CHAPTER 6

SELECTION OF ROUTES TO BE IMPROVED

CHAPTER 6
SELECTION OF ROUTES TO BE IMPROVED

Based on a review of the key strategies stated in the 6th Highway Plan, the following fundamental concepts were established to select the priority routes to be improved:

a) Trunk highway network (national and main provincial highways)

- To cope with increasing traffic and to ensure comfortable and on-time driving.

- To promote and support the national development plan.

b) Supplemental road network (provincial and rural roads)

- To improve accessibility to reinforce local socio-economic activities.

Based on the above concepts, the following items were studied on the assumption that the target year is 2000:

i) Trunk highway network studies (ML Projects)

- Road congestion
- Relation with national development programs

ii) Supplemental road network studies (IM Projects)

- Local socio-economic requirements
- Road connection

iii) Other studies (described in Chapters 7 and 10)

- Rehabilitation (RH Projects)
- Capacities of intersections

As shown above, the selected priority routes were named ML projects, IM Projects and RH Projects, respectively.

6.1 IDENTIFICATION OF PRIORITY ROUTES BASED ON ROAD CONGESTION

The degree of congestion for all roads within the study area was examined by comparing the projected traffic volume (ADT as of 2000) with the traffic capacity.

Within the study area, two-lane highways make up a predominant mileage of the national and provincial highway network, while highways with multi lanes are only about 490 km in total, as shown in the road inventory shown in Appendix 4.3.1.

According to the design standards of DOH, divided four-lane highways classified as PD, SD and FD are required when the projected ADT in the 7th year after opening exceeds 8,000.

In Highway Capacity Manual: TRB, 1985, the possible capacity is indicated in terms of the number of passenger cars per hour (pcph) and traffic of 2,800 pcph is recommended as the maximum capacity for two-lane highways. It is difficult to simply convert a pcph to an ADT; however, a range of 10,000 to 15,000 of ADT can roughly be equivalent to 2,800 pcph.

In Japan, four-lane highways are routinely planned when the projected ADT exceeds 12,000 in accordance with the Geometric Design of Highways and Streets Act of 1982.

Considering the above standard and recommendation and the future increment of traffic in Thailand, 12,000 ADT was employed as the tentative criterion to improve two-lane highways to multi lane highways. For multi lane highways, a traffic capacity of 12,000 ADT per lane was employed. Based on these criteria, the required number of lanes as estimated by comparing projected ADT and traffic capacity.

The analysis results indicated that 24 roads with a total length of 1,015 km required additional lanes. Among them 19 links of 920 km require an additional two lanes to the existing two-lane highways, 4 links of 71 km in total of an additional two lanes to the existing four-lane highways and 1 link of 24 km in total additional four lanes to the existing four-lane highway.

These results are summarized in Table 6.1.1 and Figure 6.1.1.

Table 6.1.1 LINKS REQUIRING ADDITIONAL TRAFFIC LANES

Number of Lanes		Route	Location	Length
Exist.	Proposed	No.		(km)
2 → 4		1	J.R. 32 - C. Nakhon Sawan - J.R. 1072	50.0
		2	C. Saraburi - J.R. 2090	58.0
		3	Chon Buri Bypass	13.5
		3	Pattaya - A. Sattahip - C. Rayong	82.5
		3	A. Klaeng - Chanthaburi - J.R. 3348	73.5
		4	C. Ratchaburi (J.R 3208) - J.R. 35	21.5
		4	C. Phetchaburi - A. Hua Hin - C. Prachuap Khiri khan	158.5
		32	J.R. 1 - C. Ang Thong - J.R. 1	157.5
		35	J.R. 340 - C. Samut Sakhon - J.R. 4	76.0
		304	A. Min Buri - C. Chachoengsao - J.R. 319	77.5
		305	A. Thanyaburi - A. Ongkharak	35.0
		323	C. Kanchanaburi - J.R. 3398	7.5
		340	J.R. 3035 - J.R. 3425	14.5
		344	J.R. 3345 - J.R. 331	10.5
		3091	J.R. 4 - C. Samut Sakhon	20.0
		3111	O.R.R.- A. Sam Khok	17.0
		3119	A. Min Buri - J.R. 3256	10.5
		3256	J.R. 311 - J.R. 34 - J.R. 3268	27.0
		3414	J.R. 4 - J.R. 338	10.0
	Subtotal		19 links	920.5
4 → 6		3	J.R. 314 - C. Chon Buri	18.0
		4	J.R. 340 - J.R. 3414	11.0
		34	J.R. 3256 - A. Bang Pakong	33.0
		338	J.R. 340 - J.R. 3414	9.0
	Subtotal		4 links	71.0
4 → 8		3	C. Chon Buri - A. Sri Racha	
	Subtotal		1 link	24.5
	Total		24 links	1,015.0

6.2 IDENTIFICATION OF PRIORITY ROUTES BASED ON RELATION WITH NATIONAL DEVELOPMENT PLANS

All routes linking areas related to the Eastern Seaboard Development Program to Bangkok, Rt. 3, the Chon Buri Bypass, Rt. 34 and Rt. 304, have been selected as priority routes from the viewpoint of the congestion alleviation analyzed in Section 6.1.

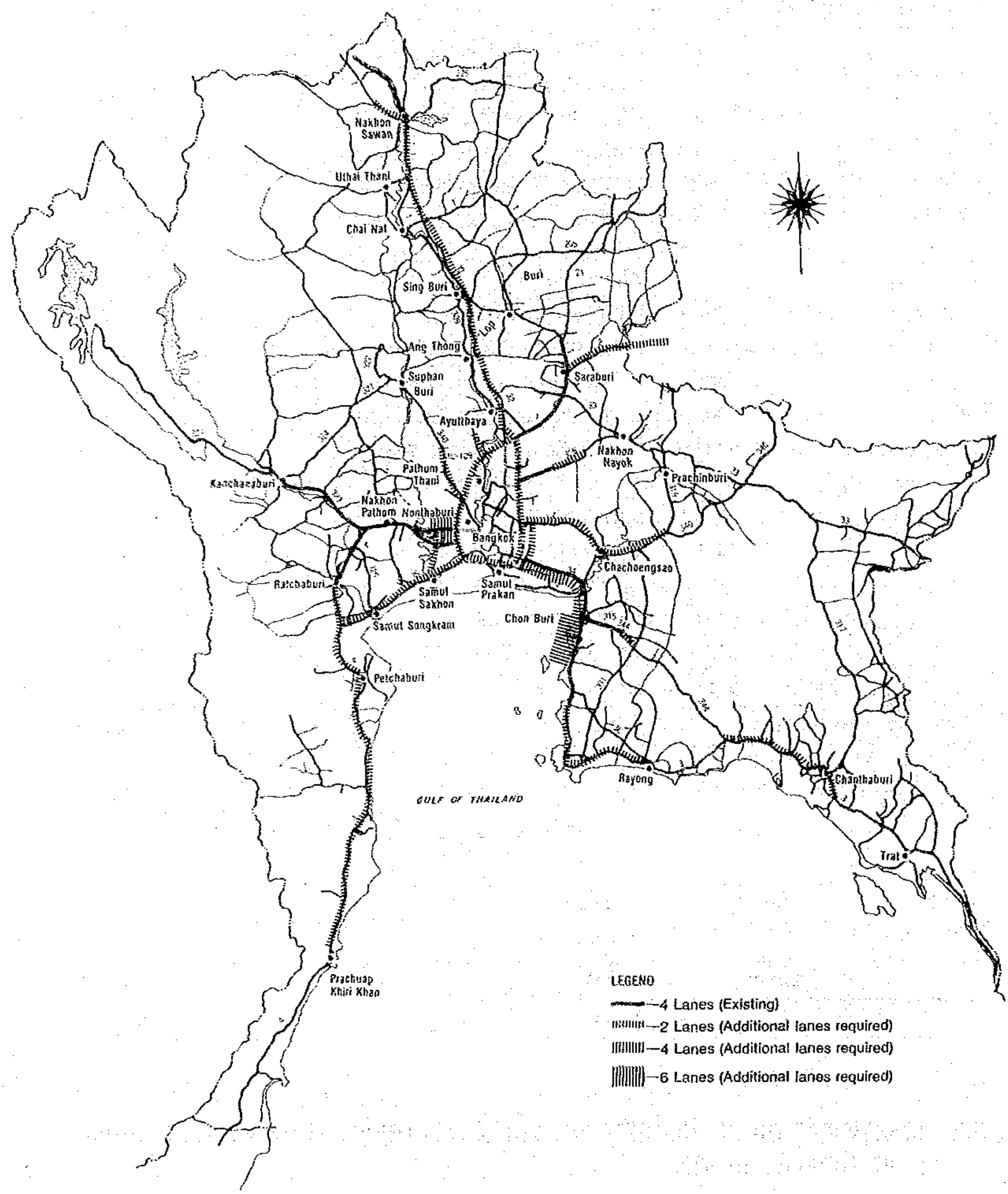


Figure 6.1.1 LINKS REQUIRED ADDITIONAL TRAFFIC LANE

6.3 IDENTIFICATION OF PRIORITY ROUTES BASED ON SOCIO-ECONOMIC REQUIREMENTS

1) Formation of Blocks Surrounded by Paved Roads

Based on the base road network map prepared in Chapter 4, block areas surrounded by paved roads were derived as study units (called Blocks). The Blocks, 216 in total, are shown in Appendices 6.3.1. and 6.3.2.

2) Selection of Priority Blocks

Selection of priority Blocks was performed based on Road Network Value (M value), taking into consideration socio-economic characteristics in the Block such as GPP by industrial sector and density of hospitals and secondary schools.

a) Road Network Value

The Road Network Value (M value) of each Block was calculated by the following formula:

$$M = \frac{P}{L} \cdot \frac{A}{L}$$

where, M : Road Network Value

P : Population in the Block

A : Cultivable area in the Block (including habitable area)

L : Total length of paved roads surrounding the Block

The cultivable area in each Block was measured on topographic maps. The population in each Block was estimated allocating Amphoe population in the year of 2000 in proportion to the cultivable area in the Block.
Calculated M. values are shown in appendix 6.3.1.

b) **Criterion of M Value and Candidate Blocks**

Theoretically, required road length for the country/region is expressed by the following formula:

$$L_T = K\sqrt{P \cdot A}$$

where, L_T : Total road length
K : Road network coefficient

$$K = a + b \times I$$

I : Per capita income
a, b : Parameter

P : Population in the area
A : Area size of cultivable land

K values of various countries were calculated and a regression line was derived for the relationship between K and I (see Appendix 6.3.3).

Using the regression lines and the following data, the calculated length of paved roads for the study area in 2000 was approximately 12,100 km. This is the required length of paved roads for the Region to be on a par with the world standard.

BASIC INDICATOR OF THE STUDY AREA (2000)

Population (thousands)	Cultivable Area (km²)	Per Capita GRP (Baht)
22,667	97,706	43,290 (K = 0.0095855)

Using this result, required average M value of the Blocks was estimated by the following formula:

$$Mc = \frac{P \cdot A}{(2L_r - L)^2}$$

where, Mc: Required average M value of the Blocks

P : Population of the region

A : Cultivable area in the region

L_r : Required total paved road length (12,100 km)

L : Road length surrounding the region boundary (477 km)

The calculated Mc was about 2,800, and this figure was applied as a criterion for initial selection of candidate Blocks. Blocks with an M value larger than Mc were considered needing more roads.

In consequence, Blocks up to 104th rank in M value were selected as candidate Blocks as shown in Appendix 6.3.1.

c) Priority Blocks

GPPs by industrial sector (primary, secondary and tertiary industries) of the candidate Blocks were estimated based on Changwat data. The normalized deviation for each estimated GPP of each Block was calculated and then totaled as shown in Appendix 6.3.4. Forty-four Blocks which have negative value in total deviation were omitted from the list of the candidate Blocks selected by M value, assuming that no significant economic benefits would be expected from road improvement in these Blocks.

Based on the number of hospitals and secondary schools in each Amphoe, the hospital and secondary school density for each Block were obtained. Their deviations were each calculated and totaled as shown in Appendix 6.3.5. Among Blocks previously omitted from the economic viewpoint, 12 Blocks which have positive values in the total deviation of the hospital/school density were revived from the social viewpoint.

The priority Blocks thus selected out of candidate Blocks were 72 Blocks in total as shown in Appendices 6.3.6 and 6.3.2.

3) Selection of Priority Routes

Existing unpaved roads under DOH or other agencies which seem to form an important road network in the priority Blocks were selected as the routes subject to the study.

The study routes totaled 85 in number and 2,017.2 km in length as shown in Appendices 6.3.7 and 6.3.8.

To analyze the extent of services that a study route provides for its related area, the Link Value expressed by the following formula was employed:

$$LV = \frac{Y_i}{L}$$

where, LVi : Link Value of Type i

$Y_i = 1$: Population in the related area

$Y_i = 2$: Cultivable area in the related area

L : Length of planned link

In the above formula, related area, population and cultivable area in the related area were estimated through the following procedures:

- The related area was delineated taking into account topographic features such as rivers and mountains and the extent of influence of other existing roads.

- The population of the related area was estimated based on Amphoe population.

- The cultivable area in the related area was measured based on a topographic map of scale 1 : 50,000.

An example of the above procedure is illustrated in Appendix 6.3.9.

The Link Values thus calculated by population and cultivable area were each transformed to normalized deviation values and totaled as shown in Appendix 6.3.7. Based on the above result, routes which have a higher value than the average total deviation of Link Values and which satisfy one of the following conditions were finally selected as priority routes:

- Routes which connect an activity center with a paved arterial highway.

- Routes included in the 6th Highway Plan but not committed.

- Routes considered to stimulate local development.

The procedure is also shown in Appendix 6.3.7.

The priority routes thus selected numbered 20 with a total length of 599.9 km. They are shown in Table 6.3.1 and Figure 6.3.1.

Table 6.3.1 PRIORITY ROUTES BASED ON SOCIO-ECONOMIC REQUIREMENTS

SEQ.	BLOCK NO.	BLOCK RANK	BLOCK M-VALUE	STUDY LINK NO.	LINK LENGTH (KM)	ORIGIN - DESTINATION
1	9	9	18329	1139	35.9	J.R.1072 - J.R.1090 (A.Lan Sak)
2	110	5	21311	RURAL	32.9	O.R.R. - J.R.314
3	58	40	6547	3196	29.3	J.R.311 - J.R.3267
4	85	12	15839	RURAL	26.4	J.R.1 - J.R.305 (A.Nong Sua)
5	50	19	10578	3306	54.3	J.R.3230 - J.R.3086 (A.Lao Khwan)
6	72	7	18584	RURAL	34.3	J.R.3195 - J.R.3263 (A.Sena)
7	89	1	35189	RURAL	55.7	A.Lam Luk Ka - A.Bang Nam Prieo J.R.305 - J.R.304
8	54	20	10511	3064	29.3	A.Sawangha - Pho Thong
9	51	32	7808	RURAL	39.3	J.R.3039 - J.R.3230(A.Nong Ya Sai)
10	168	57	3289	3361	11.8	J.R.3209 - End of R.3361
11	89	1	35189	3378	10.0	A.Bang Khla - A.Phanom Sarakhan
12	39	26	8334	3333	18.5	J.R.301 - J.R.21
13	191	63	3289	3357	24.5	J.R.3089 - J.R.3209
14	17	29	8023	3287	32.9	Ban Namphu - Lansak
15	78	35	6995	RURAL	14.3	J.R.324 - J.R.3081
16	5	49	5614	1119	39.6	Ban Phanomork - Nong Bua
17	31	66	4498	RURAL	19.3	J.R.3422 - J.R.3035
18	89	1	35189	3124	17.9	B. Bamg Khanak - B.Sang
19	13	103	2861	1145	28.7	A.Tak Fa J.R.3004
20	89	1	35189	RURAL	45.0	J.R.33 - J.R.3124 (A.Ban Sang)
				TOTAL	599.9	

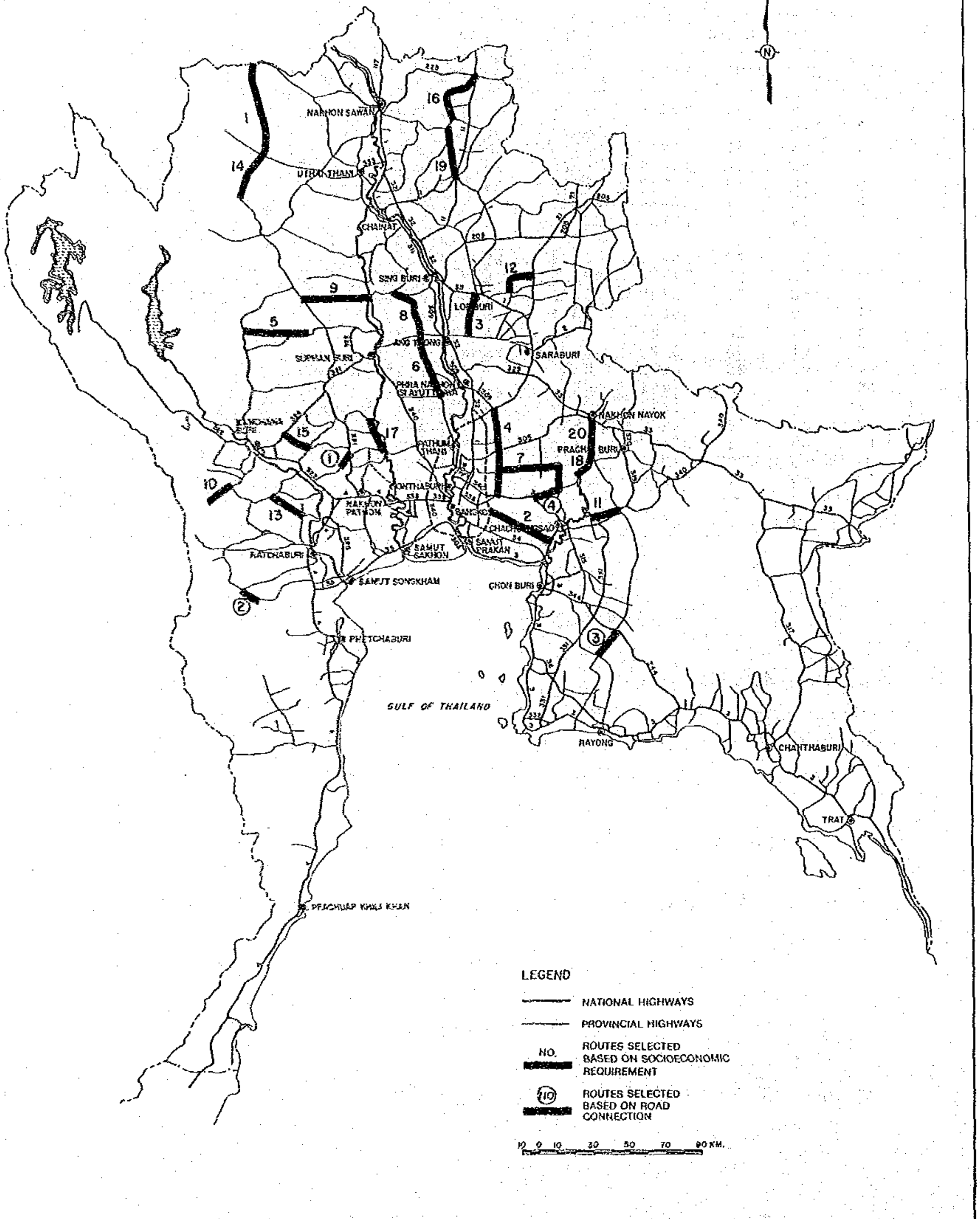


Figure 6.3.1 PRIORITY ROUTES BASED ON SOCIO-ECONOMIC REQUIREMENTS AND ROAD CONNECTION

6.4 IDENTIFICATION OF PRIORITY ROUTES BASED ON ROAD CONNECTION

In addition to an analysis of the Link Value, a further assessment was made from the viewpoint of desirable road connections by applying the following criterion:

- Routes which form a better road network by improving relatively short sections.

Through a careful study of the base road network map, four routes with a total length of 39.8 km were selected. They are shown in Table 6.4.1 and Figure 6.3.1.

Table 6.4.1 PRIORITY ROUTES BASED ON ROAD CONNECTION

Seq.	Study Link No.	Link Length (km)
1	Rural	5.0
2	3206	10.8
3	3245	8.6
4	Rural	15.4
	Total	39.8

CHAPTER 7

SELECTION OF ROUTES TO BE REHABILITATED

CHAPTER 7
SELECTION OF ROUTES TO BE REHABILITATED

7.1 STUDY ROAD LINKS

The total length of DOH paved roads in the study area is about 10,200 km as shown in Table 4.3.1.

Among them, road links rehabilitated in the last three years and under rehabilitation, road links committed in the 6th Highway Plan, etc. were eliminated as shown below. In consequence, the length of links subject to study became 6,270 in total:

Total Paved Roads	10,200 km
Links Rehabilitated in Past 3 Years	1,340 km
Ongoing Rehabilitation Links	1,040 km
Links Committed in 6th Highway Plan	860 km
Links Planned as Four-lane Roads	690 km
Length of Links Subject to Study	6,270 km

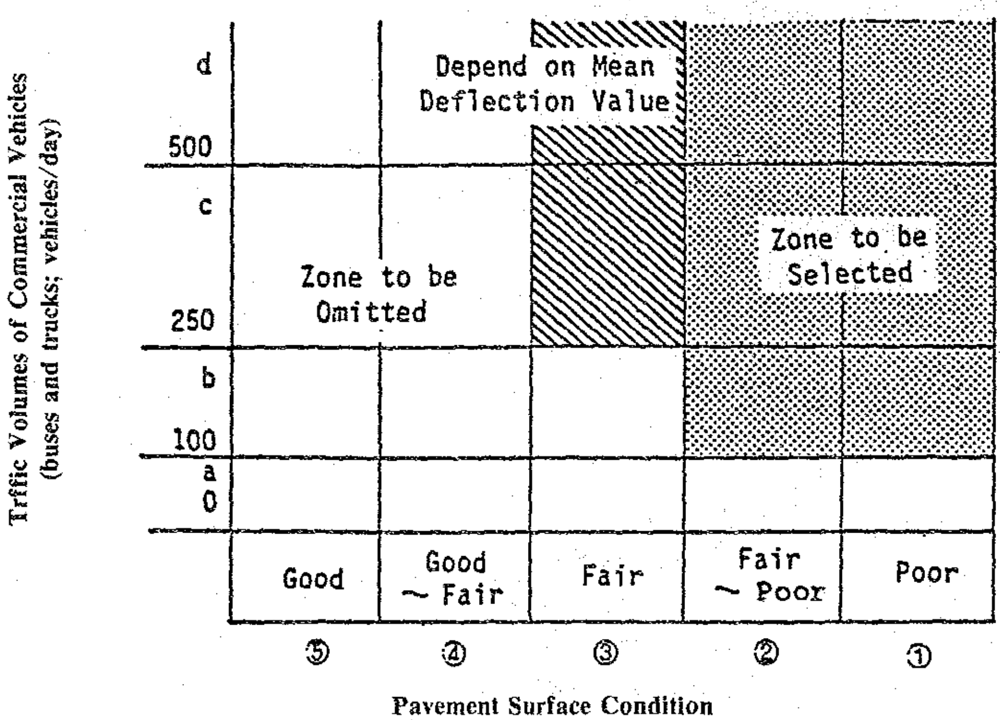
For each study link tentatively selected, existing pavement surface conditions, pavement deflections measured by Benkelman Beam and heavy traffic volumes were examined based on road inventory data prepared by DOH.

Based on this examination, the following links were further omitted from the above study links:

- Links with less than 100 heavy vehicles a day.
- Links which were rated at good or good to fair in pavement surface condition (pavement surface conditions have been classified into five ranks in the inventory data: good, good to fair, fair, fair to poor and poor.
- Links with less than 250 heavy vehicles a day and with fair surface conditions.

- Links with more than 250 commercial vehicles a day and fair surface conditions provided that the deflection is less than allowable (0.6 mm) for the major part of sections in the link.

The above criteria are illustrated below:



Criteria for Selection of Links to be Rehabilitated

In addition to the criteria described above, short links of less than 5 km in length were also eliminated from the study links in the case of provincial roads.

As a result, 2,531 km of 124 links were selected as the study links. They are shown in Appendix 7.1.1.

The list of study links thus selected was shown to District/Division engineers of the DOH to get information of updated pavement conditions.

Through this process, some links were revived, but a considerable numbers of links were eliminated because they had recently been rehabilitated.

As a result, 60 links with a total length of 1,304.3 km were selected as the links subject to field investigation and pavement condition surveys. They are shown in Appendix 7.1.2.

7.2 PAVEMENT CONDITION SURVEY

For the subject links, the following surveys were conducted in order to obtain data for final selection of the study links and rehabilitation design in the preliminary evaluation:

- Present Serviceability Index (PSI) survey
- Cracking survey
- Deflection survey
- Supporting capacity survey

7.2.1 PSI Survey

The PSI is the most important factor for identification of links to be rehabilitated and the rehabilitation design. Rough PSI surveys were performed for all the subject links in order to review the present pavement surface conditions.

PSI was visually assessd by applying the rating method (five ranking rates) adopted in the AASHTO Road Test.

The employed specifications were as follows:

Rating Panel	4 engineers
Survey Speed	50 to 60 km/h
Unit Length for Assessment	1.0 km

The average PSI for each subject link is shown in Appendix 7.1.2 and the measured value by each 1.0 km in Appendix 7.2.1.

7.2.2 Cracking Survey

Among subject links, only 32.4 km of two links, 4-0100 and 4-0201, were concrete pavement, in which 7 km in total was overlaid by asphalt concrete. For those two links, the cracking ratio was visually inspected by each 1.0 km.

The average cracking ratio is shown in Appendix 7.1.2

7.2.3 Deflection Survey

Among the subject links, deflection data were not available for 588 km of 31 links. Deflection surveys were conducted by means of Benkelman Beam at intervals of 1.0 km.

The average deflection for each subject link is shown in Appendix 7.1.2 and the measured value by each 1.0 km in Appendix 7.2.1.

7.2.4 Supporting Capacity Survey

Data collection on CBR values of subgrade, subbase and base courses was made for rehabilitation design in the preliminary evaluation.

CBR data of the subgrade were collected for all subject links. CBR data of the subbase and base were not available for more than half of the total length of subject links. Therefore, these were estimated based on the kinds of soil as described in Chapter 12.

Collected data are shown in Appendix 7.2.2.

7.3 IDENTIFICATION OF PRIORITY LINKS FOR REHABILITATION

AASHTO Design Guide for Pavement Structures 1986 suggests the following guidelines for rehabilitation:

GUIDELINES FOR REHABILITATION

Road Class	PSI	Cracking Ratio
Major Highway	2.5	20
Highway with Low Traffic	2.0	30
Minor Highway	1.5	50

The above guidelines were basically applied for the selection of links. That is, links of flexible pavement with a PSI value of less than 2.0 and concrete pavement links with a cracking ratio of more than 30 were selected. The basic data for the selection is shown in Appendix 7.1.2.

The priority links thus selected numbered 16 with a total length of 423.7 km. They are shown in Table 7.3.1 and Figure 7.3.1.

Table 7.3.1 PRIORITY LINKS FOR REHABILITATION

Route No.	Link No.	Surface Type	Link Length (km)	Origin Destination	Proposed Length (km)
1	0700	SST	41.1	Khok Samronk - Brg. Km 230.9	41.1
1	0801	AC	8.2	Brg. Km 230.9 - Muai Haeng	8.2
1	1001	UPM	25.5	J. to Chai Nat - Ban Hannam	25.5
3	1300	SST	42.7	Ban Tha Chot - Trat	20.0
4	0100	PCC	3.6	Bangkok - Yak Samut Sakhon	3.6
4	0201	PCC	27.8	Yak Samut Sakhon - J. Bypass Nakhon Phathom	27.8
225	0100	DBST	38.3	J. Rt 1 - Chumsaeng	38.3
311	0200	SST	49.7	Sing Buri - Chainat (Route 1)	49.7
325	0200	DBST	18.0	Damnoen Saduak - Samut Songkhram	18.0
332	0100	AC	14.5	Khao Hadyao - Ban Khlong Phai	14.5
344	0200	AC	63.1	Ban Bung - Ban Khlong Phu	39.5
3067	0100	SST	40.0	Aranyaprathet - Ta Phraya	40.0
3089	0101	DBST	27.8	Ban Khao Ngu - Ban Khao Sung	27.8
3116	0100	SST	9.7	Samut Prakan (Rt. 3) - Ban Phraeksa	9.7
3267	0101	AC	26.5	J. Rt. 32 - Km 26.5	26.5
3395	0100	SST	33.5	Ban Phrao - Ban Khlong Hat	33.5
Total 16 Links					423.7

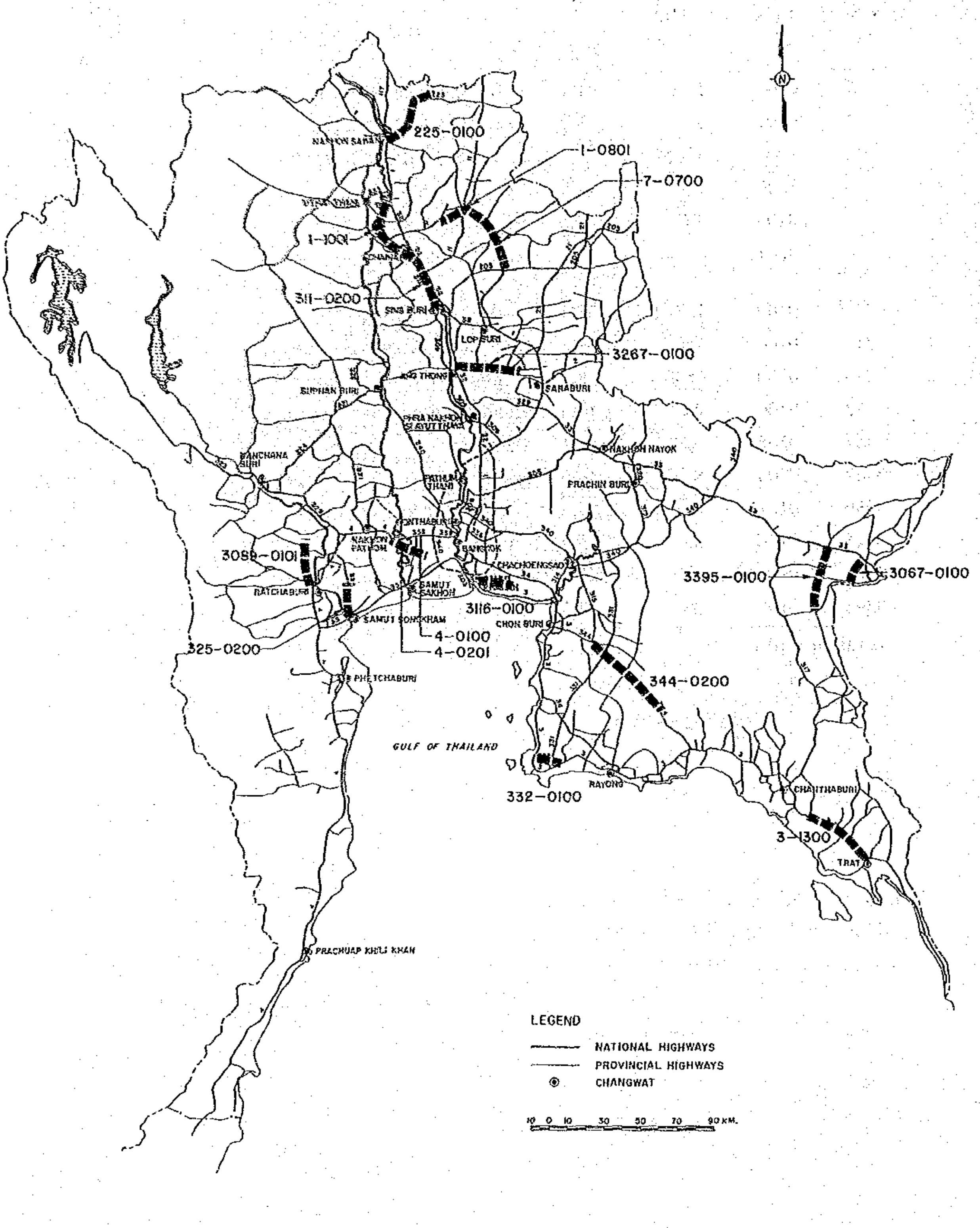


Figure 7.3.1 PRIORITY LINKS FOR REHABILITATION

CHAPTER 8
PROJECT SCREENING

CHAPTER 8
PROJECT SCREENING

The priority routes identified in the previous chapters were derived mainly through theoretical analysis. Therefore, in order to select proposed projects to be studied in the preliminary evaluation among them, an overall review was carried out with DOH from the following viewpoints:

- Relevance to DOH's 6th Highway Plan.
- Relevance to road development plans of other agencies.
- Intention of local administrations.
- Special circumstances of concerned areas.

8.1 PROPOSED PROJECTS FOR IMPROVEMENT AND NEW CONSTRUCTION

8.1.1 Proposed Projects Selected Based on Road Congestion and Relation with National Development Plan (ML Projects)

As the proposed projects for preliminary evaluation, eight links of 288.8 km in total were selected out of 25 links of 1,016.0 km in total identified in Chapter 6 as shown in Table 8.1.1 and Figure 8.1.1.

Links which were not selected as proposed projects include such links as Rts. 2, 4, 32 and 35, which are expected to have a higher degree of congestion than selected proposed projects. They were excluded because DOH had already committed for early implementation of additional two-lane construction by that time.

Among the eight selected ML Projects, ML-5 is a new four-lane highway planned for the alleviation of road congestion on Rt. 3 between Chon Buri and Pattaya. The other seven remaining ML Projects are to add two more lanes to the existing two-lane highways.

Table 8.1.1 PROPOSED PROJECTS FOR IMPROVEMENT AND NEW CONSTRUCTION

Project No.	Changwat	Division	Route No.	Origin - Destination	Length (km)
(1) PROJECT SELECTED BASED ON ROAD CONGESTION (ML-PROJECTS)					
ML-1	Chon Buri	Chachoengsao	3	Chon Buri Bypass (STA.0+000 - STA.13+823)	13.8
ML-2	Chon Buri	Chachoengsao	3	Pattaya - A.Sattahip (STA.147+775) (STA.175+049)	27.3
ML-3	Chon Buri Rayong	Chachoengsao	3	A.Sattahip - C.Rayong (STA.175+049) (STA.221+000)	48.8
ML-4	Rayong Chantha Buri	Chachoengsao	3/316	A.Klaeng - C.Chanthaburi (STA.269+119 - STA.324+309)	61.3
ML-5	Chon Buri	Chachoengsao	New Route	Chon Buri - Pattaya New Highway (includ.Access Road to Laem Chabang)	48.8
ML-6	Ratchaburi	Prachuap Khiri Khan	4	C.Ratchaburi - J.R.35 (J.R.3208)	22.2
ML-7	Bangkok Chachoengsao	Chachoengsao	304	A.Min Buri - C.Chachoengsao (J.R.3101) (J.R.314)	41.0
ML-8	Nonthaburi	Bangkok	340	B.Bang Muang - A.Lat Lum Khaew (J.R.3035)	25.6
	Total				288.8
(2) PROJECTS SECLECTED BASED ON SOCIO ECONMIC REQUIREMENT & ROAD CONNECTION (IM-PROJECTS)					
IM-1	Nakhon Phathom	Bangkok	PWD	A.Bang Len - B.Bang Noi Nai (J.R.3035) (J.R.3422)	18.8
IM-2	Kanchanaburi	Bangkok	3306	B.Nong Pru - A.Lao Khwan (J.R.3086)	36.0
IM-3	Suphanburi	Bangkok	PWD/ ARD	B.Nong Ei Pang - A.Sam Chuk (J.R.3230) (J.R.3039)	33.6
IM-4	Uthai Thani	Lop Buri	3282	B.Thong Lang - A.Lan Sak (J.R.3282) (J.R.3438)	34.0
IM-5	Uthai Thani Nakhon Sawan	Lop Buri	3438/PWD /ARD	A.Lan Sak - B. Kao Chonkhon (J.R.3438) (J.R.1072)	69.1
IM-6	Nakhon Sawan	Lop Buri	PWD	B.Thap Krit Klang - B.Phanom Rok (J.R.225) (J.R.1119)	25.0
IM-7	Lop Buri	Lop Buri	2321	K.A.Khok Charoen - B.Mai Samakki (J.R.21) (J.R.2219)	66.3
IM-8	Lop Buri	Lop Buri	2247	B.Khao Noi - B.Chang Ko Nok (J.R.2256) (J.R.205)	16.8
IM-9	Lop Buri	Lop Buri	PWD	B.Dilang - B.Wang Phloeng (J.R.21) (J.R.205)	18.0
IM-10	Lop Buri Ang Thong	Lop Buri	3196	B.Reng Sung - C.Lop Buri (J.R.3267) (J.R.311)	34.8
IM-11	Sing Buri Ang Thong	Bangkok	RID	B.Chana Soot - A.Pho Thong (J.R.3251) (J.R.3064)	41.0
IM-12	Ang Thong Ayutthaya	Bangkok	RID	A.Pho Thong - A.Sena (J.R.3064) (J.R.3263)	50.0
IM-13	Ayutthaya	Bangkok	PWD	A.Bang Pa-in - C.Ayutthaya (J.R.308) (J.R.3059)	16.2
IM-14	Ayutthaya Phathom Thani	Bangkok	RURAL	A.Wang Noi - A.Thanyaburi (J.R.1, J.R.309) (J.R.305)	24.4
IM-15	Phathom Thani Bangkok	Bangkok	RURAL	B.Klong Luang - A.Min Buri (J.R.305) (J.R.304)	24.3
IM-16	Phathom Thani Nakhon Nayok	Bangkok	3312	A.Lam Luk Ka - B.Khlong 16 (J.R.3312)	20.8
IM-17	Bangkok Samut Prakarn Chachoengsao	Chachoengsao	PWD	A.Lat Krabang - B.Khlong Tha Thua (J.R.314)	29.3
IM-18	Nakhon Nayok	Bangkok	RID/307	C.Nakhon Nayok - A.Ban Sang (J.R.3347)	26.7
IM-19	Prachin Buri	Chachoengsao	RURAL	A.Sa Kaeo - DOH Const. Office (J.R.33) (Waterfall)	27.3
IM-20	Chanthaburi	Chachoengsao	3249/ RURAL	B.Khlong Takhian - J.R.3322 (J.R.3249) B.Chan Khrem	44.5
IM-21	Chon Buri Rayong	Chachoengsao	3245	B.Nong Chang - J.R.3138 (J.R.344)	18.3
IM-22	Bangkok Chachoengsao	Chachoengsao	RURAL	A.Nong Chok - A.Bang Nam Prieo (J.R.3120) (J.R.3124)	16.5
IM-23	Ayutthaya	Bangkok	3267	J.R.32 - J.R.3022	26.5
Total 23 Links					718.2

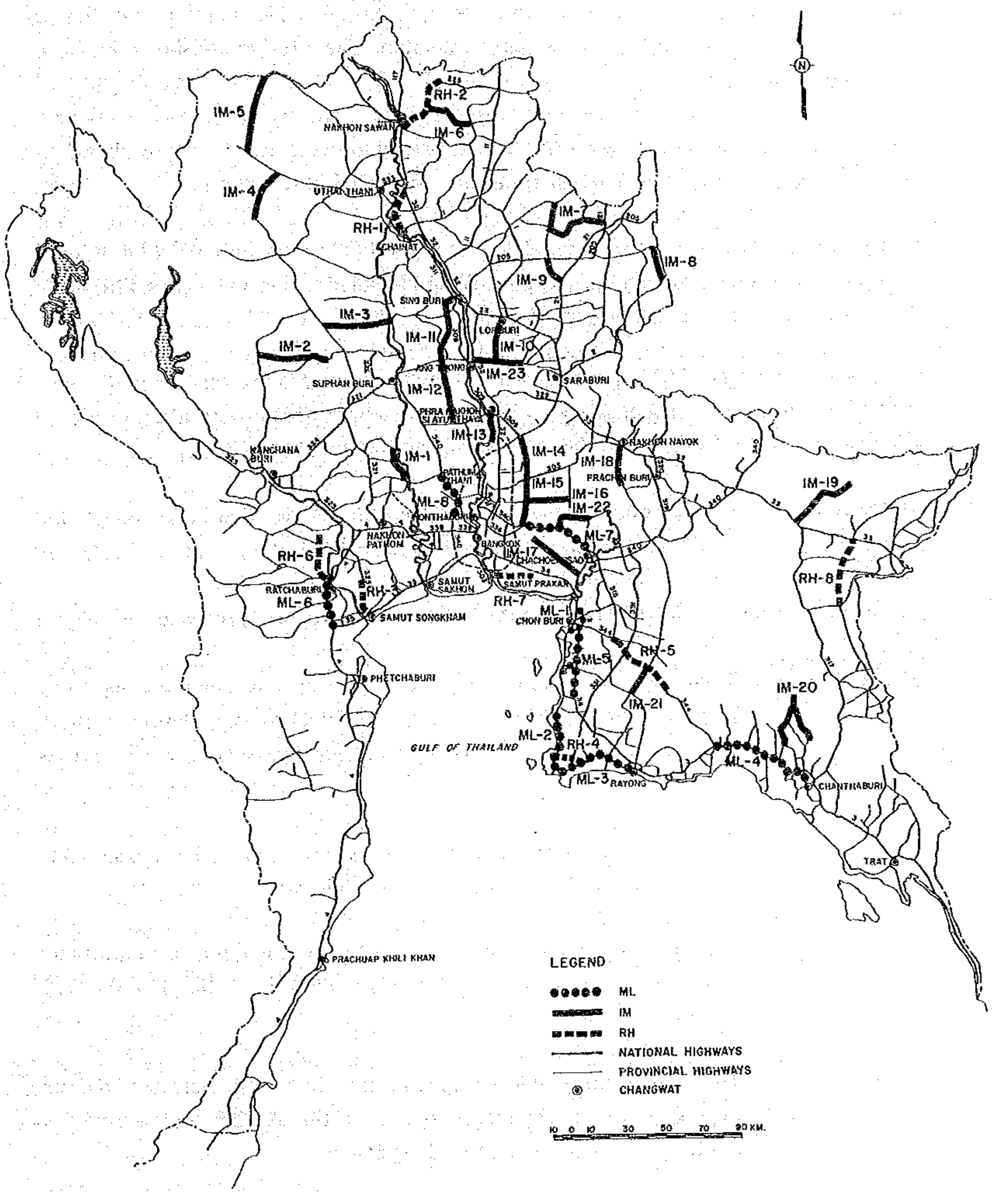


Figure 8.1.1 PROPOSED PROJECT

8.1.2 Proposed Projects Selected Based on Socio-Economic Requirements, and Road Connection (IM Projects)

Through the overall review performed with DOH, 23 links of 718.2 km in total were selected as the proposed projects for the preliminary evaluation. These routes are shown in Table 8.1.1 and Figure 8.1.1.

The lengths of each project shown in Table 8.1.1 are figures corrected by the results of inventory survey, and they are different from those indicated in Chapter 6.

As described in Chapter 6, 24 routes of 639.7 km in total (20 routes with 599.9 km in total based on socio-economic requirements and local development and 4 routes with 39.8 km in total based on road connection) were identified as priority routes.

Of these, 15 routes of 477.6 km in total were selected as proposed projects for preliminary evaluation, but seven routes of 214.1 km in total were newly incorporated after a series of discussions with DOH, although they were not identified in Chapter 6.

All the routes newly added were located in the priority Blocks identifed in Chapter 6, but they were not selected as priority routes, because their Link Values were estimated fairly low.

The reasons why these routes were added to the final list of the proposed project are as follows:

IM-6 and IM-9 : These two routes are under PWD at present, but they are going to be transferred to DOH in the near future. DOH strongly desires to check up on the present conditions and to review the feasibility of improvement of these routes.

IM-7 : K.A. Khok Charoen was established recently. This route is essential to connect this King Amphoe with paved highways.

IM-8 : Since most of this route is in the Northeastern Region, the importance of this route was not discussed in this study which focused on the Central Region.

IM-13 : This route is under PWD at present but will be transferred to DOH in the near future. DOH intends to improve this as a key tourist route for the King's Summer Palace in Bang Pa-In.

IM-19 : Construction to extend this route to Nakhon Ratchasima in the Northeastern Region is being carried out. Therefore, this will become an important provincial highway after completion of the extension. Also, there is a famous waterfall which is a tourist attraction along the route.

IM-20 : This area is designated as a development zone for durian plantations, which is an important export product in Thailand.

In addition, IM-23 (Rt. 3267) of 26.5 km in total selected initially as a priority route for rehabilitation was transferred to this group, because this route requires improvement work for the upgrading of road class together with rehabilitation.

8.2 PROPOSED PROJECTS FOR REHABILITATION (RH Projects)

As the proposed projects for rehabilitation, eight links of 206.0 km in total length were selected out of 16 links of 423.7 km identified in Chapter 7, by examining the priority order of the implementation in collaboration with DOH. They are shown in Table 8.2.1 and Figure 8.1.1.

As described in Section 8.1.1., Rt. 3267 selected initially as a rehabilitation project was transferred to the IM Project group.

Table 8.2.1 LIST OF PROPOSED PROJECTS FOR REHABILITATION

Proposed Route No.	District	Route Link No.	Origin - Destination	Surface Type	Link Length (Km)
RH-1	Chainat	1 1001	J.to Chainat - Ban Hannam	UPM	25.5
RH-2	Nakhon Sawan	225 0100	J.Route No.1 - Chumsaeng	SST	38.3
RH-3	Ratchaburi	325 0200	Damnoen Saduak - Samut Songkham	DBST	18.0
RH-4	Chon Buri	332 0100	Khao Hadyao - Ban Khlong Phai	DBST	14.5
RH-5	Chon Buri	344 0200	Ban Bung - Ban Khlong Phu	AC	39.5
RH-6	Ratchaburi	3089 0101	Ban Khao Ngu - Ban Khao Sung	DBST	27.8
RH-7	Bangkok	3116 0100	Samut Prakan - Ban Phraeksa	SST	9.7
RH-8	Wat Thana Nakhon	3395 0100	Ban Phrao - Ban Khlong Hat	SST	33.5
				Total	206.8

CHAPTER 9

ANALYSIS OF FUTURE ROAD NETWORK

CHAPTER 9
ANALYSIS OF FUTURE ROAD NETWORK

In order to analyze the adequency of the future road network, traffic forecasts were made for 2000 and 2008 by applying the procedures explained in Chapter 5.

As described in Chapter 4, the base road network was formed by adding ongoing and committed project roads with the existing road network. The future road network was created by further inserting the following project roads into the base road network on the assumption that they have already been completed:

- Toll road construction projects with 401 km in total length for improving Rts. 2, 32 and 35 to four-lane highways, which were committed by DOH after the base road network had been set up.

- IM Projects and ML Projects proposed for the preliminary evaluation in Chapter 8.

The traffic volumes assigned on the future road network are shown in Figures 5.4.2 and 5.4.3 for each subject year.

As described in Section 6.3.1, the traffic capacity of multi lane roads was specified at 12,000 ADT per lane. Therefore, a projected traffic volume of more than 48,000 ADT calls for more additional lanes for four-lane highways.

The future road network was formulated on the assumption that most major trunk highways would have already been improved to four-lane highways. Even under these conditions, however, four-lane national highways whose future traffic will be beyond their tolerable capacity were found as shown in Table 9.1.

Table 9.1 ROUTES REQUIRING MORE THAN 6 LANES

2000

Route No.	Origin-Destination	Approximate Projected ADT	Approximate Length (km)
3	J.R. 34 - Chon Buri Bypass	54,000	45
4	Outer Ring Road - Nakhon Pathom	110,000	45
34	Outer Ring Road - J.R. 3	60,000	45
3 routes			135

2008

Route No.	Origin-Destination	Approximate Projected ADT	Approximate Length (km)
1	Bang Pa-In - Saraburi	58,000	50
ML-5	Chon Buri - J.R. 36	48,000-54,000	40
35	Outer Ring Road - Samut Sakhon	62,000	20
338	Outer Ring Road - J.R. 4	50,000	25
4 routes			135

At this stage there is no plan to deal with future road congestion for the roads listed in the above table. However, urgent countermeasures should be considered at least for the following routes whose projected traffic volumes will exceed their capacity by 2000:

- Route 4 (Outer Ring Road - Nakhon Pathom): This section is heavily congested even now and the traffic volume in 2000 is estimated at more than 100,000 ADT. Construction of an additional two lanes is possible but not enough to cope with such heavy traffic. Considering this fact and the future area development, a new four-lane highway should urgently be planned.

- Route 3 (J.R. 34 - Chon Buri) and Route 34 (Outer Ring Road - J.R. 3): As described in Chapter 8, ML-1 (Chon Buri Bypass) and ML-5 (Chon Buri - Pattaya New Highway) were selected as proposed projects in the study in connection with the alleviation of traffic congestion on concerned existing roads and the Eastern Seaboard Development Program. If they are completed, however, they cannot function properly in case road congestion on above Rts. 3 and 34 remains unsolved. For this reason, a plan for a new four-lane highway directly connecting Bangkok with Pattaya by extending the ML-5 route is strongly recommended.

The traffic forecasts in the study were obtained on the basis of the relationship between the number of registered vehicles and GPP observed so far in Thailand. Therefore, the results may well be on the conservative rather than the optimistic side, because past experience elsewhere has shown that the number of registered vehicles can grow faster when GDP exceeds a certain level. The following table shows changes in the number of registered vehicles per 1,000 people in Japan since 1963, when the level of GNP was roughly equivalent to Thailand in 1986. The number of registered vehicles increased sixfold in the ensuing 22-year period.

It is uncertain that Thailand will match Japan's economic growth during the same period. However, it is certain that the number of registered vehicles will grow well above those obtained from the conservative forecast in this study.

Figures shown in the below table as Case A indicate the average number of registered vehicles of Japan and Thailand for the two comparative periods. It may show the approximate future vehicle ownership level in Thailand.

TREND IN NUMBER OF REGISTERED VEHICLES

(Study Area)

Year Thailand	Equivalent Year Japan	Vehicles/ Population Thailand (thousand)	Vehicles/ Population Japan (thousand)	Vehicles/ Population Case A (thousand)
1986	1963	59	60	—
1993	1970	79	150	115
2000	1977	102	280	191
2008	1985	141	380	261

If the Case A figures are taken, the future traffic will become twice those forecasted by the conservative forecast, and a serious shortage of roads will be inevitable in the near future. In order to cope with this prediction, a drastic restructuring of the present road network by introducing a expressway system should be considered without delay. Restructuring of the present road network by introducing a national expressway system is thought to be essential.

CHAPTER 10

IDENTIFICATION OF INTERSECTIONS TO BE IMPROVED

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IDENTIFICATION OF INTERSECTIONS TO BE IMPROVED

10.1 ANALYSIS APPROACH

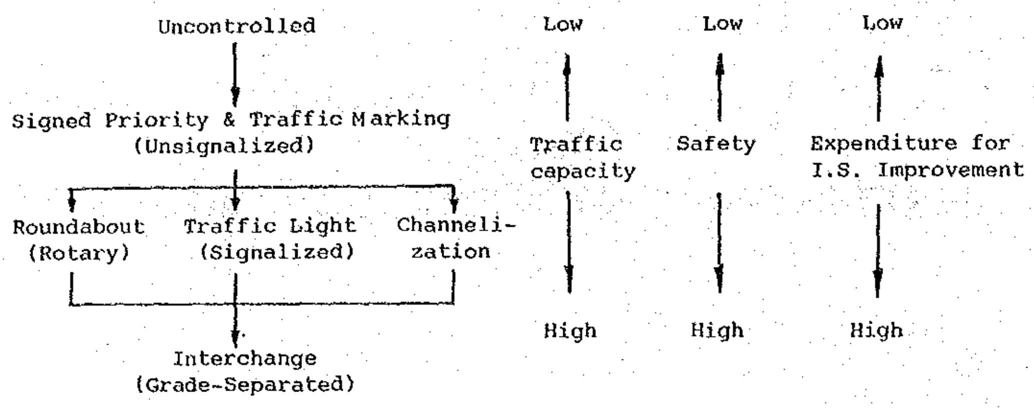
In order to identify intersections to be improved, a macroassessment of traffic capacity against future traffic volumes at existing intersections was carried out. Major intersections picked as the study subjects totaled 304. They are shown in Appendix 10.4.1 with sequential study numbers.

Among them, 28 intersections in large municipal areas were not analyzed. It was considered that the turning movements forecasted by the analytical model of regionwide road network could not well represent actual traffic flows for such intersections (nodes) located in the center of municipal areas due to the complex movements of internal traffic and the interwoven street network within cities.

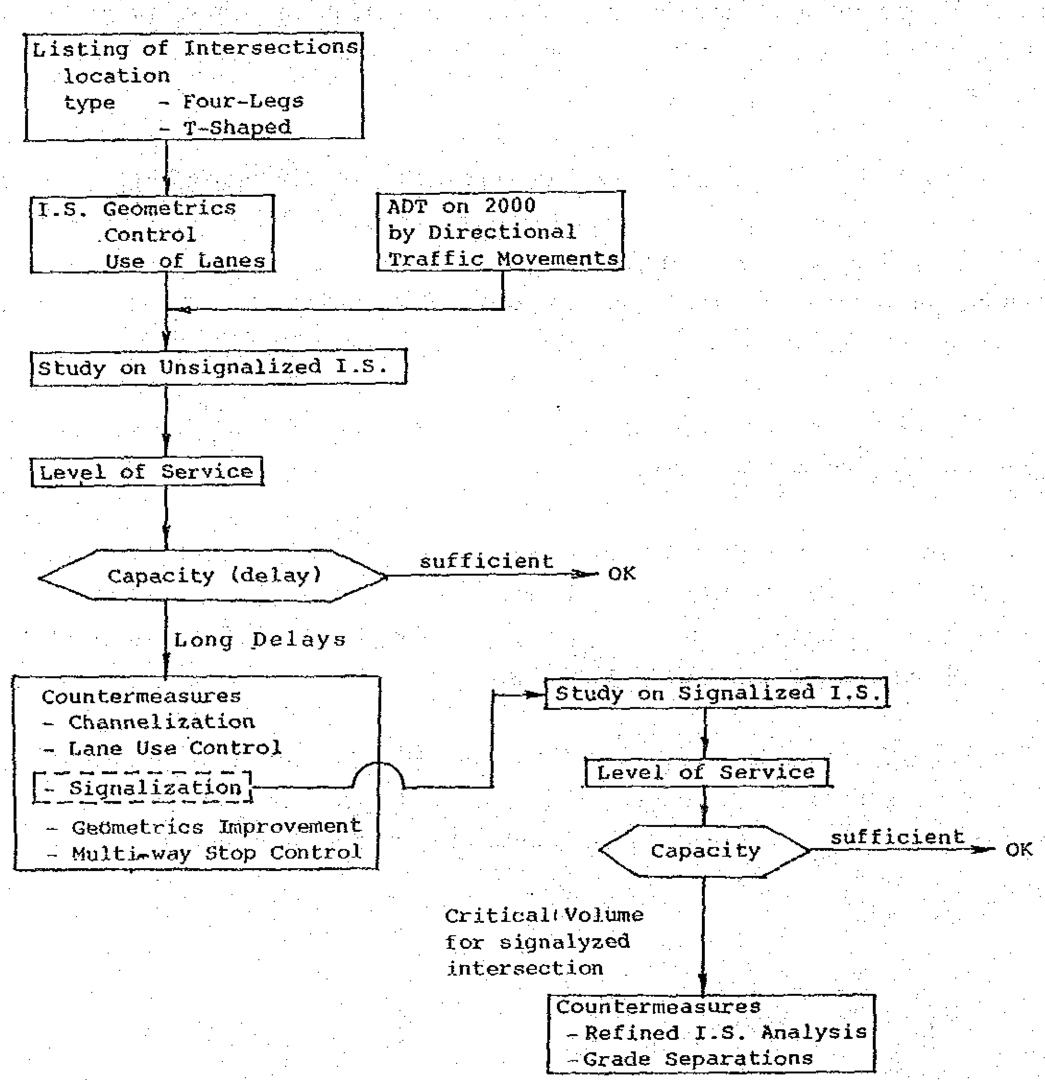
Turning movements at the intersections were forecasted on the future road network for the year 2000 as described in Chapter 9.

Major physical features of intersections such as geometry, number and use of lanes, channelization and traffic control were obtained from the Road Intersection Report prepared by the DOH. As the Report, however, lacked information for some areas, supplemental data were collected through the field investigation.

It is the usual practice to take a phased approach for improvement of intersections taking many aspects into account such as traffic volumes and accidents, delays, land availability and surrounding environment, which is illustrated in the following diagram:



Following the phased improvement approach given above, the intersection study was proceeded in accordance with the following work flow:



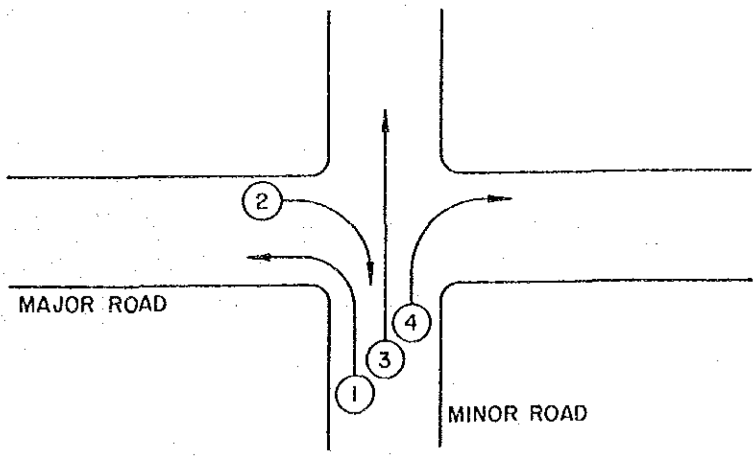
10.2 UNSIGNALIZED INTERSECTIONS

Unsignalized intersections make up the vast majority of at-grade junctions in the study area. Stop or Yield signs are used to assign right-of-way to roads at such intersections. This designation forces drivers on the controlled road to seek gaps in the major road traffic flow for crossing or turning movements.

The procedure employed for the capacity analysis of unsignalized intersections is provided in the Highway Capacity Manual (HCM). It is based on the use of gaps in the major traffic stream by vehicles crossing or turning into the stream. Therefore it requires that the right-of-way be clearly assigned. Assignment of right-of-way to one road was made by putting emphasis primarily on the DOH highway class. Major directional traffic volumes and intersection layouts were also taken into consideration.

Gaps in the major road traffic flows are used by a number of competing flows. Priority order for the utilization of gaps by vehicles is as follows:

- Left turns from the minor road ①
- Right turns from the major road ②
- Through movements from the minor road ③
- Right turns from the minor road ④



For each movement, the conflicting traffic volumes (Vci) which conflict with movement i are calculated. The conflicting traffic volume for movement i is computed in terms of hourly volume. Hourly peak volume was tentatively set at 10% of ADT referring to the traffic count report *.

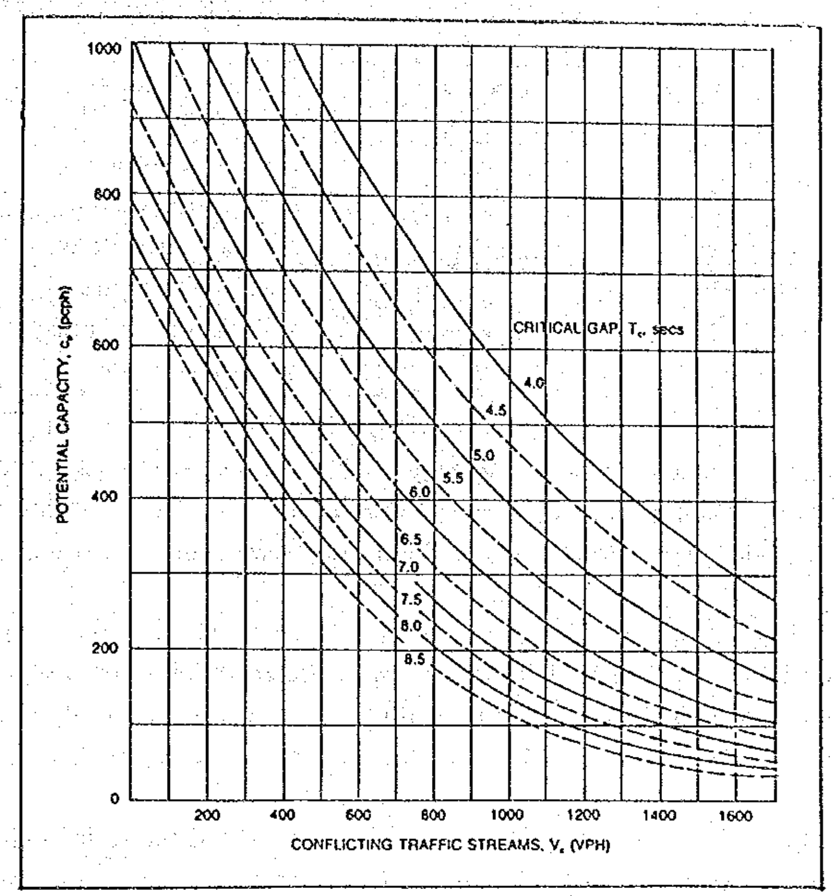
The critical gap is defined as the median time headway between two successive vehicles in the major road traffic stream that is accepted by drivers in the subject movement that must cross and/or merge with the major road flow.

The critical gap size for each vehicle maneuver was directly introduced from the HCM as follows:

Vehicle Maneuver	Average Running Speed (major road)	
	50 km/h	90 km/h
1. Left Turn from Minor Road	5.5 sec	6.5 sec
2. Right Turn from Major Road	5.0	5.5
3. Cross Major Road	6.0	7.5
4. Right Turn from Minor Road	6.5	8.0

The potential capacity of a movement is defined as the "ideal" capacity for a specific subject movement. The potential capacity in passenger cars per hour is selected from the following Figure (HCM):

* Traffic Count in DOH and Proposal of the Count System Improvement. June 1987, Masuda, JICA Expert



A solution for the capacity of each lane on the minor approaches to a Stop- or Yield-controlled intersection is given in Level-of-Service criteria. It is related to general delay ranges. The criteria are given below and are based on the reserve, or unused, capacity of the lane in question. This value is computed as:

$$C_R = C_{SH} - V$$

where,

C_R : Reserve or unused capacity of lane in pcph
C_{SH}: Shared-lane capacity of lane in pcph
V : Total volume or flow rate using lane in pcph

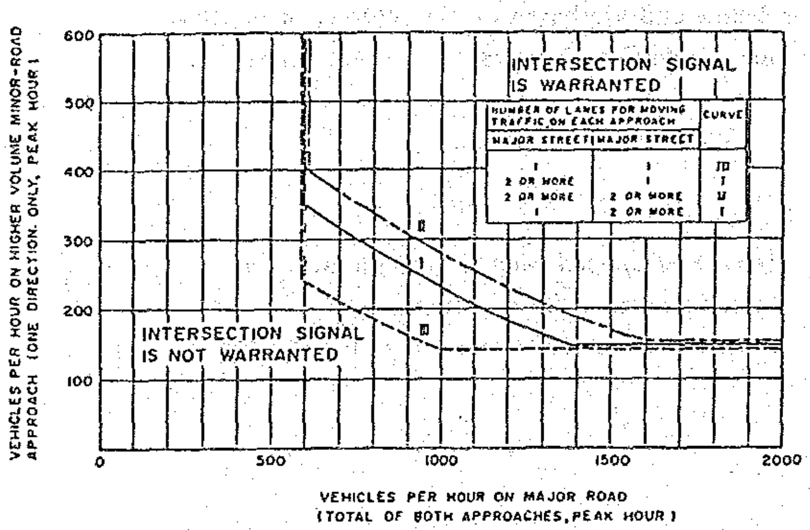
LEVEL-OF-SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS

Reserve Capacity (pcph)	Level of Service	Expected Delay to Minor Road Traffic
>400	A	Little or no delay
300 - 399	B	Short traffic delays
200 - 299	C	Average traffic delays
100 - 199	D	Long traffic delays
0 - 99	E	Very long traffic delays
Less than 0	F	Severe congestion

When demand volume exceeds the capacity of the lane, extreme delays will be encountered with queuing which may cause severe congestion affecting other traffic movements in the intersection. This condition usually warrants improvement of the intersection.

Intersections with Service Levels of D, E and F were subject to the study of signalized intersections. They were 48 in total. The study results are given in Appendix 10.2.1 with sample calculations.

Evaluation of signal installation was also made on the basis of the following figure. The evaluation results are also given in Appendix 10.2.1.



Warrant for Traffic Control by Pretimed Signal *

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* Traffic Safety Plan for Roads in the Kingdom of Thailand, JICA, January 1985

10.3 SIGNALIZED INTERSECTIONS

In the Master Plan Study phase, detailed information on signalization conditions and vehicle type distribution needed to estimate delays was not available.

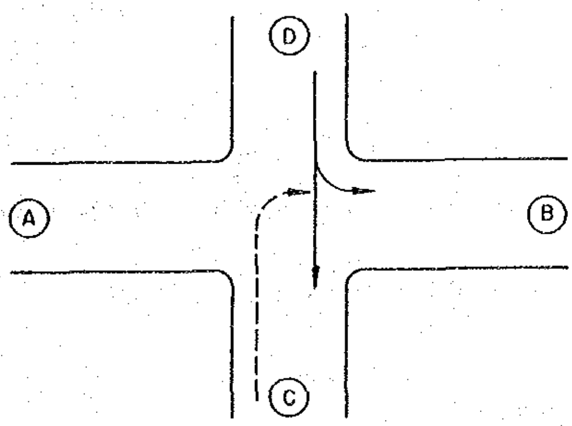
To make a preliminary assessment of the signalized intersections, a method shown in HCM was employed. The method provides a broad assessment of whether the intersection under consideration is likely to be over-saturated for a given set of demand volumes and geometrics.

The following information on intersection geometrics and turning movements are required to evaluate the probable capacity of signalized intersections:

Geometrics : Number and use of lanes
Volumes : Given in total vph for each movement

The procedure does not consider the details of lane width, parking conditions or other features, nor does it consider the number of trucks and buses in the traffic stream. One exception to this simple technique is for one-lane approaches, where permitted right-turning volumes are considered in terms of total numbers of passenger car equivalents.

As the signal design is not known, combinations of critical lane volumes are identified by considering conflicting movements:



For a (C—D) road, critical conflicts are the (C→B) movement with the C-bound through movement and the (D→A) movement with the D-bound through movement. The critical volume for the (C—D) road is the largest sum among:

(C→B) volume plus the maximum single-lane volume for the C-bound through plus left-turn movement, or (D→A) volume plus the maximum single-lane volume for the D-bound through plus left-turn movement.

The critical volume for the (A—B) road is obtained in a similar way.

The total critical volume for the intersection is the sum of the critical volumes for the (C—D) and (A—B) roads. The critical volume for the intersection is compared with the criteria to generally determine the probable traffic conditions at the intersection. The capacity criteria in HCM are given for normally occuring situations as follows:

CAPACITY CRITERIA FOR SIGNALIZED INTERSECTIONS

Critical Volume for Intersection (vph)	Relationship to Probable Capacity
0 – 1,200	Under
1,201 – 1,400	Near
< 1,401	Over

Intersections with low Service Levels estimated for unsignalized intersections were subject to the analysis of signalized intersections by employing the methodology described above.

Study results indicated that further detailed studies are deemed necessary for those intersections with "Near" or "Over" capacity levels. They were 22 in total. The study results are given in Appendix 10.3.1.

10.4 CONCLUSIONS

The results of the foregoing analyses are summarized in Table 10.4.1 and below:

Recommended Improvement	Number
All intersections subject to the study	304
A. No action needed	228
B. Action needed	48
B.1 Signalization sufficient	26
B.2 Detailed signalization analysis or grade separation needed	22
C. No analysis made (intersections in municipal areas)	28

Table 10.4.1 INTERSECTIONS REQUIRING DETAILED ANALYSIS

Seq. No.	Route No.	District Code	Type	Capacity Level*
1	1-32	413	3	Over
2	1-309, 3189	413	4	Near
3	1-33, 329	430	4	Over
36	3-3 (start of Chon Buri Bypass)	422	3	Over
37	3-315	422	4	Near
38	3-344	422	4	Over
41	3-3241	422	(4)	Near
56	3-3154	423	3	Over
64	4-3091, 3414	410	4	Over
65	4-3415	410	3	Over
67	4-3094	410	3	Near
68	4-4, 3097	410	4	Over
80	4-35	335	3	Over
87	4-326	333	3	Near
104	32-3267, 3341	413	4	Over
119	34-3413	420	3	Over
123	35-3097	415	3	Over
139	304-314	421	3	Near
142	304-3121	421	4	Over
209	340-3242	421	4	Over
210	340-3215	410	4	Near
271	3089-3090, 3357	335	4	Near

Note: * Near: Traffic volume is close to signalized intersection capacity.
Over: Traffic volume is more than signalized intersection capacity.

The locations of intersections classified in Groups B.1 and B.2 above are shown in Appendix 10.4.1.