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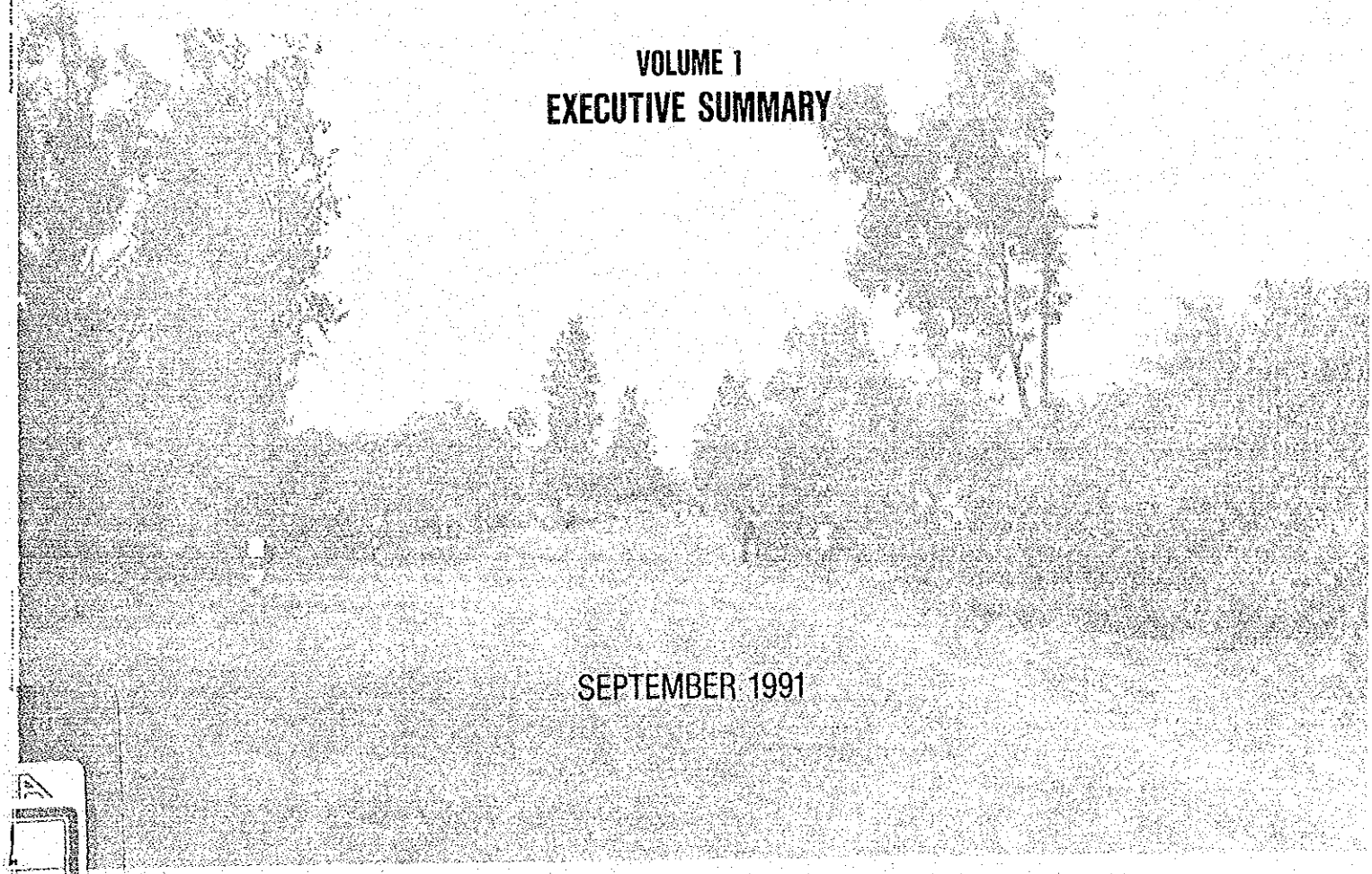
KINGDOM OF THAILAND
MINISTRY OF TRANSPORT AND COMMUNICATIONS
DEPARTMENT OF HIGHWAYS

ROAD DEVELOPMENT STUDY IN THE SOUTHERN REGION

FINAL REPORT

VOLUME 1
EXECUTIVE SUMMARY



SEPTEMBER 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct the Road Development Study in the Southern Region of the Kingdom of Thailand and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Thailand a study team headed by Mr. Nobuhiro Koyama, Pacific Consultants International from February 1990 to July 1991.

The team held discussions with the officials concerned of the Government of Thailand, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

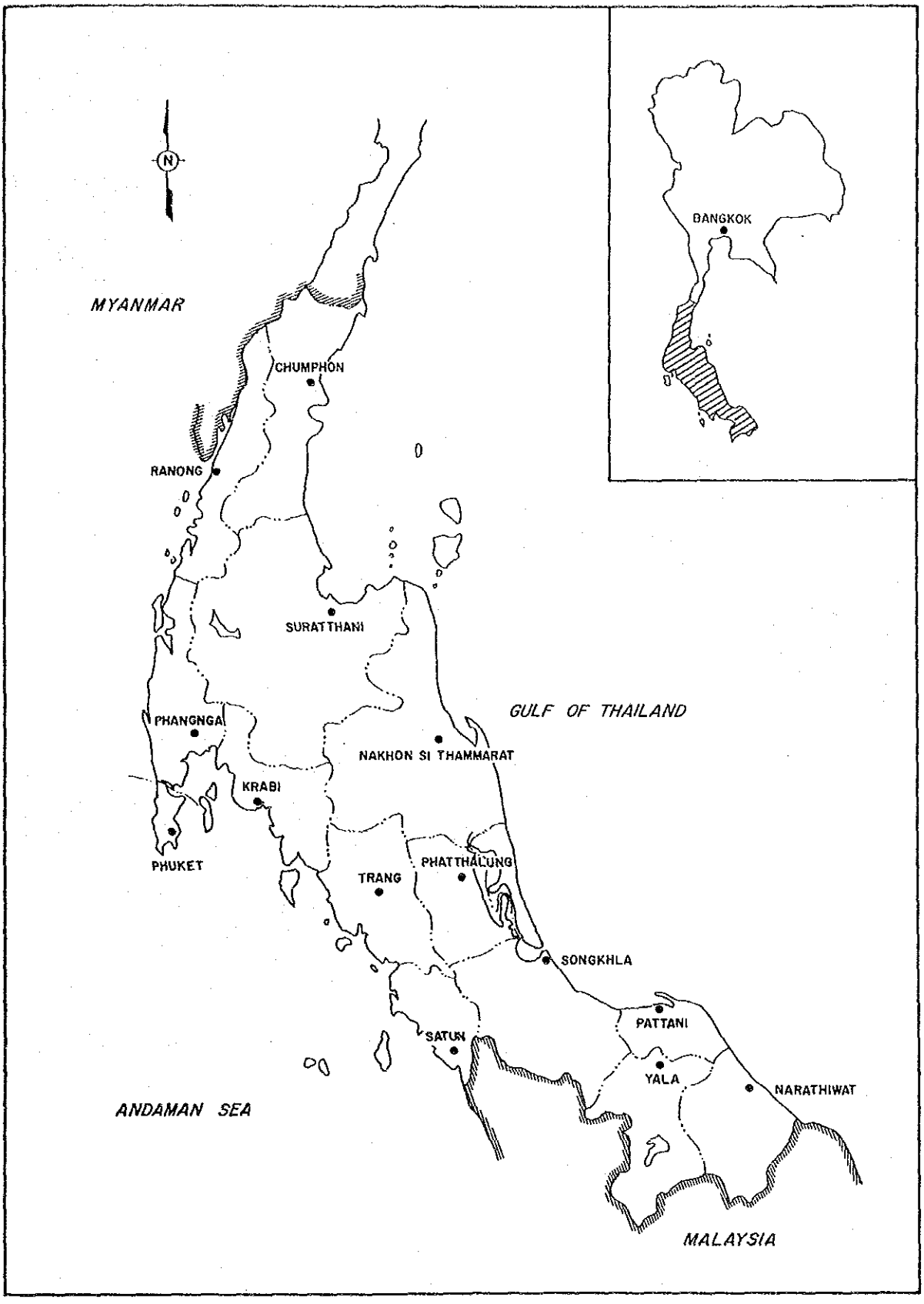
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

September 1991

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency



LOCATION MAP OF THE STUDY AREA

NC-1 Typical View on PWD Road
(Laterite Surface Condition)

AD-1 Typical View on Route 401

AD-2 Urban Section on Route 402
(Near PHUKET City)

NC-3 Typical View on Route 416
(Laterite Surface Condition)

WD7-4 Typical View on Route 408

WD6-1 Typical View on Route 417

NC-5 Typical View on PWD Road
(Laterite Surface Condition)

RW7-1 Flooding Section on Route 4063

SUMMARY

SUMMARY

1. Introduction

This report summarizes the results of the "Road Development Study in the Southern Region" carried out during the period of February 1990 to June 1991. The Study comprises two parts: one to develop a highway development master plan for the Southern Region including feasibility studies on selected projects; and another to perform a feasibility study on the Krabi - Khanom Highway which is a component of the Southern Seaboard Development Program (SSDP).

The study on a highway development master plan for the Southern Region was carried out independently with the Krabi - Khanom Highway because the development framework of the SSDP has not been fixed yet.

The study results are compiled into the Final Report which consists of the following five volumes:

Volume 1:	Executive Summary
Volume 2:	Main Text
Volume 3:	Preliminary Feasibility Study on the Nineteen Projects
Volume 4:	Feasibility Study on the Eight Selected Projects
Volume 5:	Feasibility Study on the Krabi Khanom Highway

2. Present Conditions of the Highways in the Southern Region

The highway network in the Southern Region is judged to be well structured. Most parts of the east and west coasts are linked to the network. Some highways connect the east coast directly with the west coast, provincial centers are connected to each other at the shortest possible distance, and rural roads penetrate deep inland from the highway network.

Highway capacity, however, has become insufficient due to the rapid increase of vehicle traffic in recent years. Traffic demand increased from 2,000 AADT in 1980 to 4,200 AADT in 1989 (8.6 % per annum) on the national highways and from 1,200 AADT in 1980 to 3,100 AADT in 1989 (11.4 % per annum) on the provincial highways. More than 90 % of the highways in the Southern Region, more over, are of "P3/S3/F3" or lower standards. Highways of this standard are designed to accommodate not more than 2,000 AADT. The increase of highway capacity, therefore, is the most urgent issue to be addressed.

New highway construction to cope with the increasing traffic is unlikely to be a good solution in the Southern Region. This is because about 35 % of total land of the region is mountainous and about 40 % of the total land belongs to a national conservation area. This suggests that new highway construction adding to the existing network would be greatly constrained by the requirements for environmental protection and natural disaster prevention. Thus, upgrading and improvement of the existing highways would be a better solution than the new highway construction to cope with the future traffic increase.

3. Future Development of the Southern Region

The Southern Region faces the Gulf of Thailand to the east and the Andaman Sea to the west. Due to this locational advantage, the region is a promising economic development zone in an international context.

The development plans and programs in the Southern Region prepared for the Sixth Five Year Plan which are likely to be carried over to the Seventh Plan include:

1) "New Economic Areas" of the Upper South Sub-Region, Songkhla Lake Basin and Pak Phanang Basin;
2) "Regional Urban Growth Centers" of Songkhla-Hat Yai, Surat Thani, Phuket, Pattani and Nakhon Si Thammarat;
3) "Tourism Promotion Centers" of Surat Thani-Ko Samui, Songkhla-Hat Yai and Phuket;
4) "Rural Development; and
5) "Development of Southern Border Provinces".

The Government announced the launching of the Southern Seaboard Development Program (SSDP) which aims to transform the Krabi - Khanom Corridor into a new economic zone through introducing the "Trans-Thai Land Bridge" connecting the Gulf of Thailand with the Andaman Sea.

Table 3.1 shows the future development framework of the Southern Region for this Study excluding the possible economic expansion by the SSDP. The framework is based on the assumption that the region will regain the highest GRP share of 11.5 % achieved in the past only in the year 2011 through the regional development plans and programs initiated in the Sixth Five Year Plan. The GRP is

estimated to grow from 144.5 billion baht in 1988 to 506.7 billion baht in 2006 at an annual growth rate of 7.2 %, higher than the national average of 6.5 %. Because of the slightly higher growth rate assumed for the Southern Region, a gap of the per capita GRP of the Southern Region against the national average will gradually be improved from 79.9 % in 1988 to 84.3 % in 2006.

Table 3.1 FUTURE FRAMEWORK OF THE SOUTHERN REGION

Year	GRP	Population	Per Capita GRP		
	(bil. B)	(thousand)	South	Country	%
1988	144.47	6,861	21,057	26,364	79.9
1991	185.95	7,283	25,532	31,447	81.2
1996	262.63	7,998	32,837	39,805	82.5
2001	367.62	8,724	42,139	50,287	83.8
2006	506.70	9,456	53,585	63,532	84.3
Growth(%pa)	7.2	1.8	5.3	5.0	

Note: The SSDP is not included.

Future traffic demand was estimated based on the above planning framework as well as the analyses of the present traffic situations in the Southern Region. Daily vehicle trip production in the region was estimated to grow from 69.5 thousand trips in 1990 to 319.6 thousand trips in 2006 at an annual growth rate of 10.0 % as shown in Table 3.2.

Table 3.2 FUTURE TRAFFIC DEMAND IN THE SOUTHERN REGION

unit: 1,000 trips/day

Vehicle Type	1990	1996	2001	2006
Car	30.8	63.7	99.1	146.1
Bus	11.3	18.8	27.0	37.7
Truck	27.4	58.3	91.6	135.8
Total	69.5	140.8	217.7	319.6
Motorcycle	119.7	245.1	380.3	559.4

Fig. 3.1 illustrates the estimated traffic volume on the highway network in the Southern Region during the period of 1990 - 2006. It is estimated that the traffic volume on the north-south artery of Route 4 and 41 will substantially be increased toward the year 2006. Some sections of the artery likely need additional lane construction by the year 1996, including sections of Chumphon - Surat Thani and Phattalung - Hat Yai. The highways directing to such major urban centers as Songkhla - Hat Yai, Surat Thani, Phuket, Nakhon Si Thammarat and Pattani most likely need a capacity increase.

4. Highway Development Master Plan for the Year 2001

Fig. 4.1 shows a functional highway development scheme based on the development plans and programs for the Sixth Five Year Plan. The highway sections with plural lines imply that they are expected to serve various development objectives of the Southern Region at the same time. The Surat Thani - Hat Yai and Phuket - Khanom sections are noteworthy as multi-purpose highways. The figure can be interpreted as a strategic highway network for improvement to support the development plans and programs.

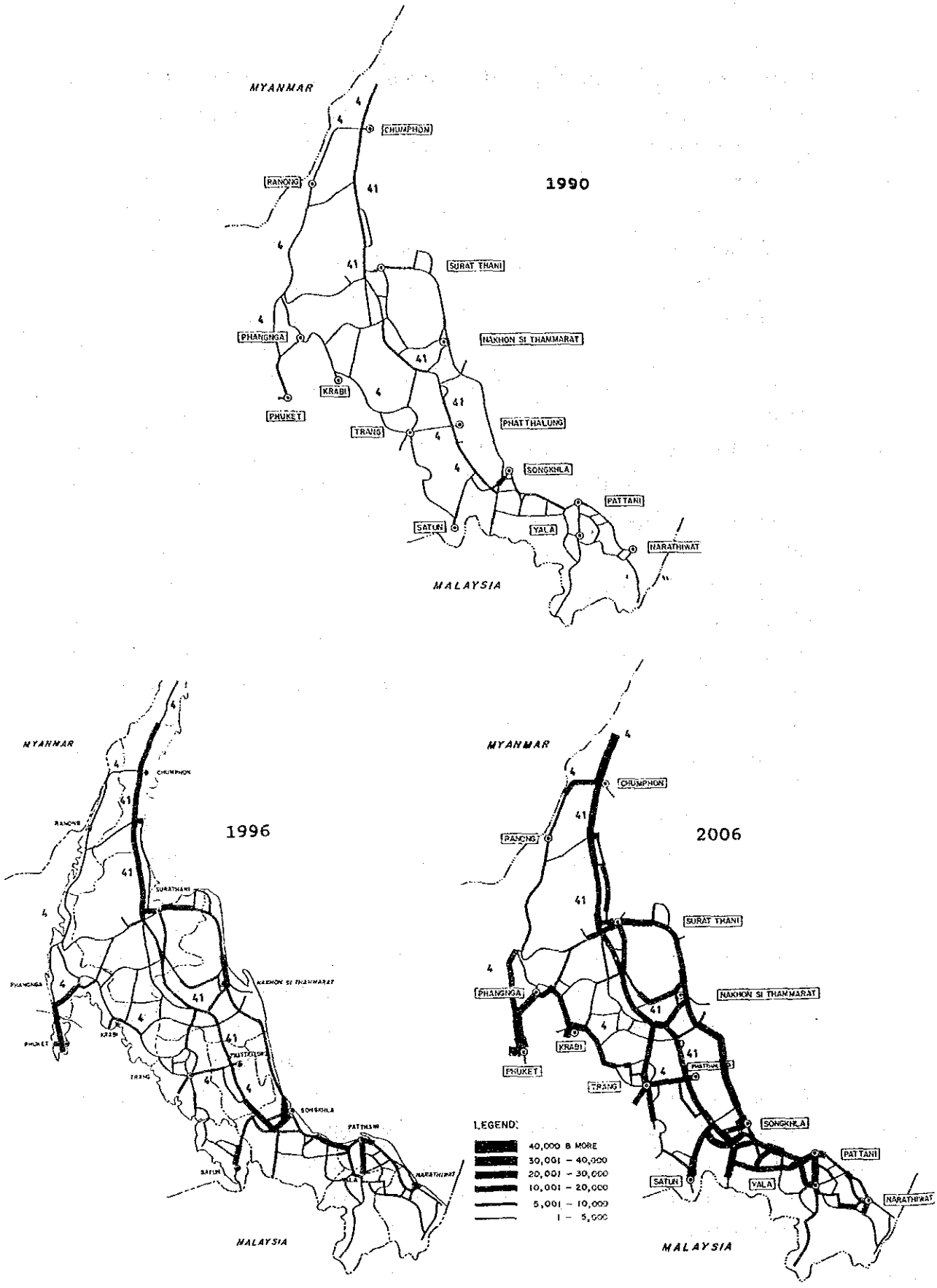


Fig. 3.1 TRAFFIC DEMAND ON HIGHWAYS (PCU)

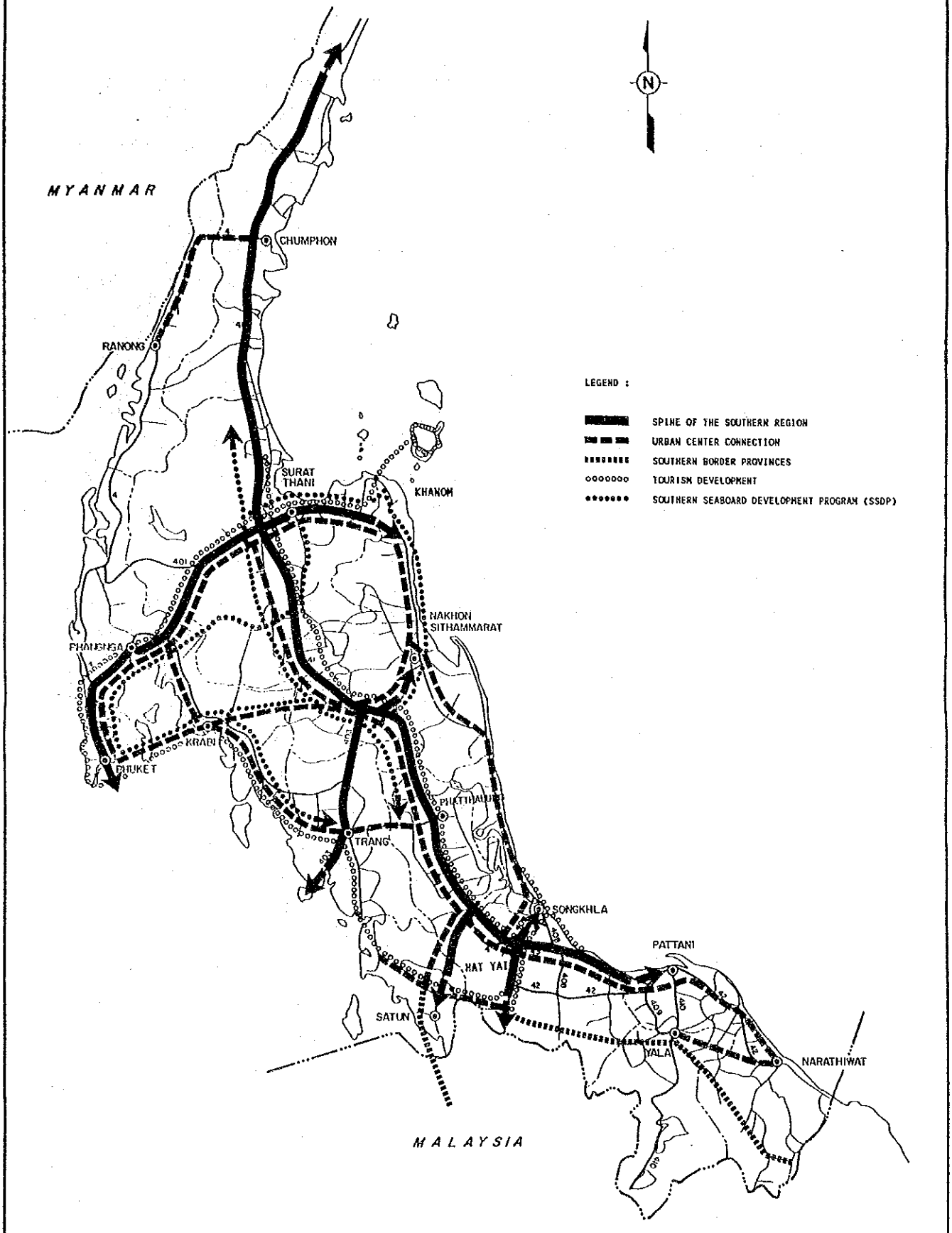


Fig. 4.1 HIGHWAY DEVELOPMENT SCHEME FOR THE SOUTHERN REGION

On top of the above strategic scheme, a highway development master plan for the year 2001 should be developed by taking account of the region specific variables including:

1) environmental protection particularly to conserve the designated national reserve forest;
2) disaster prevention particularly to alleviate flood damages;
3) existing conditions of highways particularly in terms of designed traffic capacity; and
4) future transport demand on each highway section toward the year 2006.

Based on the above considerations, a highway development master plan for the year 2001 was established as shown in Fig. 4.2. The total length of projects is estimated to amount to 2,330 km which contains:

1) Additional lane construction or new highway construction to create total six lane urban corridors in Songkhla - Hat Yai, Surat Thani, and Phuket (150 km);
2) Additional lane construction to create four lane national highways (1,210 km);
3) Widening of carriageway to 7.0 meters for connecting multiple lane highways (970 km); and
4) Construction of grade separated intersections at junctions of multi lane highways.

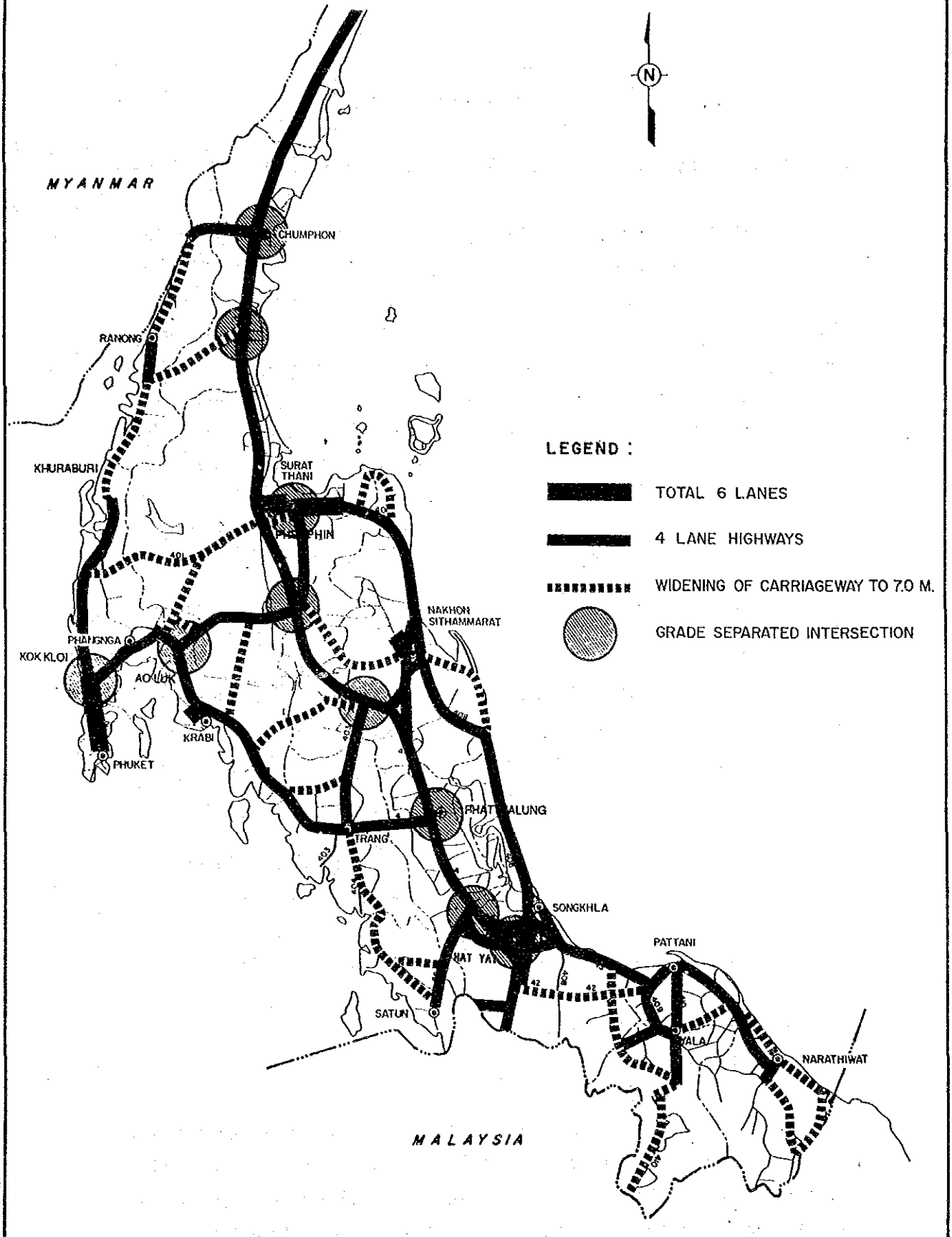


Fig. 4.2 HIGHWAY DEVELOPMENT MASTER PLAN 2001

5. Highway Projects by the Year 1996

5.1 A Highway Development Master Plan for the Year 1996

A highway development master plan for the year 1996 was prepared as an intermediate step toward the year 2001 with a view to relieving the expected deficiency of highway capacity as well as supporting regional development of the Southern Region. Fig. 5.1 illustrates the proposed highway development master plan for the year 1996. Total length of the proposed projects in the master plan amounts to 2,622 kilometers as shown in Table 5.1.

Table 5.1 PROJECTS PROPOSED BY THE MASTER PLAN FOR THE YEAR 1996

(1)	New Road Construction	120 km
(2)	Additional Lane Construction	780 km
(3)	Widening of Carriageway to 7 Meters	1,460 km
(4)	Widening of Carriageway to 6 Meters	130 km
(5)	Others (Reconstruction and Upgrading)	132 km
	Total	2,622 km

Out of the total length of 2,622 kilometers, nineteen projects of about 910 kilometers were selected for the preliminary study and eight projects out of the nineteen projects were selected for the further feasibility study.

5.2 Preliminary Feasibility Study on the Nineteen Projects

Fig. 5.2 shows the locations of the nineteen projects proposed for the preliminary feasibility study. The important highway projects to upgrade the whole stretch of the north-south artery of Route 4 and 41, however, are

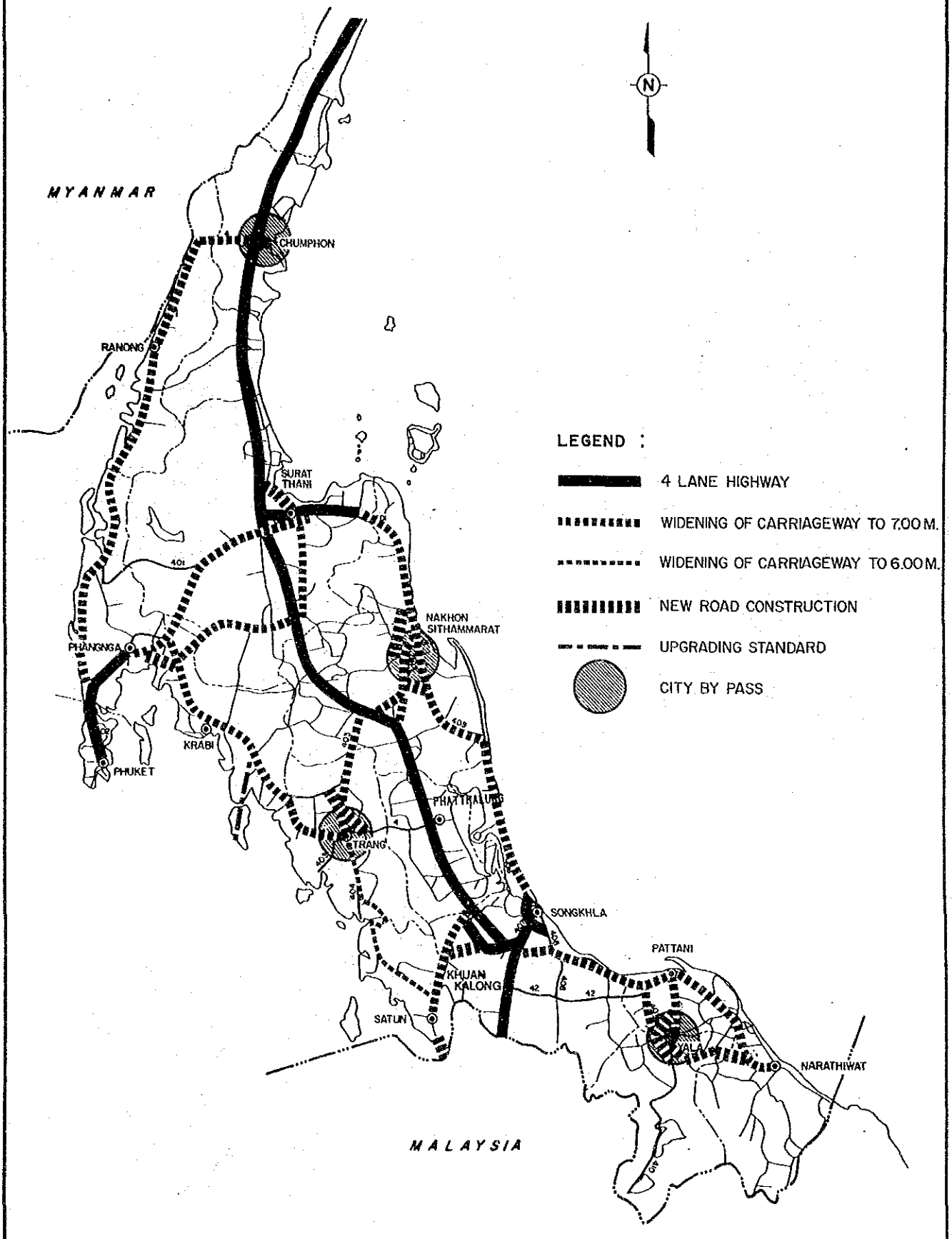


Fig. 5.1 HIGHWAY DEVELOPMENT MASTER PLAN 1996

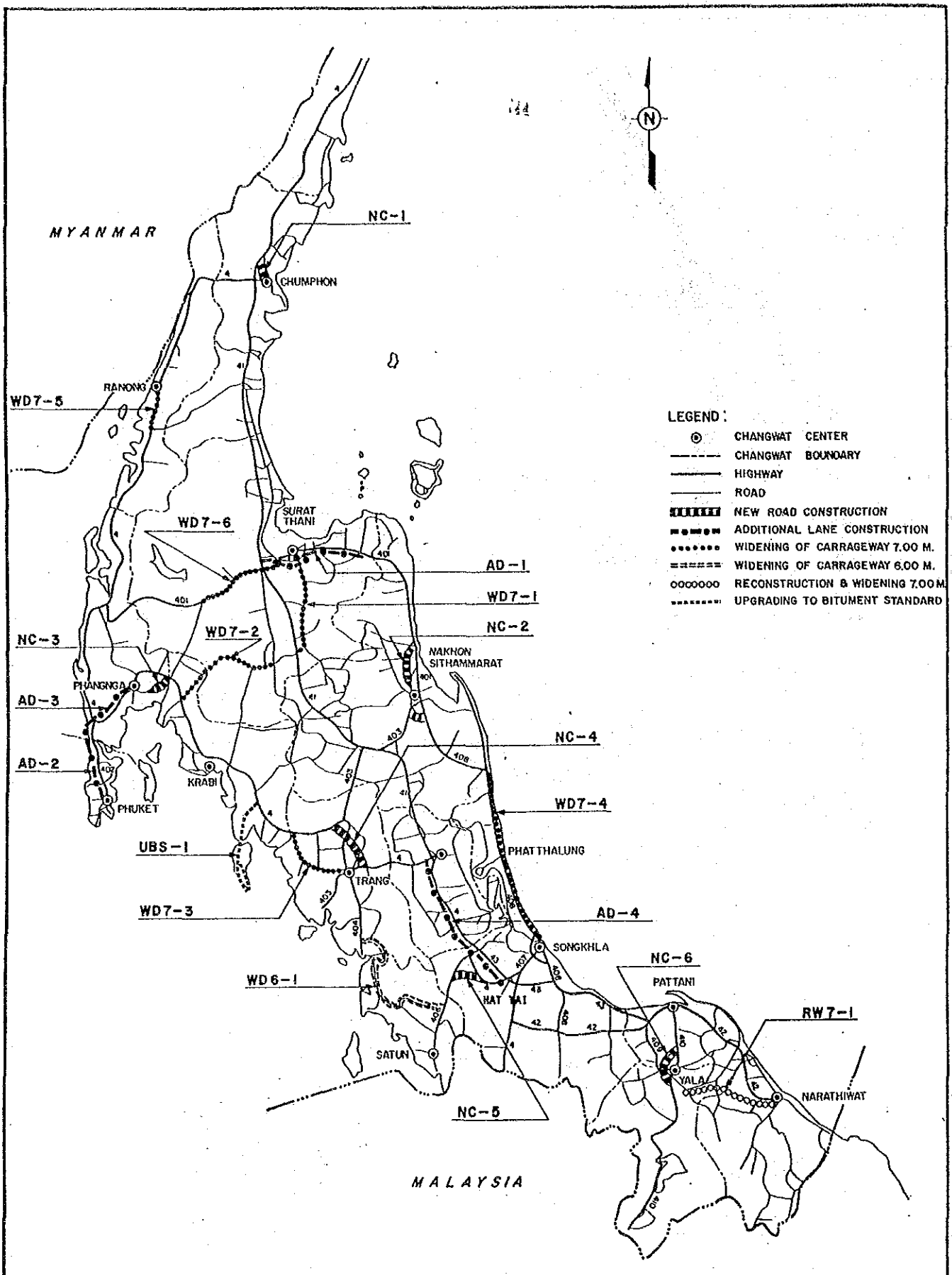


Fig. 5.2 NINETEEN PROJECTS FOR PRE-FEASIBILITY STUDY

not included in these projects because the government has determined to construct additional lanes along these highways from Bangkok to the Malaysian border. The ongoing and programed highway projects are also excluded to avoid duplication.

Preliminary feasibility studies on the nineteen projects were carried out with a focus on identifying the relative priority among these projects in terms of economic viability. The basic design policies for these projects are that:

1) design standard should be in accordance with the DOH standard;
2) the existing highways should be best utilized for improvement;
3) earth work materials should be procured from borrow pits in the vicinity; and
4) measures for preventing natural disasters should be incorporated into designing.

Table 5.2 summarizes the estimated project costs and the calculated internal rates of return (EIRRs) of these projects. Total cost for the nineteen projects is estimated at 6.08 billion baht. AD-2 showed the highest EIRR of 77.6 % followed by NC-1 of 73.5 % while NC-6 showed the lowest EIRR of 4.1 % followed by WD7-6 of 10.8 %. It should, however, be noted that the project viability should be further tested by a feasibility study in which area specific information is to be fully taken into account.

Volume 3 of the Final Report describes more details of the preliminary feasibility studies on the nineteen projects.

Table 5.2 PRELIMINARY FEASIBILITY STUDY ON THE NINETEEN PROJECTS

No.		Road Class	Length (km)	Cost (mil. B)	EIRR (%)
NC-1	Chumphon	F1	9.4	93.5	73.5
NC-2	Nakhon Si.	F1	20.5	280.4	12.6
NC-3	Thap Put	S1	7.7	82.9	30.4
NC-4	Trang Bypass	F1	30.7	383.1	12.3
NC-5	Route 4/406	S3	17.3	140.2	53.8
NC-6	Yala Bypass	S1	16.7	342.3	4.1
	Sub Total		102.3	1,322.4	
AD-1	Surat Thani	SD	60.3	666.9	34.2
AD-2	Phuket	SD	45.6	528.6	77.6
AD-3	Phangnga	PD	35.6	273.9	51.0
AD-4	Phatthalung	PD	95.5	994.0	42.9
	Sub Total		237.1	2,463.4	
WD7-1	Route 4009	F1	62.8	166.2	43.3
WD7-2	Route 4035	F1	68.1	200.2	21.8
WD7-3	Route 4046	F1	49.0	168.7	16.0
WD7-4	Route 408	S1	95.4	140.4	46.3
WD7-5	Ranong	P1	25.9	88.0	18.1
WD7-6	Route 401	S1	64.0	165.6	10.8
	Sub Total		365.2	929.1	
WD6-1	Route 417	S3	79.2	251.2	22.4
RW7-1	Yala-Narathiwat	F1	51.2	309.1	26.7
UBS-1	Ko Lanta	F3	78.7	804.0	12-22
	Grand Total		913.6	6,079.2	

Note: NC - New Construction
AD - Additional Lane Construction
WD7 - Widening of Carriageway to 7 Meters
WD6 - Widening of Carriageway to 6 Meters
RW7 - Reconstruction and Widening to 7 Meters
UBS - Upgrading to Bitumen Standard

5.3 Feasibility Study on the Eight Selected Projects

The eight projects were selected for the feasibility study based on the results of the preliminary feasibility study, strategic importance in the Southern Region and coordination with the ongoing and programed highway projects. Fig. 5.3 shows the location of the eight projects.

The projects can be categorized into four groups:

1) Chumphon City Link (NC-1) in the northern part of the Southern Region to provide a flood free connection to the north-south artery of Route 4 in addition to the existing Route 327;
2) East - West Corridor in the upper part of the Southern Region to support the development of the Surat Thani - Phuket Sub-Region including the projects of Surat Thani Additional Lane Construction (AD-1), Phuket Additional Lane Construction (AD-2) and Thap Put Bypass Construction (NC-3) in between;
3) East - West Corridor in the lower part of the Southern Region to support the development of Songkhla - Satun Sub-Region including the projects of Hua Sai - Songkhla Highway (WD7-4), Palian - Khuan Kalong Highway (WD6-1) and Highway 4/406 Short Cut Route (NC-5) in between; and
4) Yala - Narathiwat Highway Construction (RW7-1) in the Southern Border Provinces to stimulate economic activities including tourism development.

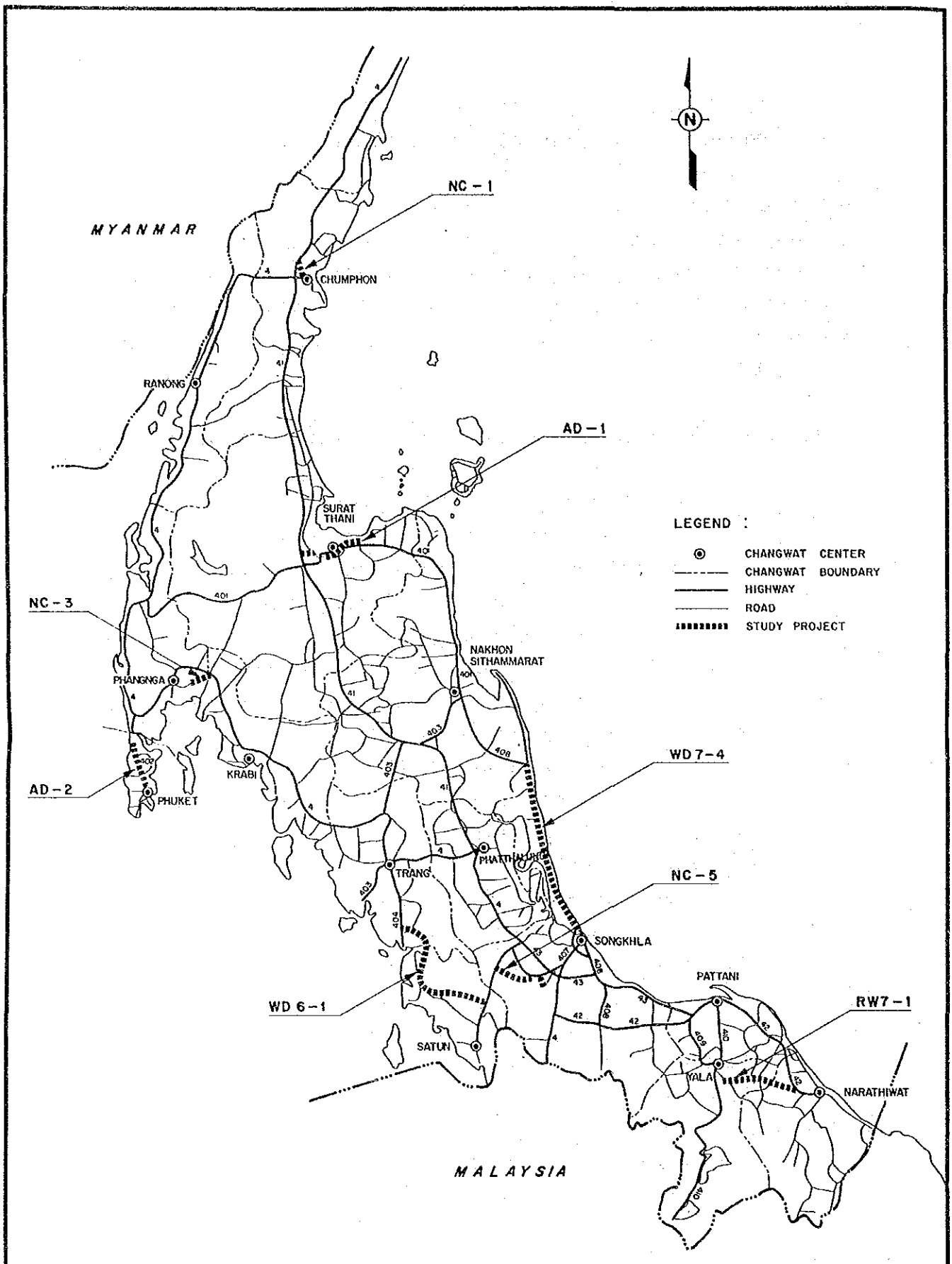


Fig. 5.3 EIGHT PROJECTS FOR FEASIBILITY STUDY

Feasibility studies were carried out based on more detailed information of project areas, including geography, water discharge, soil conditions, flood history, traffic demand and environmental impact. Table 5.3 summarizes the results of the feasibility study. All the projects are judged viable with the EIRRs in the range of 19.2 - 69.9. The EIRRs of NC-1 and AD-2-1 are substantially high because of the absolute lack of highway capacity of the existing two lane highways to cope with the increasing traffic demand for the future. Preliminary environmental impact assessment reveals that some sections of AD-2-2 and RW7-1 might need further environmental impact assessment when these projects are to be implemented. Volume 4 describes more details of the feasibility study on the eight projects.

Table 5.3 FEASIBILITY STUDY ON EIGHT PROJECTS

No.	Project	Length (km)	Cost (mil.B)	EIRR (%)
NC-1	Chumphon City Link	9.1	110.2	69.9
AD-1-1	Surat Thani	32.0	375.6	57.3
AD-1-2	Surat Thani Alternative	40.1	468.6	58.1
AD-2-1	Phuket	38.4	612.6	69.2
AD-2-2	Phuket Alternative	35.2	1,401.0	27.4
NC-3	Thap Put Bypass	8.0	120.3	23.0
WD7-4-1	Hua Sai-Songkhla	96.3	215.6	34.3
WD7-4-2	Hua Sai-Songkhla Alt.	96.3	271.8	29.9
WD6-1	Palian-Khuan Kalong	82.6	318.3	19.2
NC-5	4/406 Short Cut	24.1	285.3	52.3
RW7-1	Yala-Narathiwat	53.0	385.9	24.7
	Total	351.6	2,516.8	

Note: "Total" does not include AD-1-1, AD-2-2 and WD7-4-2.

5.4 Recommendation

Table 5.4 summarizes the estimated project costs and the calculated internal rates of return (EIRRs) of F/S and pre-F/S projects. The financial costs of the eight F/S projects amounts to about 2.52 billion baht. The financial costs of the remaining eleven pre-F/S projects amounts to about 3.87 billion baht including two projects of which EIRRs were preliminarily calculated at lower than the bench mark value of 12 %. The financial costs of the remaining master plan projects of 1,720 kilometers were estimated at 8.66 billion baht based on the unit cost obtained in the F/S studies. The total budget required for the 2,622 kilometers, therefore, is estimated at 15.04 billion baht in 1990 price.

The amount is about 2.8 times as large as the highway budget of the Southern Region during the Sixth Five Year Plan period. The budgetary requirement would be in the possible range of attainment if the yearly budget of 20.0 billion, average of 1990 and 1991 budget, is allocated for the coming five years in the Seventh Five Year Plan period and the present percentage share of the Southern Region (about 15 %) is maintained throughout the period.

It is recommended even in a case of insufficient budget allocation to the Southern Region that:

1) additional lane construction along the north-south arteries of Route 4 and 41 be implemented at the earliest possible timing with a view to providing better inter-regional linkage with Bangkok and international linkage with Malaysia and Singapore through the "Trans Malaysian Highway";

Table 5.4 SUMMARY OF PROJECTS BY THE YEAR 1996

No.	Project		Length (km)	Cost (mil.baht)	EIRR (%)
F/S Projects					
1	NC-1	Chumphon	9.1	110.2	69.9
2	AD-2-1	Phuket	38.4	612.6	69.2
3	AD-1-2	Surat Thani	40.1	468.6	58.1
4	NC-5	4/406	24.1	285.3	52.3
5	WD7-4-1	Hua Sai	96.3	215.6	34.3
6	NC-3	Thap Put	8.0	120.3	23.0
7	RW7-1	Yala	53.0	385.9	24.7
8	WD6-1	Palian	82.6	318.3	19.2
	Sub Total		351.6	2,516.8	
Pre F/S Projects					
9	AD-3	Phangnga	35.6	273.9	51.0
10	WD7-1	Route 4009	62.8	166.2	43.3
11	AD-4	Phattalung	95.5	994.0	42.9
12	WD7-2	Route 4035	68.1	200.2	21.8
13	WD7-5	Ranong	25.9	88.0	18.1
14	WD7-3	Route 4046	49.1	168.7	16.0
15	NC-2	Nakhon Si	20.5	280.4	12.6
16	NC-4	Trang	30.7	383.1	12.3
17	UBS-1	Ko Lanta	78.7	804.0	12-22
18	WD7-6	Route 401	64.0	165.6	10.8
19	NC-6	Yala	16.7	342.3	4.1
	Sub Total		547.6	3,866.4	
20	Remaining Projects		1,722.8	8,659.0	
	Grand Total		2,622.0	15,042.2	

Note: Cost for "No. 20 Remaining Projects" was estimated based on the unit project costs derived from the feasibility studies on the eight projects.

2) the eight F/S projects be implemented at the earliest possible timing as well with a view to encouraging sub-regional development in the Southern Region as well as resolving area specific transportational issues; and

3) the ongoing and programed highway projects be succeeded to the Seventh Plan with a view to continuing the general efforts to rehabilitate and upgrade the existing highway system in the Southern Region, upgrading to bitumen standard in particular.

6. The Krabi - Khanom Highway

6.1 The Southern Seaboard Development Program (SSDP)

The Southern Seaboard Development Program (SSDP) is the second national project that the government is going to introduce after the Eastern Seaboard Development Program (ESDP). The SSDP places an utmost focus on external orientation to transform the isthmus of the Malay Peninsula into a new international economic zone through inviting active participation of international community.

The SSDP is located at strategically important point in terms of international shipping route, as shown in Fig. 6.1, connecting the Pacific region to the east and the Middle-East and European regions to the west. The Strait of Malacca is the only one route that provides the shortest shipping distance between these regions. It is likely that the SSDP aims to attract oil and container shipment to the Land Bridge when the capacity of the Strait of Malacca becomes insufficient to accommodate the increasing vessel traffic in a medium term perspective, and to invite various types of international investment to the Land Bridge Corridor in a longer term perspective.

The SSDP is planned to be composed of: (1) a "Land Bridge" connecting Krabi deep sea port on the west coast with Khanom deep sea port on the east coast through three transport modes of highway, railway and pipeline; and (2) industrial estates and urban centers in Krabi and Khanom areas including regional oil refinery, oil product distribution center and oil storage depot.

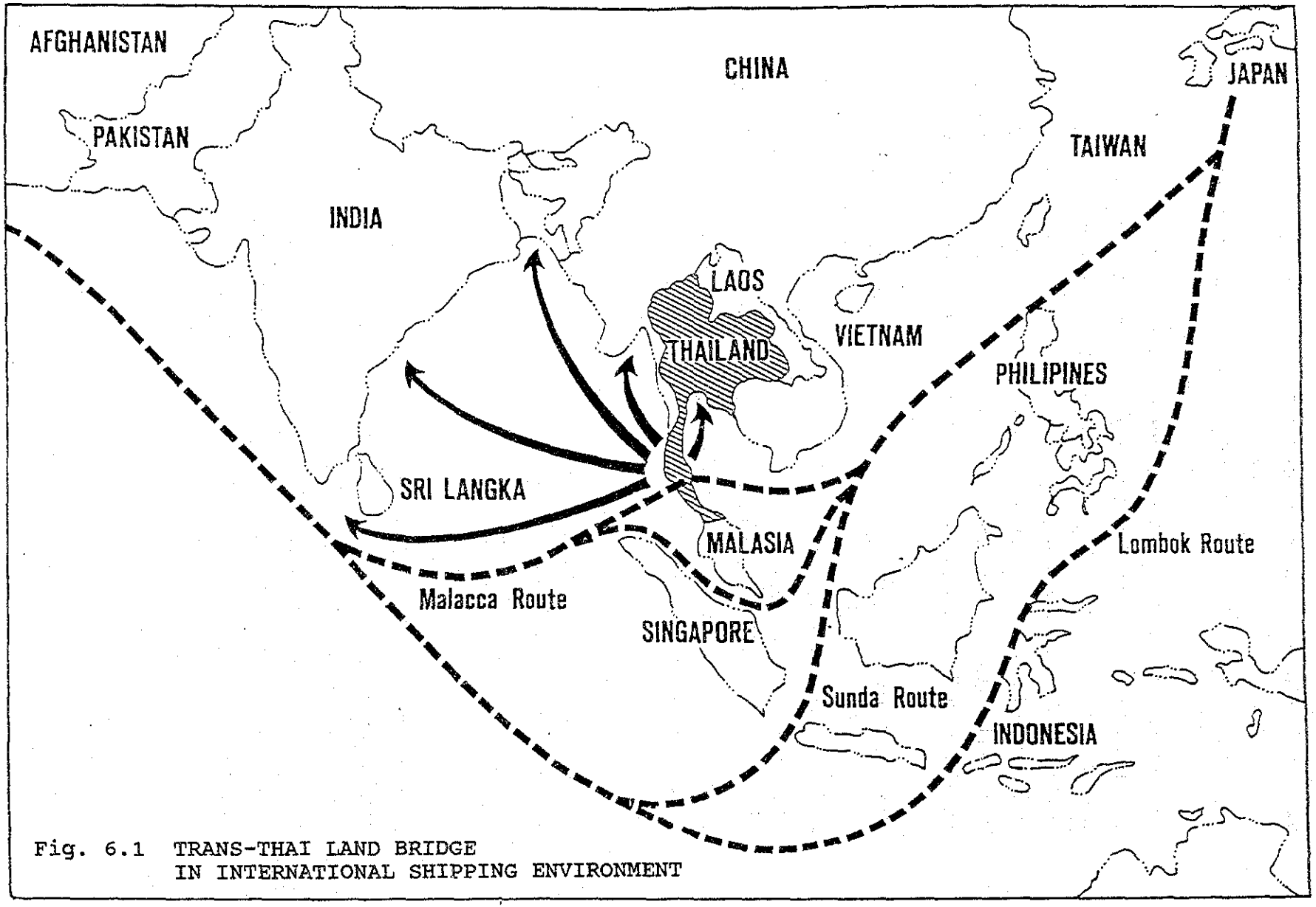


Fig. 6.1 TRANS-THAI LAND BRIDGE
IN INTERNATIONAL SHIPPING ENVIRONMENT

6.2 Traffic Demand on the Krabi - Khanom Highway

The Krabi - Khanom Highway is a component of the "Trans-Thai Land Bridge" under the SSDP. A feasibility study on the Highway was carried out in this Study separately with the highway development master plan in the Southern Region outlined in the preceding sections.

The alignment of the highway is in accordance with the proposed concept of the SSDP that the travel time between both deep sea ports should be less than two hours. Fig. 6.2 and Table 6.1 show the alternative alignment of the Krabi - Khanom Highway. The total length of all project alternatives is in the range of 189 - 197 kilometers. The Krabi - Khanom Highway is expected to reduce the shipping distance via the Strait of Malacca approximately by 830 kilometers.

Table 6.1 ALTERNATIVE ALIGNMENT

unit: km

	Krabi side		Khanom side	
	Flat	Hilly	Flat	Total
Alternative A	25.0	60.0	108.5	193.5
Alternative B	21.0	59.5	108.5	189.0
Alternative C	24.0	65.0	108.5	197.5

Traffic demand on the Krabi - Khanom Highway would be mainly consisted of: (1) international containers diverted from the Strait of Malacca; (2) production materials imported from and products exported to overseas countries; (3) business and commuting trips related to the SSDP; and (4) local traffic. Presently, however, it would be still early to estimate traffic demand because the development framework of the SSDP has not been fixed

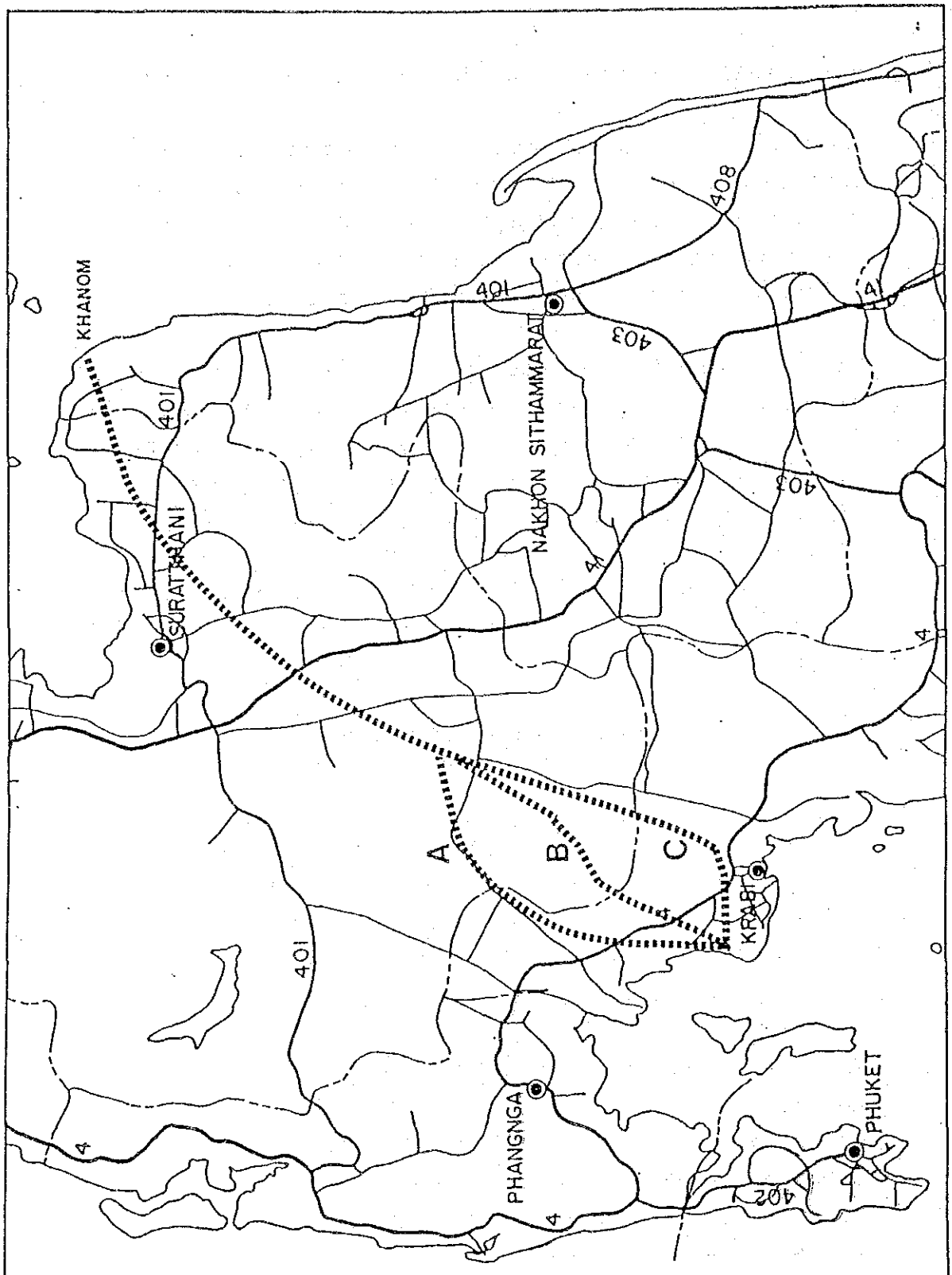


Fig. 6.2 ALIGNMENT ALTERNATIVES OF THE KRABI - KHANOM HIGHWAY

yet. With a view to providing an input to the SSDP Master Plan Study, this Study forecasted the future traffic demand based on a set of assumptions prepared by the Study Team. Major assumptions are:

1) A container vessel call to Krabi and Khanom ports in 2001 is assumed once a week to each port, mainly consisting of regional container ships of 1,000 TEUs between Bangkok and the Middle Asia. A container vessel call in 2006 is assumed twice a week to each port, mainly consisting of international containers of 3,600 TEUs in addition to the regional containers assumed for 2001; and

2) The production framework of the SSDP is assumed at 18.1 billion baht in 2001 and 60.9 billion baht in 2006 based on an assumption that the SSDP will raise per capita GRP of the Southern Region equal to the national average in 2011.

Traffic demand on the Highway was estimated based on the above assumptions as well as the planning framework prepared for the "Highway Development Master Plan in the Southern Region". Daily average traffic demand on the Highway was estimated in the range of 3,000 - 5,000 AADT in 2001 and 9,000 - 12,000 AADT in 2006 excluding business and commuting trips. Due to the intermittent arrival of container ships to the ports, daily traffic demand is likely to fluctuate to a considerable extent. It can be concluded, however, that a four lane highway should be constructed in the first phase with the right-of-way wide enough to accommodate additional lanes in the future.

6.3 Outline of the Highway

As show in Fig. 6.3, the Highway is designed as a four lane highway with a center median which is wide enough to accept additional lanes in the future. The average width of the right-of-way required for the Highway excluding pipeline and railway is estimated at less than a half of the 200 meters proposed by the SSDP. The width of right-of-way at intersections, however, will be in the range of 500 - 550 meters. Design speed is assumed at 120 kilometers per hour and a maximum gradient of 2 percent. The height of embankment is designed at 3 - 6 meters from the existing ground level to secure the height clearance for the crossing highways and rural roads.

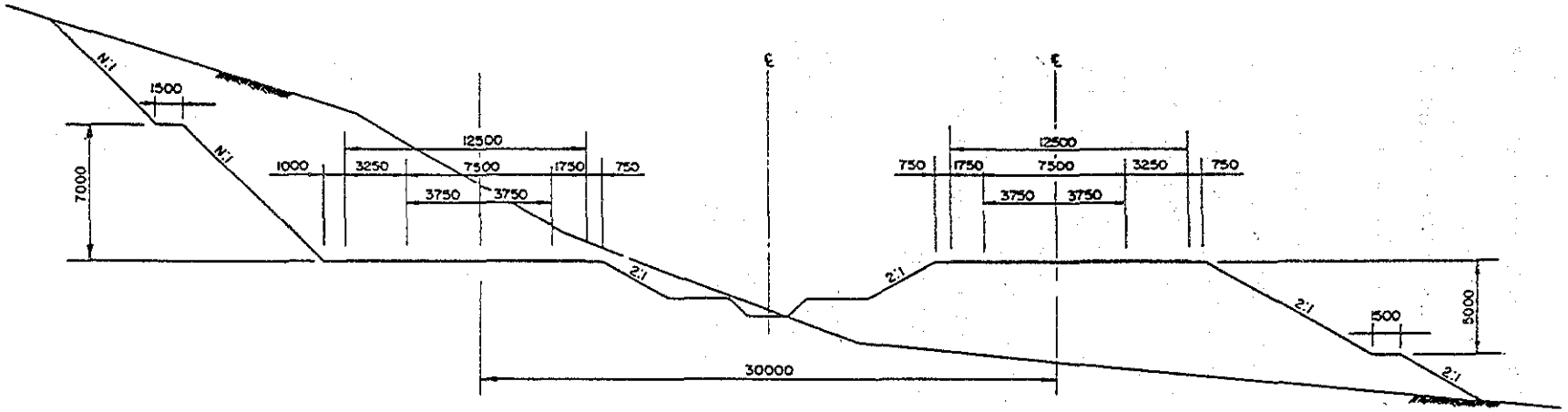
Project cost is estimated at:

Alternative A	8.44 billion baht
Alternative B	9.42 billion baht
Alternative C	8.44 billion baht

6.4 Preliminary Evaluation of the Project

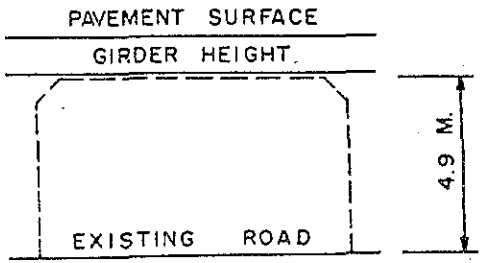
The SSDP would be non-existent if the "Trans-Thai Land Bridge" is not a component of the Program. In this case, Krabi and Khanom ports would remain as a regional port just facing to one side of the Peninsula. The corridor would not attract any significant attention of the international investors. It is likely, therefore, that economic benefit attributable to the Krabi - Khanom Highway would be a portion of the production increment of the SSDP.

A preliminary test of project viability was performed based on the above considerations. In case the



TYPICAL EARTHWORK SECTION

- Major Highways (Route 4, 41, 401)



- Provincial Highways and Rural Roads

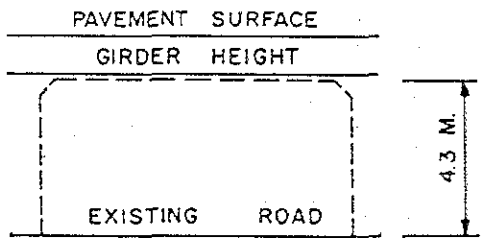


Fig. 6.3 TYPICAL CROSS-SECTION AND HEIGHT OF EMBANKMENT FOR CROSSING HIGHWAYS

production increment of the SSDP, the internal rates of return for Alternative A and C are calculated at 11 - 19 % while Alternative B at 10 - 18 %. Alternative A and C, therefore, are slightly better than Alternative B.

In terms of preservation of natural environment, Alternative B needs a careful environment impact assessment because the route passes through a natural reserve forest by a tunnel. In terms of land acquisition, Alternative C likely have more difficulties than the other alternatives because Alternative C passes the vicinity of Krabi city where population density and land price are higher. In terms of regional context, Alternative A would be better than others because it provides shorter access to Phuket direction.

As a preliminary conclusion, the Alternative A is considered the best alignment of the three. Volume 5 of the Final Report describes more details of the feasibility study on the Krabi - Khanom Highway.

JICA