetburi Area to show how to implement the aforementioned Roadside Interview OD Survey and Vehicle Owner Interview OD Survey. Table 5.6 outlines the sample survey.

Sample OD Survey are to be conducted directly by Traffic Engineering Division by following the OD Survey Manual prepared by the Study Team. The OD Survey Manual has been attached in separate volume. In Appendix 5.1 zone map and network map of Phetburi Area is provided.

Table 5.6 Outline of Sample OD Survey

Objectives	1) Clarify the method of conducting OD surveys 2) Clarify the method of compiling and analyzing OD survey results 3) Clarify the method of utilizing OD survey results
Subject Area	Phetburi Area
Manual Prepared by Team	1) OD Survey Manual 2) Traffic Forecast Manual (including computer program)
Works Conducted by Team	July Determination of sample survey framework (subject area, etc.)
	Aug. Preparation of OD Survey Manual
	(Sep. Implementation of sample survey by DOH)
	(Oct. Compilation of sample survey by DOH)
	Nov. Preparation of Traffic Forecast Manual
	(Dec. Estimation of future traffic volume by DOH)

In addition to the survey manual, a Traffic Forecast Manual has been prepared for future traffic volume estimation based on the results obtained from Sample OD Survey. The Traffic Forecast Manual is provided in separate volume.

The Traffic Forecast Manual is so designed that all the processing involved can be handled by computer. In this study, major processing of the future traffic volume estimation have been programmed so that the estimation will be available at the Traffic Engineering Division.

5.5 CONTINUOUS TRAFFIC VOLUME OBSERVATION SURVEY

5.5.1 Necessity of Continuous Observation and Its Utilization

In the continuous observation survey, observation points are set up along selected urban and inter-urban routes to continuously record 24-hour traffic throughout the year, so that it is possible to obtain changes in traffic volume as a time series. Continuous traffic observation is conducted by vehicle detectors.

Since no other traffic survey provides 24-hours of continuous traffic observation throughout the year, this survey produces valuable traffic engineering data and contributes greatly to the reliability and enhancement of the road traffic census.

Table 5.7 shows the functional characteristics of the continuous observation survey and the method of its utilization in the future road improvement schemes.

Table 5.7 Functional Characteristics and Advantages of Continuous Observation Survey

Functional Characteristics	Functions	Advantages
Collection of basic traffic engineering data	* Basic traffic engineering data can be collected, as listed below. 1) AADT 2) Peak hour factor 3) Day-of the week factor 4) Time factor 5) Ratio of daily traffic to daytime traffic 6) Heavy vehicles ratio 7) Composition of vehicle types	* Useful in upgrading the reliability of road traffic census by supporting census data. * Useful in the public understanding of road traffic by supplying traffic engineering data. * Useful in optimizing the calculation of traffic capacity.
Measurement of traffic variation characteristics	* Traffic variation characteristics of each individual route can be measured. * Variations in traffic volume resulting from socio-economic changes can be measured. * Variations in traffic volume due to road improvement can be measured. * Variations in traffic volume caused by the construction of large structures such as industrial complexes and truck. terminals can be measured * Variations in traffic volume caused by abnormal weather or any other unexpected phenomenon can be measured. * Variations in traffic volume resulting from changes in the traffic of tourists and sightseers can be measured.	* Useful in formulating an arterial road improvement plan. * Useful in evaluating the impact of economic tendencies on road traffic. * Useful in evaluating the road improvement effect. * Useful in evaluating the impact of large facilities construction work on road traffic. * Useful in evaluating the influences of traffic impediments due to abnormal weather on road traffic in other parts. * Useful in promoting the development of resort areas for tourists and sightseers.

5.5.2 Selection of Survey Routes/Stations

The following are the criteria on which the observation stations should be set up to make the most effective use of the two functional characteristics of continuous observation survey, i.e., collection of basic traffic engineering data, and measurement of the change in traffic volume.

1) Collection of basic traffic engineering data

On the basis of existing survey data, 24-hour observations should be conducted to set up new stations in sections considered to be in need of such installation from a traffic engineering point of view.

2) Measurement of change in traffic volume

To acquire a firm, constant understanding of change in traffic volume, 24-hour observation stations need to be set up in sections where weekday traffic shows large variations from holiday traffic, with priority given to sections where the frequency of traffic jams shows a difference of three times or more between weekdays and holidays.

5.6 IMPLEMENTATION PLAN OF TRAFFIC CENSUS SYSTEM

5.6.1 General Traffic Volume Survey

The General Traffic Volume Survey consists of a Traffic Volume Survey and a Travel Speed Survey. The Traffic Volume Survey has been conducted by DOH since 1962 and it is desirable to improve the survey step by step taking aforementioned reviews into consideration. On the other hand, a Travel Speed Survey has not been implemented systematically so far. It is recommended to introduce this survey since it is very useful in identifying bottlenecks on DOH roads.

Travel Speed Survey is to be conducted annually on major routes by following the survey method previously described. The routes to be surveyed initially will be those with many control sections having high congestion levels as shown in Chapter 3. Table 5.8 shows selected routes which need to be surveyed.

Table 5.8 Proposed Route for Travel Speed Survey

Route No.	Survey Section (Control Section)
Route 1	0001 0100 (Bangkok) - 0001 1202 (Nakhon Sawan)
Route 2	0002 0101 (Sara Buri) - 0002 1201 (Udon Thani)
Route 3	0003 0100 (Bangkok) - 0003 1200 (Chanthaburi)
Route 4	0004 0100 (Bangkok) - 0004 1100 (Prachuap - Khiri Khan)
Route 31/32	0031 0100 (Bangkok) - 0032 0802 (Chaint)

5.6.2 Motor Vehicle Origin - Destination Survey

Even though its value is unquestioned, it is very difficult to conduct an OD survey on a nation - wide basis. In Japan, when OD surveys were first introduced, it was only done in major city groups. At the present time, it is judged impossible to obtain enough survey staff to conduct a nation wide OD survey in Thailand. Therefore, for the time being, DOH should conduct OD survey locally and wait until a future time before conducting a survey on a nation-wide scale.

There are two ways to conduct OD survey locally.

1) Structure a city group with a major core city
2) Divide the country into blocks.

DOH is in control of all major trunk roads throughout the country and it is important that DOH is aware of nation-wide traffic flows. In the light of such an objective, method 1 is not recommended since it tends to focus on some major cities and may fail to reflect nation-wide traffic flows. Also such a grouping method