CHAPTER 6 SELECTION OF ROUTES TO BE IMPROVED

Based on the 6th Highway Plan, a master plan was established from the following fundamental concepts:

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

- To cope with increasing traffic and to ensure comfortable, on-time travel.
- To promote and support national development programs.

b) Supplemental road network (provincial and rural roads)

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

Based on the above concepts, the following concrete items were studied and priority routes were selected putting the study target at 2000:

a) Trunk highway network (ML Projects)

- Road congestion
- Relation with national development programs

b) Supplemental road network (IM Projects)

- Local socio-economic requirements
- Road connection

c) Other studies

- Rehabilitation (RH Projects)
- Intersections

As shown above, the projects with respect to each study item were abbreviated as ML, IM and RH.

Item c) above is described in a separate chapter.

6.1 IDENTIFICATION OF PRIORITY ROUTES BASED ON CONGESTION ALLEVIATION (ML Projects)

Road links which require additional lanes were selected by comparing the projected ADT in 2000 with the road capacity.

According to the design standards of DOH, divided four-lane highways classified as PD, SD and FD are required when a 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 pcph to ADT. However, a range of 10,000 to 15,000 ADT is generally equivalent to 2,800 pcph.

It is the usual practice to plan four-lane highways when the projected ADT exceeds 12,000 in Japan.

Considering the above standard and recommendation and the future increment of traffic in Thailand, the following traffic capacity was tentatively adopted:

Two-direction two-lane highway : 12,000 ADT
Divided four-lane highway : 48,000 ADT

Based on these criteria, the required number of lanes were estimated by comparing projected ADT and traffic capacity as follows:

SELECTED ROAD LINKS

2-lane highway → 4-lane highway =	19 links	920.5 km
4-lane highway → 6-lane highway =	4 links	71.0 km
4-lane highway → 8-lane highway =	1 link	24.5 km
Total	24 links	1,015.0 km

Analytical results are shown in Figure 1.6.1.

Within the study area, two-lane highways make up the predominant length of the national and provincial highway network, while highways with multilanes are only about 490 km in total, as shown in Figure 1.6.1.

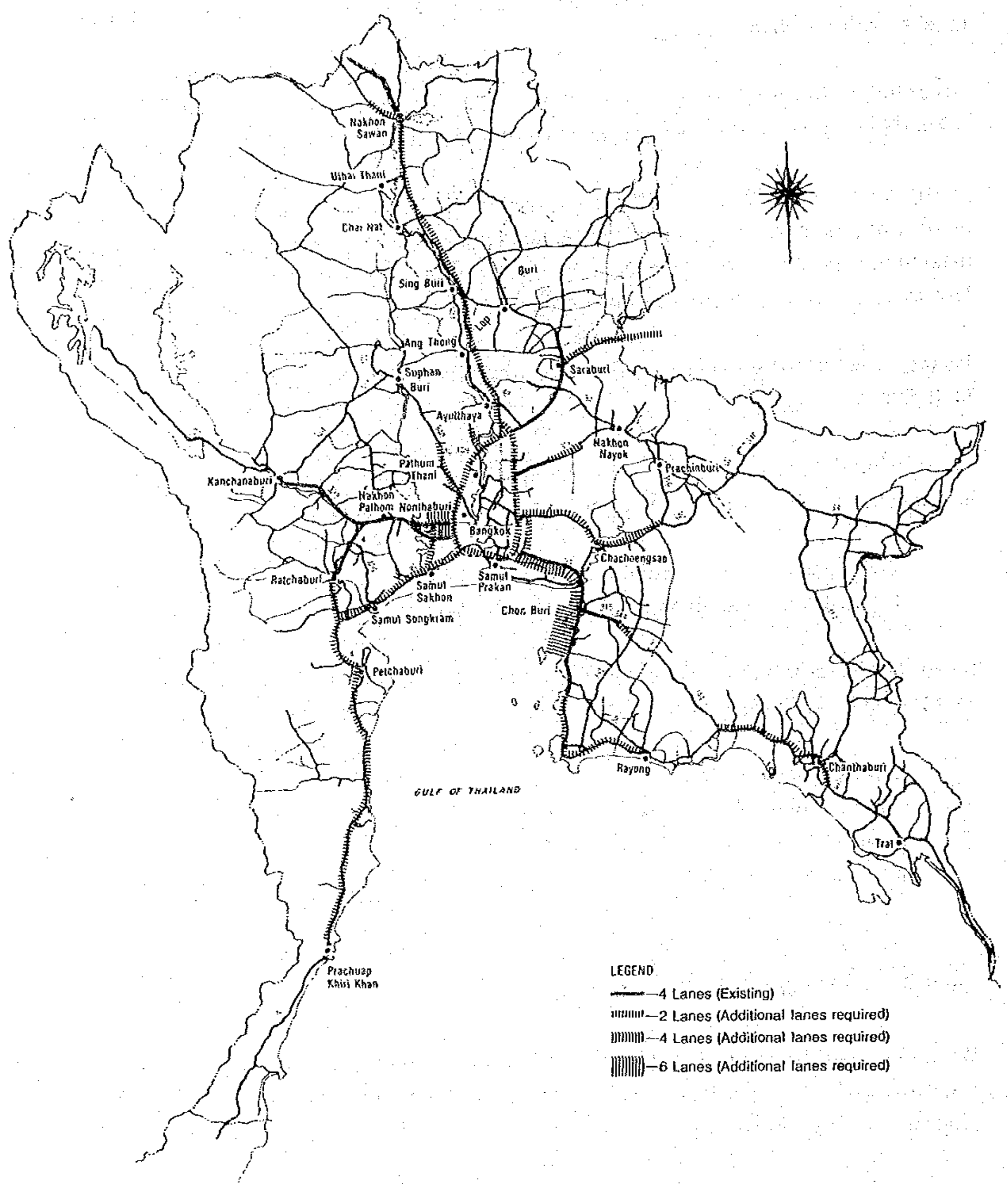


Figure 1.6.1 LINKS REQUIRING ADDITIONAL TRAFFIC LANES

6.2 IDENTIFICATION OF PRIORITY ROUTES RELATED TO NATIONAL DEVELOPMENT PROGRAM (ML Projects)

Rt. 3, the Chon Buri Bypass, Rt. 34 and Rt. 340, which directly link Bangkok with the area related to the Eastern Seaboard Development Program, were all selected as priority routes for congestion alleviation. They are included in the selected road links described in 6.1 above.

6.3 IDENTIFICATION OF PRIORITY ROUTES BASED ON SOCIO-ECONOMIC REQUIREMENTS AND LOCAL DEVELOPMENT (IM Projects)

Based on the base road network map described in Chapter 4, block areas surrounded by paved roads were derived as a study unit (called Block).

The road length required for an area might be obtained by putting the population, cultivable area and per capita income in the area in 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 : parameters

P : Population in the area

A : Area size of cultivable land

Analyzing the relationship between the variables in the above equation and the lengths of existing roads in various countries, the K Value of the international level was determined. By applying this K Value, the paved road length required in each Block was estimated. In a comparison between the required road length calculated and the existing paved road length in each Block, the Blocks whose road length did not satisfy the required length were selected as candidate Blocks. In consequence, 104 Blocks were selected out of the total 216 Blocks.

GPPs and the hospital and secondary school densities in these 104 Blocks were examined. Blocks whose GPP was less than the average were finally selected as priority Blocks from the socio-economic viewpoint. The priority Blocks thus selected were 72.

Existing unpaved roads under DOH or other agencies which seem to form an important road network in the 72 Blocks were selected as the routes subject to the study. The study routes totaled 85 routes, for a total of 2,017.2 km in length.

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 and calculated:

$$L_{Vi} = \frac{Y_i}{L}$$

where, L_{Vi} : 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

Based on the above result, routes which have a higher value than the average Link Value and 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 priority routes thus selected numbered 20 with a total length of 599.9 km.

6.4 IDENTIFICATIONS OF PRIORITY ROUTES BASED ON ROAD CONNECTION (ML Projects)

Routes expected to form a better road network by improving relatively short sections were selected by studying the existing base road network.

Selected were 4 routes, totaling 39.8 km in length.

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.

Among them, road links rehabilitated in the past three years and being rehabilitated, road links committed in the 6th Highway Plan, etc., were eliminated. In consequence, the length of links in the study became 6,270 km.

Based on the inventory data prepared by DOH, the following links were further omitted from the above study links:

- Links with less than 100 heavy vehicles a day.
- Links which are rated good or good to fair in pavement surface condition.
- Links with less than 250 heavy vehicles a day and with fair surface condition.
- Links with more than 250 commercial vehicles a day and fair surface condition, provided that the deflection is less than the allowable limit (0.6 mm) for most sections in the link.

The above criteria are illustrated below (Figure 1.7.1).

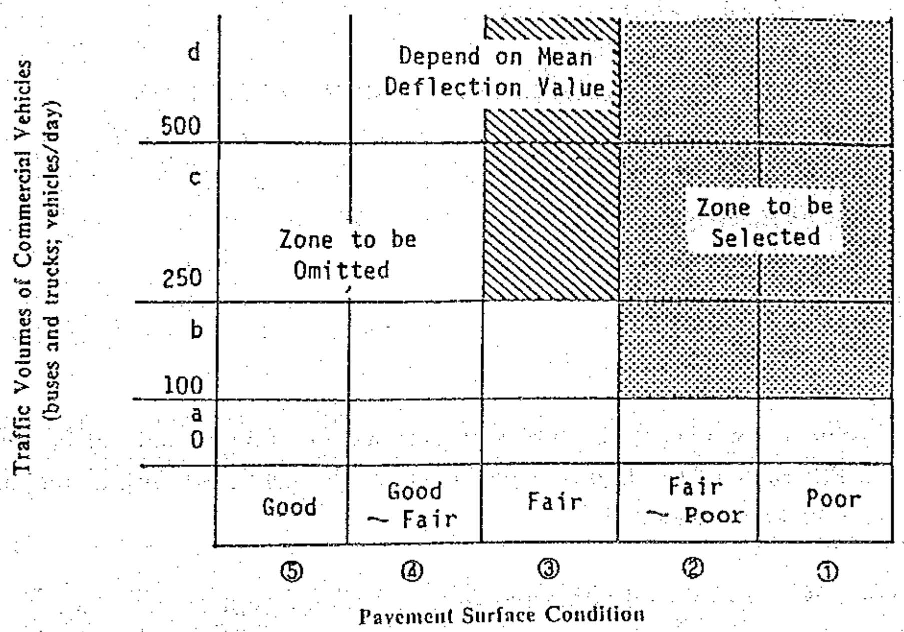


Figure 1.7.1 CRITERIA FOR SELECTION OF LINKS TO BE REHABILITATED

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

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

For concrete pavement, cracking survey was conducted to evaluate pavement cracks.

Deflection survey was conducted by means of a Benkelman Beam.

Data on CBR values of subgrade, subbase and base courses were obtained from DOH. CBR for which data were not available were estimated by examining kinds of soil.

7.3 IDENTIFICATION OF PRIORITY LINKS FOR REHABILITATION

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

Table 1.7.1 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 to the selection of links. 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 priority links thus selected numbered 16 with a total length of 423.7 km.

CHAPTER 8 PROJECT SCREENING

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, an overall review was carried out 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 Selected Projects Based on Road Congestion and National Development Program (ML Projects)

As the proposed projects for preliminary evaluation, eight links of 288.8 km were selected out of 25 links of 1,016.0 km identified in Chapter 6 as shown in Table 1.8.1 and Figure 1.8.1.

Primary priority was given to the projects related to the Eastern Seaboard Development Program.

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 to 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 seven remaining ML Projects are to add two more lanes to the existing two-lane highways.

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

Through the overall review, 23 links of 718.2 km were selected as the proposed projects for preliminary evaluation. These routes are shown in Table 1.8.1 and Figure 1.8.1.

As described in Chapter 6, 24 routes of 639.7 km and four routes with 39.8 km based on road connection were identified as priority routes, for a total of 28 routes of 679.5 km. Then, through discussion with DOH, seven routes of 477.8 km were added. Finally, the selected projects were 35 routes of 1,157.3 km.

Table 1.8.1 PROPOSED PROJECTS FOR IMPROVEMENT AND NEW CONSTRUCTION

Project No.	Changwat	Division	Route No.	Origin - Destination	Length (km)
(1) PROJECTS 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 SELECTED BASED ON SOCIO-ECONOMIC REQUIREMENTS & 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

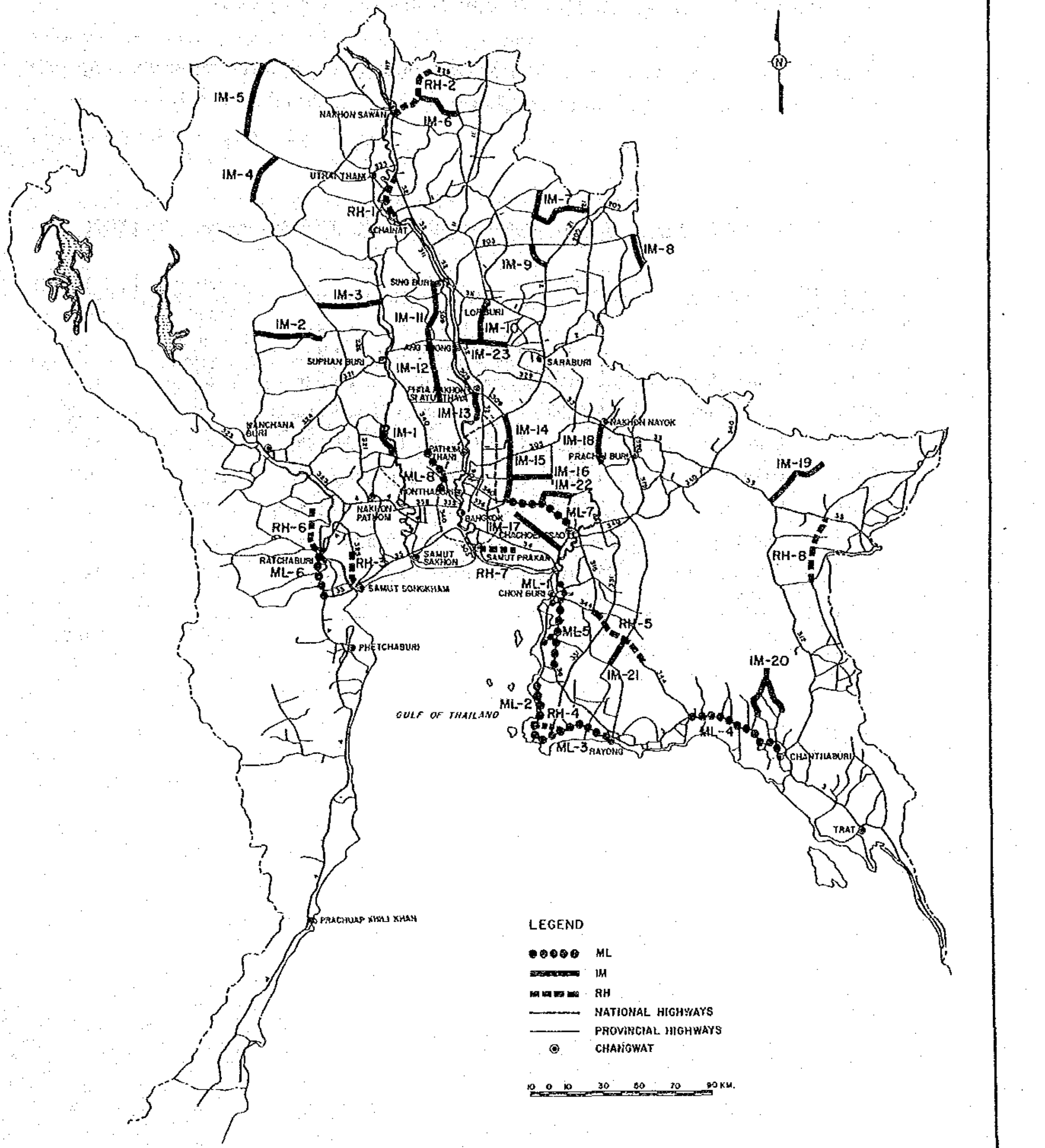


Figure 1.8.1 PROPOSED PROJECTS

IM-23 (Rt. 3267) of 26.3 km, selected initially as a priority route for rehabilitation, was transferred to this group, because this route requires upgrading of road class together with rehabilitation.

8.2 PROPOSED PROJECTS FOR REHABILITATION (RH Projects)

As the proposed projects for rehabilitation, eight links of 207.0 km were selected out of 16 links of 423.7 km identified. They are shown in Table 1.8.2 and Figure 1.8.1.

Table 1.8.2 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	334 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

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 to the existing road network. The future road network was created by further inserting the following project roads into the base road network assuming that they have already been completed:

- Toll road construction projects with 403 km in length for improving Rts. 2, 32 and 35 to four-lane highways, which were committed by DOH.

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

The traffic volumes were assigned to the future road network.

Analytical results are described in Chapter 13, Conclusion and Recommendation.

CHAPTER 10 IDENTIFICATION OF INTERSECTIONS TO BE IMPROVED

A macroassessment of traffic capacity against future traffic volumes at intersections was carried out.

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

Calculation of intersection capacity was based on Highway Capacity Manual (HCM).

The number of major intersections picked as the study subject totaled 304. Summary results are as follows:

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

CHAPTER 11 PRELIMINARY EVALUATION OF PROJECTS FOR IMPROVEMENT AND NEW CONSTRUCTION

In Chapter 8, the following links were selected as the proposed projects to be studied in the preliminary evaluation process:

ML Projects	=	8 links	288.80 km
IM Projects	=	23 links	718.20 km

They are shown in Table 1.8.1 and the locations are shown in Figure 1.8.1.

11.1 FUTURE TRAFFIC VOLUME ON PROJECT ROUTES

The traffic forecast described in Chapter 5 was made on the basis of trends of the number of registered vehicles and the results of O/D surveys. The main purpose of this forecasting exercise was to understand the general behavior of region-wide traffic. The assigned traffic volumes on each route were not always accurate enough to be applied to the evaluation of particular projects. In consequence, traffic forecasts for the preliminary evaluation were made by applying the Growth Rate Method or the Assignment Method.

The Growth Rate Method estimates future traffic volume by applying the growth rate to the base traffic volume. It was adopted for projects to which diverted traffic is hardly expected (all projects except for ML-1 and ML-5).

The Assignment Method, which estimates future traffic volume based on O/D tables, was adopted to M-1 and ML-5, to which diverted traffic from Rt. 3 is expected.

For the purpose of estimation of road user benefits, traffic was classified into four types, normal, diverted, induced and development traffic.

Development traffic is defined as the traffic which occurs in excess of natural growth of population and economic activities due to the road improvement. However, this was disregarded in the preliminary evaluation.

Vehicles were classified into seven types at this stage. They were motorcycle, passenger car, light bus and heavy bus for passenger traffic, and light truck, medium truck and heavy truck for freight traffic.

Base and future traffic volumes (ADT) forecasted through the procedures mentioned above are summarized in Tables 1.11.1 and 1.11.2.

Table 1.11.1 TRAFFIC FORECAST ON ML PROJECTS

Route	Section	Base ADT		Future ADT		
		Year	ADT	1993	2000	2008
ML-1	3-0403-N	—	—	24203	36147	55092
	3-0403-E	—	—	25237	37821	57452
	3-0403-S	—	—	21704	33218	51122
	3-0403-s	—	—	2991	5173	8216
	Average	—	6964	18534	28090	42970
ML-2	3-0701	1986	4958	7673	11214	16629
ML-3	3-0800	1986	8830	14573	21749	32800
ML-4	3-1000	1086	7102	12474	17748	25857
	3-1102	1986	4863	7298	10666	15952
	Average	—	5983	9886	14207	20905
	BP-N	—	—	20805	33602	54389
	BP-M	—	—	20962	33835	54717
	Ave. N & M	—	—	20884	33719	54553
	BP-S	—	—	18048	29525	48078
	BP-W	—	—	2914	4310	6639
	Average	—	—	15682	25318	40956
ML-6	4-0502	1986	8004	15210	21925	32583
ML-7	304-47KM	1986	15110	21610	31302	47384
	304-73KM	1986	6583	9595	13852	20738
	Average	—	10847	15603	22577	34061
ML-8	340-0300	1986	5569	10109	14258	21311

Note: N: North Section, E: East section, S: Upper south section, s: Lower south section,
M: Middle section

Table 1.11.2 TRAFFIC FORECAST ON IM PROJECTS

Route	Section	Base ADT		Future ADT		
		Year	ADT	1993	2000	2008
IM-1	PWD	1986	300	553	754	1080
IM-2	3306-0100	1986	385	721	959	1332
IM-3	PWD	1988	174	282	400	573
	ARD	1987	165	235	327	470
	Average	—	170	259	364	522
IM-4		1988	112	180	268	391
IM-5	PWD/ARD	1988	87	142	202	294
IM-6	PWD	1987	68	133	162	209
IM-7	2321-1002	1988	46	65	86	121
		1988	63	88	118	164
	Average	—	55	77	102	143
IM-8	2247	1986	531	816	1118	1609
IM-9	PWD	1987	202	299	374	506
IM-10	3196	1987	550	1029	1462	2067
IM-11	RID-N	1988	463	1055	2312	3631
	RID-M	1987	280	700	1099	1643
	RID-S	1988	787	1745	4122	6449
	Average	—	510	1167	2511	3908
IM-12	RID	1987	240	513	945	1456
IM-13	PWD	1986	200	737	1071	1577
IM-14	RURAL	1988	196	320	443	631
IM-15	RURAL-N	1988	582	968	1402	2039
	RURAL-S	1988	1657	2563	3732	5519
	Average	—	1120	1766	2567	3779
IM-16	3312	1988	514	894	1281	2024
	PWD	1988	274	399	567	888
	Average	—	394	647	924	1456
IM-17	PWD	1988	1371	2162	3259	5086
IM-18	RID	1987	170	358	550	779
IM-19	RURAL	1988	183	277	403	565
IM-20	3249-0200	1986	179	315	464	692
	3249-0300	1986	144	254	368	542
	RURAL	1988	905	1431	2100	3107
	Average	—	409	667	977	1447
IM-21	3245-0402	1988	338	422	521	697
IM-22	RURAL	1988	121	194	284	418
IM-23	3267-0101	1986	2587	5730	7771	10980

11.2 ENGINEERING STUDY AND COST ESTIMATE

Inventory Survey and Field Reconnaissance

To collect information necessary for the road design, an inventory survey for the proposed projects was carried out with an accuracy at the level of prefeasibility study.

Major items surveyed were road length and width, general conditions of alignment, surface type, embankment height/cutting depth, location and condition of bridges, terrain, land use and name of villages along the routes, and past records of flooding.

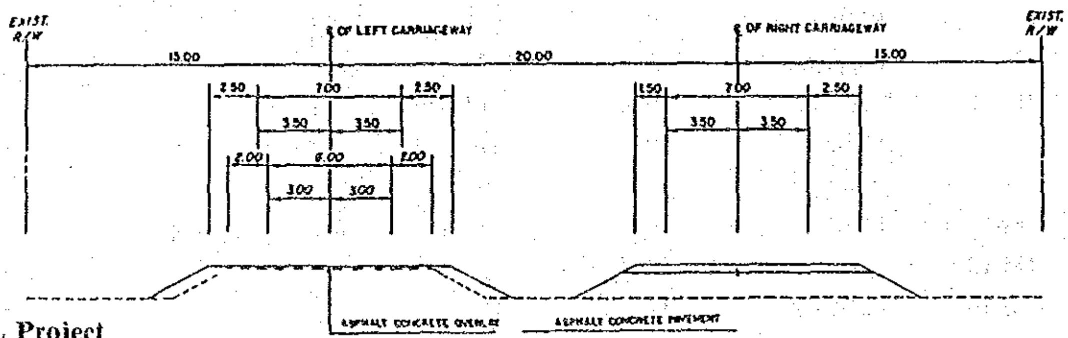
Preliminary Design

Alignment was studied at the preliminary evaluation level on the basis of 1/50,000 scale topographic maps. The alignment, except for ML-5, was determined utilizing the existing alignment as much as possible in order to minimize the construction cost.

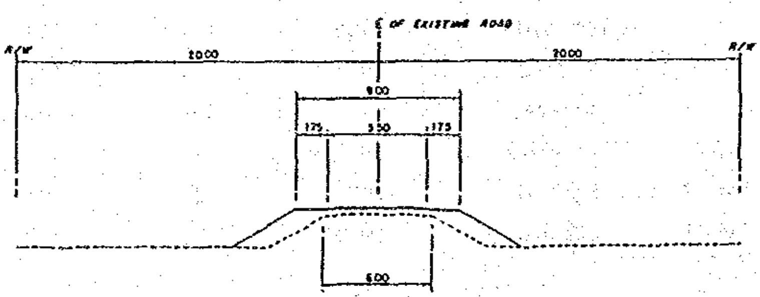
Major components of cross section such as road width, surface type, and cross slope are specified in DOH standards and they were used unchanged in this study. Other components such as embankment and cut slopes and minimum depth of side ditch were determined through the study of typical cross sections of DOH highway projects implemented recently.

Typical cross sections applied to each project are shown below:

TYPICAL CROSS SECTIONS



ML Project



IM Project

DOH has the highway standards of P Standard (P_D to P_3) for primary highways and S Standard (S_D to S_5) for secondary highways based on predicted ADT.

Since all ML Projects belong to national highways, the proposed road class was given to each project as shown in Table 1.11.3.

For provincial highways, DOH applies F Standard (F_D to F_6). Since all IM Projects belong to provincial highways, the proposed road class was given to each project as shown in Table 1.11.4.

However, an exceptional road class was applied to some projects depending on their future roles or difficulty of right-of-way acquisition.

Required minimum heights of embankments were determined mainly in consideration of the influence of surface water on road structures. The minimum heights of embankment employed are shown below.

MINIMUM EMBANKMENT HEIGHT

Description	Minimum Height (m)
Ordinary Sections	1.0
Approach to Bridge in Flat Areas	2.0
Flood Sections	0.7 (above flood level)

The side-borrow method is the most common and economical method for embankment construction in Thailand. This method was, therefore, applied to most sections of the projects.

For IM-10, IM-11, IM-12 and ML-7, however, the borrow-pit method was adopted in which embankment materials are carried from distant borrow pits, because there is not enough room to apply the side-borrow method within the right-of-way of these routes.

For the trunk highways under DOH, PCC pavement is sometimes applied recently. However, only AC pavement was adopted in the preliminary evaluation for the purpose of evaluating all projects on a equal basis.

Table 1.11.3 APPLIED ROAD CLASS (P AND S CLASS ROADS)

Project No.	ADT after Opening		Road Class	
	7th year (2000)	15th year (2008)	Existing	Proposed
ML-1	18,606	27,641	P1	PD
ML-2	11,214	16,629	P1	PD
ML-3	21,749	32,800	P1	PD
ML-4	14,207	20,905	P1	PD
ML-5 (B.N.)	33,719	54,553	—	PD
(B.S.)	29,525	48,073	—	P1
(B.W.)	4,310	6,639	—	FD
ML-6	21,925	32,583	P1	PD
ML-7	22,577	34,061	S3	SD
ML-8 Rt. 340 Sect.	14,258	21,311	S3	SD
Outer Ring Road Sect.			P1	PD

Note: For ML-5:
B.N. = Chon Buri Bypass to Rt. 3241
B.S. = Rt. 3241 - Rt. 36
B.W. = Access to Laem Chabang

Table 1.11.4 APPLIED ROAD CLASS (F CLASS ROADS)

Project No.	ADT after Opening		Road Class[1]	
	7th year (2000)	15th year (2008)	Existing	Proposed
IM-1	754	1,080	[2]	F3
IM-2	959	1,332	Laterite, Substandard	F3
IM-3	364	522	-do-	F4
IM-4	268	391	-do-	F4 *
IM-5	202	294	-do-	F5 *
IM-6	162	209	-do-	F6
IM-7	102	143	-do-	F6
IM-8	1,118	1,609	-do-	F3
IM-9	374	506	-do-	F4
IM-10	1,462	2,067	[3]	F2
IM-11	2,511	3,908	[3]	F2
IM-12	945	1,456	[3]	F2 *
IM-13	1,071	1,577	[2]	F3
IM-14	443	631	Laterite, Substandard	F4 * (6.5-m wide pavement)
IM-15	2,567	3,779	-do-	F2
IM-16	924	1,456	-do-	F3
IM-17	3,259	5,086	-do-	F3 *
IM-18	550	779	-do-	F4
IM-19	403	565	-do-	F3
IM-20	977	1,447	-do-	F4
IM-21	521	697	-do-	F4
IM-22	284	418	-do-	F4 *
IM-23	7,771	10,980	F4	F1

Note: [1] : Road classes of the existing roads were estimated from the typical cross section.
[2] : PWD plans a 5-m wide pavement on a 8-m wide roadbed.
[3] : 8.0-m wide roadbed and 5.0-m wide carriageway.
* : Exceptional application was applied.

Typical pavement structures applied, corresponding to each of standards, are as follows:

PD, SD, S1, FD, and F1 Standards

- AC		10 cm
- Crushed stone base	CBR > 80	20 cm
- Soil aggregate subbase	CBR > 20	20 cm
- Selected materials	CBR > 6	15 cm

F2, F3 and F4 Standards

- DBST		2.5 cm
- Crushed stone base	CBR > 80	1.5 cm
- Soil aggregate subbase	CBR > 20	20 cm
- Selected materials	CBR > 6	15 cm

F5 and F6 Standards

- Soil aggregate surface	CBR > 20	15 cm
- Selected material	CBR > 6	20 cm

For ML Projects except for ML-5, an AC overlay of 5 cm in thickness was applied to the existing lanes at the opening year to rehabilitate existing pavement.

A 5 cm thick AC overlay was planned in the 8th year after opening for all projects except IM-5 where F5 standard was applied.

Substantial improvement of drainage facilities was planned on the basis of inventory survey and reconnaissance. Pipe culverts of minimum 100 cm in diameter were adopted considering easy maintenance. 2.4 m × 2.4 m double cell type concrete culvert boxes were adopted referring to the typical structures employed by DOH.

Temporary wooden bridges and some concrete bridges which do not satisfy design loading and carriageway width were replaced with standard concrete bridges. New concrete bridges were planned at river crossing sites where no bridges exist and also in new construction sections. The types of bridges selected were as follows:

RC Slab	:	Short span bridge
PC Girder	:	Long span bridge

Construction Quantities and Costs

Construction quantities by major work items were calculated on the basis of the engineering studies. The applied unit rates were those as of 1987. They were developed from DOH cost data. The unit rates for the major items are shown in Table 1.11.5.

Construction costs by major work items were calculated by applying these unit rates to the estimated construction quantities. Costs of minor items such as side ditches, slope protection, guard rails, traffic signs, etc., were estimated at 7% of total cost of major work items. The direct construction cost was obtained by totalling these costs.

The total construction costs were calculated by adding the following cost items to the direct construction cost:

Physical contingency	:	10% of direct construction costs
Engineering and administration	:	10% of direct construction costs

Economic construction cost used in the economic evaluation was calculated by deducting the tax component of each work item from the financial construction cost. They are given in Tables 1.11.6 and 1.11.7.

Table 1.11.5 UNIT RATES OF MAJOR WORK ITEMS

Item	Unit	Financial Unit Rate (Baht)	Economic Cost (%)	Residual Value (%)
EARTHWORK			83	90
Clearing & Grubbing	ha	9,500		
Earth Excavation	m^3	16		
Embankment (side borrow)	m^3	40		
Embankment (borrow pit)	m^3	100		
PAVEMENT			83	50
Subbase (selected material)	m^3	180		
Subbase (soil aggregate)	m^3	220		
Base (soil aggregate)	m^3	350		
Shoulder (soil aggregate)	m^3	250		
Prime Coat	m^2	12		
DBST Surface	m^2	40		
AC Surface	ton	190		
STRUCTURES			83	50
RC Pipe Culvert (D = 1.00 equivalent)	m	1,800		
RC Box Culvert (2 × 2.4 × 2.4 equivalent)	m	20,000		
RC Bridge (W = 7.0, L = 10.0 equivalent)	m	60,000		
PC Bridge	m	80,000		
INTERCHANGES/INTERSECTIONS	no.	5,000,000 30,000,000	83	50
LAND ACQUISITION				
Highly Developed Land	ha	200,000	—	

(1 Baht = 5.2 Yen)

Table 1.11.6 SUMMARY OF COSTS (ML PROJECTS)

(Unit: thousand Baht)

Route No.	Road Class	Length (km)	Financial Cost	Average Cost (per km)	Economic Cost
ML-1	PD	13.8	112,932	8,132	93,940
ML-2	PD	27.3	167,168	6,123	139,053
ML-3	PD	48.8	284,713	5,834	236,830
ML-4	PD	61.3	445,894	7,274	370,904
ML-5	PD,P1,FD	48.8	518,297	10,621	447,526
ML-6	PD	22.8	155,216	6,808	129,111
ML-7	SD	41.0	421,562	10,282	350,662
ML-8	SD,PD	25.6	254,890	9,957	212,022
TOTAL		289.4	2,360,672		1,980,048

(1 Baht = 5.2 Yen)

Table 1.11.7 SUMMARY OF COSTS (IM PROJECTS)

(Unit: thousand Baht)

Route No.	Road Class	Length (km)	Financial Cost	Average Cost (per km)	Economic Cost
IM-1	F3	18.8	13,617	724	11,327
IM-2	F3	36.0	86,408	2,400	71,876
IM-3	F4	33.6	79,643	2,370	66,249
IM-4	F4	34.0	80,852	2,378	67,255
IM-5	F5	69.1	104,873	1,518	87,235
IM-8	F3	16.8	42,394	2,523	35,263
IM-9	F4	18.0	43,633	2,424	36,295
IM-10	F2	34.8	124,047	3,565	103,185
IM-11	F2	41.0	132,540	3,233	110,250
IM-12	F2	50.0	178,910	3,578	14,821
IM-13	F3	16.2	13,193	814	10,975
IM-14	F4	24.4	69,706	2,857	58,589
IM-15	F2	24.3	62,268	2.562	51,796
IM-16	F3	20.8	82,226	3,953	68,397
IM-17	F3	29.3	79,437	2,711	66,078
IM-18	F4	26.7	68,086	2,550	56,635
IM-19	F3	27.3	70,595	2,586	58,723
IM-20	F4	44.5	105,575	2,372	87,820
IM-21	F4	18.3	41,755	2,282	34,733
IM-22	F4	16.5	61,211	3,710	51,774
IM-23	F1	26.5	95,561	3,606	79,490
TOTAL		626.9	1,636,530		1,228,766

(1 Baht = 5.2 Yen)

11.3 BENEFITS ESTIMATION

Benefits due to the projects were estimated in terms of vehicle operating cost (VOC) savings and time savings between with and without project cases.

Vehicle operating costs on level tangent roads were estimated based on DOH data in 1986. They were updated using new materials. These data for ideal conditions were modified by incorporating actual road geometory and speed change cycle.

Value of time was estimated separately for drivers and assistants and for passengers. Value of time for drivers and assistants was estimated by analyzing monthly wages and working hours.

Value of time for passengers was estimated separately for business purposes and other trips. For the former, it was estimated from monthly wage; for the latter, a constant 5.44 Baht/hr was applied.

Occupancy rate of passengers was estimated from O/D survey results. Then the time value by vehicle type was calculated using the time value previously calculated.

The benefits are given in Tables 1.11.8 and 1.11.9.

11.4 PRELIMINARY EVALUATION

For the purpose of determining the priority order of the projects, an economic evaluation was conducted using the conventional benefit/cost analysis in terms of internal rate of return (IRR).

Analytical results are shown in Chapter 13.

Table 1.11.8 BENEFITS OF ML PROJECTS

(Unit: thousand Baht)

Project No.	VOC Savings		Time Savings		Total Benefits	
	2000	2008	2000	2008	2000	2008
ML-1	24,605	11,628	38,051	17,476	62,656	29,104
ML-2	14,436	28,268	57,785	87,295	72,221	115,563
ML-3	45,101	64,406	112,890	109,954	157,991	174,360
ML-4	42,755	65,300	108,972	141,345	151,727	206,645
ML-5	83,359	138,186	417,943	682,281	501,302	820,467
ML-6	27,134	38,761	46,388	44,525	73,522	83,286
ML-7	60,732	71,163	130,666	118,064	191,398	189,227
ML-8	31,721	46,854	73,597	91,498	105,318	138,352

(1 Baht = 5.2 Yen)

Table 1.11.9 BENEFITS OF IM PROJECTS

(Unit: thousand Baht)

Project No.	VOC Savings		Time Savings		Total Benefits	
	2000	2008	2000	2008	2000	2008
IM-1	3,492	5,008	1,661	2,356	5,153	7,364
IM-2	33,401	46,634	2,428	3,425	35,829	50,059
IM-3	9,890	14,135	1,404	2,035	11,294	16,170
IM-4	12,530	18,264	901	1,332	13,431	19,586
IM-5	9,704	14,045	4,526	6,649	14,230	20,694
IM-8	10,293	14,719	960	1,405	11,253	16,124
IM-9	4,592	6,314	206	281	4,798	6,595
IM-10	19,782	27,855	8,203	11,614	27,985	39,469
IM-11	59,461	95,427	12,800	19,232	72,261	114,659
IM-12	27,143	43,405	6,721	10,188	33,864	53,593
IM-13	4,950	7,245	2,916	4,244	7,866	11,489
IM-14	18,060	25,587	3,029	4,360	21,089	29,947
IM-15	21,243	31,228	3,334	4,977	24,577	36,205
IM-16	38,731	61,312	3,729	5,937	42,460	67,249
IM-17	69,221	107,977	9,353	14,837	78,574	122,814
IM-18	9,747	13,699	2,493	3,624	12,240	17,323
IM-19	10,303	14,450	936	1,327	11,239	15,777
IM-20	45,310	67,030	6,420	9,908	51,730	76,938
IM-21	7,693	10,164	846	1,181	8,539	11,345
IM-22	12,035	18,128	3,755	5,633	15,790	23,761
IM-23	51,179	71,880	23,149	33,225	74,328	105,105

(1 Baht = 5.2 Yen)

CHAPTER 12 PRELIMINARY EVALUATION OF PROJECTS FOR REHABILITATION

In Chapter 8, 8 links of 206.8 km were selected as the projects for rehabilitation to be studied in the preliminary evaluation. They are shown in Table 1.8.2 and also in Figure 1.8.1.

12.1 FUTURE TRAFFIC VOLUME ON PROJECT ROUTES

Traffic forecast was carried out according to the procedure described in Chapter 11. Forecasted ADT is shown in Table 1.12.1.

12.2 ENGINEERING AND COST ESTIMATE

Engineering Survey

Results of PSI survey, deflection survey and supporting capacity survey as described in Chapter 7 were applied to the preliminary design of the proposed projects.

Traffic Loading Analysis

For rehabilitation design, the wheel loads of vehicles converted to equivalent standard 8,200 kg axle loads (ESA) were adopted.

Only heavy vehicles such as 6-wheel trucks (MT), 10-wheel trucks (HT) and heavy buses (HB) were taken into consideration in the analysis of rehabilitation design.

Actural loading weight distribution of MT, HT and HB, and equivalent factors to ESA prepared in AASHTO Guide 1986 were applied to the forecasted traffic volume to obtain accumulated standard 8,200 kg axle loads.

Preliminary Design

In order to design overlay and reconstruction for the project links, the following design methods were applied:

- AASHTO Design Guide for Pavement Structures 1986
  (AASHTO Guide 1986 Method)
- DOH Method (California Method)

Table 1.12.1 TRAFFIC FORECAST ON RH PROJECTS

Route	Section	Year	MC	PC	LB	HB	LT	MT	HT	ADT
RH-1	1-1001	1986	1056	686	97	108	319	198	114	1522
		1993	1056	1078	143	159	499	270	155	2304
		2000	2233	1566	202	225	660	358	206	3217
		2008	3232	2388	302	336	852	495	285	4658
RH-2	255-0100	1986	1279	1243	129	135	354	320	34	2215
		1993	1279	1922	190	199	656	436	46	3449
		2000	2640	2599	269	281	772	577	61	4559
		2008	3503	3320	401	419	946	800	84	5970
RH-3	325-0200	1986	1275	2132	779	393	780	317	237	4638
		1993	1275	3648	1202	561	1037	404	320	7172
		2000	2748	5233	1657	773	1371	537	429	10000
		2008	4066	8051	2424	1068	1931	728	595	14797
RH-4	332-0100	1986	461	449	172	84	366	206	207	1484
		1993	461	853	342	134	573	320	348	2570
		2000	1424	1611	481	234	969	568	722	4585
		2008	2211	2483	698	340	1536	896	1167	7120
RH-5	344-0200	1986	1255	1547	412	691	1810	467	941	5868
		1993	1255	2353	613	1037	2665	706	1393	8767
		2000	2747	3410	969	1349	3910	1038	1937	12613
		2008	4152	5221	1640	1791	5776	1495	2537	18460
RH-6	3089-0101	1986	546	486	110	90	1053	1475	1028	4242
		1993	546	756	162	133	1435	2010	1401	5897
		2000	1025	1121	230	188	1902	2665	1857	7963
		2008	1452	1760	342	280	2635	3690	2572	11279
RH-7	3116-0100	1986	705	222	336	2	560	1351	267	2738
		1993	705	345	494	3	763	1838	364	3807
		2000	1316	512	700	4	1011	2442	482	5151
		2008	1857	804	1045	6	1400	3382	667	7304
RH-8	3395-0100	1986	263	109	82	76	193	53	121	634
		1993	263	170	121	112	248	72	165	888
		2000	540	251	171	159	405	96	221	1303
		2008	793	395	255	236	587	133	305	1911

In the DOH Method, the thickness of overlay is determined on the basis of deflection of existing pavement and cumulative number of ESA. Then no overlay is required for sections with low deflection and low cumulative number of ESA even where the existing surface is almost destroyed. This contradicts the actual situation.

Therefore, design results by the AASHTO Method only were finally adopted.

Sections to be rehabilitated were selected in 1 km units on the basis of serviceability of the pavement expressed in terms of PSI. Pavement with PSI value less than 2.0 was selected for rehabilitation.

The preliminary design results are shown in Table 1.12.2. Out of total 206.8 km in length, overlay is required for 116.0 km and reconstruction for 55.2 km. The required pavement cross sections are given in Figure 1.12.1.

Table 1.12.2 SUMMARY OF REHABILITATION WORKS

Project No.	Link No.	Link Length (km)	Length to be Rehabilitated	
			Overlay	Reconstruction
RH-1	1-1001	25.5	11.0 (t=65mm) 6.0 (t=90mm)	—
RH-2	225-0100	38.3	27.0 (t=75mm) 1.0 (t=95mm)	6.0
RH-3	325-0200	18	8.0 (t=100mm)	5.0
RH-4	332-0100	14.5	11.0 (t=60mm) 2.0 (t=75mm)	—
RH-5	344-0200	39.5	27.0 (t=55mm) 1.0 (t=80mm)	2.0
RH-6	3089-0101	27.8	16.0 (t=110mm)	5.0
RH-7	3116-0100	9.7	—	9.7
RH-8	3395-0100	33.5	1.0 (t=45mm) 5.0 (t=70mm)	27.5
Total		206.8	116.0	55.2

RH-1

REQUIRED SN = 2.78

	THICKNESS	SN
A.C.	10 CM.	1.80
BASE	10 CM.	0.52
SUBBASE	15 CM.	0.54
TOTAL	35 CM.	2.86

RH-2

REQUIRED SN = 2.75

	THICKNESS	SN
A.C.	10 CM.	1.80
BASE	10 CM.	0.52
SUBBASE	15 CM.	0.54
TOTAL	35 CM.	2.86

RH-3

REQUIRED SN = 3.11

	THICKNESS	SN
A.C.	10 CM.	1.80
BASE	15 CM.	0.78
SUBBASE	15 CM.	0.54
TOTAL	40 CM.	3.12

RH-4

REQUIRED SN = 2.30

	THICKNESS	SN
A.C.	5 CM.	0.90
BASE	15 CM.	0.78
SUBBASE	20 CM.	0.72
TOTAL	40 CM.	2.40

RH-5

REQUIRED SN = 2.81

	THICKNESS	SN
A.C.	10 CM.	1.80
BASE	10 CM.	0.52
SUBBASE	15 CM.	0.54
TOTAL	35 CM.	2.86

RH-6

REQUIRED SN = 3.35

	THICKNESS	SN
A.C.	10 CM.	1.80
BASE	20 CM.	1.04
SUBBASE	15 CM.	0.54
TOTAL	45 CM.	2.38

RH-7

REQUIRED SN = 3.51

	THICKNESS	SN
A.C.	10 CM.	1.80
BASE	20 CM.	1.04
SUBBASE	20 CM.	0.72
TOTAL	50 CM.	3.56

RH-8

REQUIRED SN = 2.18

	THICKNESS	SN
A.C.	5 CM.	0.90
BASE	15 CM.	0.78
SUBBASE	15 CM.	0.54
TOTAL	35 CM.	2.22

Figure 1.12.1 RECOMMENDED PAVEMENT STRUCTURAL COMPONENTS FOR RECONSTRUCTION

Construction Quantities and Costs

Based on typical cross sections of rehabilitation works obtained from overlay and reconstruction designs, construction quantities were calculated. Construction unit rates were established based on the latest bidding rates in similar projects in Thailand. This is shown in Table 1.12.3.

Table 1.12.3 UNIT RATES FOR MAJOR WORK ITEMS

Item		Unit	Financial Unit Rate (Baht)
Selected Material		m3	180
Removal of Existing Pavement Structure		m3	60
Subbase Soil Aggregate		m3	220
Base Course Crushed Stone		m3	350
Asphalt Concrete	(t = 4.5cm)	ton	86
Asphalt Concrete	(t = 5.0cm)	ton	95
Asphalt Concrete	(t = 5.5cm)	ton	105
Asphalt Concrete	(t = 6.0cm)	ton	114
Asphalt Concrete	(t = 6.5cm)	ton	124
Asphalt Concrete	(t = 7.5cm)	ton	143
Asphalt Concrete	(t = 8.0cm)	ton	152
Asphalt Concrete	(t = 9.0cm)	ton	171
Asphalt Concrete	(t = 9.5cm)	ton	180
Asphalt Concrete	(t = 10.0cm)	ton	190
Asphalt Concrete	(t = 11.0cm)	ton	209
Prime Coat		m2	12
Tack Coat		m2	8
Shoulder Soil Aggregate		m3	250

(1 Baht = 5.2 Yen)

The following costs for miscellaneous works, physical contingencies and design/supervision are added to the direct construction cost as follows:

- Miscellaneous : 7% of construction cost of major work items
- Physical contingency : 10% of direct construction cost
- Engineering and supervision : 10% of direct construction cost

Construction costs by project link are summarized in Table 1.12.4 by financial and economic costs.

Table 1.12.4 SUMMARY OF COSTS (RH PROJECTS)

(Unit: thousand Baht)

Route No.	Link Length (km)	Length to be Rehabilitated (km)	Financial Cost	Average Cost (per km)	Economic Cost
RH-1	25.5	17.0	24,057	1,415	18,152
RH-2	38.3	34.0	44,986	1,323	33,944
RH-3	18.0	13.0	27,552	2,119	20,789
RH-4	14.5	13.0	12,597	969	9,505
RH-5	39.5	30.0	37,832	1,261	28,545
RH-6	27.8	21.0	42,768	2,037	32,270
RH-7	9.7	9.7	27,712	2,857	20,910
RH-8	33.5	33.5	59,051	1,763	44,557
Total	206.8	171.2	276,555		208,672

(1 Baht = 5.2 Yen)

12.3 BENEFITS ESTIMATION

The main benefits accruing from pavement rehabilitation are VOC savings and time savings. They were estimated by applying the VOC and time values described in 11.3.

The results of calculation of benefits by project are summarized in Table 1.12.5.

Table 1.12.5 BENEFITS OF REHABILITATION PROJECT

(Unit: thousand Baht)

Project	VOC Savings		Time Savings		Total Benefits	
	1990	1996	1990	1996	1990	1996
RH-1	11,867	16,706	6,626	9,465	18,493	26,171
RH-2	42,828	56,705	28,011	38,180	70,839	94,885
RH-3	31,857	44,719	30,277	42,445	62,134	87,164
RH-4	7,722	16,070	4,416	8,365	12,138	24,435
RH-5	81,037	117,093	59,026	81,809	140,063	198,902
RH-6	52,267	70,694	20,569	28,554	72,836	99,248
RH-7	18,109	24,444	8,784	12,151	26,893	36,595
RH-8	26,904	39,848	40,602	59,652	67,506	99,500

(1 Baht = 5.2 Yen)

12.4 PRELIMINARY EVALUATION

Economic evaluation for the project roads was conducted by means of the conventional benefit/cost analysis.

The calculated IRRs are shown in Chapter 13.

CHAPTER 13 CONCLUSION AND RECOMMENDATION

13.1 SELECTION OF PROPOSED PROJECTS FOR FEASIBILITY STUDY

ML Projects

As described in Chapter 11, eight projects with 288.8 km in total length were evaluated in terms of IRR as shown in Table 1.13.1.

Table 1.13.1 RANKING BY IRR OF ML PROJECTS

Ranking	Project No.	Origin — Destination	Length (km)	IRR (%)
1	ML-5	Chon Buri-Pattaya New Highway	48.8	43.4
2	ML-3	A. Sattahip - C. Rayong	48.8	32.8
3	ML-1	Chon Buri Bypass	13.8	32.7
4	ML-6	C. Ratchaburi - J.R. 35	22.8	29.6
5	ML-7	A. Min Buri - C. Chachoengsao	41.0	29.1
6	ML-8	B. Bang Muang - A. Lat Lum Khaew	25.6	24.7
7	ML-2	M. Pattaya - A. Sattahip	27.3	23.9
8	ML-4	A. Klaeng - C. Chanthaburi	61.3	21.0
Total	8 Projects		288.8	

The results indicate that IRRs are between 21.0% and 43.4%, feasible enough for early implementation.

Among them, projects related to the Eastern Seaboard Development Program, which is a key target of the Sixth Plan, ML-5, ML-3, ML-1, ML-7 and ML-2, were selected as proposed projects for the feasibility study.

Although unrelated to the above Program, ML-4 was additionally selected because of its importance as the only trunk highway leading to the eastern area along the Gulf of Thailand.

IM Projects

As described in Chapter 11, 21 projects with 629.9 km in total length were evaluated in terms of IRR as shown in Table 13.1.2.

Among them, projects for the feasibility study were selected by applying the following principles:

- To follow basically the ranking order of IRR.
- To apply a threshold IRR of 12%, which has usually been adopted in various studies in Thailand.
- To consider the possible number of projects to be implemented during the 6th Highway Plan.

Based on the first two criteria, 11 projects were finally selected.

Following the ranking order of IRR, IM-20 of the 10th rank and IM-8 of the 11th rank ought to be selected. However, they were substituted with IM-22 of the 12th rank and IM-12 of the 13th rank considering their importance.

Table 1.13.2 RANKING BY IRR OF IM PROJECTS

Ranking	Project No.	Origin - Destination	Length (km)	IRR (%)
1	IM-17	A. Lat Krabang - B. Khlong Tha Thua	29.3	45.6
2	IM-23	J.R. 32 - J.R. 3022	26.5	40.7
3	IM-13	A. Bang Pa-In - C. Ayutthaya	16.2	38.5
4	IM-16	A. Lam Luk Ka - B. Khlong 16	20.8	31.1
5	IM-11	B. Channasut - A. Pho Thong	41.0	28.6
6	IM-15	B. Khlong Luang - A. Min Buri	24.3	28.0
7	IM-2	B. Nong Pru - A. Lao Khwan	36.0	27.0
8	IM-1	A. Bang Len - B. Bang Noi Nai	18.8	26.6
9	IM-14	A. Wang Noi - A. Thanyaburi	24.4	23.0
10	IM-20	B. Khlong Takhian - J.R. 3322	44.5	21.8
11	IM-8	B. Khao Noi - B. Chang Ko Nok	16.8	20.8
12	IM-22	A. Nong Chok - A. Bang Nam Prieo	16.5	20.1
13	IM-12	A. Pho Thong - A. Sena	50.0	17.3
14	IM-10	B. Reng Sung - C. Lop Buri	34.8	17.0
15	IM-21	B. Nong Chang - J.R. 3138	18.3	16.7
16	IM-19	A. Sa Kaeo - DOH Const. Office	27.3	12.7
17	IM-4	B. Thong Lang - A. Lan Sak	34.0	12.3
18	IM-5	A. Lan Sak - B. Kao Chonkhon	69.1	11.5
19	IM-3	B. Nong Ei Pang - A. Sam Chuk	33.6	10.7
20	IM-9	B. Dilang - B. Wang Phloeng	18.0	8.7
21	IM-18	C. Nakhon Nayok - A. Ban Sang	26.7	6.2
Total	21 Projects		626.9	

RH Projects

As described in Chapter 12, 8 links with 206.8 km in total length were evaluated in terms of IRR as shown in Table 1.13.3.

The results indicate that IRRs are between 65.9% and 181.1%, feasible enough for early implementation.

In the selection of proposed projects for the feasibility study, priority was put on national highways in view of their importance, and the ranking order of IRR was respected.

As a result, projects of national highways up to the 3rd rank of IRR, RH-5, RH-3 and RH-2, were selected as proposed projects for the feasibility study.

Table 1.13.3 RANKING BY IRR OF RH PROJECTS

Ranking	Project No.	Link No.	Route No.	Length (km)	IRR (%)
1	RH-5	0200	344	39.5	181.1
2	RH-3	0200	325	18.0	133.9
3	RH-6	0101	3089	27.8	111.8
4	RH-2	0100	225	28.3	106.1
5	RH-8	0100	3395	33.5	87.1
6	RH-4	0100	332	14.5	82.4
7	RH-7	0100	3116	9.7	77.0
8	RH-1	1001	1	25.5	65.9
Total	8 Projects			206.8	

Project Phasing in the Feasibility Study

Proposed projects for the feasibility study selected in the previous sections were classified into two groups, Phase I Projects and Phase II Projects, as follows:

Phase I Projects: This group is composed of projects for which early implementation is required. Their feasibility studies were requested to be finished well before the end of the Study.

Through a series of discussions with DOH, high priority was given to ML Projects especially related to the Eastern Seaboard Development Program in the light of the development policies of the Government of Thailand. As a result, ML-5, ML-1, ML-7, ML-2 and ML-4 were selected as Phase I Projects. ML-3 and the remaining IM Projects and RH Projects were classified into Phase II Projects.

Only IM-23 was selected as a Phase I Project among IM Projects, because it was judged to require urgent improvement because of the severe deterioration of its pavement.

Phase II Projects: This group is composed of the remaining projects. Their feasibility studies were to be finished by the end of the Study.

The list of the proposed projects thus classified is shown in Tables 1.13.4 and 1.13.5 and they are also shown in Figure 1.13.1.

The Study Team strongly recommended that it is indispensable to construct a new trunk highway extending directly from ML-5 to Bangkok to alleviate traffic congestion on Rts. 34 and 3, as well as to effectively operate the Eastern Seaboard Development Program. The Government of Thailand accepted this recommendation and requested that the Government of Japan include the feasibility study on the said project in the current Study. In response to the request, the Government of Japan decided to carry out the project as Project ML-9 in Phase II. This project is included in Table 1.13.5.

Table 1.13.4 PHASE I PROJECTS

Project No.	Origin - Destination	Length (km)
ML Projects (5 projects)		192.20
ML-1	Chon Buri Bypass	13.60
ML-2	M. Pattaya - A. Sattahip	27.27
ML-4	A. Klaeng - C. Chanthaburi	61.86
ML-5	Chon Buri - Pattaya New Highway	50.33
ML-7	A. Min Buri - C. Chachoengsao	40.94
IM Projects (1 project)		26.87
IM-23	J.R. 32 - J.R. 3022	26.87
Total	6 Projects	220.87

Table 1.13.5 PHASE II PROJECTS

Project No.	Origin - Destination	Length (km)
ML Projects (1 project)		126.3
ML-3	A. Sattahip - C. Rayong	44.6
ML-9	Bangkok-Chun Buri	81.7
IM Projects (10 projects)		279.8
IM-1	A. Bang Len - B. Bang Noi Nai	18.7
IM-2	B. Nong Pru - A. Lao Khawn	35.9
IM-11	B. Channasut - A. Pho Thong	40.7
IM-12	A. Pho Thong - A. Sena	51.0
IM-13	A. Bang Pa-In - C. Ayutthaya	17.8
IM-14	A. Wang Noi - A. Thanyaburi	25.6
IM-15	B. Khlong Luang - A. Min Buri	24.7
IM-16	A. Lam Luk Ka - B. Khlong 16	20.8
IM-17	A. Lat Krabang - B. Khlong Tha Thua	28.7
IM-22	A. Nong Chok - A. Bang Nam Prieo	15.9
RH Projects (3 projects)		96.7
RH-2	Rt. 225	39.5
RH-3	Rt. 325	17.9
RH-5	Rt. 344	39.3
Total	15 Projects	502.8

13.2 PROPOSED PROJECTS FOR THE NEXT STAGE

ML Projects

Links which require additional lanes were selected in Chapter 6, as shown in Figure 1.6.1, while the projects decided by DOH for implementation and the projects subjected to the feasibility study in this Study are shown in Figure 1.13.1.

Comparing these two figures, those projects remaining in Figure 1.6.1 after implementing the projects given in Figure 1.13.2 were selected as the proposed projects for the next stage. They are shown in Table 1.13.6 and Figure 1.13.1.

IM Projects

The following projects are proposed to be implemented in the next stage:

- Projects omitted as subjects for the preliminary evaluation although they were given high priority in Chapter 6.
- Projects omitted as subjects for the feasibility study although they showed more than 12% of IRR in the preliminary evaluation.

They are shown in Table 1.13.7 and Figure 1.13.1.

Table 1.13.6 ML PROJECTS PROPOSED FOR NEXT STAGE

Project No.	Origin - Destination	Length (km)
ML-6 (Rt. 4)	C. Ratchaburi - J.R. 35	22.8
ML-8 (Rt. 340)	B. Bang Muang - A. Lat Lum Khaew	25.6
ML-101 (New Highway)	Outer Ring Road - C. Nakhon Pathom	30.0
ML-102 (Rt. 1)	C. Nakhon Pathom - J.R. 1072	18.0
ML-103 (Rt. 4)	A. Hua Hin - C. Prachuap Khiri Khan	93.0
ML-104 (Rt. 304)	C. Chachoengsao - J.R. 319	37.0
ML-105 (Rt. 305)	A. Thanyaburi - A. Ongkharak	35.0
ML-106 (Rt. 323)	C. Kanchanaburi - J.R. 3398	7.5
ML-107 (Rt. 344)	J.R. 3345 - J.R. 331	10.5
ML-108 (Rt. 3091)	J.R. 4 - C. Samut Sakhon	20.0
ML-109 (Rt. 3111)	O.R.R. - A. Sanakhok	17.0
ML-110 (Rt. 3119)	A. Min Buri - J.R. 3256	10.5
ML-111 (Rt. 3256)	J.R. 3119 - J.R. 34 - J.R. 3268	17.0
ML-112 (Rt. 3414)	J.R. 4 - J.R. 338	10.0
Total	14 Projects	353.9

Table 1.13.7 IM PROJECTS PROPOSED FOR NEXT STAGE

Project No.	Origin - Destination	Length (km)
IM-20	B. Khlong Takhian - J.R. 3322	44.5
IM-8	B. Khao Noi - B. Chang Ko Nok	16.8
IM-10	B. Reng Sung - C. Lop Buri	34.8
IM-21	B. Nong Chang -J.R. 3138	18.3
IM-19	A. Sa Kaeo - DOH Const. Office	27.3
IM-4	B. Thong Lang - A. Lan Sak	34.0
IM-101	J.R. 3209 - End of Rt. 3361	11.8
IM-102	A. Bang Khla - A. Phanom Sarakham	10.0
IM-103	J.R. 3017 - J.R. 21	18.5
IM-104	J.R. 3089 - J.R. 3209	24.5
IM-105	J.R. 324 - J.R. 3081	14.3
IM-106	B. Phanomrok - B. Nong Bua	39.6
IM-108	A. Tak Fa - J.R. 3004	28.7
Total	13 Projects	323.1

RH Projects

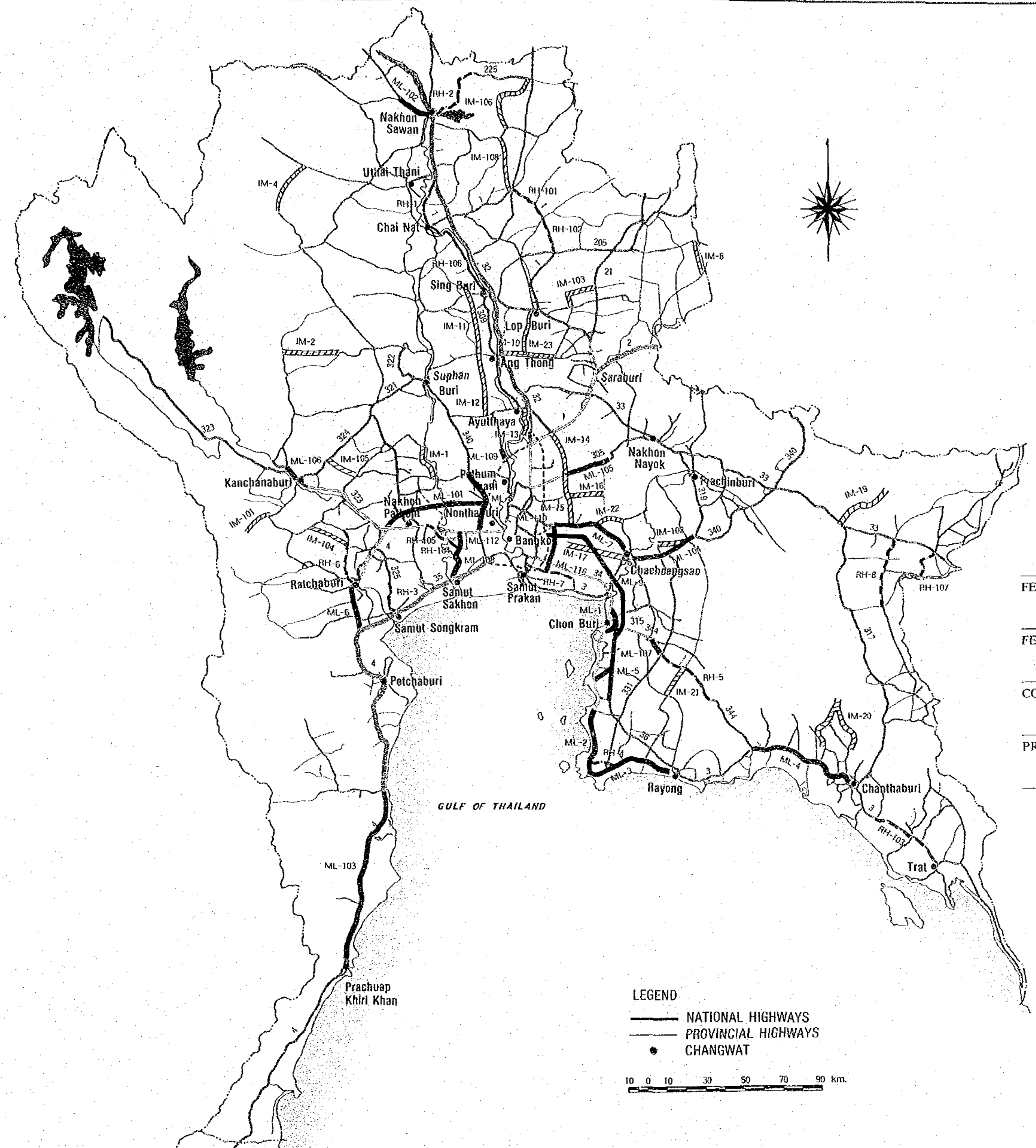
The following projects are proposed to be implemented in the next stage.

- Projects omitted as subjects for the preliminary evaluation although they were given high priority in Chapter 7.
- Projects omitted as subjects for the feasibility study although they showed high IRR.

They are shown in Table 1.13.8 and Figure 1.13.1.

Table 1.13.8 RH PROJECTS PROPOSED FOR NEXT STAGE

Project No.	Route No.	Link No.	Length (km)
RH-1	1	1001	25.5
RH-4	332	0100	14.5
RH-6	3089	1001	27.8
RH-7	3116	0100	9.7
RH-8	3395	0100	33.5
RH-101	1	0700	41.1
RH-102	1	0801	8.2
RH-103	3	1300	42.7
RH-104	4	0100	3.6
RH-105	4	0201	27.8
RH-106	311	0200	49.7
RH-107	3067	0100	40.0
Total	12 Projects		324.1



LEGEND

	ML Projects	IM Projects	RH Projects	Total
FEASIBILITY STUDY PHASE I	5 projects 192.2 km	1 project 26.9 km	—	6 Projects 219.1 km
FEASIBILITY STUDY PHASE II	2 project 126.3 km	10 project 279.8 km	3 projects 93.7 km	15 Projects 502.8 km
COMMITTED ROUTE	4 Routes 412 km	—	—	4 Routes 412 km
PROPOSED FOR NEXT STAGE	14 Projects 353.9 km	13 Projects 323.1 km	12 Projects 324.1 km	39 Projects 1,000.1 km

Figure 1.13.1. PROJECTS TO BE IMPLEMENTED IN NEAR FUTURE

Intersections to be Improved

Intersections to be improved were identified in Chapter 10. They are shown in Table 1.13.9 and Figure 1.13.2.

They are requested to be improved urgently following the detailed analysis.

Table 1.13.9 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 (Beg. 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	410	4	Over
210	340-3215	410	4	Near
271	3089-3090, 3357	335	4	Near

Note: Near: Signalized intersection which is close to capacity.
Over: Signalized intersection to be improved to a grade separation.

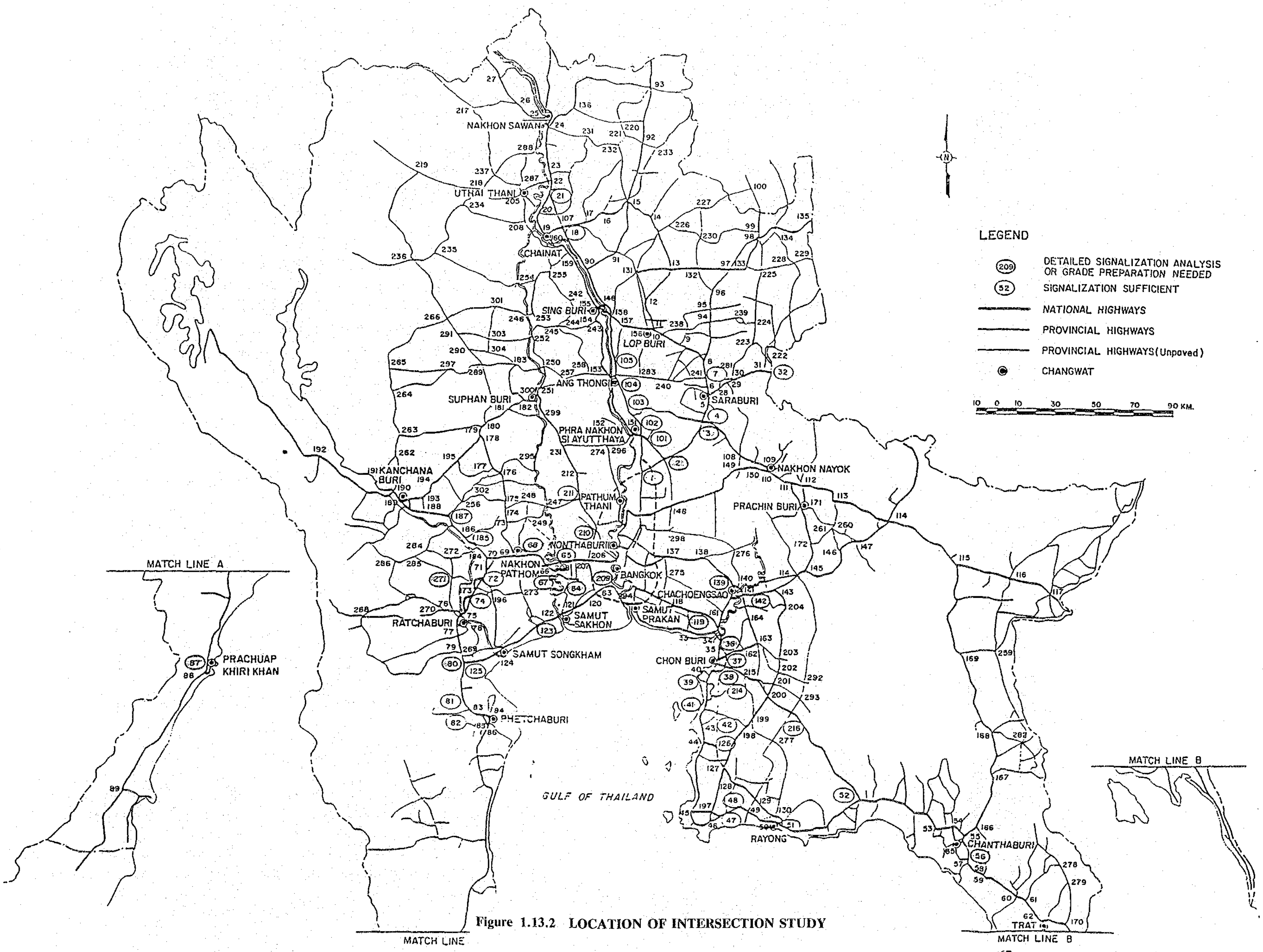


Figure 1.13.2 LOCATION OF INTERSECTION STUDY

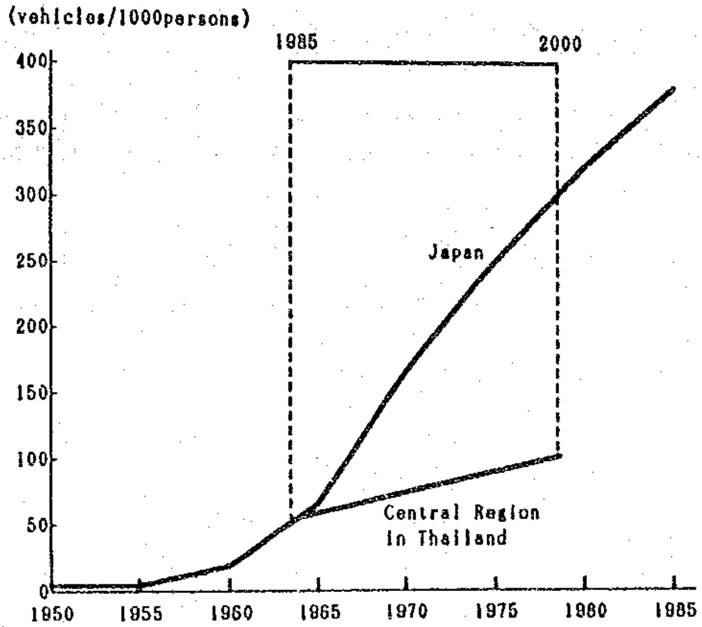
13.3 RECOMMENDATION

National Highway Network

As described in Chapter 9, the traffic forecast in this study was performed primarily on the basis of the relationship between the number of registered vehicles and GPP observed so far in Thailand. Past experience elsewhere has show that the number of vehicles could grow fast when GDP exceeds a certain level.

The following figure shows the yearly trend of the number of registered vehicles per person in Japan and the forecast for the Central Region in this study. The figure is drawn on the basis that Japan in 1963 is roughly equivalent to Thailand in 1986 in terms of GNP. The figure indicates that the number of registered vehicles per person in Japan increased sharply. On the other hand, the forecast for the central Region shows a gradual increase far below Japan's case, since the forecast is based on a linear projection of past trends.

Trend of Registered Vehicles per Person



It cannot be predicted that future vehicle registrations in Thailand will follow the same trend as in Japan, but a more rapid increase can be expected than the forecast in this Study.

Supposing that the estimation might be correct, more additional lanes or new highways than those given in 13.1 and 13.2 will be required to alleviate traffic congestion.

Further, viewed from economic development and attributed increase of land transportation in Thailand, it will be insufficient to simply improve the existing road network to cope with the anticipated traffic situation. It is considered that road network development which pays primary attention to inter-city expressway development may be indispensable.

Provincial Road Network

As described in 13.1 and 13.2, 24 routes of 629.8 km were selected as subjects for the feasibility study or projects proposed for the next stage.

However, it is required to improve 85 routes of 2,017 km to reach the international level of road development as described in Chapter 6. This is expected to improve the level of provincial and rural roads.

Rehabilitation

DOH has already established a manual for the selection of sections to be rehabilitated. However, a design method for pavement structures including rehabilitation has not yet been designated. It is necessary to establish a design method as early as possible.

The design method must be simple enough to be adopted widely by engineers. The Study Team, therefore, recommends that a simple method of pavement design applicable to Thailand be established.

VOLUME II FEASIBILITY STUDY

VOLUME II FEASIBILITY STUDY

CHAPTER 1 SUBJECT ROADS AND SCOPE OF WORK

The feasibility study was carried out for the 21 priority routes selected in the Master Plan Study.

1.1 STUDY ROUTES

The feasibility study was carried out by dividing the projects into urgent projects (Phase I) and remaining projects (Phase II) as follows:

Phase I : 6 routes, 220.9 km
(5 ML Projects and 1 IM Project)
Phase II : 15 routes, 493.3 km
(2 ML Projects, 10 IM Projects and 3 RH Projects)

Addditionally, the study of the Bangkok-Chon Buri New Highway (ML-9) was included in Phase II following the request of DOH.

The list and location of the study projects, 21 routes with 714.2 km described above, is given in Chapter 13 of Volume 1, Master Plan Study.

1.2 STUDY ACTIVITIES

The following activities for the feasibility study were carried out:

- Review of the Master Plan Study.
- Review of the Eastern Seaboard Development Program and other related development programs.
- Traffic surveys such as traffic counts and origin/destination (O/D) surveys.
- Engineering investigations such as topographic surveys, soil and construction materials investigations, and hydrological investigations.
- Route location study and preliminary engineering design.
- Estimation of construction costs.

- Traffic projections and calculation of benefits.

- Economic evaluation.

- Optimal phasing for implementation.

CHAPTER 2 EFFECT OF PLANNED DEVELOPMENTS ON PROPOSED ROUTES

Large-scale development projects planned or under implementation in the Central Region, such as the Eastern Seaboard Development Program and industrial estate development, are particularly important to the forecast of traffic volume of the study routes. This chapter examines these development plans specifically in terms of their potential effect on road traffic.

Laem Chabang Industrial Complex

The Laem Chabang Industrial Complex is a large-scale project which will have a commercial deep-sea port, an industrial estate and an export processing zone backed up by a complete urban center and essential infrastructure.

Generated traffic from this project comprises the following sources:

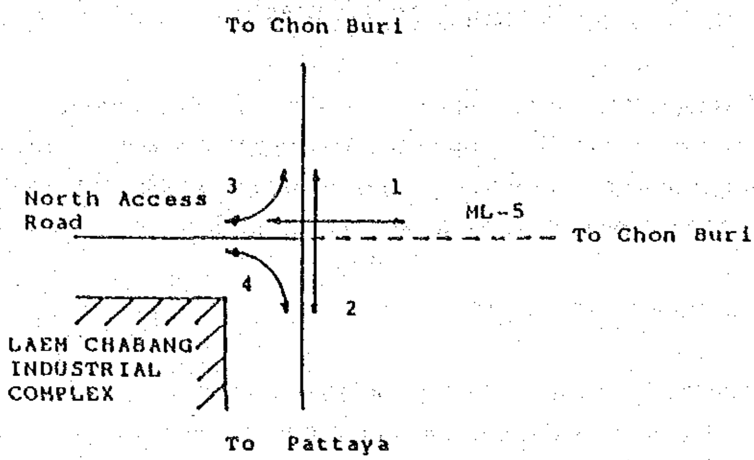
- Freight traffic transporting materials and factory products from/to the industrial estate
- Traffic of containerized freight and break-bulk cargo from the commercial port
- Passenger car traffic for commuters from/to the industrial estate
- Passenger car traffic for port workers

The future generated traffic volume is forecasted as shown in Table 2.2.1.

Table 2.2.1 TRAFFIC GENERATED FROM LAEM CHABANG INDUSTRIAL COMPLEX

(Unit: vehicles/day)

Direction	Type of Vehicle	1994	2000	2008
1. Complex - BKK on ML-5	Passenger Car	784	1,210	1,780
	Medium Truck	461	636	869
	Heavy Truck	2,362	3,522	5,069
	Total	3,607	5,368	7,718
2. Chon Buri - Pattaya	Motorcycle	698	930	1,240
	Passenger Car	1,551	2,433	3,609
	Heavy Bus	126	156	196
	Total	2,375	3,519	5,045
3. Complex - Chon Buri	Motorcycle	281	361	467
	Passenger Car	629	925	1,319
	Heavy Bus	51	62	77
	Total	961	1,348	1,863
4. Complex - Pattaya	Motorcycle	263	391	561
	Passenger Car	546	1,186	2,040
	Bus	48	67	92
	Total	857	1,644	2,693



Map Ta Phut Industrial Comlex

The Map Ta Phut Industrial Complex is a large-scale project comprising a petrochemical industrial complex using natural gas generated in the Gulf of Thailand, and industrial harbor construction.

Generated traffic from this project comprises the following sources:

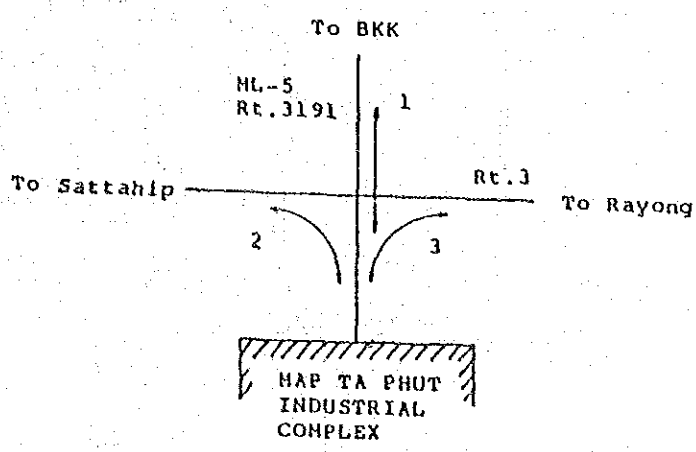
- Cargo trucks transporting petrochemical industrial products
- Cargo trucks for other industrial products
- Freight traffic for port handling
- Passenger car traffic for estate workers and residents in the new town

The future generated traffic volume is forecasted as shown in Table 2.2.2.

Table 2.2.2 TRAFFIC GENERATED FROM MAP TA PHUT INDUSTRIAL COMPLEX

(Unit: vehicles/day)

Direction	Type of Vehicle	1994	2000	2008
1. Complex - BKK on Rt. 3191	Medium Truck	699	936	1,182
	Heavy Truck	1,212	1,624	2,050
	Total	1,911	2,560	3,232
2. Complex - Sattahip on RT. 3	Motorcycle	123	231	575
	Passenger Car	315	725	1,271
	Heavy Bus	28	43	63
	Total	466	999	1,909
3. Complex - Rayong on RT. 3	Motorcycle	470	813	1,270
	Passenger Car	999	2,289	4,009
	Heavy Bus	88	139	207
	Medium Truck	133	133	133
	Heavy Truck	231	231	231
	Total	1,921	3,605	5,850



Lat Krabang Industrial Estate

The Lat Krabang Industrial Estate located 30 km east of Bangkok has had 200 ha of development, half of its final target, completed. Many international manufacturers have already established production plants in the Estate, producing general industrial products or export products.

Development of the remaining 200 ha is taking place, resulting in the employment of 33,000 persons and generated cargo traffic of 800 trucks per day upon full development.

Inland Container Depot

An Inland Container Depot (ICD) is proposed to be constructed in Lat Krabang. The ICD is expected to reduce the total traffic volume on roads between the ICD and Laem Chabang Port and to lighten the burden on the Laem Chabang Port in terms of port load and terminal congestion.

Second Bangkok International Airport

The new airport is to be located in Amphoe Bang Phli about 25 km east of Bangkok. The airport will have a total area of 3,200 ha. The ultimate traffic demand is forecasted at 65 million passengers and 2.5 million tons in the year 2010.

Railways, expressways and a mass transit transport system are proposed for access to the airport. Study route ML-9 is also considered as one of the access means.

Figure 2.2.1 shows the proposed location of the Lat Krabang Industrial Estate, the ICD and the new airport.

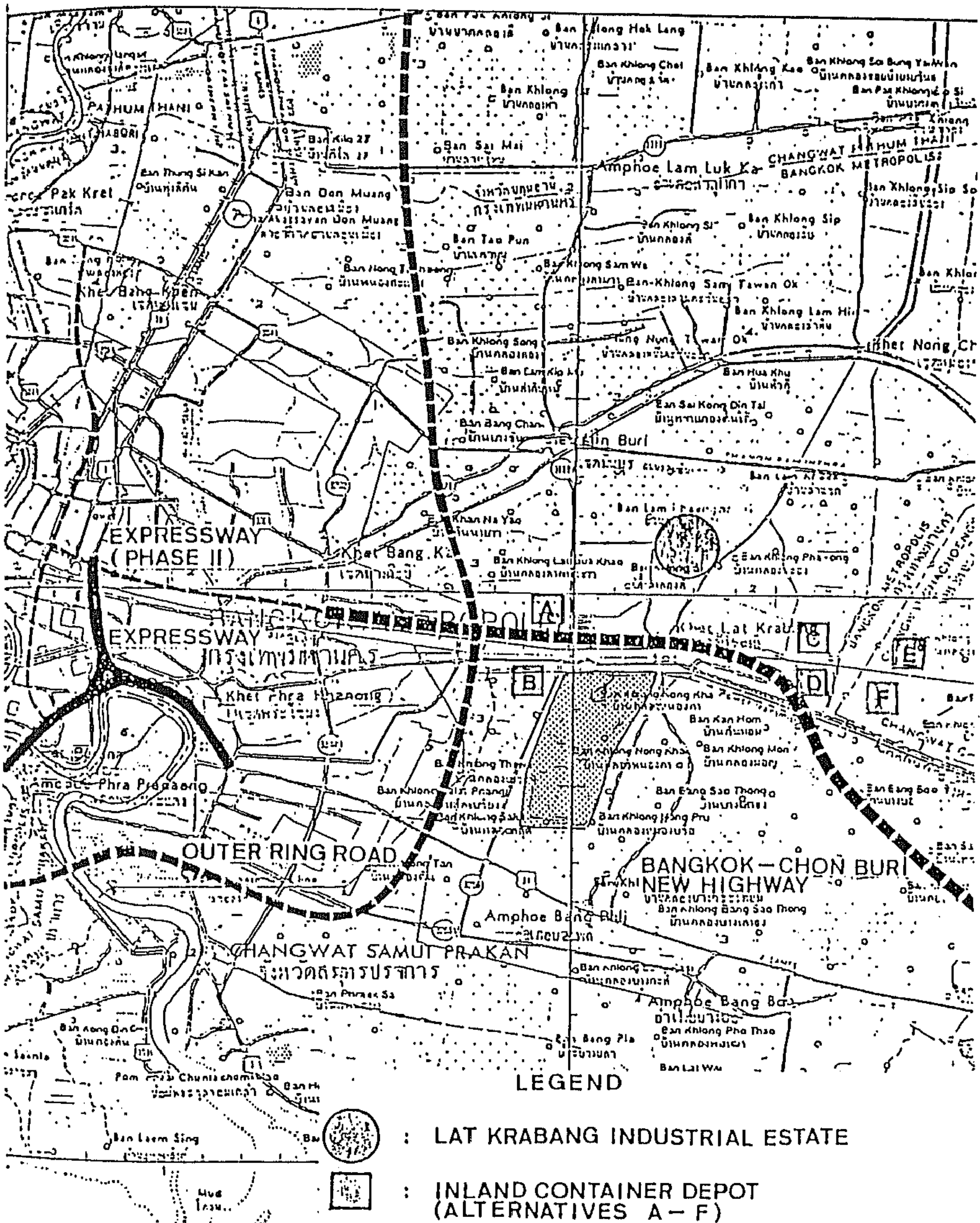


Figure 2.2.1 DEVELOPMENT PLAN RELATED TO BANGKOK–CHON BURI NEW HIGHWAY (ML-9)

CHAPTER 3 TRAFFIC SURVEYS AND FORECAST

3.1 METHODOLOGY FOR FORECAST OF FUTURE TRAFFIC

The traffic forecast was proceeded on the following flow chart:

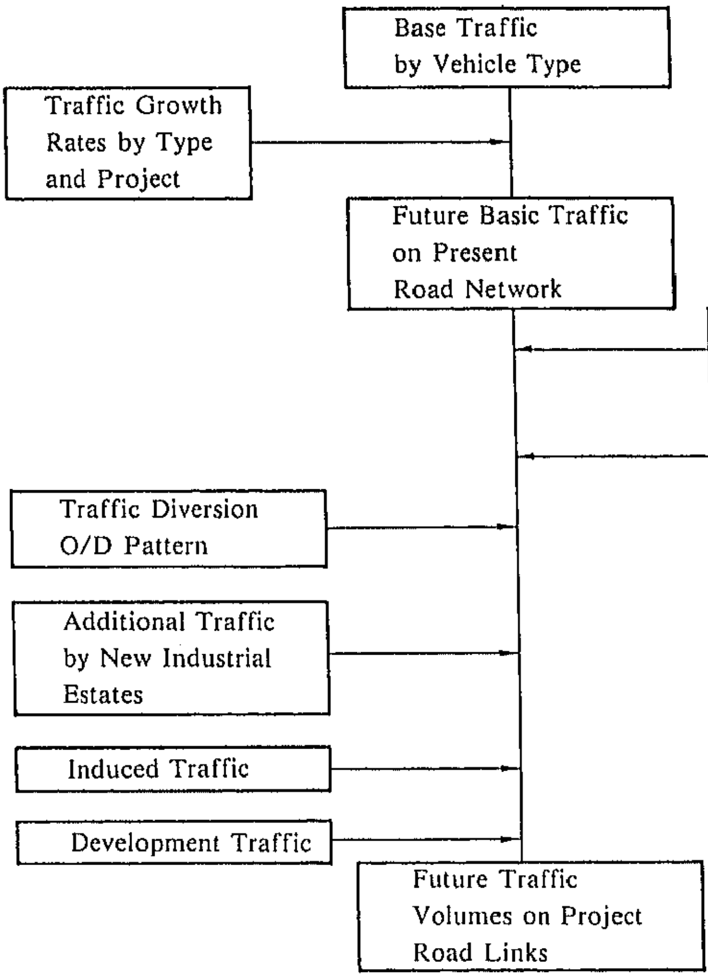


Figure 2.3.1 FLOW CHART OF TRAFFIC FORECAST PROCEDURES

3.2 TYPES OF TRAFFIC AND VEHICLES

For the estimation of road user benefits, traffic was classified into four types, normal, diverted, induced and development traffic.

For the purpose of traffic surveys, all vehicles were classified into 11 types, but were combined to seven types for forecasting purposes based on DOH's classification.

3.3 TRAFFIC SURVEYS

Traffic surveys comprised roadside interview survey, manual traffic counts, automatic traffic counts and a license plate survey.

The number of survey points was as follows:

Roadside Interview Survey	:	6	locations
Traffic Count Survey	:	28	〃
Turning Movement Survey	:	8	〃
License Plate Survey	:	7	〃

3.4 TRAFFIC FORECAST

Base Traffic

Base traffic volumes were obtained from traffic surveys in 1988 conducted by the Study Team and the "Annual Average Daily Traffic" table published by DOH in 1986 and 1987, as shown in Table 2.3.1.

Traffic Growth

Traffic growth rates were determined based on the results of the Master Plan Study, in which a region-wide network traffic projection was carried out primarily on the basis of existing traffic, growth in population, gross provincial income and vehicle registration.

Table 2.3.1 BASE TRAFFIC VOLUME

Phase I Projects

(Unit: vehicles/day)

Project Code	Section	Year	Traffic Volume							
			MC	PC	LB	HB	LT	MT	HT	ADT
ML-1	3-0403-N	1988	985	1229	134	261	2921	1330	8896	14771
	3-0403-E	1988	1303	1381	372	135	3263	1375	9029	15555
	3-0403-S	1988	2043	1078	555	151	3141	919	6297	12141
	3-0403-s	1988	2043	1078	555	151	3141	919	6297	12141
	Average	—	1594	1192	404	175	3117	1136	7630	13652
ML-2	3-158KM	1986	2467	1748	1740	308	870	201	91	4958
	3-175KM	1988	3676	1078	2348	508	2356	301	109	6700
	Average	—	3072	1413	2044	408	1613	251	100	5829
ML-4	3-1000	1986	2697	1349	750	278	3230	655	840	7102
	3-1102	1988	1537	891	953	186	3851	566	856	7303
	316	1988	2395	920	1169	195	4500	373	210	7367
	Average	—	2210	1053	957	220	3860	531	635	7257
ML-5	BP-N	—	—	—	—	—	—	—	—	—
	BP-S	—	—	—	—	—	—	—	—	—
	BP-W	—	—	—	—	—	—	—	—	—
	3-0502	1988	2729	5724	2101	2447	7776	1383	2399	21830
	3-0601	1987	1682	5649	1925	1397	2830	1229	530	13560
ML-7	304-40KM	1988	935	1440	911	597	1680	911	387	5926
	304-J. 314	1988	1512	1371	355	391	2967	597	440	6121
	Average	—	1224	1406	633	494	2324	754	414	6024
IM-23	3267- 5KM	1987	464	504	92	146	980	395	534	2651
	3267-20KM	1988	414	264	89	226	769	175	437	1960
	Average	—	439	384	91	186	875	285	486	2306

Note: ML-1: N: North section, E: East section, S: Upper south section, s: Lower south section
ML-5: BP-N: North section, BP-S: South section, BP-W: West section

Phase II Projects

Project Code	Section	Year	Traffic Volume							
			MC	PC	LB	HB	LT	MT	HT	ADT
ML-3	3-0702	1988	4128	1473	721	47	293	2398	74	5006
	3-0800-W	1988	1370	696	779	237	2122	220	334	4388
	3-0800-E	1988	1895	806	668	249	3180	349	557	5809
	Average	—	2464	992	723	178	1865	989	322	5068

BASE TRAFFIC VOLUME (Cont'd)

Phase II Projects (Unit: vehicles/day)

Project Code	Section	Year	Traffic Volume MC	PC	LB	HB	LT	MT	HT	ADT
ML-9	34-0100-E	1987	1457	10126	875	1740	7306	2777	4750	27574
	4-0402&3	1988	3475	7380	741	2525	12673	2159	9707	35185
IM-1	PWD-N	1988	399	21	54	25	299	35	92	526
	PWD-S	1988	257	8	14	4	191	24	34	275
	Average	—	328	15	34	15	245	30	63	401
IM-2	3306-0100-W	1988	205	1	5	4	176	66	2	254
	3306-0100-E	1988	271	1	6	4	171	70	3	255
	Average	—	238	1	6	4	174	68	3	255
IM-11	RID-N	1988	844	38	12	38	229	55	33	405
	RID-M	1988	245	10	9	0	98	18	14	149
	RID-S	1988	610	73	26	2	275	285	60	721
	Average	—	566	40	16	13	201	119	36	425
IM-12	RID-N	1988	465	39	87	16	120	52	26	340
	RID-M	1988	443	24	0	0	221	68	8	321
	RID-S	1988	250	63	42	0	272	48	7	432
	Average	—	386	42	43	5	204	56	14	364
IM-13	PWD	1988	253	33	83	67	120	10	27	340
IM-14	RURAL-N	1988	423	9	4	0	91	29	31	164
	RURAL-S	1988	133	5	2	0	71	6	0	84
	Average	—	278	7	3	0	81	18	16	124
IM-15	RURAL-N	1988	227	30	6	1	187	78	77	379
	RURAL-S	1988	349	217	87	32	890	397	380	2003
	Average	—	288	124	47	17	539	238	229	1191
IM-16	3312	1988	355	50	39	51	344	37	19	540
	PWD	1988	151	7	77	0	148	7	35	274
	Average	—	253	29	58	26	246	22	27	407
IM-17	PWD-W	1988	529	69	281	7	558	164	88	1167
	PWD-M	1988	99	54	16	0	103	24	4	201
	PWD-E	1988	238	53	24	19	317	131	129	673
	Average	—	289	59	107	9	326	106	74	680
IM-22	RURAL	1988	141	3	0	1	26	1	0	31
RH-2	225-0100-N	1988	782	105	43	125	797	133	163	1366
	225-0100-S	1986	1279	1243	129	135	354	320	34	2215
	Average	—	1031	674	86	130	576	227	99	1791
RH-3	325-0200	1987	1222	2419	717	428	544	305	248	4661
RH-5	344-0200-N	1987	1162	1492	171	574	2017	279	678	5211
	344-0200-S	1988	493	937	88	324	2821	316	630	5116
	Average	—	828	1215	130	449	2419	298	654	5164

Note: N: North section, E: East section, S: South section, W: West section

Diverted Traffic

Diverted traffic was forecasted in the case that the route has competitive alternative routes. The forecast was performed on the basis of the O/D pair distribution and the result of the license plate survey, and the forecasted results were confirmed by applying the following formula employed by DOH:

$$P = \frac{100}{1 + \left(\frac{T_2}{T_1}\right)^6}$$

where, P : Diversion Rate
T_1 : Trip time using old road
T_2 : Trip time using new road

Induced Traffic

Induced traffic was estimated by applying the same equation which was used in the Master Plan Phase.

Development Traffic

In the Central Region, almost all areas have already been developed. Therefore no development traffic was counted. However, for ML-7 which is located close to Bangkok, development traffic was considered due to housing developments along the route based on the experience of Route 34.

Future Traffic

Future traffic volumes, which were estimated by means of the methods described above, are summarized in Table 2.3.2.

Future turning movement volumes at major intersections were also estimated by applying the same methodology as applied to the road sections.

Table 2.3.2 SUMMARY OF FUTURE TRAFFIC VOLUME

Phase I Projects (Unit: vehicles/day)

Project Code	Section	Base ADT		Future ADT			
		Year	ADT	1992	1994	2000	2008
ML-1	3-0403-N	1988	14771	23700	28900	28300	55500
	3-0403-E	1988	15555	24700	30100	30100	58300
	3-0403-S	1988	12141	20400	25200	23100	48000
	3-0403-s	1988	12141	18500	23000	22400	37400
	Average	—	13652	21800	26800	26000	49800
ML-2	3-158KM	1986	4958	—	8100	11200	16600
	3-175KM	1988	6700	—	9500	12900	18700
	Average	—	5829	—	8800	12000	17600
ML-4	3-1000	1986	7102	—	13100	17700	25900
	3-1102	1988	7303	—	10300	14200	21400
	316	1988	7367	—	10400	14400	22000
	Average	—	7257	—	11300	15500	23100
ML-5	BP-N	—	—	15700	17400	25500	38500
	BP-S	—	—	3300	3300	5100	7200
	BP-W	—	—	12400	14100	20500	31300
	Average	—	—	10500	11600	17000	25700
ML-7	304-40KM	1988	5926	—	8800	13400	19600
	304-J. 314	1988	6121	—	8100	11000	16100
	Average	—	6024	—	8500	12000	17900
IM-23	3267- 5KM	1987	2651	—	4300	5600	7900
	3267-20KM	1988	1960	—	2900	3800	5400
	Average	—	2306	—	3600	4700	6700

Note: ML-1: N: North section, E: East section, S: Upper south section, s: Lower south section
ML-5: BP-N: North section, BP-S: South section, BP-W: West section

Phase II Projects (Unit: vehicles/day)

Project Code	Section	Base ADT		Future ADT		
		Year	ADT	1994	2000	2008
ML-3	3-0702	1988	5006	7100	9800	14600
	3-0800-W	1988	4388	6600	9300	14000
	3-0800-E	1988	5809	8700	12200	18300
	Average	—	5068	7500	10400	15700
ML-9	1. Sri Nak'n-Outer R.	—	—	27700	39700	61300
	2. Outer R.-R.3119	—	—	25400	36300	55800
	3. R.3119-R.314	—	—	19900	28500	43600
	4. R.314-R.315	—	—	18800	27600	43500
	5. R.315-R.344	—	—	11300	16500	25800
	6. R.344-ML-5	—	—	17700	25500	38500
	Average	—	—	20200	29000	44800

Table 2.3.2 SUMMARY OF FUTURE TRAFFIC VOLUME (Cont'd)

Phase II Projects

(Unit: vehicles/day)

Project Code	Section	Base ADT		Future ADT		
		Year	ADT	1994	2000	2008
IM-1	PWD-N	1988	526	800	1000	1400
	PWD-S	1988	275	400	600	800
	Average	—	401	600	800	1100
IM-2	3306-0100-W	1988	254	500	600	800
	3306-0100-E	1988	255	400	500	700
	Average	—	255	400	500	700
IM-11	RID-N	1988	405	700	1100	1600
	RID-M	1988	149	300	500	800
	RID-S	1988	721	1300	2000	3000
	Average	—	425	800	1200	1800
IM-12	RID-N	1988	340	700	1000	1500
	RID-M	1988	321	800	1200	1800
	RID-S	1988	432	1100	1600	2500
	Average	—	364	800	1300	1900
IM-13	PWD	1988	340	1100	1500	2100
IM-14	RURAL-N	1988	164	800	1000	1400
	RURAL-S	1988	84	700	900	1300
	Average	—	124	700	1000	1400
IM-15	RURAL-N	1988	379	1200	1700	2400
	RURAL-S	1988	2003	3300	4500	6600
	Average	—	1191	2300	3100	4500
IM-16	3312	1988	540	900	1200	1900
	PWD	1988	274	500	600	1000
	Average	—	407	700	900	1500
IM-17	PWD-W	1988	1167	1500	2100	3300
	PWD-M	1988	201	300	400	700
	PWD-E	1988	673	1000	1300	2100
	Average	—	680	900	1300	2000
IM-22	RURAL	1988	31	700	1100	1700
RH-2	225-0100-N	1988	1366	2000	2500	3200
	225-0100-S	1986	2215	3600	4600	6000
	Average	—	1719	2800	3500	4600
RH-3	325-0200	1987	4661	7200	9600	14200
RH-5	344-0200-N	1987	5211	7700	10600	15500
	344-0200-S	1988	5116	7200	9800	14300
	Average	—	5164	7400	10200	14900

Note: N: North section, E: East section, S: South section, W: West section M: Middle section

CHAPTER 4 ENGINEERING

4.1 FIELD SURVEYS

Inventory Survey and Field Reconnaissance

An inventory survey with an accuracy of prefeasibility study level was done in the Master Plan Phase. Therefore, emphasis on the inventory survey was put on confirming the following matters as well as reviewing the performance in the Master Plan Phase in order to improve the accuracy at the feasibility study level. In the inventory survey, a PSI survey was carried out for the existing lanes of ML Projects and PH Projects. The survey was done according to the following specifications:

For new construction routes ML-5 and ML-9, detailed reconnaissance was carried out to clarify the following control points in determining its alignment:

- Deep cuts
- High embankments
- Soil characteristics
- Required drainage structures
- River conditions and bridge locations
- Necessity of access roads for construction
- Difficulties of acquisition of right-of-way

Route surveys composed of center line, profile and cross section surveys, and intersection topographic mapping surveys were conducted for use for the preliminary designs.

Material Source Survey and Soil Tests

Embarkment and subgrade material sources and their quantities and qualities were examined, and representative materials were sampled for laboratory tests. Soil samplings of subgrade and base course were made about every 10 km, and the materials were also tested for pavement design.

Boring Survey

A boring survey was carried out at 17 sites for analysis of soft ground and bridge foundation design. Boring consisted of drilling a borehole with the standard penetration test (SPT) and collecting soil samples of each stratum for laboratory tests.

4.2 PRELIMINARY DESIGN

Design Standards

DOH classifies highways under its jurisdiction into several categories as national and provincial highways according to its importance to the Kingdom, further subclassified into road classes according to projected ADT.

Based on the specifications of DOH design standards and the projected ADT, the road class to be applied to each study route was determined as shown in Table 2.8.1.

Geometric Design

Based on the specifications in DOH standards, the design speeds shown in Table 2.4.1 were adopted to the preliminary design.

Geometric design criteria employed in the preliminary design are shown in Table 2.4.2.

Typical Cross Section

Typical cross sections of an ML project and an IM project are given in Table 2.4.1.

Alignment

Two study routes, ML-5 and ML-9, are new alignment projects among the feasibility study projects. The horizontal alignment of ML-5 followed the established alignment surveyed by DOH. Vertical alignment was designed by the Study Team.

On the other hand, ML-9 alignments were designed by the Study Team. ML-9 is planned to alleviate the traffic congestion of Rt. 34, due to remarkable traffic increase attributable to the progress of the Eastern Seaboard Development Program. The planned route originates at a junction with Srinakarin Road and comes to ML-5 to the south of Chon Buri. As shown in Figure 2.4.2, a route corridor about 10 km wide was established between these origin and end points. Then the control matters within and around the corridor were examined as given in Table 2.4.3. Taking these control matters into considerations, three route alternatives were then proposed basing their respective planning principles on different viewpoints. Through discussions with DOH engineers, the C-route was considered most preferable and selected for the subsequent feasibility study of ML-9.

Table 2.4.1 ADOPTED DESIGN SPEEDS

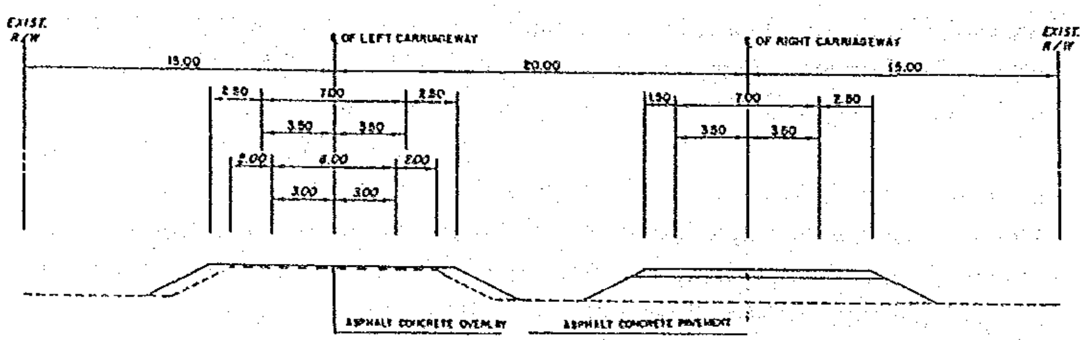
(Unit: km/h)

Terrain Conditions	Road Classes		
	P	S	FD, FI
Flat and Moderately Rolling	80–100	70–90	70–90
Rolling and Hilly	60– 80	55–70	55–70
Mountainous	50– 60	40–55	40–55

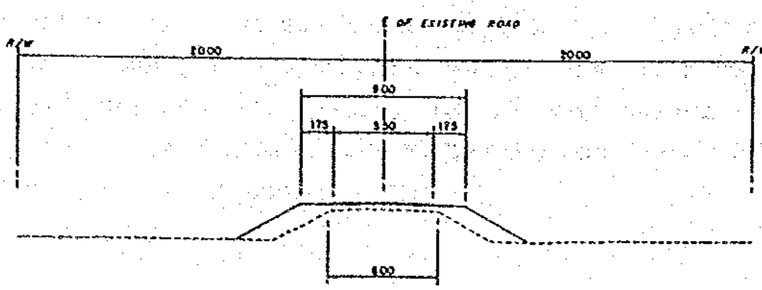
Table 2.4.2 GEOMETRIC DESIGN CRITERIA

Description (km/h)	Design Speed (km/h)							
	120	100	90	80	70	60	50	40
Minimum Radius of Curvature (m)	710	360	280	210	160	120	80	50
Minimum Stopping Sight Distance (m)	210	160	140	115	90	75	60	45
Maximum Gradient (%)	5	6	7	8	9	10	10	12

Figure 2.4.1 TYPICAL CROSS SECTIONS



ML Project



IM Project

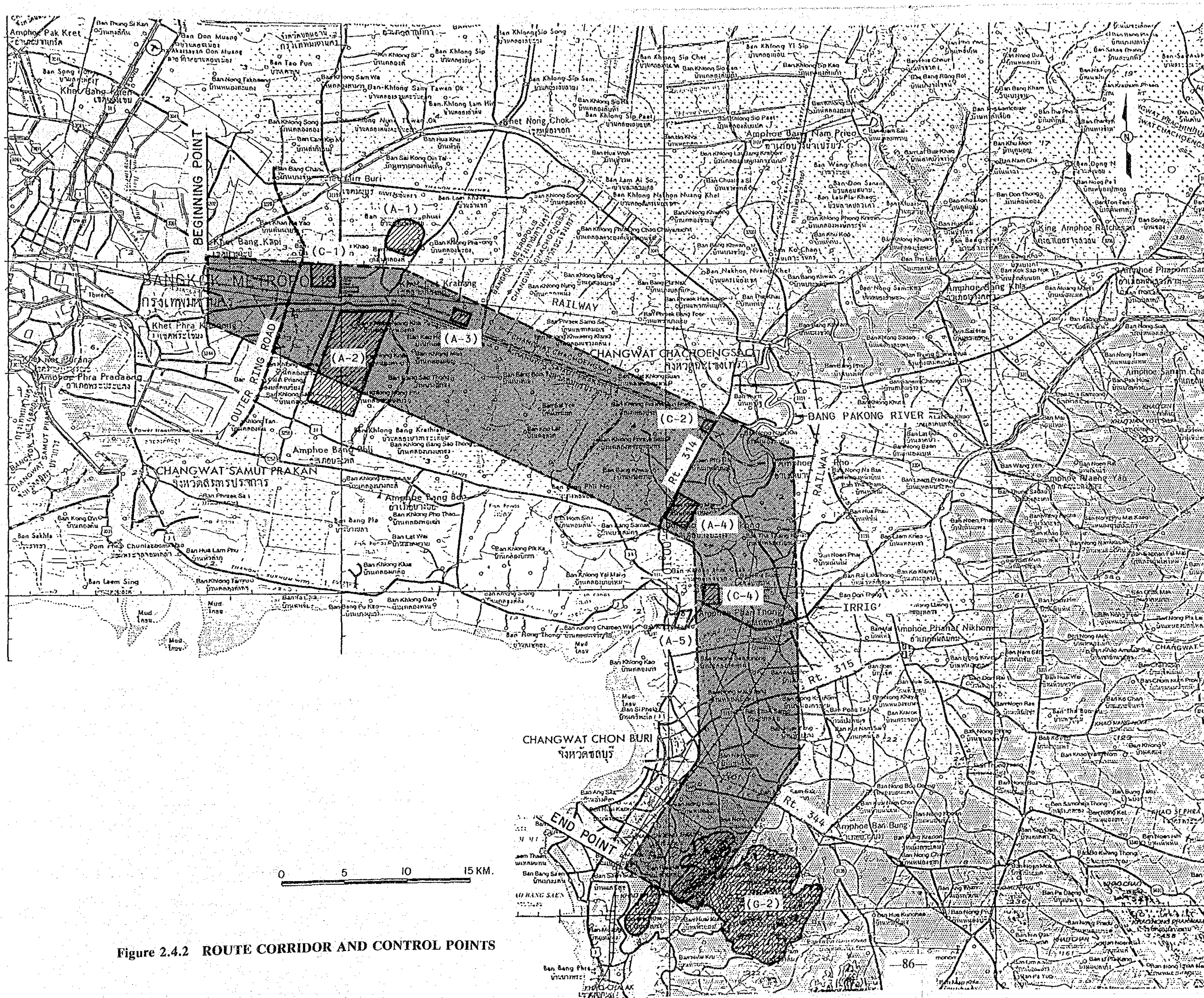


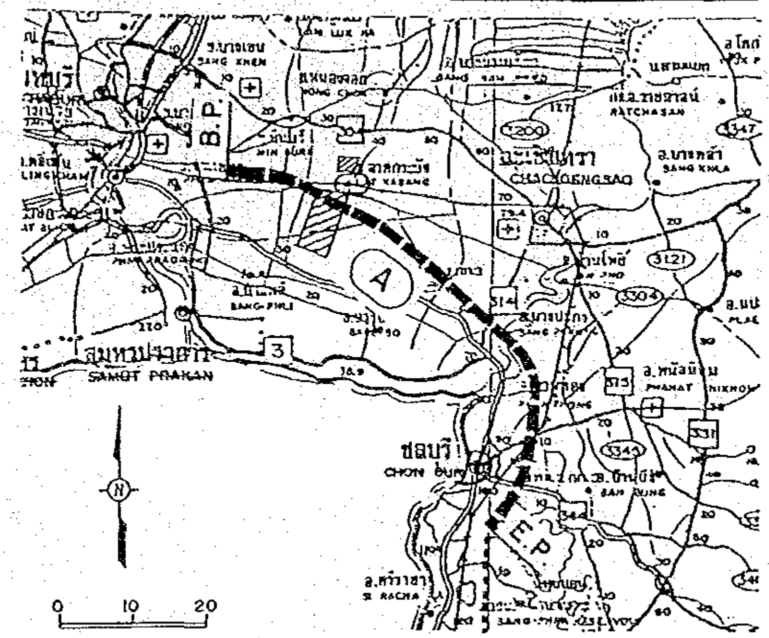
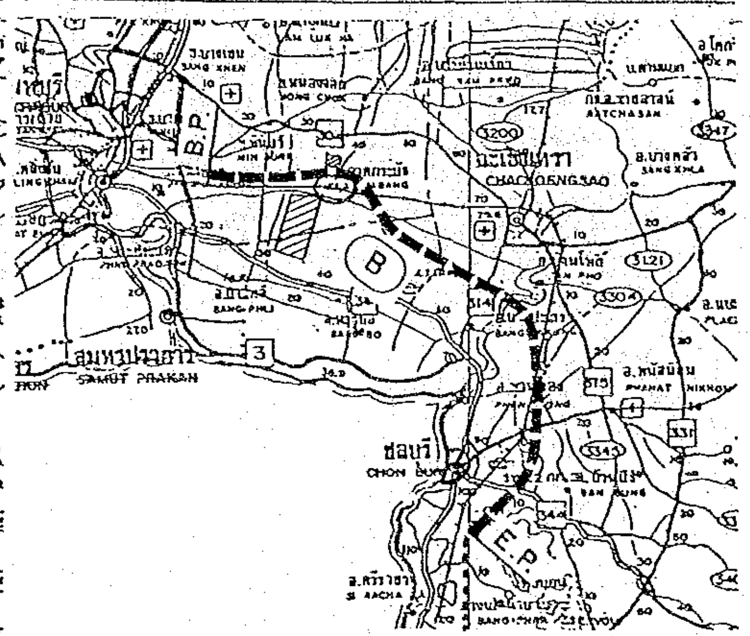
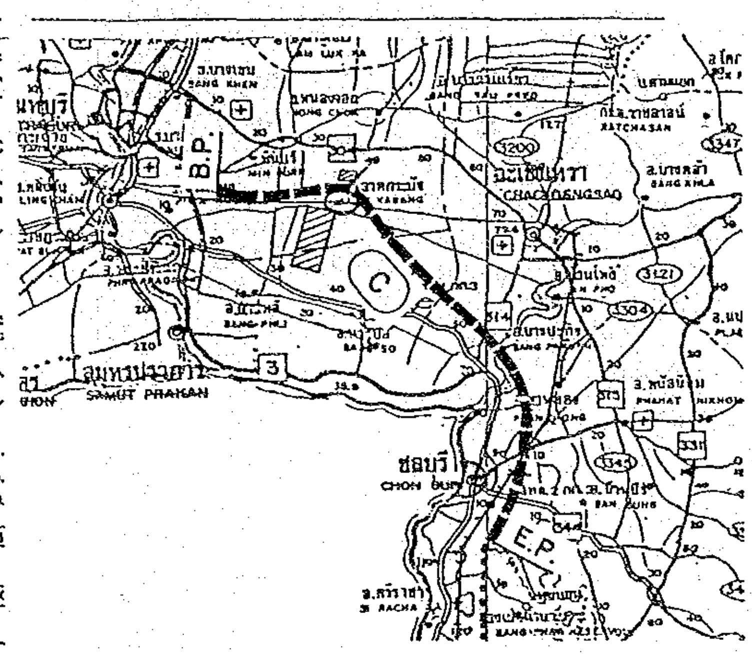
Figure 2.4.2 ROUTE CORRIDOR AND CONTROL POINTS

Table 2.4.3 **CONTROL POINTS FOR BANGKOK - CHON BURI NEW HIGHWAY (ML-9)**

Control Points	Planning Principle of Route Alignment	Control Objects	Remarks
Beginning Point End Point		End Point of ETA 2nd Stage Project Chon Buri - Pattaya New Highway (ML-5)	
Development Plans	Detouring the Development Zone	(A-1) Lat Krabang Industrial Estate (A-2) Proposed Nong Ngu Hao Airport Site (A-3) Privately-owned Industrial Estate (A-4) Bang Pakong Riverside Country-Club (A-5) Bang Pakong Industrial Estate	Estate Area ≒ 4 km2 Decreed Area ≒ 32 km2 Area ≒ 1.3 km2 { Orchard & Housing Area: 5 km2 { Golf Course 0.5 km2
Artery Roads to be Crossed	Crossing at Right Angle to Roads Junction Interchange Intersection	(B-1) Beginning Point (Si Nakarin Road) Rt.3344 (B-2) Junction with Bangkok Outer Ring Road (B-3) Intersection with Rt. 3119 (B-4) Intersection with Rt. 314 (B-5) Intersection with Rt. 315 and Railway (B-6) Intersection with Rt. 344 (B-7) End Point (Connecting with ML-5)	Confirm ETA Plan } Cross Measures (Over-pass/Under-pass)
Temple, Graveyard, School	Detouring the Objects	Δ marks on Map	
Large-scale Factory, Plants, Facility Yards	Detouring the Objects	(C-1) Inland Container Depot (C-2) EGAT Substation (Chachoengsao) (C-3) BKK Metal Company/Factory (C-4) EGAT Thermal Power Station (Bang Pakong)	Candidate depots : 6-depots
Big River to be Crossed	Crossing at Right Angle to River, Height Clearance	(D-1) Bang Pakong River (Width 350-400 m.)	Highest water level, Foundation Condition for Piers & Abutments
Railway Crossing	Crossing at Right Angle to Railway	(E-1) Bangkok - Chachoengsao (E-2) Chachoengsao - Sattahip	Confirming Double-Tracks Plan
Densely Populated Area	Detouring the Objects	marks on Map	
Medium/Small River & Canals	Bridge or Box Culvert Construction	(F-1) Canal Pla Thia (F-2) Canal Pla Ong Chao (F-3) Canal Prawet Buri Rom (F-4) Irrigation Canal (W = 30 m.)	
Unfavarable Topography	Detour	(G-1) Low-land Area (Soft Ground) (G-2) Mountain	
Power Transmission Line & Tower	Clearance under Power Lines	marks on Map	

Figure 2.4.3 ROUTE COMPARISON FOR BANGKOK – CHON BURI NEW HIGHWAY (ML-9)

Highway Standard	National Primary Highway (PD) (Divided 4-lanes)	
Design Speed	100 km/h	
Origin-Destination	Beginning Point	End of ETA 2nd-phase Project (Srinakarin Road, Rt. 3344)
	End Point	Chon Buri-Pattaya New Highway (JICA Study Road ML-5)
Right-of-way Width	80 m	

Route Alternatives	Route A	Route B	Route C
Alignment			
Route Length (km)	78.0	88.5	81.5
Route Characteristics	The Route aims at the shortest connection of the origin point (end point of ETA Project) with the destination (Chon Buri-Pattaya New Highway), avoiding such major control conditions as large scale industrial facilities, temples and schools and also taking the desirable crossing with rivers and canals, railway, artery roads and power transmission lines.	The Route detours the planned airport area (Nong Ngu Hao) and densely populated area of Amphoe Lat Krabang. Then it takes the alignment in parallel with Study Road IM-17. The Route crosses at right angles to Rt. 314 and the Bang Pakong River. The latter half of the Route passes through paddy fields dotted with farmhouses. The Route is conveniently located for the Container Yard planned at around Amphoe Lat Krabang.	The first 25 kilometers of the Route is common to Route B. Then it takes the direct aligment to Amphoe Bang Pakong. The latter half, which follows the same route as Route A, takes the shortest course to the destination.
Remarks	The Route passes: -the planned Nong Ngu Hao Airport site. -amid paddy fields of rather soft soil ground. -densely populated areas at crossings of highway Rt. 315 and Rt. 344. -sites close to power transmission towers and lines.	The Route is: -around 10 kilometers longer in distance compared with Route A. -located a little far from the Chon Buri municipal area.	The Route is well located, eliminating the disadvantages seen in both Route A and Route B.

Earthwork Design

The required minimum height of the road formation was determined at 70 cm above the surrounding high water level estimated during the road inventory survey.

The side-borrow method is common and economical for embankment construction in Thailand, but it was considered to be difficult to obtain good quality fill materials by the side-borrow method. Then the borrow-pit method was applied for all projects except for IM-2 located in a hilly area.

Three ML projects, ML-1, ML-7 and ML-9, are located in soft ground area. Then countermeasures for these projects were studied by analyzing the existing soil properties as follows:

	ML-1	ML-7	ML-9
Thickness of Soft Layer (m)	5	11	11 ~ 14
Natural Moisture Content (%)	40 ~ 80	80 ~ 100	80 ~ 130
N-Value		1	
Unconfined Compressive Strength (kg/cm^2)			0.8 ~ 1.8
Height (m)		4.5	2.3
Total Settlement (cm)		40	180
Countermeasures	• Soil property is better than ML-7; therefore, settlement prevention slab behind bridge abutment only is required.	• Max. embankment height restriction = 4.5m • Extra fill ($t = 30$cm) for settlement during construction • Settlement prevention slab behind bridge abutment • Pavement type: Asphaltic Concrete	• Counterfill to prevent embankment sliding: in case embankment > 2.5m • Sand mat ($t = 50$cm) to accelerate settlement • Extra fill, in case embankment < 2.0m • Settlement prevention slab behind bridge abutment • Pavement type: Asphaltic Concrete

Pavement Design

Two types of pavement design for new construction and for rehabilitation were carried out.

Pavements for new construction were designed and classified into two types, high class pavements (PCC pavement and AC pavement) and low class pavements (DBST). For projects for which high class pavements were applied, both AC pavement and PCC pavement were designed. After a simple comparison between the two types of pavement from the technical and economical viewpoints, the pavement type to be applied was decided. Pavement types employed are as follows:

PCC Pavement	:	ML-1, ML-5, ML-9 (partly) and IM-23
AC Pavement	:	All projects except for IM-2 and PCC pavement projects
DBST	:	IM-2

The initial overlay was designed by PCC for projects with heavy traffic, ML-1 and IM-23, and by AC for remaining projects.

The following design periods were applied to pavement designs for new construction:

- AC pavement : 10 years
- PCC pavement : 20 years

Ten years after opening to traffic, AC overlay was planned for original AC pavement but no overlay was planned for PCC pavement.

Drainage Design

The location, type and size of drainage facilities, pipe culverts and box culverts were planned and determined on the basis of the discharge calculation corresponding to catchment area and rainfall intensity.

Bridge Design

All of the existing wooden or narrow concrete bridges were planned to be replaced by standard permanent bridges. For newly installed bridges, the length and type were decided based on the survey results.

The type of bridges to be applied was determined based on the following principle:

- Steel Box Girder : Curve bridges in intersections
- Steel I Girder : Skew bridges with less than 60 degrees in intersection angle
- PC Box Girder : Bridges with more than 30 m in span
- PC I Girder : Bridges which range from 25 m to 30 m in span
- PC Box Girder (in situ) : Extraordinarily long span bridges
- Slab Bridge : Bridges with less than 25 m in span

Planned bridges by study project are shown in Table 2.4.4.

Table 2.4.4 LIST OF BRIDGES

Phase I Projects

Project No.	Type	Number of Bridges	Length (m)
ML-1	PC I Girder	6	147
	PC Box Girder	4	140
	Steel I Girder	2	58
	Steel Box Girder	7	175
	Subtotal	19	450
ML-2	Slab Bridge	10	218
ML-4	Slab Bridge	35	754
	PC Box Girder	2	118
	Subtotal	37	872
ML-5	Slab Bridge	20	542
	PC Girder	6	220
	Steel Box Girder	13	490
	Subtotal	39	1252
ML-7	Slab Bridge	28	825
	PC I Girder	5	1084
	Subtotal	33	1909
IM-23		—	—
Total		138	4701

Table 2.4.4 LIST OF BRIDGES (Cont'd)

Phase II Projects

Project No.	Type	Number of Bridges	Length (m)
ML-3	Slab	11	210
ML-9	Slab	12	1496
	PC Girder	4	788
	PC Box	10	504
	PC Box (in situ)	2	520
	Subtotal	88	3308
IM-1	Slab	3	37
IM-2	Slab	—	—
IM-11	Slab	1	27
IM-12	Steel I Girder	1	17
	Slab	1	70
	Subtotal	2	87
IM-13		—	—
IM-14	Slab	3	140
IM-15	Slab	6	72
IM-16	Slab	9	377
IM-17	Slab	3	65
IM-22	Slab	6	225
Total		134	4548
Grand Total		272	9249

Intersection Design

The assessment of 17 major intersections was carried out following the study procedure shown in Figure 2.4.4.

Analytical results indicated that five intersections can be sufficiently controlled by installing traffic signals, whereas the other intersections require grade-separation control as shown in Table 2.4.5. The grade-separation method is shown in Figure 2.4.5.

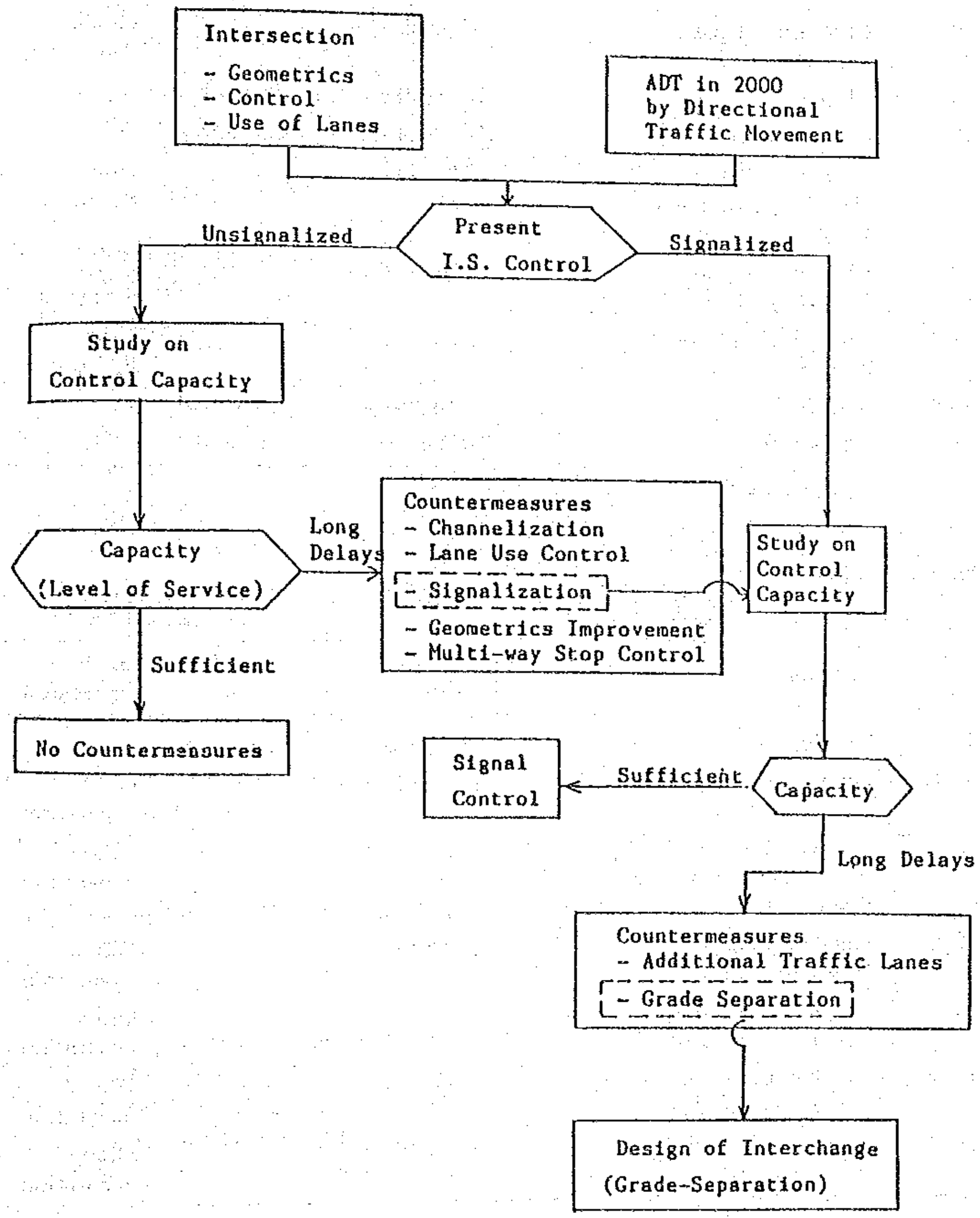


Figure 2.4.4 FLOW OF INTERSECTION ANALYSIS

Table 2.4.5 SUMMARY OF INTERSECTION ANALYSIS

Phase I Projects

Seq. No.	Location	Existing Control	Improvement	
			Signalized	Grade Separation
IS-1	Chon Buri Bypass, Beginning Point	Signalized		Grade Separation
IS-2	Chon Buri Bypass, Rt. 315	Signalized		Grade Separation
IS-3	Chon Buri Bypass, Rt. 344	Signalized		Grade Separation
IS-4	Klaeng	Unsignalized	Signalized	
IS-5	Chantha Buri	Unsignalized	Signalized*	
IS-6	Chon Buri-Pattaya New Hwy., Beginning Point	(New Plan)		Grade Separation
IS-7	Chon Buri-Pattaya New Hwy., Laem Chabang	(New Plan)		Grade Separation
IS-8	Chon Buri-Pattaya New Hwy., Laem Chabang	(New Plan)		Grade Separation
IS-9	Min Buri	Unsignalized	Signalized	
IS-10	Chachoengsao	Unsignalized	Signalized*	

* Including channelization

Phase II Projects

Seq. No.	Location	Existing Control	Improvement	
			Signalized	Grade Separation
IS-11	Sattahip	Unsignalized	Signalized	
IS-12	Bangkok-Chon Buri New Hwy., Rt. 3344	(New Plan)		Grade Separation
IS-13	Bangkok-Chon Buri New Hwy., Outer Ring Road	(New Plan)		Grade Separation
IS-14	Bangkok-Chon Buri New Hwy., Rt. 319	(New Plan)		Grade Separation
IS-15	Bangkok-Chon Buri New Hwy., Rt. 314	(New Plan)		Grade Separation
IS-16	Bangkok-Chon Buri New Hwy., Rt. 315	(New Plan)		Grade Separation
IS-17	Bangkok-Chon Buri New Hwy., Rt. 344	(New Plan)		Grade Separation

Figure 2.4.5 SUMMARY OF INTERSECTION DESIGN

Phase I Projects

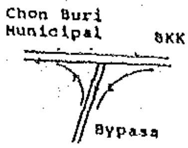
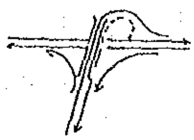
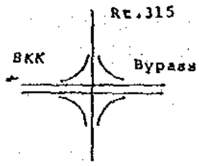
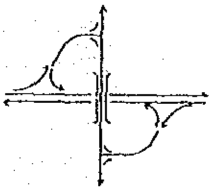
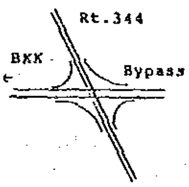
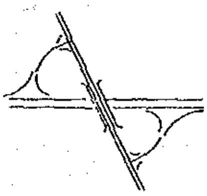
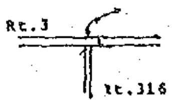
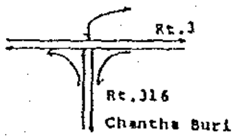
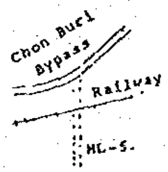
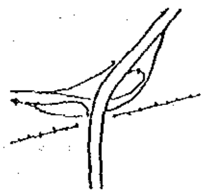
Seq. No.	Improvement Points	Existing Conditions	Improvement Plan
IS-1	- A trumpet type intersection was planned. - An overpass bridge was designed for traffic flow from Chon Buri Bypass to Bangkok. - For traffic flow from Chon Buri to Chon Buri Bypass, an existing at-grade intersection shall remain because of low traffic volume in this direction. However, room for ramp way construction remains for future increasing traffic volumes.		
IS-2	- A partial cloverleaf type was planned. - In order not to interrupt traffic flow on Chon Buri Bypass, Rt. 315 was designed to cross over Chon Buri Bypass. For right-turn traffic from Chon Buri Bypass, a two-quadrant cloverleaf type ramp was planned.		
IS-3	- The same type of intersection as IS-2 was planned.		
IS-5	- Only two channels were designed for left-turn traffic from Rt. 3 and Rt. 316.		
IS-6	- A modified Y-type intersection was planned. - For traffic flows in all directions, a grade separation crossing over Chon Buri Bypass and a railway closely located was designed. - In order to shorten the overpass bridge, the lane to Pattaya was shifted to the railway side.		

Figure 2.4.5 SUMMARY OF INTERSECTION DESIGN (Cont'd)

Phase I Projects

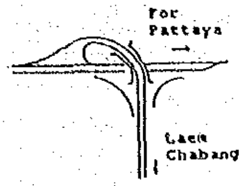
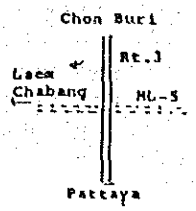
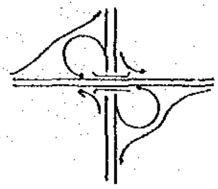
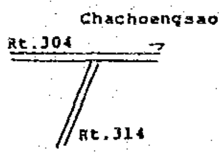
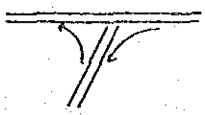
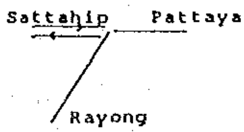
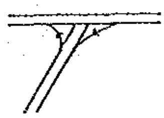
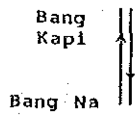
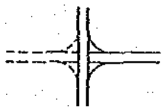
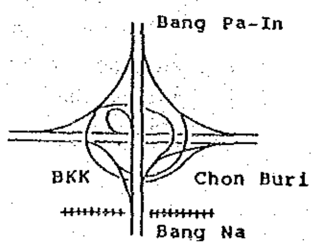
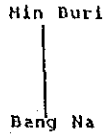
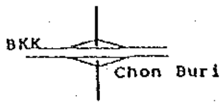
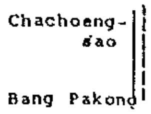
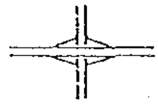
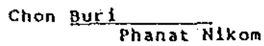
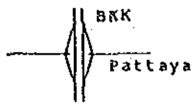
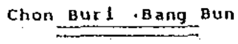
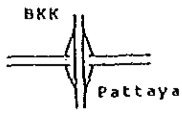
Seq. No.	Improvement Points	Existing Conditions	Improvement Plan
IS-7	- A trumpet type intersection was planned. - An overpass bridge was designed for a traffic flow to Laem Chabang.		
IS-8	- A partial cloverleaf type interchange was planned. - ML-5 was designed to cross over Rt. 3 by an overpass bridge. - For traffic flow from Pattaya to ML-5 and right turn traffic from Chon Buri to Laem Chabang, loop ramps were designed. - Since forecasted traffic flows from ML-5 to Chon Buri and from Laem Chabang to Pattaya were low, they were planned to be treated by U-turn on Rt. 3.		
IS-10	- Only two channels were designed for left-turn traffic.		
IS-11	- Two channels were planned for left-turn traffic (Pattaya to Rayong, Rayong to Sattahip).		
IS-12	- ETA Second Stage elevated expressway is planned to extend up to the IS-12 intersection in the near future. Therefore, this intersection is to be operated by at-grade signal control until ETA's flyover is constructed.		
IS-13	- Traffic volume of the New Highway and Bangkok Outer Ring Road are as high as 25,000-33,000 ADT. They are proposed to be high class roads in that the designed speed is 100 km/h. As both highways are expected to open to traffic at the same time in 1994, a junction style interchange was planned in this intersection.	(New Plan)	

Figure 2.4.5 SUMMARY OF INTERSECTION DESIGN (Cont'd)

Phase I Projects

Seq. No.	Improvement Points	Existing Conditions	Improvement Plan
IS-14	- A normal diamond-type interchange was designed within 80 meter wide right-of-way (New Highway : Overpass)		
IS-15	——— do ———		
IS-16	——— do ———		
IS-17	——— do ———		

CHAPTER 5 CONSTRUCTION AND MAINTENANCE COSTS

5.1 CONSTRUCTION COST

Quantities

The major work items were established based on the standard specifications of DOH. The work quantities were calculated based on the preliminary designs.

	Unit
EARTH WORK	
Clearing and Grubbing	ha
Roadway Excavation (Unclassified)	m^3
Roadway Excavation (Classified)	m^3
Embankment (Common)	m^3
Embankment (Borrow)	m^3
Sand Mat	m^3
Removal of Existing Structure	each
SUBBASE AND BASE COURSES	
Subbase	m^3
Aggregate Base	m^3
Shoulder (Soil Aggregate)	m^3
SURFACE COURSES	
Asphaltic Prime Coat	m^2
Asphaltic Tack Coat	m^2
Double Bituminous Surface Treatment	m^2
Asphalt Concrete Surfacing	ton
Portland Cement Concrete Pavement	m^3
STRUCTURES (Equivalent)	
RC Pipe Culvert (D = 1.00 m)	m
RC Box Culvert (2 – 2.40 × 2.40 m)	m
RC Bridge (W = 11.00 m)	m
PC Bridge (W = 11.00 m)	m
Bearing Unit	m^2
LAND ACQUISITION (Average)	ha

Unit Costs

The unit costs of 1988 were derived from both actual contract unit costs in similar construction projects in the Region and preliminary unit costs estimated by the Study Team.

Both percentages for tax and currency portions were quoted from available materials on construction contracts.

Construction Costs

Construction costs of major work items were estimated based on the unit costs and work quantities. The cost of miscellaneous works was estimated at 7% of the total cost of major work items. The total construction costs were computed by adding the following cost items to the above construction costs:

- Physical contingency: 10% of direct construction costs
- Design and construction supervision: 10% of direct construction costs
- Land acquisition cost

The financial and economic project costs for each study route are summarized in Table 2.5.1.

Residual Values

Based on FSH, the residual value in the case of a 15-year lifetime was estimated based on the available materials as follows:

Earthworks	:	90%
Pavement	:	50%
Major Structure	:	50%

Residual values for each study route were reflected in the economic analysis.

Table 2.5.1 SUMMARY OF PROJECT COSTS

(Unit: thousand Baht)

Project No.	Length (km)	Financial Cost	Economic Cost
Phase I Projects			
ML-1	13.60	347,856	317,675
ML-2	27.27	224,503	197,763
ML-4	61.86	593,260	534,823
ML-5	50.33	1,105,048	1,020,239
ML-7	40.94	754,017	664,890
IM-23	26.87	164,043	147,322
Subtotal	220.87	3,188,727	2,882,712
Phase II IM & ML Projects			
ML-3	44.6	417,200	373,297
ML-9	81.7	3,569,696	3,214,898
IM-1	18.7	49,294	43,295
IM-2	35.9	46,437	40,627
IM-11	40.7	139,179	122,930
IM-12	51.0	245,340	216,902
IM-13	17.8	81,048	71,884
IM-14	25.6	136,369	120,628
IM-15	24.7	115,250	101,977
IM-16	20.8	118,251	104,335
IM-17	19.2	97,534	85,744
IM-22	15.9	95,838	85,714
Subtotal	396.6	5,111,436	4,582,231
Phase II RH Projects			
RH-2	39.5	52,949	47,511
RH-3	17.9	23,668	21,257
RH-5	39.3	42,381	38,360
Subtotal	96.7	118,998	107,128
Grand Total	714.17	8,419,161	7,572,071

(1 Baht = 5.2 Yen)

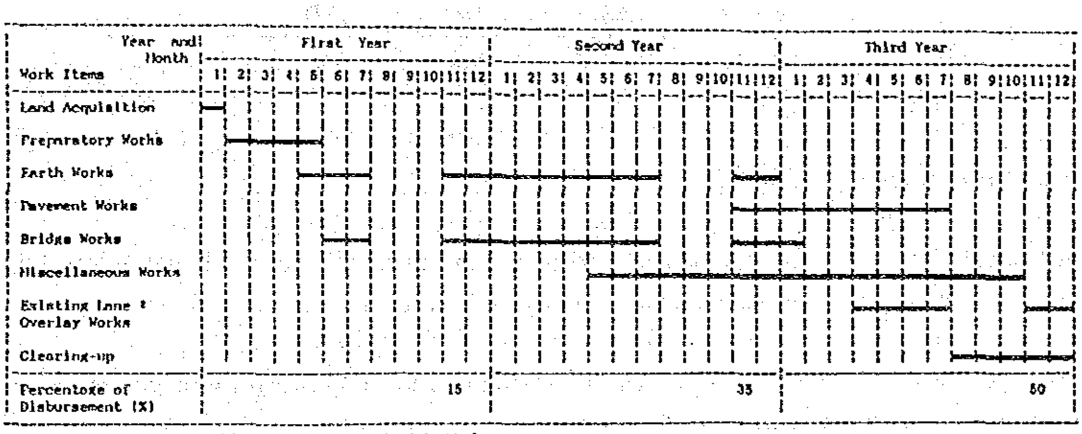
Construction Schedule

Taking into account the project scale and rainy period, the construction period by study project was established as follows:

All ML Projects and IM-12	:	3 years
IM Projects except for IM-12	:	2 years
All RH Projects	:	1.5 years

Construction schedules are shown in Tables 2.5.1, 2.5.2. and 2.5.3.

Figure 2.5.1 CONSTRUCTION SCHEDULE FOR ML PROJECTS AND IM-12



x = This item is not required in ML-5
( ) = Alternative schedule for ML-1 and ML-6 Projects

Figure 2.5.2 CONSTRUCTION SCHEDULE FOR IM PROJECTS

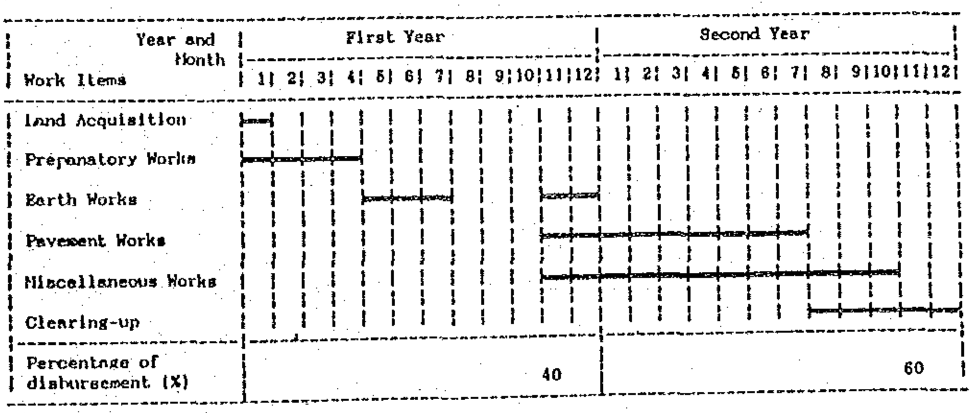
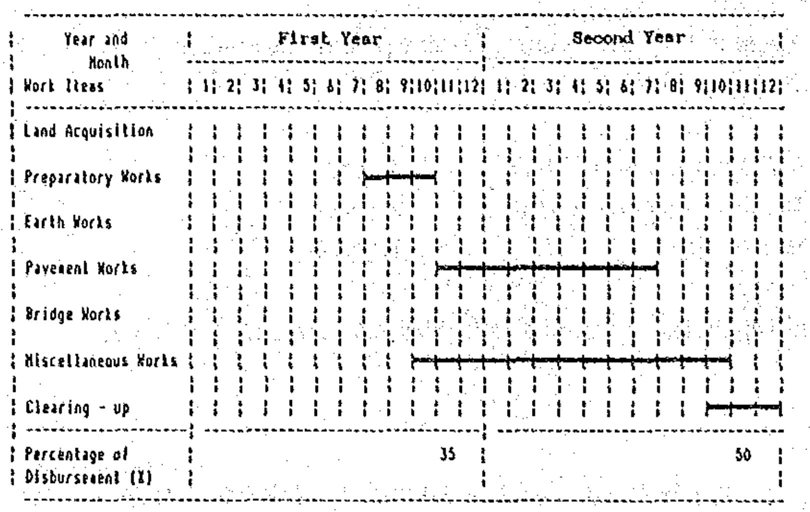


Figure 2.5.3 CONSTRUCTION SCHEDULE FOR RH PROJECTS



5.2 MAINTENANCE COST

For calculation of standard maintenance costs, the so-called K Factor Method employed by DOH was used. Routine maintenance costs are shown in Table 2.5.2.

For asphaltic concrete pavement, a 5 cm thick asphaltic concrete overlay was counted at 10 years after opening to traffic (Table 2.5.3).

Table 2.5.2 ROUTINE MAINTENANCE COSTS

Phase I Projects

(Unit: million Baht/year)

Route	Length (km)	Existing		Proposed	
		1994	2008	1994	2008
ML-1	13.6	0.368	0.368	0.419	0.660
ML-2	27.3	0.644	0.714	0.735	1.276
ML-4	61.9	1.809	1.883	2.111	3.252
ML-5	50.3	*	*	1.781	2.202
ML-7	40.9	1.038	1.146	1.262	2.100
IM-23	26.9	0.518	0.606	0.272	0.348

Phase II Projects

(Unit: million Baht/year)

Route	Length (km)	Existing		Proposed	
		1994	2008	1994	2008
ML-3	44.6	1.020	1.221	0.714	1.164
ML-9	81.7	*	*	1.303	1.818
IM-1	18.7	0.318	0.326	0.180	0.314
IM-2	35.9	0.469	0.538	0.403	0.651
IM-11	40.7	0.690	0.782	0.435	0.707
IM-12	51.0	0.874	0.965	0.516	0.942
IM-13	17.8	0.197	0.197	0.171	0.282
IM-14	25.6	0.275	0.314	0.267	0.443
IM-15	24.7	0.382	0.407	0.287	0.440
IM-16	20.8	0.255	0.267	0.192	0.331
IM-17	19.2	0.388	0.442	0.295	0.504
IM-22	15.9	0.188	0.190	0.155	0.262
RH-2	39.5	0.646	0.761	0.376	0.701
RH-3	17.9	0.364	0.459	0.239	0.431
RH-5	39.3	0.757	0.831	0.662	0.918

(1 Baht = 5.2 Yen)

Table 2.5.3 PERIODIC MAINTENANCE COSTS

Phase I Projects

Route	Overlay	
	Year	Cost (thousand Baht)
ML-1	—	—
ML-2	2004	39,874
ML-4	2004	90,658
ML-5	—	—
ML-7	2004	59,603
IM-23	—	—

Phase II Projects

Route	Overlay	
	Year	Cost (thousand Baht)
ML-3	2004	61,748
ML-9	2004	187,544
IM-1	2004	11,036
IM-2	2004	6,318
IM-11	2004	28,448
IM-12	2004	35,762
IM-13	2004	12,348
IM-14	2004	16,446
IM-15	2004	18,592
IM-16	2004	13,434
IM-17	2004	19,995
IM-22	2004	10,203
RH-2	—	—
RH-3	—	—
RH-5	—	—

(1 Baht = 5.2 Yen)

CHAPTER 6 ROAD USER BENEFITS

6.1 VOC SAVINGS

In the feasibility study phases of the Study, vehicle operating costs in Thailand were thoroughly reviewed and updated.

Representative vehicles, VOC components (fuel, oil, tires, maintenance, capital cost and overhead) and road surface conditions were considered to be same as those in the Master Plan Study stage.

Vehicle operating cost by vehicle type on ideal level tangent roads was calculated by road surface type, by running speed.

Actual VOCs on each study project road were obtained by modifying basic VOCs with respect to actual geometry and speed changes.

The savings were calculated as the difference in total VOCs in the related road network of with or without project cases. They are shown in Table 2.6.1.

Table 2.6.1 VOC SAVINGS

PHASE I PROJECTS (Unit: thousand Baht)

Project No.	1994	2000	2008
ML-1	77,362	239,797	404,206
ML-2	28,562	39,535	89,418
ML-4	65,543	88,702	358,698
ML-5	105,206	320,988	1,548,475
ML-7	105,799	151,219	238,926
IM-23	27,961	36,196	51,124

(1 Baht = 5.2 Yen)

Table 2.6.1 VOC SAVINGS (Cont'd)

PHASE II PROJECTS

Project No.	1994	2000	2008
ML-3	74,227	109,363	182,535
ML-9	540,204	2,097,793	6,044,138
IM-1	9,986	12,936	18,350
IM-2	9,785	12,629	17,880
IM-11	27,513	36,489	51,199
IM-12	28,683	38,930	54,921
IM-13	11,580	15,706	22,752
IM-14	28,645	37,333	52,246
IM-15	37,355	50,505	72,791
IM-16	15,933	21,675	34,412
IM-17	21,233	29,982	46,568
IM-22	18,219	27,068	42,606
RH-2	36,886	46,260	46,260
RH-3	45,648	61,185	—
RH-5	85,832	117,434	—

(1 Baht = 5.2 Yen)

6.2 TIME SAVINGS

Time values were estimated separately for drivers and assistants and for passengers.

Time values of drivers and assistants were estimated based on their monthly wages and working hours.

The time values of passengers were estimated for business trips and for trips for all other purposes. The former could be considered to reflect economic productivity. For the latter, the so-called equity value of time, 25% of overall average wage, was used.

Occupancy rates by vehicle type were calculated based on the latest results of the O/D surveys conducted by the Study Team.

Time values by vehicle type were estimated by combining the time values of drivers and assistants and those of passengers with average vehicle occupancy rates.

Time savings were estimated as the difference in total time costs in the related road network of with or without project cases. They are shown in Table 2.6.2.

Table 2.6.2 TIME SAVINGS

PHASE I PROJECTS

(Unit: thousand Baht)

Project No.	1994	2000	2008
ML-1	52,542	103,234	137,475
ML-2	16,493	24,871	88,961
ML-4	25,072	37,676	228,231
ML-5	115,967	428,365	1,348,348
ML-7	56,237	84,719	142,219
IM-23	7,737	10,196	14,673

PHASE II PROJECTS

Project No.	1994	2000	2008
ML-3	35,595	56,855	107,074
ML-9	864,164	1,635,826	3,780,942
IM-1	4,027	5,298	7,663
IM-2	4,630	6,110	8,780
IM-11	6,603	8,770	12,023
IM-12	7,205	9,577	13,227
IM-13	5,665	7,760	11,151
IM-14	3,118	4,107	5,910
IM-15	4,872	6,719	9,902
IM-16	6,190	8,441	13,526
IM-17	6,368	9,080	14,332
IM-22	3,122	4,859	7,722
RH-2	22,061	28,542	—
RH-3	31,372	41,799	—
RH-5	48,462	63,962	—

(1 Baht = 5.2 Yen)

CHAPTER 7 EVALUATION

7.1 ECONOMIC EVALUATION

Evaluation was made for each project road to determine whether its construction will generate benefits large enough to justify the investment or not.

Methods of estimating construction costs, financial and economic, and the disbursement schedule of construction, are explained in Chapter 5. Residual values and economic costs were estimated component by component.

Benefits were taken as the difference in vehicle operating cost and travel time for with and without cases as described in Chapter 6, together with maintenance cost savings as described in Chapter 5.

Costs and benefits were calculated for 15 years for each project on a yearly basis from 1991 to 2008 with the opening year in 1994. Conventional economic evaluation criteria were employed, i.e., internal rate of return, benefit cost ratio and net present value under an interest rate of 12% p.a. Table 2.7.1 summarizes the results. For ML-1 and ML-5, the case with the opening year of 1992 was also tested and the results are shown in Table 2.7.1.

Table 2.7.1 ECONOMIC EVALUATION SUMMARY

Phase I Projects

Project	Economic Construction Cost (1000 Baht)	Total Benefit (1000 Baht)	Net Present Value (discounted at 12%) (1000 Baht)	Benefit Cost Ratio	Internal Rate of Return (%)
ML-1	317,675	5,291,228 (4,417,663)	1,635,055 (1,532,943)	5.54 (4.40)	36.5 (30.8)
ML-2	197,763	1,406,009	283,476	2.25	22.2
ML-4	534,823	3,832,328	644,678	2.03	19.7
ML-5	1,020,239	19,029,843 (13,880,510)	4,907,436 (3,939,115)	5.23 (3.71)	30.6 (25.6)
ML-7	664,890	3,926,336	821,595	2.10	21.9
IM-23	147,322	748,996	151,534	1.95	21.5

Phase II Projects

Project	Economic Construction Cost (1000 Baht)	Total Benefit (1000 Baht)	Net Present Value (discounted at 12%) (1000 Baht)	Benefit Cost Ratio	Internal Rate of Return (%)
ML-3	373,297	2,852,331	689,450	2.60	25.6
ML-9	3,214,898	75,240,330	22,392,735	7.20	39.6
IM-1	43,295	294,867	72,659	2.46	26.7
IM-2	40,627	301,212	79,041	2,72	28.1
IM-11	122,930	723,162	159,912	2.14	23.9
IM-12	216,902	774,679	70,074	1.28	15.1
IM-13	7,883	376,733	74,655	1.93	21.7
IM-14	120,628	662,029	142,006	2.07	22.9
IM-15	101.977	920,963	263,797	3.29	32.5
IM-16	104,335	503,968	88,278	1.76	19.9
IM-17	85,744	644,332	163,509	2.69	27.7
IM-22	85,714	524,402	116,910	2.26	23.7
RH-2	47,511	469,177	257,177	6.99	74.2
RH-3	21,257	630,502	382,502	20.91	150.1
RH-5	38,350	1,105,136	669,655	20.26	147.1

Note : ( ) Shows opening year assumed at 1992 for ML-1 and ML-5. (1 Baht = 5.2 Yen)

7.2 IMPACT OF PROJECTS

As most of the feasibility study projects are located in an agriculturally developed area, not much contribution to agro-industry promotion can be expected by project implementation. However, those projects will help accelerate the dispersal of industry facilities outside the Bangkok Metropolitan Area, which is one of the national policies of Thailand.

It is particularly convincing that newly planned highways such as ML-5 and ML-9 can be expected to play a role in industry dispersal, industrial development and tourism development.

7.3 IMPLEMENTATION PROGRAM

Considering the necessary period for detailed design, tender and contract negotiation, the construction of the project roads was assumed to start at the beginning of 1991 for ML projects and IM-12. For IM projects, start of construction was assumed to be one year later, opening to traffic in 1994.

Fund requirements were calculated from the construction costs at 1988 prices and the assumed price increases. The results are shown in Tables 2.7.2

Table 7.3.1 also shows the case of an opening year of 1992 for ML-1 and ML-5.

Table 2.7.2 FUND REQUIREMENT FOR PROJECTS

(Unit: million Baht)

Project	Total at 1988 Price	1989 Local	1989 For.	1989 Total	1990 Local	1990 For.	1990 Total	1991 Local	1991 For.	1991 Total	1992 Local	1992 For.	1992 Total	1993 Local	1993 For.	1993 Total	Total Local	Total For.	Total Total
ML PROJECTS																			
ML-1	347.9	-	-	-	-	-	-	29.8	28.9	58.7	86.8	84.0	170.8	107.5	104.1	211.6	209.7	203.1	412.8
		(27.6)	(26.7)	(54.3)	(67.0)	(64.8)	(131.8)	(99.3)	(96.3)	(195.6)	-	-	-	-	-	-	(193.9)	(187.8)	(381.7)
ML-2	224.5	-	-	-	-	-	-	19.2	18.6	37.8	46.7	45.2	91.9	69.4	67.2	136.6	135.3	131.0	266.3
ML-3	417.2	-	-	-	-	-	-	35.8	34.6	70.4	86.8	84.0	170.8	128.9	124.9	253.8	251.5	243.5	495.0
ML-4	593.3	-	-	-	-	-	-	50.9	49.2	100.1	123.4	119.5	242.9	183.3	177.6	360.9	357.6	346.3	703.9
ML-5	1105.0	-	-	-	-	-	-	94.7	91.8	186.5	229.9	222.6	452.5	341.5	330.7	672.2	666.1	645.1	1311.2
		(87.6)	(84.8)	(172.4)	(212.5)	(205.8)	(418.3)	(315.7)	(305.7)	(621.4)	-	-	-	-	-	-	(615.8)	(596.3)	(1212.1)
ML-7	754.0	-	-	-	-	-	-	64.6	62.6	127.2	156.8	151.9	308.7	233.0	225.7	458.7	454.4	440.2	894.6
ML-9	3569.7	-	-	-	-	-	-	408.0	395.1	803.1	954.6	924.6	1879.2	772.2	747.9	1520.1	2134.8	2067.6	4202.4
TOTAL	7011.6	-	-	-	-	-	-	703.0	680.8	1383.8	1685.0	1631.8	3316.8	1835.8	1778.1	3613.9	4209.4	4076.8	8286.2
	(7011.6)	(115.2)	(111.5)	(226.7)	(279.5)	(270.6)	(550.1)	(993.5)	(962.1)	(1955.6)	(1368.3)	(1325.2)	(2693.5)	(1386.8)	(1343.3)	(2730.1)	(4143.3)	(4012.7)	(8156.0)
IM PROJECTS																			
IM-1	49.3	-	-	-	-	-	-	-	-	-	10.3	9.9	20.2	19.8	19.2	39.0	30.1	29.1	59.2
IM-2	46.4	-	-	-	-	-	-	-	-	-	12.4	12.0	24.4	15.8	15.3	31.1	28.2	27.3	55.5
IM-11	139.2	-	-	-	-	-	-	-	-	-	29.0	28.0	57.0	55.9	54.2	110.1	84.9	82.2	167.1
IM-12	245.3	-	-	-	-	-	-	21.0	20.4	41.4	51.0	49.4	100.4	75.8	73.4	149.2	147.8	143.2	291.0
IM-13	81.0	-	-	-	-	-	-	-	-	-	16.8	16.3	33.1	32.5	31.5	64.0	49.3	47.8	97.1
IM-14	136.4	-	-	-	-	-	-	-	-	-	28.4	27.5	55.9	54.8	53.1	107.9	83.2	80.6	163.8
IM-15	115.3	-	-	-	-	-	-	-	-	-	24.0	23.2	47.2	46.3	44.9	91.2	70.3	68.1	138.4
IM-16	118.3	-	-	-	-	-	-	-	-	-	24.6	23.8	48.4	47.5	46.0	93.5	72.1	69.8	141.9
IM-17	97.5	-	-	-	-	-	-	-	-	-	20.3	19.6	39.9	39.2	37.9	77.1	59.5	57.5	117.0
IM-22	95.8	-	-	-	-	-	-	-	-	-	19.9	19.3	39.2	38.5	37.3	75.8	58.4	56.6	115.0
IM-23	164.0	-	-	-	-	-	-	-	-	-	39.0	37.8	76.8	60.8	58.9	119.7	99.8	96.7	196.5
TOTAL	1288.5	-	-	-	-	-	-	21.0	20.4	41.4	275.7	266.8	542.5	486.9	471.7	958.6	783.6	758.9	1542.5
RH PROJECTS																			
RH-2	52.9	-	-	-	-	-	-	-	-	-	-	-	-	32.7	31.7	64.4	32.7	31.7	64.4
RH-3	23.7	-	-	-	-	-	-	-	-	-	-	-	-	14.6	14.2	28.8	14.6	14.2	28.8
RH-5	42.4	-	-	-	-	-	-	-	-	-	-	-	-	26.2	25.4	51.6	26.2	25.4	51.6
TOTAL	119.0	-	-	-	-	-	-	-	-	-	-	-	-	73.5	71.3	144.8	73.5	71.3	144.8
GRAND TOTAL	8419.1	-	-	-	-	-	-	724.0	701.2	1425.2	1960.7	1898.6	3859.3	2396.2	2321.1	4717.3	5066.5	4907.0	9973.5
	(1407.5)	(115.2)	(111.5)	(226.7)	(279.5)	(270.6)	(550.1)	(1014.5)	(982.5)	(1997.0)	(1644.0)	(1592.0)	(3236.0)	(1947.2)	(1886.3)	(3833.5)	(5000.4)	(4842.4)	(9843.3)

Note : ( ) shows opening year assumed at 1992 for ML-1 and ML-5.

(1 Baht = 5.2 Yen)

CHAPTER 8 CONCLUSION

Project priority order by IRR is as follows:

1) ML Projects

RANKING BY IRR OF ML PROJECTS

Project No.	Origin - Destination	Length (km)	IRR (%)
ML-9	Bangkok - Chon Buri New Highway	81.7	39.6
ML-1	Chon Buri Bypass	13.6	36.5
ML-5	Chon Buri-Pattaya New Highway	50.3	30.6
ML-3	A. Satthahip - C. Rayong	44.6	25.6
ML-2	M. Pattaya - A. Sattahip	27.3	22.2
ML-7	A. Min Buri - C. Chachoengsao	40.9	21.9
ML-4	A. Klaeng - C. Chanthaburi	61.9	19.7

IRRs are between 19.7% and 39.6%, worth implementing with the opening year of 1994. For the opening year of 1992, IRRs of ML-1 and ML-9 are 30.8% and 25.6%, respectively, still high figures.

It is highly desirable to construct ML-5 and ML-9 as early as possible, since these new highways will connect Bangkok and the Eastern Seabord area to support the development of the latter.

Preliminary design of ML-9 was done with the possibility of making it a toll road in mind. Design speed was set at 120 kp/h and all intersections with major roads were assumed to be grade separated.

2) **IM Projects**

RANKING BY IRR OF IM PROJECTS

Project No.	Origin - Destination	Length (km)	IRR (%)
IM-15	B. Klong Lunang - A. Min Buri	24.7	32.5
IM-2	B. Nong pru - A. Lao Khawn	35.9	28.1
IM-17	A. Lat Krabang - B. Khlong Tha Thua	19.2	27.7
IM-1	A. Bang Len - B. Bang Noi Nai	18.7	26.7
IM-11	B. Channa Soot - A. Pho Thong	40.7	23.9
IM-22	A. Nong Chok - A. Bang Nam Prieo	15.9	23.7
IM-14	A. Wang Noi - A. Thanyaburi	25.6	22.9
IM-13	A. Bang Pa-in - C. Ayutthaya	17.8	21.7
IM-23	J.R. 32 - J.R. 3022	26.9	21.5
IM-16	A. Lam Luk Ka - B. Khlong 16	20.8	19.9
IM-12	A. Pho Thong - A. Sena	51.0	15.1

IRRs are between 15.1% and 32.5%, worth implementing with the opening year of 1994.

3) **RH Projects**

RANKING BY IRR OF RH PROJECTS

Project No.	Link No.	Length (km)	IRR (%)
RH-3	325 0200	17.9	150.1
RH-5	344 0200	39.3	147.1
RH-2	225 0100	39.5	74.2

IRRs are between 74.2% and 150.1%, worth implementing with the opening year of 1994.

The Feasibility Study is summarized in Table 2.8.1

Table 2.8.1 SUMMARY OF FEASIBILITY STUDY FOR ROAD DEVELOPMENT STUDY IN THE CENTRAL REGION OF THAILAND

STUDY PROJECT							MAJOR CONSTRUCTION WORK QUANTITIES					
							EARTHWORK	PAVEMENT	BRIDGE			
NO.	ORIGIN - DESTINATION	LOCATION	JURISDICTION	LENGTH (km)	PROPOSED ROAD CLASS	PROJECTED AADT IN 2000	Excavation & Embank't (thousand m³)	AC or PCC Thickness (cm)	Accumu-lative Length (m)	PROJECT COST (thousand Baht)	IRR (%)	REMARKS
ML PROJECTS*												
ML-1	Chon Buri Bypass	Chon Buri	DOH (Rt. 3)	13.6	PD	23,000-30,000	312	PCC: 30.0	520	348,000	36.5	3 grade separated intersections
ML-2	M. Pattaya - A. Sattahip	Chon Buri	DOH (Rt. 3)	27.3	PD	11,000-13,000	768	AC: 5.0	218	225,000	22.2	
ML-3	A. Sattahip - C. Rayong	Chon Buri/ Rayong	DOH (Rt. 3)	44.6	PD	9,000-12,000	1,010	AC: 10.0	210	418,000	25.6	
ML-4	A. Klaeng - C. Chanthaburi	Rayong/ Chanthaburi	DOH (Rt. 3, Rt. 316)	61.9	PD/SD	14,000-18,000	1,762		872	594,000	19.7	
ML-5	Chon Buri-Pattaya New Highway	Chon Buri	DOH (Rt. 36)	50.3	PD/P1 FD	26,000/7,000 21,000	2,417	PCC: 28.0 (24 km) 23.0 (18 km) 25.0 (8 km)	1,252	1,105,000	30.6	2 grade separated intersections
ML-7	A. Min Buri - C. Chachoengsao	Bangkok - Chachoengsao	DOH (Rt. 304)	40.9	SD	11,000-14,000	1,389	AC: 10.0	1,909	754,000	21.9	
ML-9	Bangkok - Chon Buri New Highway	Bangkok/ Samut Prakan / Chachoengsao/ Chon Buri	DOH (Rt. 36)	81.7	PD	17,000-40,000	5,973[1)]	AC: 10.0 (66 km) PCC: 28.0 (16 km)	6,522[2)]	3,570,000	39.6	4 grade separated intersections and 1 junction [1)] Includes sand mat volume [2)] 3,261 m (one way) × 2
			Subtotal	320.3								
IM PROJECTS**												
IM-1	A. Bang Len - B. Bang Noi Nai	Nakhon Phathom	PWD	18.7	F4	600-1,000	80	AC: 5.0	37	50,000	26.7	
IM-2	B. Nong Pru - A. Lao Khwan	Kanchanaburi	DOH (Rt. 3306)	35.9	F4	500-600	230	DBST	—	47,000	28.1	
IM-11	B. Channasut - A. Pho Thong	Sing Buri/ Ang Thong	RID	40.7	F2	500-2,000	234	AC: 7.5	27	140,000	23.9	
IM-12	A. Pho Thong - A. Sena	Ang Thong/ Ayutthaya	RID	51.0	F2	1,000-1,600	575	AC: 10.0	88	246,000	15.1	New construction: 1.7 km
IM-13	A. Bang Pa-In - C. Ayutthaya	Ayutthaya	DOH (Rt. 3059)	17.8	F2	1,500	160	AC: 10.0	—	81,000	21.7	
IM-14	A. Wang Noi - A. Thanyaburi	Ayutthaya/ Phathum Thani	Rural Munici-pality (part of DOH Rt. 3189)	25.6	F3	900-1,000	276	AC: 10.0	140	137,000	22.9	New construction: 5.0 km
IM-15	B. Khlong Luang - A. Min Buri	Phathum Thani/ Bangkok	Rural Municipality	24.7	F2/F1	2,500/5,200	147	AC: 10.0	72	116,000	32.5	North section: F2 Class South section: F1 Class
IM-16	A. Lam Luk Ka - B. Khlong 16	Phathum Thani/ Nakhon Nayok	DOH (Rt. 3312)	20.8	F3	600-1,200	180	AC: 5.0	337	119,000	19.9	
IM-17	A. Lat Krabang - B. Khlong Tha Thua	Bangkok/ Samut Prakhan/ Chachoengsao	PWD	19.2	F2	400-2,100	208	AC: 7.5	65	98,000	27.7	
IM-22	J.R. 304 - A. Bang Nam Prieo	Bangkok/ Chachoengsao	Rural Municipality	15.9	F3	1,100	182	AC: 7.5	225	96,000	23.7	New construction: 5.0 km
IM-23	J.R. 32 -J.R. 3022	Ayutthaya	DOH (Rt. 3267)	26.9	F1	4,000-6,000	124	PCC: 23.0	-	164,000	21.5	
			Subtotal	297.2								
PH PROJECTS***												
RH-2	Rt. 225 Link 0100	Nakhon Sawan	DOH	39.7	S2		—	AC: 5.0	—	53,000	74.2	
RH-3	Rt. 325 Link 0200	Samut Songkram	DOH	17.9	S2		—	AC: 5.0	—	24,000	150.1	
RH-5	Rt. 34 Link 0200	Chon Buri	DOH	39.3	S1		—	AC: 5.0	—	42,000	147.1	
			Subtotal	96.2								
			Grand Total	713.7								

(1 Baht = 5.2 Yen)

Note: * Multilane highway construction projects. ML-5 and ML-9 are new construction projects.
** Improvement projects of existing roads.
*** Pavement rehabilitation projects.

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