4.3.2 Guideline 1: Environmental Protection

Conservation of natural environment is one of the important objectives of the Sixth Five Year Plan and is expected to be taken over to the Seventh Plan. Environmental conservation should be regarded as a guideline in preparation of a highway development master plan, particularly for new road construction.

Almost all the areas of low highway density in the Southern Region belong to the mountain areas where economic development activities are restrained to preserve natural environment including forest reserve, national park and wild life sanctuary. Proposals for new road construction invading into deep mountains should be carefully assessed with a view to preserving natural environment.

Due to the extended mountain ranges in the Southern Region, it is very likely that new road construction into the areas of low highway density will incur several folds of investment and maintenance costs as well as add a possible cause of natural disasters as compared with the new road construction in a flat land. Unless there is any specific consensus to open up the mountains, this type of new road construction should be avoided in principle.

In view of the present highway network in the Southern Region, however, it would be worthwhile to have a standpoint that every sub-district center should have accessibility to the existing highway network. In the Southern Region, Ko Lanta is the only amphoe that has no direct connection to the highway network. The island should be connected with the main land through bridges, coupled with upgrading of the existing rural roads to bitumen standard and construction of some missing links.

For developing the Southern Border Provinces, highway development is be very important, particularly toward the western side of the area. Although the area is surrounded by the Sankalakhiri Mountain Range, new road construction would become necessary especially in the following sections:

(1) direct highway link between Narathiwat and Yala;
(2) a highway connecting Route No. 4 with Route No. 4085 in the south of Route No. 42 based on the existing rural roads; and
(3) a highway connecting Route No. 4 with Route No. 406 to provide easy access between Satun and Pattani/Yala.

Fig. 4.3.1 shows proposed new highways extending from the existing highway network with a view to providing:

(1) short cut route to save distance;
(2) bypass to detour city centers; and
(3) new highways for area development.

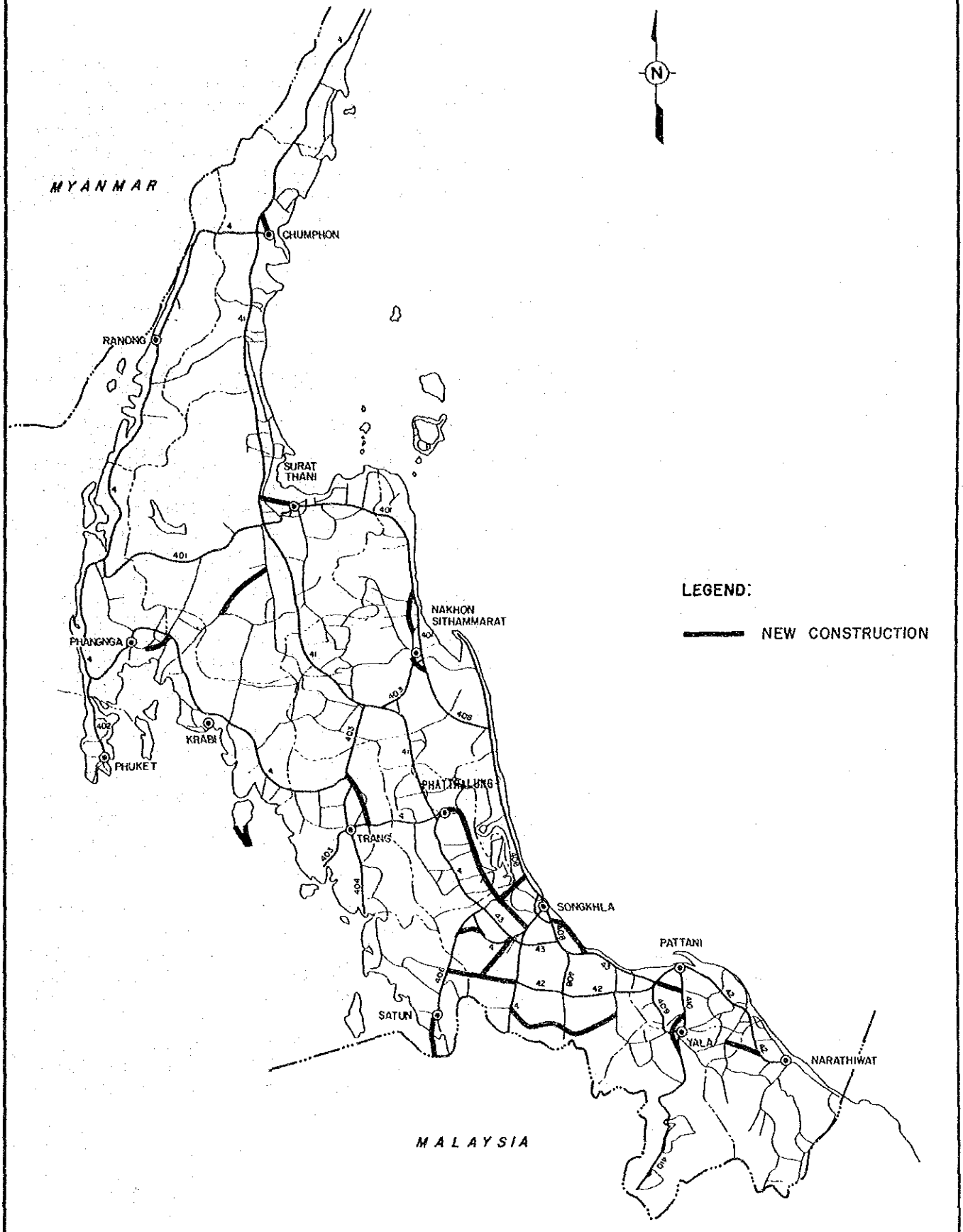


Fig. 4.3.1 NEW ROAD CONSTRUCTION

The proposed new road constructions are based as a rule on the existing roads under the jurisdiction of such agencies as PWD and ARD, other than DOH, to minimize the possible environmental impact. Some part of the new constructions, however, cannot avert clearance of forest land. In such a case, environmental impact assessment should be performed in accordance with the procedures designed by relevant authorities which organization already has this kind of procedures or regulations.

4.3.3 Guideline 2: Disaster Prevention

The report, "Safeguarding the Future" prepared by the joint team of NESDB and USAID in 1989, summarizes the landslide/flood disaster in the South as follows:

"Reduction of natural ecosystem resilience on steep hillsides through a sequence of logging, slash and burn agriculture, and planting of young rubber caused the disaster. High rainfall served as the triggering factor. The hillsides are now more unstable. Further landslide damage is therefore likely in the coming heavy rainy season even if the rainfall is not unusually high. River channels have been raised and altered by sediment deposition. Danger exists not only of flash floods but also of more severe floods in the lowlands. In future years more events on the scale of the 1988 disaster unfortunately may be anticipated since the underlying cause of inappropriate land use remains unchecked."

"Replacement of roads, bridges and drain pipes requires more detailed attention to individual site needs. The use of prefabricated components and standards which appear to be based on past levels of water flow will not be sufficient to prevent damage in the future. Solution of these design problems must be linked to information gathering on watershed hydrology, especially during the coming heavy rainy season."

The above indication is very important in improving and developing highways to avoid repeated possible destruction and damages for the future. At the same time, however, investment efficiency would still remain as an important index for the time being when financial resources are still in short of the investment requirements to come up with the increasing traffic. It is urgently needed to establish a hydrological information system which provides basic data for preparing appropriate design standards by taking account of both disaster prevention and investment efficiency.

4.3.4 Guideline 3: Existing Conditions of Highways

Table 4.3.1 summarizes the existing conditions of highways in the Southern Region in terms of highway classification. The table shows that 21 percent of the highways is unpaved (Class 5 & 6) and that 42 percent belongs to Class 4 which has carriageway width of 5.5 meters. Vehicles, as a rule, are required to reduce their travelling speed to safely cross each other on a narrow carriageway of less than 6 meters. Unpaved surface forces vehicles to travel at slower speed than the paved one with higher energy consumption and damages on vehicles and cargos. It can, therefore, be inferred that two thirds of the whole highway network (Class 4, 5 and 6) belongs to substandard width and surface.

On top of the above, traffic capacity is behind the traffic volume, as discussed in 2.5.3. Most part of the existing highway network needs immediate improvement.

Fig. 4.3.2 illustrates location of the highways by pavement width. As can be easily understood, the highways of pavement width of 6.0 meters and above are sparsely distributed in the Southern Region.

Fig. 4.3.3 shows the ongoing highway projects in the Southern Region. DOH has continuously been improving the existing highway network to remove the immediate bottlenecks to smooth traffic flow. Projects are centered on provincial highways branching from the mainstay of Route No. 4 and 41, and national highway of Route No. 4 along the west coast.

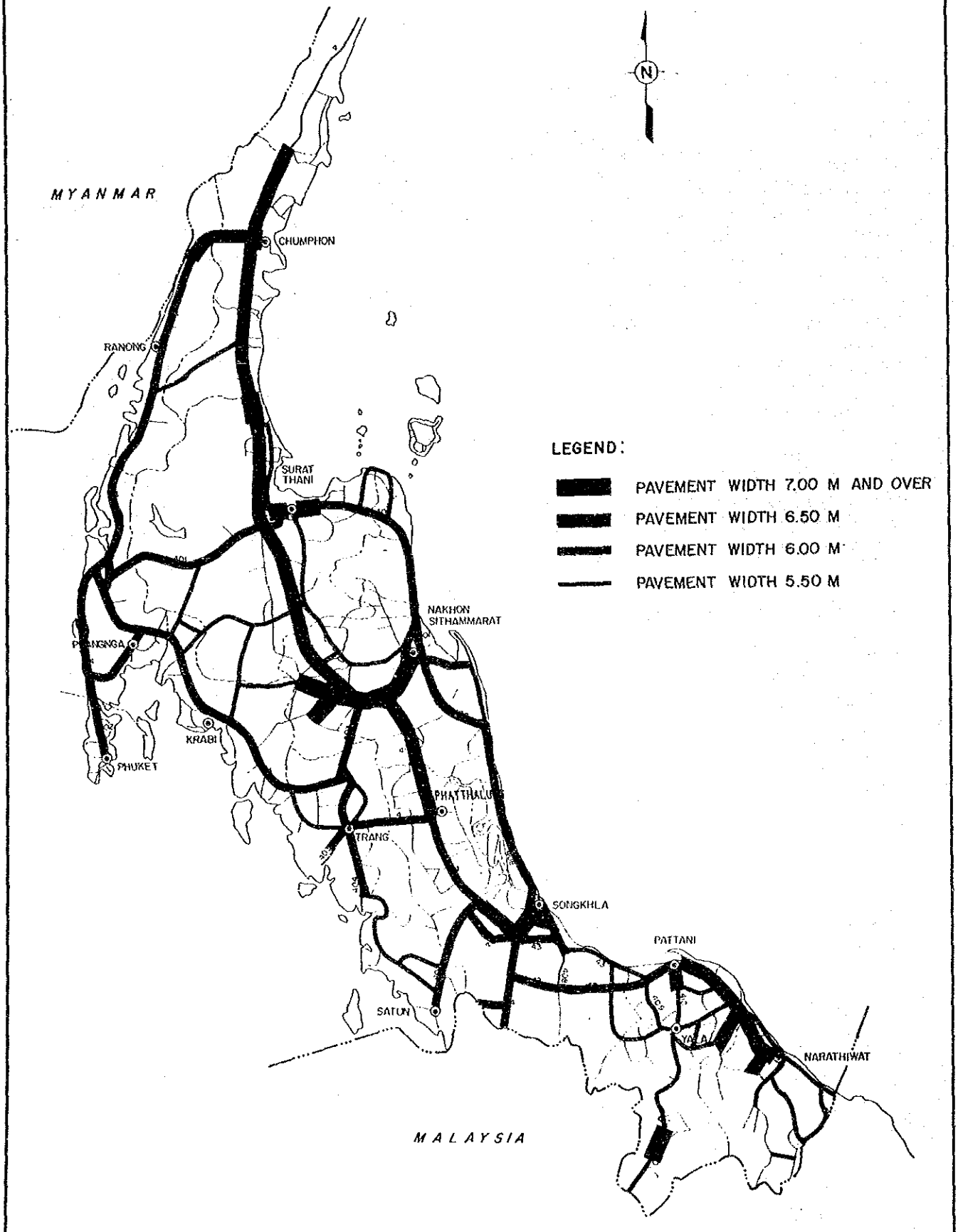


Fig. 4.3.2 PAVEMENT WIDTH IN 1990

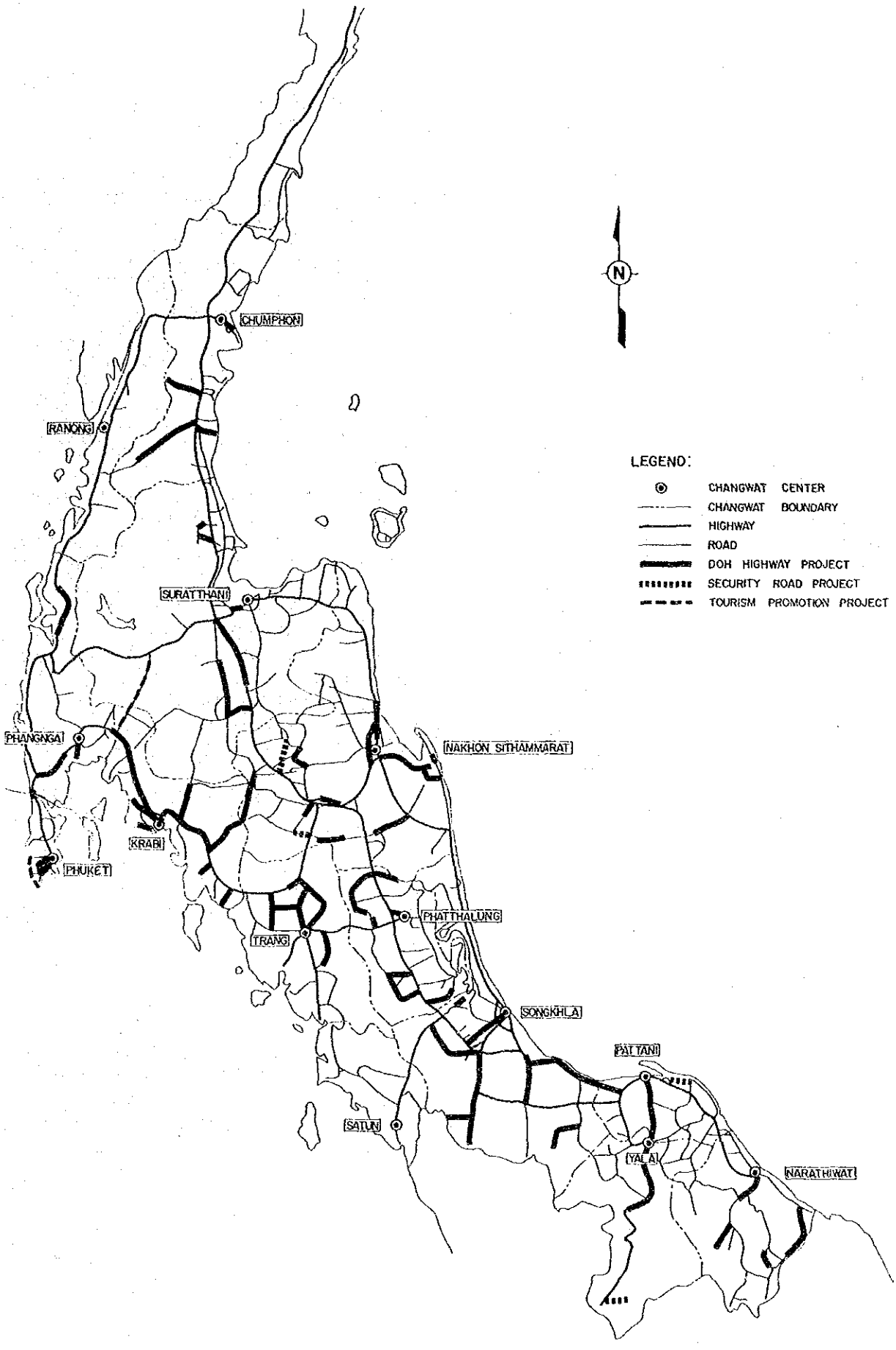


Fig. 4.3.3 ONGOING HIGHWAY PROJECTS IN THE SOUTHERN REGION

Table 4.3.1 Highway Classification by Standard

unit: km

Class	Primary (P)	Secondary (S)	Provincial (F)	Total	%	%
D	0	10	0	10	0.1	0.2
1	0	112	64	176	2.5	2.7
2	189	124	71	384	5.4	6.0
3	779	599	391	1,769	24.9	27.6
4	0	159	2,554	2,713	38.1	42.3
5	0	0	355	355	5.0	5.5
6	0	0	1,003	1,003	14.1	15.6
Sub Total	969	1,004	4,438	6,411	90.1	100.0
no data	0	578	127	705	9.9	
Total	969	1,582	4,565	7,116	100.0	

Source: DOH Road Data Base, October 1990

Note: Class D Four Lane Highway
1 Two Lanes of Paved Carriageway (7.0 m)
2 Two Lanes of Paved Carriageway (6.5 m)
3 Two Lanes of Paved Carriageway (6.0 m)
4 Two Lanes of Paved Carriageway (5.5 m)
5 Unpaved Surface of 9.0 meter width (sub-standard)
6 Unpaved Surface of 6.0 meter width (sub-standard)

* Secondary Highways of "F" standard are included in Provincial Highways.

4.3.5 Guideline 4: Future Traffic Demand

Future traffic demand is estimated based on the economic framework in which the average growth rate of the Southern Region is assumed at 7.2 % for the period of 1988 - 2006 and the GRP share of the Southern Region will increase from 10.0 % in 1988 to 11.3 % in 2006. Average annual daily traffic (AADT) on the whole highway network in the Southern Region was estimated to increase from 551,000 in 1990 to 1,162,000 in 1996, 1,791,000 in 2001 and 2,633,000 in 2006, at an average annual growth rate of 10 % for the period of 1990 - 2006.

According to the forecast, the number of highway links which need additional lane construction was estimated at 33 links by 1996, additional 46 links by 2001, and further additional 61 links by 2006 out of the total 387 links, on an assumption that AADT exceeding 8,000 needs additional lane construction.

Fig. 4.3.4 illustrates highway links which need additional lane construction in 1996, 2001, and 2006. In 1996, highway links of additional lanes required are found in the vicinity of large urban centers on major national highways like Songkhla-Hat Yai, Surat Thani and Phuket as well as several sections on the mainstay of Route No. 4, 41 and 43. In 2001, most of the sections on Route No. 4, 41 and 43 need additional lanes to accommodate increasing traffic from Chumphon to the Malaysian border and to Pattani. Highway links of additional lanes are also found in the vicinity of provincial centers like Nakhon Si Thammarat, Krabi, Phangnga, Satun, and Yala. In 2006, additional lanes become necessary on Route No. 4 on the west coast and Route No. 401 and 408 on the east coast. Traffic volume on a highway link between Songkhla and Hat Yai is estimated to exceed 32,000 AADT in 2006. It is very likely that highway links near city and town need capacity increase earlier than the above estimated year if intra zonal traffic is taken into account.

Estimated future traffic volume defines the required capacity of highways. The discrepancy between the required and the existing capacities will indicate highway sections for required future improvement and/or new additional lane construction. Due to growing economic activities and progressive motorization for the future on one hand and low standard of existing highways on the other, it is very likely that most part of the existing highways needs capacity increase and upgrading of standard.

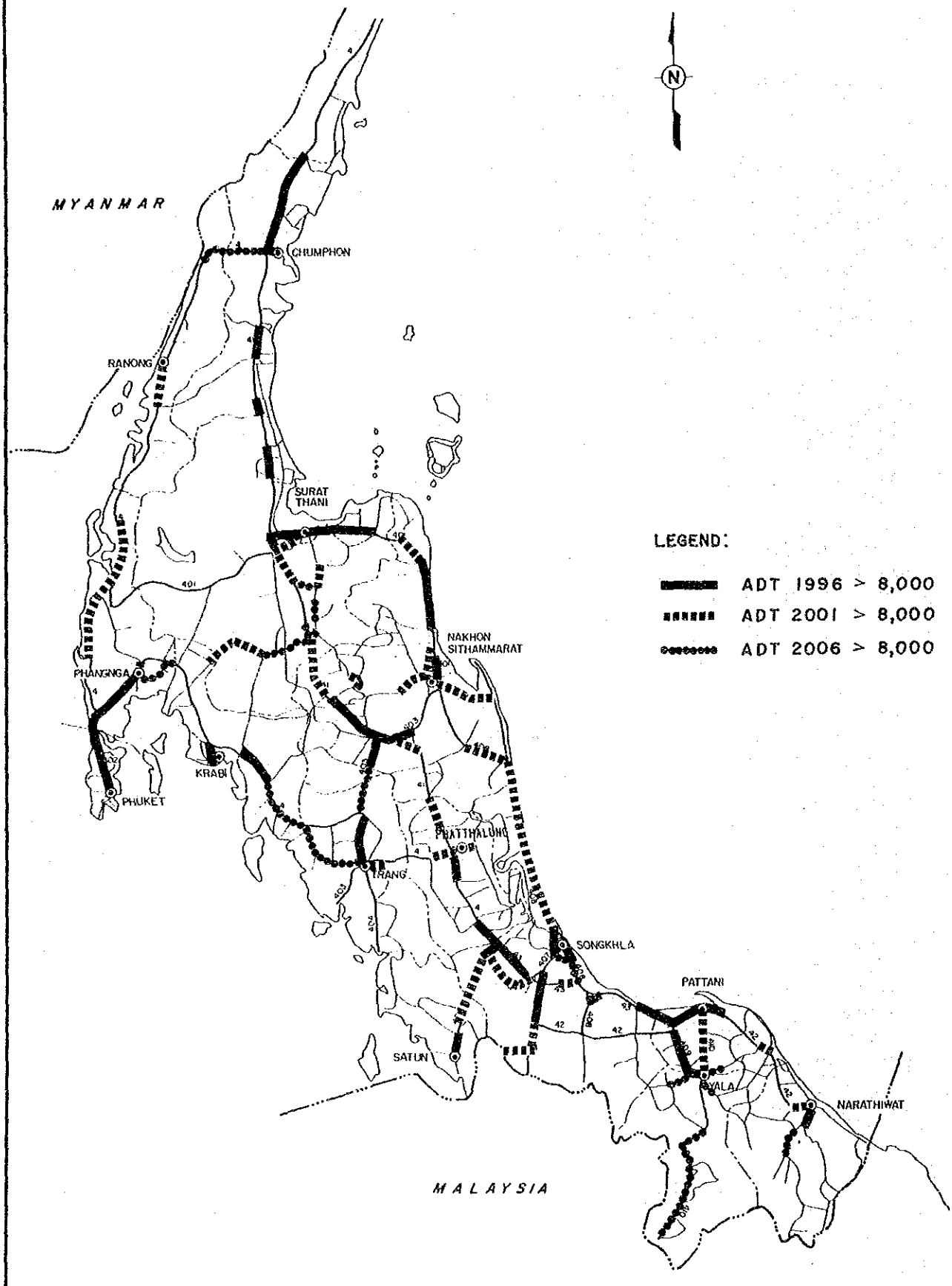


Fig. 4.3.4 CANDIDATE SECTIONS OF ADDITIONAL LANE CONSTRUCT

4.3.6 Guideline 5: Highway Development Concept

The highway network in the Southern Region is generally judged to be well structured: connecting sub-district centers with each other at possible shorter distance by avoiding intrusion into deep mountains. Rural roads branching from the highway network provides access to most part of the inner areas. This is seemingly the results of the past efforts with a focus on highway network extension in order to turn the unused land into agricultural production field.

In recent years, however, the economic situations have been shifting from agricultural extension to production of high value added products both in agriculture and industry. Market orientation has been emphasized to yield higher return. This phenomenon has been encouraging progress of urbanization.

Future development of the Southern Region will rely mostly on industrialization which would accelerate the urbanization trend including concentration of economic activities and population in urban areas, especially in such urban centers as Songkhla- Hat Yai, Phuket, Surat Thani, Nakhon Si Thammarat, and Pattani. This trend is very likely to generate increasing traffic in urban areas, coupled with more active demand for inter-city traffic.

Highway network development should aim to cope with this urbanization trend with more emphasis on capacity increase and upgrading of standard of the existing network than on further extension to depth of the inland. Highway network should also be developed to support such regional development programs as new economic zones, tourism, southern border provinces and the SSDP.

4.3.7 Highway Development Master Plan

A highway development master plan was established based on the discussions in the preceding sections. The highway development concept discussed in 4.2 outlines the future directions of highway network development of the Southern Region while the highway development guidelines discussed in 4.3.2 - 5 are the main factors to identify possible highway projects under the specific conditions of the region. Important points to be taken into account for developing a master plan of the highway network in the Southern Region are to:

(1) increase highway capacity, especially of national highways connecting main urban centers;

(2) increase highway capacity near city areas, including new bypass construction;

(3) supplement missing highway links to connect neighboring provincial centers, especially on the west coast and in the southern border provinces;

(4) upgrade highways of lower standard to Class 3 standard with pavement width of 6.0 meters to facilitate traffic flow;

(5) give more importance to disaster prevention and traffic safety; and

(6) pay full attention to environmental protection, particularly for new highway construction into mountain areas.

The highway development master plan for the year 2001 was established based on the traffic demand forecast by the year 2001 and 2006. Due to the increasing traffic volume for the future, capacity shortage was estimated to prevail on the most part of the existing highway network including national and provincial highways.

As shown in Fig. 4.3.5, the highway development master plan for the year 2001 contains major projects for increasing highway capacity:

(1) Additional lane construction or new road construction to prepare total six lanes in urban corridors of Songkhla- Hat Yai, Surat Thani and Phuket;

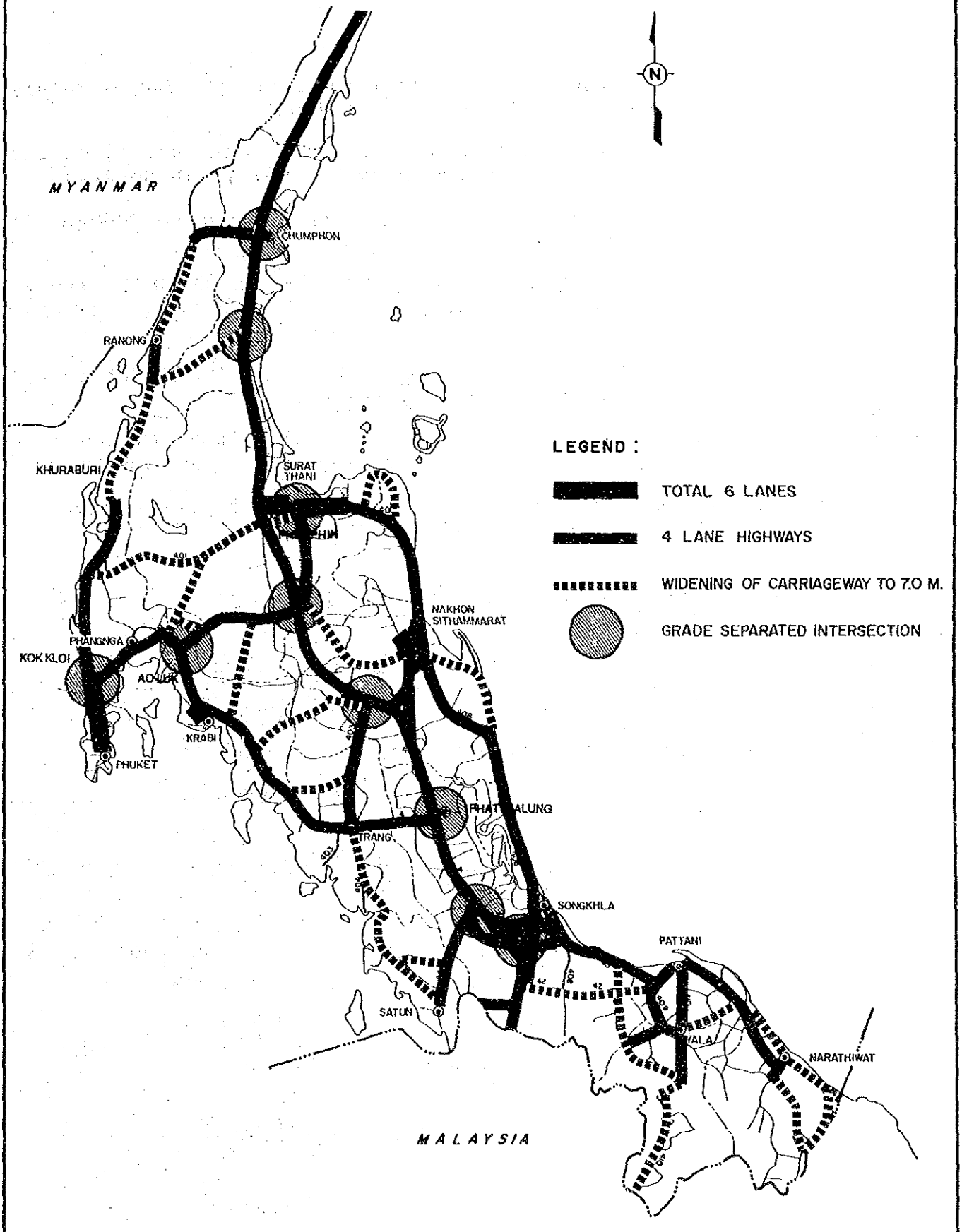


Fig. 4.3.5 HIGHWAY DEVELOPMENT MASTER PLAN 2001

(2) Additional Lane Construction to Four Lanes mainly on National Highways including;

a) The North-South Artery of Route No. 4, 41 and 43 from Chumphon to the Malaysian Border;

b) Route No. 401 from Phun Phin to Nakhon Si Thammarat;

c) Routes branching from the North-South Artery of Route No. 4, 41 and 43 to Ao Luk, Trang, Nakhon Si Thammarat and Satun;

d) Route No. 43 and 42 from Hat Yai to Narathiwat through Pattani; and

e) Route No. 4 from Khuraburi to Kok Kloi and from Kok Kloi to Phatthalung via Krabi and Trang.

(3) Widening of carriageway to 7.0 meters for connecting a multi lane highway to another; and

(4) Construction of grade separated intersections mainly at junctions of multi lane highways.

In order to ensure better accessibility to any sub-district centers away from the above highways, upgrading of provincial highways should be performed at the same time, including:

(5) Complete pavement of provincial highways;

(6) Upgrading every highway to Class 3 standard of pavement width of 6.0 meters; and

(7) Construction of bypass to the city areas of provinces as well as major sub-districts.

Total length of major projects in the master plan of 2001 amounts to 2,330 kilometers comprising:

(1)	Total Six (6) Lanes	150 km
(2)	Four (4) Lanes	1,210 km
(3)	Widening of Carriageway to Seven (7) Meters	970 km
	Total Length	2,330 km

4.4 Rural Road Development

4.4.1 Guidelines for Rural Road Development

The Sixth National Economic and Social Development Plan (1987 - 1991) stipulates the operational guidelines for solving rural problems, particularly guidelines for solving rural transport and communications as follows:

(1) Accord priority to improving and maintaining existing rural roads especially where there is an urgent need. New construction will be limited to missing links that are necessary to connect the network to national and provincial highways;

(2) Place special emphasis on the construction, improvement and maintenance of rural roads that directly support local and regional economic activities such as development of tourism and rural industry, transport of products to markets, and exports. Routing priorities will be selected with due regard to the other development activities; and

(3) Prioritize backward areas that have communication problems, especially in areas where there is an urgent need and border areas where there are security problems. Construction and maintenance should aim at ensuring the availability of all weather roads.

Major function of the highway network under the Department of Highways (DOH) is to accommodate inter regional, inter provincial and inter sub-district traffic demand in an economically efficient way. Rural roads, however, place more importance to the standard of living of local communities by providing accessibility to various facilities necessary for daily life. Although emphases on highways and rural roads are placed differently, highways and rural roads should be formed into an integrated total road system to ensure undisturbed vehicular traffic from an origin in a local community to a destination in another.

Based on the above considerations, development guidelines for rural roads can be enumerated as follows:

(1) The standard of rural roads should be upgraded to accommodate vehicular traffic to comply with the increasing trend of motorization in recent years;

(2) The existing rural roads should be upgraded to all-weather roads to assure the roads passable even in rainy season;

(3) Maintenance practices should be improved to ensure better accessibility throughout a year;

(4) Right-of-Way for new rural roads should be acquired to allow widening of carriageway to accommodate likely increase of vehicular traffic in the future; and

(5) Impact of rural road construction on natural environment should be assessed carefully because rural roads are likely to invade into the environmentally sensitive areas.

4.4.2 Priority Area for Rural Road Development

Fig. 2.6.2 shows the villages of lower accessibility in the Southern Region. These villages have been suffering either unavailability of access roads to sub-district centers or unavailability of bus services during rainy season. Rural road development should firstly be focused on these villages to satisfy the basic communication needs of local people.

Table 4.4.1 shows a list of important rural road development projects in the villages of lower accessibility on a basis of the following selection criteria:

(1) higher priority for the villages of lower income level than those of average;

(2) higher priority for the villages of large number of population engaging in labor intensive agricultural production;

(3) higher priority for the villages of such specific development programs as rural industry, tourism and security in the Southern Border Provinces; and

(4) higher priority for the villages without any road development programs in the near future.

Table 4.4.1 PRIORITY AREA FOR RURAL ROAD DEVELOPMENT

Name of Amphoe	Present Land Use	Production Level	Related Development	Priority	Remarks *1
1. Pathiu (Chumpon)	Orchard, Plantation	Low	-	II	Dan Yang (L), Pak Klong (L)
2. La-un (Ranong)	Plantation Mountainous	Low	Proposed road development by DOH	III	La-un Neu-uh (L), Bang Pra Neu-uh (M)
3. Muang Surat Thani (Surat Thani)	Orchard, Rice field	Low	-	I	Klong Chanak (M), Klong Nai (M), Bang Chana (L) Bang Sai (L), Bang Baimai (L), Bang Pho (M)
4. Khiri Rattanikhan (ditto)	Plantation, Rice field	Low	Wildlife sanctuary area	III	Takuk Tai (L), Takuk Neu-uh (L), Tam Singkorn (M)
5. Khian Sa (ditto)	Plantation	Middle	-	III	Paing Pram Karn (M), Aran Kamwaree (M), Ban Saded (M)
6. Phanom (ditto)	Plantation, Forest	Low	-	II	Panom (L), Klong Sak (L), Phu Teu-un (L), Pang Karm (L)
7. K.A. Chai Buri (ditto)	Plantation, Forest	Low	Partially Wildlife sanctuary	III	Sang Prake (L), Chaiburi (L)
8. K.A. Koyao (Phangnga)	Plantation, Forest	Middle	-	III	Ko Yao Yai (L), Pru Nai (M)
9. Ko Lanta (Krabi)	Plantation, Forest	Low	-	II	Ko Lanta Yai (L), Ko Klong (L), Ko Lanta Nai (M), Klong Yang (L)
10. Pak Phanong (Nakon Si Thammarat)	Rice field, Orchard	Low	-	I	Bang Tapong (L), Pa Rakan (L), Ban Mai (L), Hu long (L), Laem Talum Puk (L), Pak Pruke (L)
11. Chain Yai (ditto)	Rice field, Orchard	Low	-	I	Kao Prabaht (L), Chain Kao (L), Ta Kanarn (L), Ban Klong (L), Ban Nern (L), Seu-uh Heung (L), Sai Mark (L)
12. Cha-uat (ditto)	Orchard Rice field,	Low	-	I	Kawn Had (L), Treng (L), Nang Lang (L)
13. Lan-saka (ditto)	Plantation, Forest	Middle	National park	III	-
14. K.A. Bang Khan (ditto)	Plantation, Forest	Middle	-	III	Ban Kan (L), Wang Hin (L), Ban Nikom (M)
15. Tepha (Songkhla)	Rice field, Orchard	Middle		II	Ko Saba (M), Tha Moing (M), Pak Bang (L), Wang Yai (M)
16. Ruso (Narathiwat)	Orchard, Plantation	Middle		II	Ba Tong (M), Rieng (M), Sa Waw (M), Suwaree (M), Kok Sataw (L)
17. K.A. Cha-nae (ditto)	Forest, Plantation	Low		II	-

*1 Name of the related Tumbong
L: Low income
M: Middle income

4.4.3 Institute for Rural Road Development

In order to enhance the efficiency of rural road development, it would be imperative to review the present system of administration and institution for rural road development and maintenance. As described in section 2.6, there are so many agencies working independently for rural roads with their specific purposes. As stipulated in the Sixth National Economic and Social Development Plan, it is very important to "establish working groups under the supervision of the Planning and Project Subcommittee to study guidelines for developing rural roads and ensure that they conform to rural development policies."

The rural road development system should integrate the whole process of planning, implementation, and monitoring under a single body. Under such a system, every agency engaged in rural road development and maintenance should be assured of easy access to the central information system which stores updated inventory of the rural road network. At the same time, mapping system of the rural road network should be standardized to facilitate information transaction though every agency, at present, uses various types and scales of maps just for their internal use.

In order to develop an integrated body on rural road development, DOH should play a key role in coordinating and giving guidance to the related agencies because of its long time involvement in the rural road development, particularly in: acceptance of rural roads to DOH highway network; and maintenance works acting for other agencies and local government.

DOH should support establishing the rural road information system as well based on its cumulated experience until now to make information transaction between the rural road database and the DOH's highway database easier and more efficient.

CHAPTER 5

Highway Projects by the Year 1996

5. HIGHWAY PROJECTS BY THE YEAR 1996

5.1 General

This chapter discusses the highway projects which are proposed to be implemented by the year 1996.

Firstly, a highway development master plan toward the year 1996 is proposed as an intermediate step on the way to the highway development master plan toward the year 2001 proposed in the preceding chapter.

Secondly, nineteen (19) projects totalling 914 kilometers were selected as priority projects for preliminary feasibility study. These projects include:

(1) new road construction (NC);
(2) additional lane construction (AD);
(3) widening of carriageway to 7.0 meters (WD7);
(4) widening of carriageway to 6.0 meters (WD6);
(5) reconstruction and widening of carriageway to 7.0 meters (RW7); and
(6) upgrading to bitumen standard (UBS).

Seventeen (17) projects were proved to be viable out of the nineteen (19) projects.

Thirdly, eight (8) projects were selected out of the above seventeen (17) projects for further feasibility study based on the results of the pre-feasibility study as well as through the coordination with the Government policy to construct additional two lanes on the mainstay of Route No. 4, 41 and 43 from Bangkok to the Malaysian border. The eight (8) projects are:

(1) Chumphon City Link (NC-1);
(2) Surat Thani Additional Lane (AD-1);
(3) Phuket Additional Lane (AD-2);
(4) Thap Put Bypass (NC-3);
(5) Hua Sai - Songkhla Highway (WD-7);
(6) Palian - Khuan Kalong Highway (WD6-1);
(7) Highway 4/406 Short Cut Route (NC-5); and
(8) Yala - Narathiwat Highway (RW7-1).

Project Cost of the highway development master paln toward the year 1996 was estimated at 15.0 billion baht including 2.5 billion baht for the eight F/S projects, 3.9 billion baht for the remaining pre F/S projects and 8.6 billion baht for the remaining master plan projects. The total project cost is about 2.8 times as large as the budget of the Sixth Five Year Plan period.

5.2 Highway Development Master Plan toward the Year 1996

The highway development master plan toward the year 2001 was established in view of the estimated traffic demand in 2006 as discussed in the preceding chapter. Based on the long term master plan, a medium term master plan toward the year 1996 is to be prepared in line with the Seventh Five Year Plan period (1992 - 1996). This master plan should be deemed as an intermediate step toward the year 2001.

It is likely that the highway capacity shortage will become more apparent on most of the highway network toward 1996. In order to better support the regional development plans in the Southern Region, more emphasis should be placed on improving the existing major highways which forms the spine of the region.

Fig. 5.2.1 shows a proposed highway network development master plan toward the year 1996, the end year of the Seventh Five Year Plan Period. Major projects are consisted of:

(1) additional lane construction to four lanes on the north-south artery of Route No. 4, 41 and 43 from Chumphon to the Malaysian Border;

(2) additional lane construction to four lanes on Route No. 402 and 4 from Phuket to Phangnga and Route No. 401 near Surat Thani city;

(3) widening of carriageway to 7.0 meters on Route No. 4 running on the west coast of the region from Chumphon through Trang via Ranong (some exceptions);

(4) widening of carriageway to 7.0 meters on the east-west link between Surat Thani and Phangnga;

(5) widening of carriageway to 7.0 meters on Route No. 408 from Nakhon Si Thammarat through Songkhla on the east coast which runs in parallel with the regional mainstay of Route No. 41 and 4;

(6) widening of carriageway to 6.0 meters on the west coast link from Trang to Khuan Kalong with some realignment sections;

(7) construction of a new link to Chumphon city and city bypasses to such city centers as Nakhon Si Thammarat, Trang and Yala from main highways to ease traffic concentration in urban centers; and

(8) construction of new links to provide direct connection with the DOH highway system from every sub-district as well as to provide better connection between provincial centers.

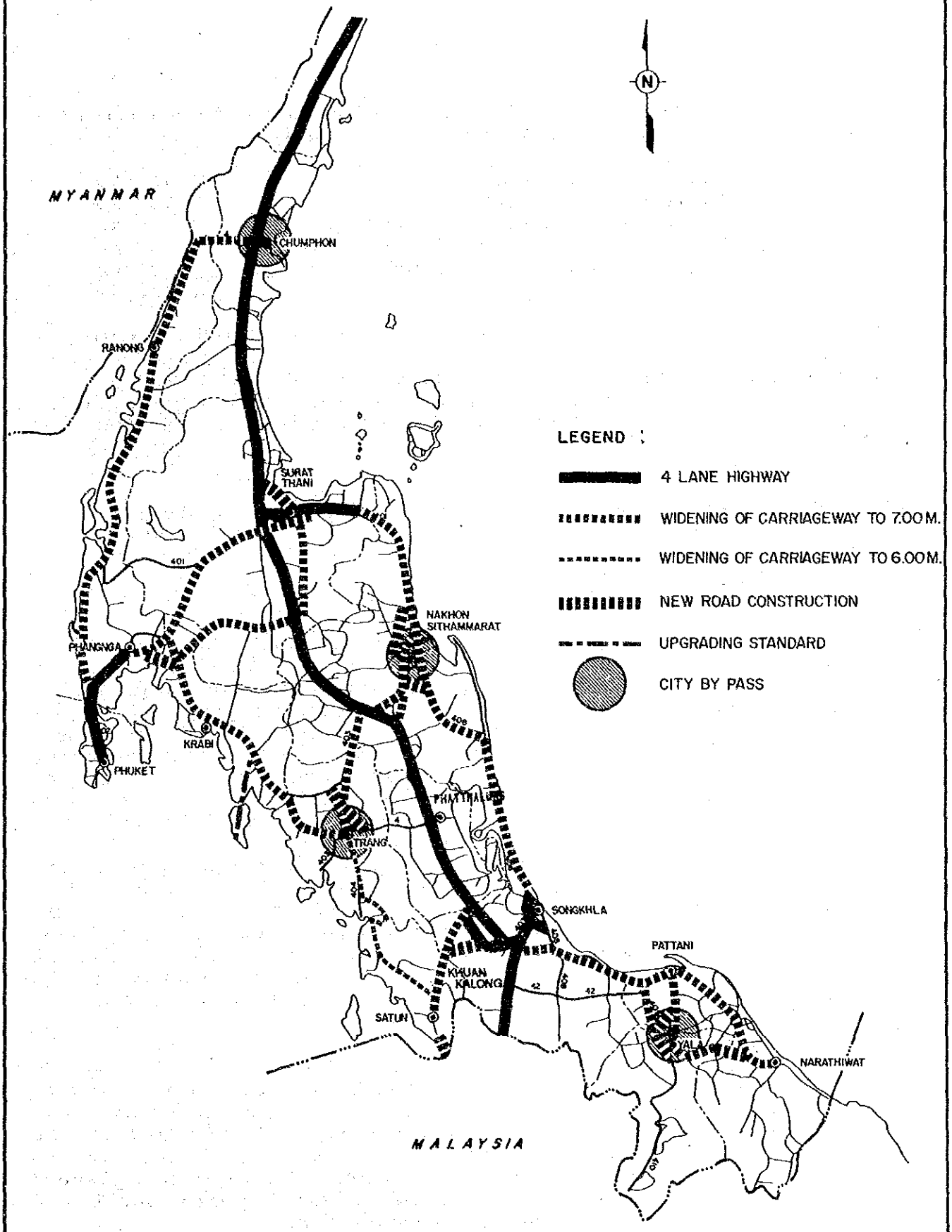


Fig. 5.2.1 HIGHWAY DEVELOPMENT MASTER PLAN 1996

Total length of the projects proposed in the master plan toward the year 1996 amounts to 2,620 kilometers, including:

(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

On top of the above projects, the ongoing efforts should be continued to pave the highways of soil aggregate surface and upgrade the sub-standard highways to the DOH standard. Preparatory works will also be required during this period to cope with the increase of additional lane construction projects toward the year 2001.

5.3 Preliminary Feasibility Study on Priority Projects

5.3.1 Policy for Selection

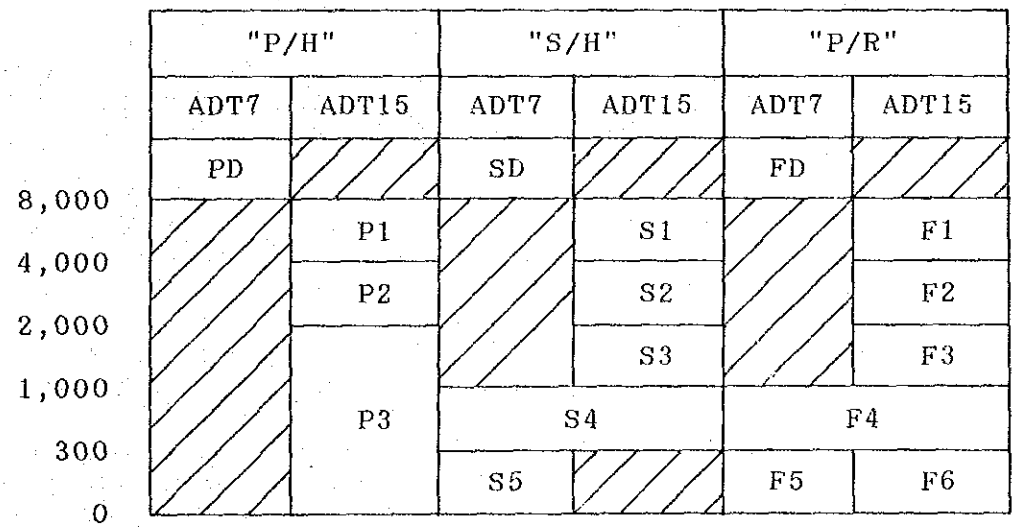
The Scope of Work for this Study specifies that the feasibility study in the Phase 3 of this Study should be carried out on about three hundred (300) kilometers for the selected priority projects. Of the highway development/improvement projects proposed in the master plan toward the year 1996, it was decided firstly to select priority projects of about nine hundred (900) kilometers for preliminary feasibility study. Secondly, based on the results of the pre-feasibility studies, projects amounting to the total length of about 300 km were to be selected for the feasibility study.

The Department of Highways (DOH) has its own criteria on screening highway improvement projects as shown in Table 5.3.1. According to the table, a highway section of AADT of 8,000 and over in 7 years later is planned to be "PD/SD/FD" standard which has four lanes with pavement width of 14.0 meters. A highway section of AADT in a range of 4,000 - 8,000 in 15 years later is planned to be "P1/S1/F1" standard which has two lanes with pavement width of 7.0 meters.

The DOH revises its future traffic estimate every year to upgrade highway sections which do not have enough capacity to accommodate the estimated traffic demand. The existing "P2" standard highway, for instance, is planned to be upgraded to "P1" standard if the AADT in 15 years later is estimated to exceed 4,000 but remains less than 8,000. The existing "P1" standard highway is not planned to be upgraded to "PD" standard for several years until the estimated AADT exceeds 8,000 in 7 years later.

Table 5.3.1 DOH'S CRITERIA FOR HIGHWAY IMPROVEMENT

ADT	"P/H"	"S/H"	"P/R"	WP	ST
ADT7>8,000	PD	SD	FD	14.0	ASC
8,000>ADT15>4,000	P1	S1	F1	7.0	ASC
4,000>ADT15>2,000	P2	S2	F2	6.5	ASC
2,000>ADT15	P3			6.0	DB
2,000>ADT15>1,000		S3	F3	6.0	DB
1,000>ADT15 and ADT7>300		S4	F4	5.5	DB
1,000>ADT15 and ADT7<300		S5		9.0	SA
1,000>ADT15>300 and ADT7>300			F5	9.0	SA
300>ADT15			F6	6.0	SA



Source: Planning Division, DOH

Note: 1) ADT Average Daily Traffic
2) P/H Primary Highway
3) S/H Secondary Highway
4) P/R Provincial Road
5) WP Width of Pavement
6) ST Surface Type
7) ASC Asphalt Concrete
8) DB Double Surface Treatment
9) SA Soil Aggregate
10) ADT7 ADT in 7 Years Later
11) ADT15 ADT in 15 Years Later

As discussed in 4.3.4, more than 90 percent of the highways in the Southern Region belongs to the standards of "Class 3 and below" which is expected to accommodate AADT of less than 2,000 in 15 years later. Even in 1989, average AADT on the provincial highways reached 3,100 which requires "Class 2" standard. In terms of the DOH criteria, almost all the highways in the Southern Region likely need immediate upgrading, capacity increase in particular. A rapid increase of vehicular traffic in recent years has caused a chronic lag of highway upgrading to come up with the traffic demand due to budgetary as well as institutional constraints.

Taking account of the above discussions, the study team prepared a set of criteria to select the highway sections for improvement:

(1) "Additional lane construction" is required for the two lane highway sections on which traffic demand is estimated at 8,000 AADT and over in 1996 irrespective of the existing highway standard;

(2) "Widening of Carriageway to 7.0 meters" is required for the highway sections of the existing pavement width of 6.0 meters or less on which traffic demand is estimated to be less than 8,000 AADT in 1996 but exceed 8,000 AADT in 2006;

(3) "Widening of Carriageway to 7.0 meters" is required as well for the highway sections where difference of pavement width between the existing and the required exceeds 1.5 meters; and

(4) "Widening of Carriageway to 6.0 meters" is required for the highway sections where difference of pavement width between the existing (5.0 meters or less) and the required exceeds 1.0 meters.

In addition to the upgrading of the existing highways, the study team also prepared a set of criteria for selecting new road construction and other improvement projects:

(1) Bypasses should be developed around the city centers where plural national highways intersect each other;

(2) Missing links and short cut routes should be developed to shorten the travel distance between provincial centers with due consideration to natural environmental conservation; and

(3) Highways should be developed to connect every sub-district center with the DOH highway system.

Finally, a policy judgement by DOH was introduced to select the projects for the pre-feasibility study in view of:

(1) avoiding duplication with the planned and ongoing projects;

(2) providing better connection to the planned and ongoing projects with the surrounding highway network; and

(3) reducing too much concentration of projects on the mainstay of Route No. 4 and 41 because of the Government determination to construct additional two lanes from Bangkok to the Malaysian border.

5.3.2 Priority Projects by 1996

Projects for the preliminary feasibility study were selected out of the projects proposed by the highway development master plan toward the year 1996 based on the above selecting criteria. Table 5.3.2 shows a list of projects for the preliminary feasibility study and Fig. 5.3.1 shows their locations. Total length of the projects is measured at about 914 kilometers:

Table 5.3.2 PROJECTS FOR PRELIMINARY FEASIBILITY STUDY

Name of Project	Length(KM)	Planning Standard
NEW ROAD CONSTRUCTION (NC)	102.3 km	
NC-1 Chumphon City Link	9.4	F1
NC-2 Nakhon Si Thammarat Bypass	20.5	F1
NC-3 Thap Put Bypass	7.7	S1
NC-4 Trang Bypass	30.7	F1
NC-5 Short Cut Route (4 - 406)	17.3	S3
NC-6 Yala Bypass	16.7	S1
ADDITIONAL LANE CONSTRUCTION (AD)	237.1	
AD-1 Route No. 401 (41 - 4142)	60.4	SD
AD-2 Route No. 402 Phuket - Kok Kloi	45.6	SD
AD-3 Route No. 4 Kok Kloi - Phangnga	35.6	PD
AD-4 Route No. 4 and 43 Phatthalung - Hat Yai	95.5	PD
WIDENING OF CARRIAGEWAY TO 7.00 M (WD7)	365.2	
WD7-1 Route No. 4009 Surat Thani - Wiang Sa (including Additional Lane to city)	62.8	F1
WD7-2 Route No. 4035 Phra Saeng - Ao Luk	68.1	F1
WD7-3 Route No. 4046 to Trang	49.0	F1
WD7-4 Route No. 408 Hua Sai - Songkhla	95.4	S1
WD7-5 Route No. 4 Ranong - 4006	25.9	P1
WD7-6 Route No. 401 from Phun Phin to 416	64.0	S1
WIDENING OF CARRIAGEWAY TO 6.00 M (WD6)	79.2	
WD6-1 Route 417(4078) Palian - Khuan Kalong	79.2	S3
RECONSTRUCTION & WIDENING TO 7.00M (RW7)	51.2	
RW7-1 Yala - Narathiwat Link	51.2	F1
UPGRADING TO BITUMEN STANDARD	78.7	
UBS-1 Ko Lanta Link	78.7	F3
Total Length	913.6 km	

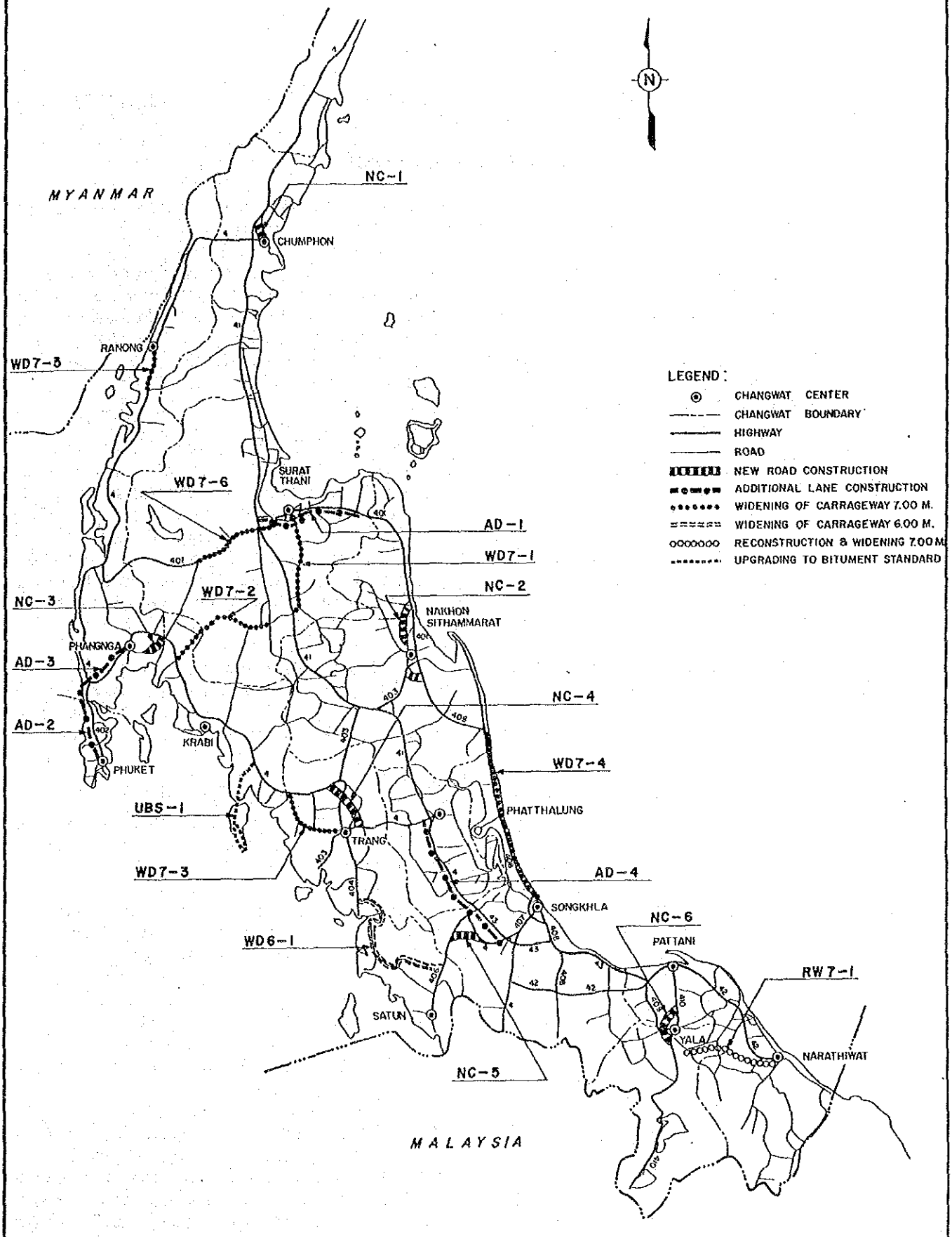


Fig. 5.3.1 PROJECTS FOR PRELIMINARY EVALUATION

Main objectives and specific characteristics of the nineteen projects are outlined as follows.

1) **New Road Construction Projects (NC)**

Six (6) projects were identified as "new road construction" project, totalling up to 102.3 kilometers.

NC-1 Chumphon City Link (9.4 km): Chumphon city needs a new highway link to Route No. 4 to secure an alternative route even in such a case of devastating disaster as experienced in 1989 as well as to ease traffic concentration on the existing Route 327. The alignment should be studied for better connection with Route No. 4 including the best use of the existing PWD road.

NC-2 Nakhon Si Thammarat Bypass (20.5 km): Extension of the existing Nakhon Si Thammarat Bypass to both north and south is required to ease traffic congestion in the city center with a view to separating urban and through traffics.

NC-3 Thap Put Bypass (7.7 km): Thap Put Bypass is planned to facilitate traffic movement between Surat Thani and Phuket and to ease traffic concentration at Thap Put intersection where local market is located.

NC-4 Trang Bypass (30.7 km): Trang Bypass is required to ease traffic concentration at the center of Trang city where three national highways of Route No. 4, 403 and 404 intersect each other as well as to mitigate flooding damages in rainy season.

NC-5 Short Cut between Route No. 4 and 406 (17.3 km): Improved accessibility from Satun to Hat Yai/Songkhla is important to stimulate economic development in Satun, particularly for tourism development.

NC-6 Yala Bypass (16.7 km): Yala Bypass is required to streamline the traffic flow to the city center on the two national highways of Route No. 409 and 410 as well as to mitigate flooding damages.

2) **Additional Lane Construction Projects (AD)**

Four (4) projects were identified as "additional lane construction" project, totalling up to 237.1 kilometers.

AD-1 Route No. 401 between the intersections with Route No. 41 and 4142 via Surat Thani Bypass (60.3 km): Additional two lanes of 7 meter pavement width are planned to be constructed along the existing highway excluding the existing four lane section between Phunphin and Surat Thani to cope with the increasing traffic demand in and around Surat Thani city.

AD-2 Route No. 402 between Phuket and Kok Kloi (45.6 km): Additional two lanes are planned to be constructed to accommodate increasing large volume of traffic among Phuket city, Phuket Airport and beaches on the west coast to support the tourism development in the island.

AD-3 Route No. 4 between Kok Kloi and Phangnga (35.6 km): Additional two lanes are planned to be constructed to accommodate traffic directing to Phuket and Surat Thani/Krabi, tourist excursion traffic around the Phangnga Bay in particular.

AD-4 Route No. 4 and 43 between Phatthalung and Hat Yai (95.5 km): Additional two lanes are planned to be constructed to facilitate inter-regional traffic movement. This is a part of "the four lane highway project from Bangkok to the Malaysian border" determined by the Government.

3) **Widening of Carriageway to 7.00 m (WD7)**

Six (6) projects were identified as "widening of carriageway to 7.00 meters", totalling up to 365.2 kilometers.

WD7-1 Route No. 4009 between Surat Thani Bypass and Wiang Sa (62.8 km): The existing pavement width of 5.50 meters is planned to be widened to 7.00 meters. A project of additional two lane construction between the center of Surat Thani city and Surat Thani Bypass (3 km) is to be included in this project.

WD7-2 Route No. 4035 between Phra Saeng and Ao Luk (68.1 km): The existing pavement width of 5.00 meters is planned to be widened to 7.00 meters for better linkage between Route 41 and the west coast, coupled with the widening of Route No. 4009.

WD7-3 Route No. 4046 between Trang and intersection with Route No. 4 (49.1 km): The existing pavement width of 5.50 meters is planned to be widened to 7.00 meters, including a new construction section of 2 kilometers.

WD7-4 Route No. 408 between Songkhla and Hua Sai (95.4 km): The existing pavement width of 6.00 meters is planned to be widened to 7.00 meters to provide an alternative highway between Songkhla and Nakhon Si Thammarat.

WD7-5 Route No. 4 between Ranong city and the intersection with Route No. 4006 (25.9 km): The existing pavement width of 6.00 meters is planned to be widened to 7.00 meters as a part of the highway improvement program on the west coast.

WD7-6 Route No. 401 between Phunphin and the intersection with Route No. 416 (64.0 km): The existing pavement width of 6.00 meters is planned to be widened to 7.00 meters for better east-west linkage and to cope with the expanding influence sphere of Surat Thani city.

4) **Widening of Carriageway to 6.00 m (WD6)**

Only one (1) project was identified as "widening of carriageway to 6.00 meters" project, totalling up to 79.2 kilometers including a new construction section of 19 kilometers.

WD6-1 Route No. 417 (4078) between Palian - Khuan Kalong: The existing pavement width of 5.00 meters is planned to be widened to 6.00 meters as a part of the highway development program along the west coast. Realignment sections are included in amphoes of Thung Wa and Langu.

5) **Reconstruction and Widening of Carriageway to 7.00 m (RW7)**

RW7-1: This is a package program to develop a direct highway link between Yala and Narathiwat in the Southern Border area, totalling up to 51.2 kilometers including new construction section of 25 kilometers. The project comprises:

(1) Route No. 4063: widening of the existing pavement width of 6.00 meters to 7.00 meters;
(2) Route No. 4066: widening of the existing pavement width of 5.00 meters to 7.00 meters;
(3) Route No. 4107: same as above (2); and
(4) reconstruction of an ARD road to a DOH standard highway of 7.00 meter pavement width connecting Route No. 4066 to Narathiwat.

6) **Upgrading to Bitumen Standard (UBS)**

UBS-1: This is a package program to develop a highway link from Route No. 4 to Amphoe Ko Lanta which is the only one amphoe that has no direct link to the DOH highway system at present, totalling up to 78.7 kilometers. The project comprises:

(1) Route No. 4206: upgrading to bitumen standard with pavement width of 6.00 meters;
(2) Construction of two bridges connecting Ko Klang with Ko Lanta Noi and Ko Lanta Noi with Ko Lanta Yai;
(3) Upgrading of the existing laterite roads of 4 meter width to pavement F3 standard on the Ko Lanta Noi and the Ko Lanta Yai islands; and
(4) New road construction on the southern past of Ko Lanta Yai.

5.3.3 Pre-Feasibility Study on Priority Projects

As outlined in the above section, nineteen (19) projects were selected as the projects for the preliminary feasibility study. This section summarizes the results of the pre-feasibility study. "Volume 3" of this report discusses more details of this part.

1) Design Policy

Preliminary designing of the projects was carried out based on the following design policy:

a) the DOH standard is to be applied in designing;
b) improvement is to be based on the best use of the existing highways;
c) earth work materials are to be procured from borrow pit; and
d) appropriate measures are to be incorporated into designing for preventing the damages caused by natural disasters.

A series of standard pattern of design was prepared for preliminary designing of the projects. Each project was designed by applying appropriate standard patterns by taking account of the project site information mainly based on the DOH road data base and site reconnaissance.

2) Project Cost

Table 5.3.3 shows project costs for all the projects. Total project cost of the nineteen projects amounts to about 6.1 billion baht in 1990 prices over the total length of 914 kilometers.

For new construction projects (NC), the total cost of 6 projects amounts to 1,322 million baht over the total length of 102 kilometers. Average cost per kilometer is calculated at 12.9 million baht. Yala Bypass (NC-6) is costly because of new construction of long bridges over a short length of the project.

The total cost of additional lane construction (AD) amounts to 2,463 million baht over the total length of 237 kilometers. Average cost per kilometer is calculated at 10.4 million baht.

The total cost of widening of carriageway to 7.0 meters (WD7) amounts to 929 million baht over the total length of 365 kilometers. Average cost per kilometer is calculated at 2.5 million baht.

The project cost of widening of carriageway to 6.0 meters (WD6) amounts to 251 million baht over the total length of 79 kilometers. Average cost per kilometer is calculated at 3.2 million baht.

Table 5.3.3 SUMMARY OF COST

Route No.	Road Standard	Project Length (km)	Improved Length (km)	Financial Cost (Mil. Baht)	Cost / km (Mil. Baht)
NC-1	F1	9.4	9.4	93.5	10.0
NC-2	F1	42.6	20.5	280.4	13.7
NC-3	S1	7.7	7.7	82.9	10.8
NC-4	F1	30.7	30.7	383.1	12.5
NC-5	S3	17.3	17.3	140.2	8.1
NC-6	S1	16.7	16.7	342.3	20.5
Sub-Total	-	124.4	102.3	1,322.4	-
AD-1	SD	69.3	60.3	666.9	11.1
AD-2	SD	50.1	45.6	528.6	11.6
AD-3	PD	35.6	35.6	273.9	7.7
AD-4	PD	95.5	95.5	994.0	10.4
Sub-Total	-	250.6	237.1	2,463.4	-
WD7-1	F1(FD)	62.8	62.8	166.2	2.6
WD7-2	F1	68.1	68.1	200.2	2.9
WD7-3	F1	49.7	49.1	168.7	3.4
WD7-4	S1	95.4	95.4	140.4	1.5
WD7-5	P1	25.9	25.9	88.0	3.4
WD7-6	S1	64.0	64.0	165.6	2.6
Sub-Total	-	365.8	365.2	929.1	-
WD6-1	S3	98.2	79.2	251.2	3.2
RW7-1	F1	51.7	51.2	309.1	6.0
USB- 1	F3	78.7	78.7	804.0	10.2
Grand Total	-	969.4	913.6	6,079.2	-

The project cost of reconstruction and widening of carriageway to 7.0 meters amounts to 309 million baht over the total length of 51 kilometers. Average cost per kilometer is calculated at 6.0 million baht.

The project cost of upgrading to bitumen standard amounts to 804 million baht over the total length of 79 kilometers. Average cost per kilometer is calculated at as high as 10.2 million baht because of the new construction of two long bridges between islands.

3) Preliminary Economic Evaluation

(1) Economic Benefit

Preliminary economic evaluation was carried out for the nineteen (19) projects on the basis of comparison between "with" and "without" the project cases. Economic benefit of a project usually comprises savings on vehicle operating costs and travel hours that the project will produce over the "without" project case.

Project period is assumed to be 15 years after the project is open to traffic. The savings on vehicle operating cost and travel hours were estimated for 1996, 2001 and 2006 based on the results of traffic assignment, unit vehicle operating cost and unit time value. Economic benefit stream comprising the above savings was prepared for 15 years: savings in 1997 - 2000 and 2002 - 2005 were interpolated based on those in 1996, 2001 and 2006; and savings after 2006 were assumed to be equal to those of 2006.

Most of the projects in this study is designed to increase traffic capacity of the existing highways without significant changes of alignment. Average length of the projects of "Additional Lane Construction" and "Widening of Carriageway to 7.0 Meters" amounts to as long as 60 kilometers. These highways are major arterial highways in the Southern Region. It is anticipated that these highways will attract traffic from the other existing highways on which traffic volume is approaching to the traffic capacity. Because of these situations, substantial part of the benefit likely result from time savings.

The project UBS-1 (Ko Lanta Link), however, followed a different method of economic benefit estimation. The island has not been connected with the DOH highway network until now. It is likely that the most important economic benefit accruing to the project will be regional development of the island, tourism development in particular. Tourism development assumption was introduced to estimate economic benefit for 1996, 2001 and 2006.

(2) Economic Cost

Economic cost of a project comprises construction cost and maintenance cost. As explained in (2) above, unit construction cost per kilometer is high for the projects of new road construction (NC) and additional lane construction (AD) while it is low for the projects of widening of carriageway to 7.0 meters (WD7), widening of carriageway to 6.0 meters (WD6) and reconstruction and widening of carriageway to 7.0 meters (RW7). Additional maintenance cost is required for most of the projects due to the increased surface of carriageway.

(3) Results of Economic Evaluation

Table 5.3.4 summarizes the results of preliminary economic evaluation. Economic internal rates of return (EIRRs) are mostly calculated at over 12 % which is a bench mark rate to conclude the viability of highway projects in the country. Out of the nineteen (19) projects, seventeen (17) projects were judged viable, excluding NC-6 (New Construction of Yala Bypass) and WD7-6 (Widining of Route 401 to 7 meters). The EIRRs of NC-1 and AD-2 are very high because of the absolute shortage of capacity of the existing highways.

Table 5.3.4 SUMMARY OF PRELIMINARY ECONOMIC EVALUATION

Project	Cost	Benefit	NPV	B/C	EIRR
	(million baht)				(%)
New Construction (NC):					
NC-1 Chumphon	81.7	2,774.3	514	12.4	73.5
NC-2 Nakhon Si T.	249.5	968.6	9	1.1	12.6
NC-3 Thap Put	70.3	506.9	63	2.7	30.4
NC-4 Trang	336.7	1,259.8	6	1.0	12.3
NC-5 Rt. 4-406	118.8	4,566.4	726	11.3	53.8
NC-6 Yala	297.8	489.9	-99	0.4	4.1
Additional Lane (AD):					
AD-1 Rt. 401 (41-4142)	587.4	9,956.1	1,341	5.0	34.2
AD-2 Rt. 402 Phuket	466.0	29,618.1	4,388	17.5	77.6
AD-3 Rt. 4 Phangnga	231.7	9,959.5	1,496	12.4	51.0
AD-4 Rt. 4/43 Hat Yai	834.7	11,017.5	1,785	4.8	42.9
Widening 7.0 Meters (WD7):					
WD7-1 Rt. 4009 Surat	138.5	2,037.3	316	5.1	43.3
WD7-2 Rt. 4035 Ao Luk	166.5	1,292.6	120	2.3	21.8
WD7-3 Rt. 4046 Trang	140.7	587.3	28	1.4	16.0
WD7-4 Rt. 408 Songkhla	116.8	3,531.3	532	8.9	46.3
WD7-5 Rt. 4 Ranong	73.2	442.4	29	1.7	18.1
WD7-6 Rt. Rt. 401	137.7	371.0	-7	0.9	10.8
Widening 6.0 Meters (WD6):					
WD6-1 Rt. 417 Palian	211.4	1,211.8	117	1.9	22.4
Reconstruction (RW7):					
RW7-1 Yala-Narathiwat	259.0	2,481.3	283	2.9	26.7
Upgrading (UBS):					
UBS-1 Ko Lanta	669.0	2,862.2	(7)	1.0	11.8
		7,155.4	587	2.5	22.0

Note: 1) Cost and Benefit in economic terms
2) NPV (Net Present Value) at 12 %
3) B/C (Benefit Cost Ration) at 12 %
4) EIRR (Economic Internal Rate of Return)

5.4 Feasibility Study on the Selected Priority Projects

5.4.1 Selected Priority Projects

Projects for the feasibility study in the Phase 3 Study were selected out of the nineteen (19) projects discussed in the preceding section by taking account of:

(1) the results of the preliminary economic evaluation of the projects, the EIRRs being higher than the bench mark value of 12 %;

(2) the policy judgement that the highway development will be of great contribution to the development of the Southern Region in conjunction with the government determination to construct additional two lanes on the mainstay of Route 4 and 41 from Bangkok to the Malaysian border; and

(3) the requirements to develop highways to urgently resolve specific traffic issues in particular areas.

Table 5.4.1 shows the list of the eight projects selected for the Phase 3 Study and Fig. 5.4.1 shows their location in the Southern Region.

The eight projects are 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 artery of Route 4;

(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 (AD-1), Phuket Additional Lane (AD-2) and Thap Put Bypass (NC-3) in between;

(3) East - West Corridor in the lower part of the Southern Region to support the development of Satun - Songkhla 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 (RW7-1) in the Southern Border Provinces to stimulate the economic activities.

Table 5.4.1 EIGHTS PROJECTS FOR THE PHASE 3 STUDY

No.	Project Name	Length (km)
NC-1	Chumphon City Link	9.1
AD-1-1	Surat Thani Additional Lane	32.0
AD-1-2	Surat Thani Additional Lane (Airport Route)	40.1
AD-2-1	Phuket Additional Lane	38.4
AD-2-2	Phuket New Highway on the West Coast	35.2
NC-3	Thap Put Bypass	8.0
WD7-4-1	Hua Sai - Songkhla Highway	96.3
WD7-4-2	Hua Sai - Songkhla Highway (Hua Sai 4 Lanes)	96.3
WD6-1	Palian - Khuan Kalong Highway	82.6
NC-5	Highway 4/406 Short Cut Route	24.1
RW7-1	Yala - Narathiwat Highway	53.0
	Total 1/	351.6

Note: NC - New Construction
AD - Additional Lane Construction
WD7 - Widening of Carriageway to 7.0 Meters
WD6 - Widening of Carriageway to 6.0 Meters
RW7 - Reconstruction and Widening of Carriageway to 7.0 Meters
1/ AD-1-1, AD-2-2 and WD7-4-2 are not included in "Total"

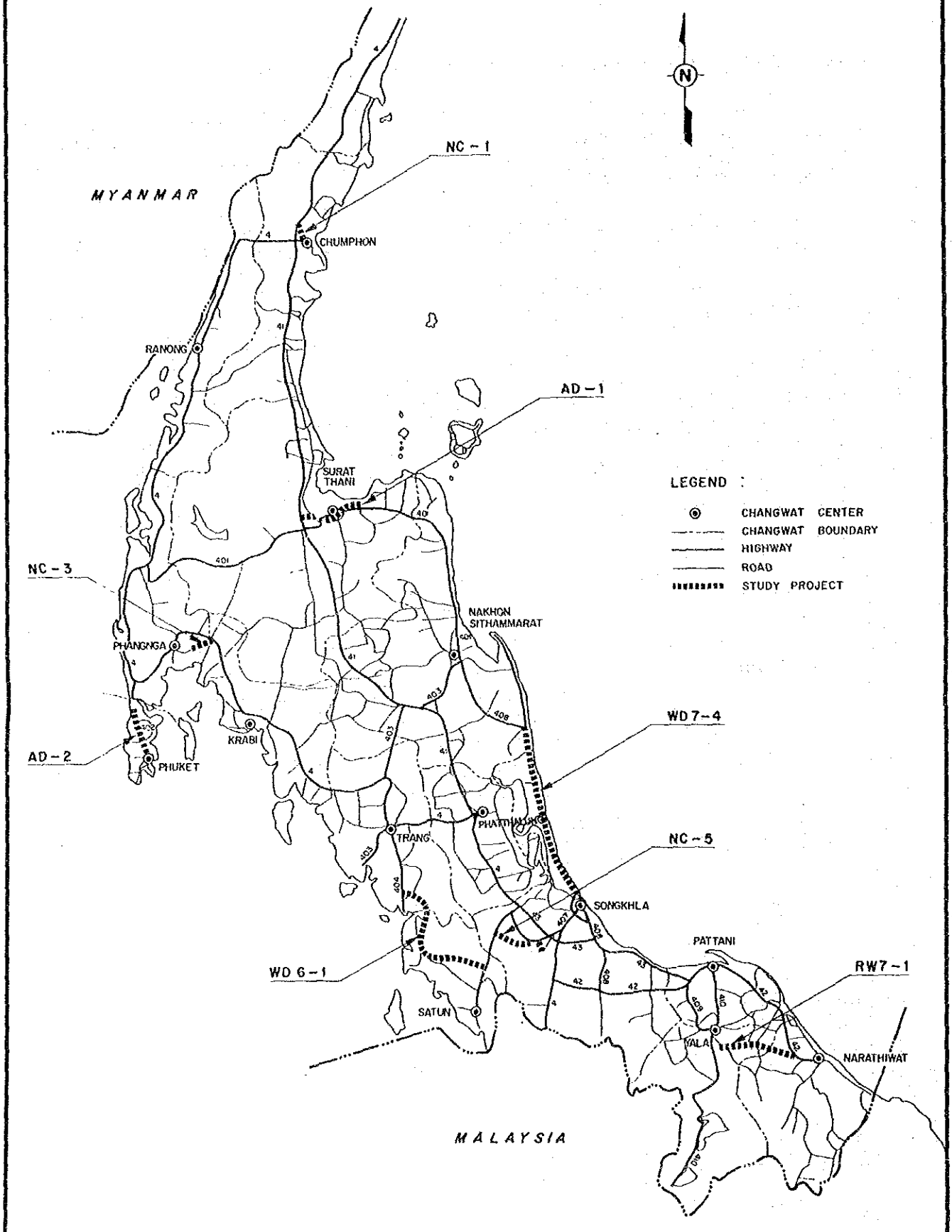


Fig. 5.4.1 EIGHT PROJECTS FOR THE PHASE 3 STUDY

Main objectives of the projects are as follows:

(1) **Chumphon City Link (NC-1):** This new link will connect Chumphon city with the north-south artery of Route 4 to relieve traffic congestions and alleviate traffic hinderance to be caused by flooding in rainy season on the existing highway Route 327. On top of this, the new link will assure a fail-safe linkage to Route 4 from Chumphon city even if Route 327 becomes impassable by such a serious disaster as experienced in 1989.

(2) **Surat Thani Additional Lane (AD-1):** The project aims to improve the accessibility between the north-south artery of Route 41 and the designated main urban center of Surat Thani city as well as to relieve traffic congestions in Surat Thani municipal area. To cope with the increasing traffic in recent years, DOH has partly constructed additional two lanes along the existing Route 401. Additional two lanes should be extended to the west and east of Surat Thani city to accommodate the increasing traffic generated by new industrial location, airport related traffic, through traffic to and from Nakhon Si Thammarat and so on.

There are two alternatives to be studied in the feasibility study: AD-1-1; and AD-1-2. AD-1-1 is a project to construct additional two lanes along the existing highway as described in the above. AD-1-2 is a project to construct a new two lane highway from Surat Thani Airport to Ban Huai Mat on Route 401 to facilitate airport related traffic to and from Surat Thani city as proposed by the Department of Town and Country Planning (DTCP). As AD-1-1, additional two lanes are to be constructed along the existing highway except for the section parallel to the new construction section.

(3) **Phuket Additional Lane (AD-2):** Phuket city is the biggest city on the west coast of the Peninsula designated as a major urban center like Surat Thani on the east coast. Tourism development on the island has remarkably been progressed in these years. Due to these factors as well as limited highway capacity between the Sarasin Bridge and Phuket city, traffic congestion on the artery of Route 402 has been worsening. The project aims to increase traffic capacity of Route 402 by constructing additional two lanes along the existing highway.

There are two alternatives to be studied in the feasibility study: AD-2-1; and AD-2-2. AD-2-1 is a project to construct additional two lanes along the existing highway as described in the above. AD-2-2 is a project to construct a new two lane highway on the west coast from near Phuket Airport to Phuket Bypass in view of a proposal by the Seventh Plan Urban and Regional Transport (SPURT) Study.

(4) **Thap Put Bypass (NC-3):** The east - west highway link connecting the two main urban centers of Surat Thani and Phuket on both sides of the Peninsula will become more important in the future as they grow. The project aims to shorten the distance of the highway between both cities as well as to detour the existing intersection with Route 4 where the crowded local market hinders smooth traffic flow.

(5) **Hua Sai - Songkhla Highway (WD7-4):** Intercity traffic between Songklah and Nakhon Si Thammarat is expected to grow: the former designated as a regional urban center and the latter as an urban growth center. The project aims to improve the existing highway Route 408 to S1 standard. This improved highway will become an alternative route for the north - south artery of Route 41 between both cities.

There are two alternatives to be studied in the feasibility study: WD7-4-1; and WD7-4-2. WD7-4-1 is a project to widen the existing pavement width of 6 meters to 7 meters as described in the above. WD7-4-2 is a project to construct additional two lanes on the existing highway from Hua Sai to the provincial border between Nakhon Si Thammarat and Songkhla, the remaining section being same as WD7-4-1.

(6) **Palian - Khuan Kalong Highway (WD6-1):** The project aims at improving the west coast highway which constitutes one of the arteries in the Southern Region. The project offers better accessibility between Palian on Route 404 directing to Trang city and Khuan Kalong on Route 406 directing to Hat Yai city and Hat Yai International Airport. The improved accessibility to Trang and Hat Yai directions will support the economic and tourism development in the project area.

(7) **Highway 4/406 Short Cut Route (NC-5):** The project aims to provide Satun with better accessibility to Hat Yai airport and Hat Yai city. It also facilitates transport services from Hat Yai to Trang and Krabi direction coupled with the project WD6-1 described in the above.

(8) **Yala - Narathiwat Highway (RW7-1):** Major highway network in the Southern Border Provinces is composed of Route 42 which runs along the east coast between Pattani and Narathiwat and Route 410 which directs to the Malaysian border from Pattani via Yala. The project aims at providing direct link between two cities of Yala and Narathiwat to encourage economic as well as tourism development of both cities in the border provinces including several towns in the project area.

5.4.2 Framework for the Feasibility Study

1) Future Traffic Demand

(1) Difference with the Phase 1 Study

The Phase 1 Study established an economic and population framework of the Southern Region for the years of 1996, 2001 and 2006. Based on the framework, future trip generation and attraction were estimated for the respective years. At the same time, present traffic distribution pattern was estimated based on the results of OD surveys. Future trip distribution (OD table) was estimated by the Fratar method on the basis of the estimated trip generation and attraction, and present distribution pattern.

On the other hand, a traffic simulation model was developed to assign the present traffic distribution on the existing highway network. After a validation check with the results of traffic count survey, future traffic volume on highway link was estimated by the simulation model, future OD tables and future highway network being input to the model.

In the Phase 1 Study, the Southern Region was divided into 68 traffic zones with a view to depicting an overall sketch of future traffic situations of the region. In the Phase 3 Study, however, a focus has been shifted to the eight selected priority projects for detailed analysis to take account of the specific conditions of the project area. Traffic zones established in the Phase 1 Study, in consequence, was subdivided into smaller zones in the Phase 3 Study particularly in the eight project areas. Table 5.4.2 shows revised traffic zones in the Phase 3 Study in comparison with the Phase 1 Study.

Major difference between the Phase 1 and Phase 3 studies arises from the subdivision of traffic zoning. The methodology applied in the Phase 1 Study is succeeded to the Phase 3 Study as a rule.

Table 5.4.2 REVISED TRAFFIC ZONES IN THE PHASE 3 STUDY

Phase 1 Study No.	Zone Name	Phase 3 Study No.	Zone Name
1	Chumphon	1	Chumphon
		69	Bang Luk
		70	Wang Phai
		71	Thung Ka
		72	Wang Mai
		87	Tak Dad
		88	Pak Nam
7	Surat Thani	7	Surat Thani
		73	Ma Kham Tia
8	Phunphin	8	Phunphin
		74	Khrud
		75	Maluan
20	Phangnga	20	Phangnga
		76	Thap Put
24	Phuket	24	Phuket
		80	Chalong
26	Thalang	26	Thalang
		77	Mai Khao
		78	Thep Kasattree
		79	Pa Klok
35	Chian Yai	35	Chian Yai
		81	Hua Sai
48	Ranot	48	Ranot
		82	Krasaesin
		83	Sathing Phra
55	Langu	55	Langu
		84	Thung Wa
61	Yala	61	Yala
		85	Raman
65	Ruso	65	Ruso
		86	Yi-ngo

(2) Traffic Zoning and Highway Network

Fig. 5.4.2 and 5.4.3 illustrate the revised traffic zoning and highway network for the Phase 3 Study. Traffic zoning and highway network are more detailed than in the Phase 1 Study particularly in the project areas.

(3) Methodology

The same methodology applied in the Phase 1 Study was adopted in the Phase 3 Study, following the estimation procedures of trip production, trip generation and attraction, trip distribution and traffic assignment on highway network.

In response to subdivision of the traffic zones in this phase, supplemental origin and destination survey was carried out in each project area. Trip distribution pattern among the subdivided zones was estimated based on the survey results as well as supplemental application of the most likelihood method on the basis of traffic count results. The total number of trips were increased due to the subdivision of the traffic zones.

Traffic assignment was performed for "with" and "without" cases of each project. Assignment simulation was repeated five times for each case by taking account of the QV relations on the highway links to estimate both vehicle hours and vehicle kilometers by vehicle type and velocity.

2) Engineering Study

(1) Difference with the Phase 1 Study

The preliminary feasibility study was carried out in the Phase 1 Study on the nineteen projects dispersed in the Southern Region, and eight projects were selected for further feasibility study. The feasibility study in this phase was conducted to improve the accuracy of the construction quantities and cost based on the project specific information.

Main difference between the feasibility study and the preliminary feasibility study can be enumerated as follows:

a) horizontal and vertical alignment studies were carried out in more detail than the preliminary feasibility study based on the topographic survey carried out in this study;

b) length of bridges and size of culverts were re-studied by taking account of the results of the field survey;

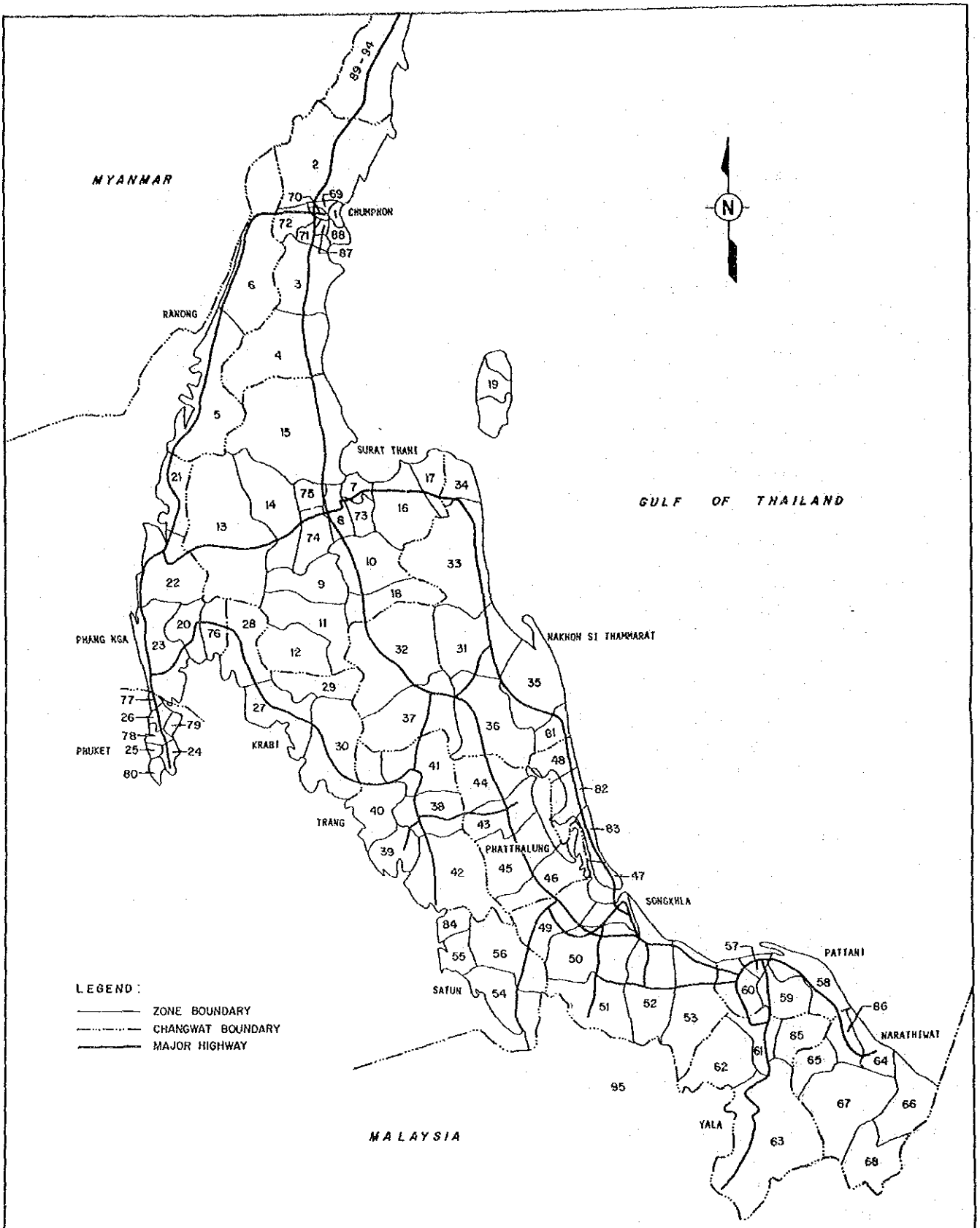


Fig. 5.4.2 TRAFFIC ZONING MAP

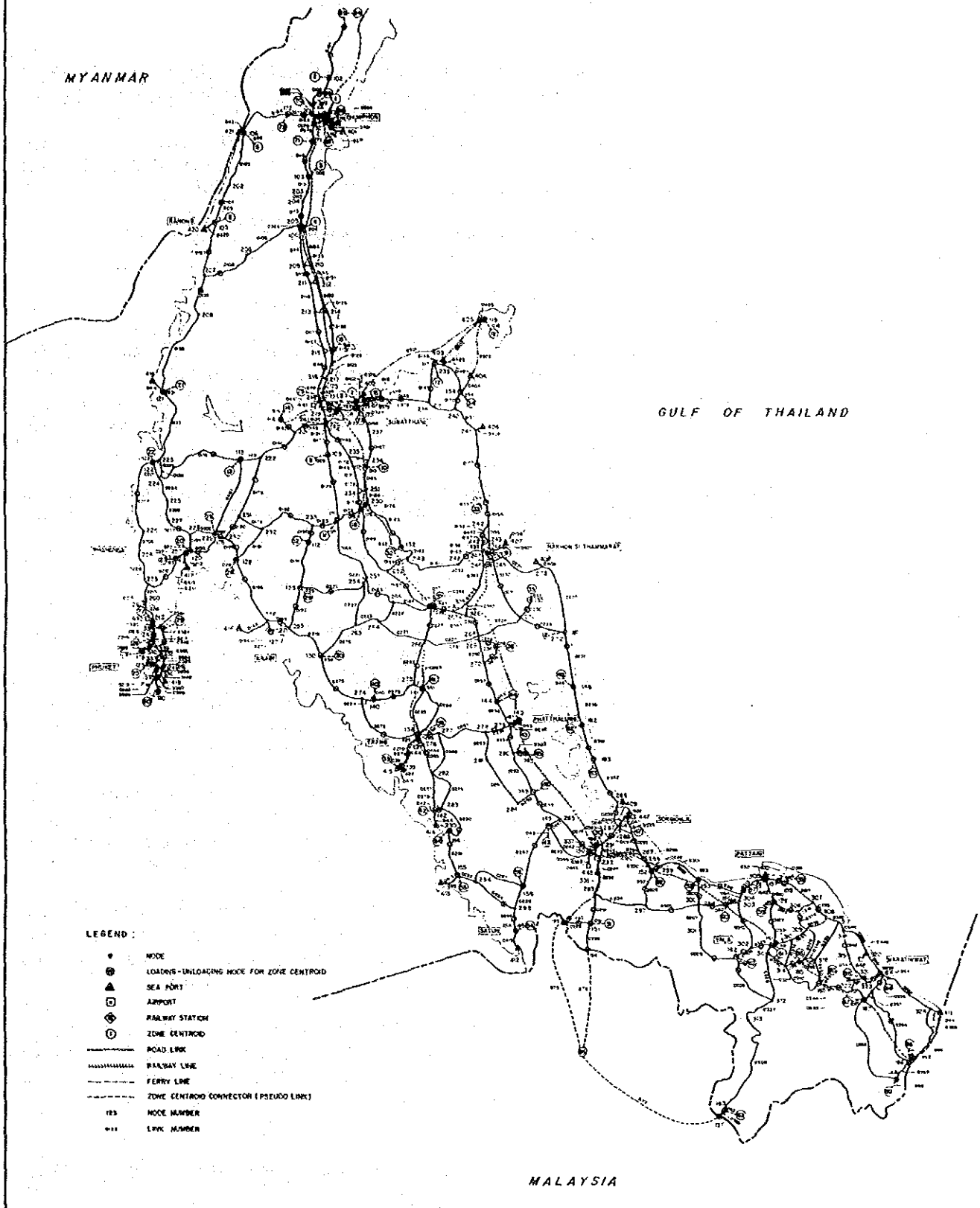


Fig. 5.4.3 HIGHWAY NETWORK FOR TRAFFIC ASSIGNMENT

c) pavement was re-designed based on the projected traffic volume and CBR value at each project site;

d) study on soft ground was carried out for the projects of AD-1, NC-3, WD6-1, NC-5 and RW7-1 based on the results of the soil survey; and

e) study on major intersection was carried out.

(2) General Design Concept

Disaster in the Southern Region has been caused mainly by heavy rainfall in a short period of time and steep gradient of rivers. Disaster prevention is one of the most important factors to be taken into account in designing highways and bridges in the region.

Disaster prevention measures were taken into account in this phase with a specific emphasis on the following three points.

a) to prevent road destruction by flooding

(a) Embankment height is designed higher than the highest flood level in the past by 60 centimeters. The height of embankment of NC-1, AD-1-2, NC-3 and RW7-1 was decided with due consideration to the flooding history in the past.

(b) Toe of the embankment slope located in flood-prone area is to be protected by block sodding. This measure was adopted in the projects of NC-1, AD-1-2, NC-3 and RW7-1.

(c) Abutment of bridge and some sections of embankment behind the abutment is to be protected by concrete cover. This measure was applied to bridges in every project.

(d) Drain facilities traversing embankment have sufficient capacity not to prevent smooth water flow from one side to another. This measure was applied to the projects of AD-2-2, WD7-4, NC-5 and RW7-1.

b) to protect road structure from mud and debris flow

(a) Bridges are designed long enough not to narrow cross-section of rivers. This type of measure was applied to the projects of AD-2-2, NC-5 and RW7-1 particularly in the mountainous area.

(b) Drain facilities to traverse the road structure are installed with enough capacity not to prevent free water flow from one side to another.

c) to prevent slope failure

Deep cut and large fill are avoided to prevent slope failure to the maximum extent. This measure was adopted in the mountainous terrain of AD-2-2, NC-5 and RW7-1.

Traffic safety is another issue to be addressed, safety measures for motorcycle traffic in urban areas in particular. Traffic accidents involving motorcycle have sharply been increasing in recent years. Motorcycle traffic often decreases the traffic capacity of highways because of its slower speed than others and weaving motion. For these reasons, installation of motorcycle lane is desirable in the urban and suburban areas where the ratio of motorcycle traffic is comparatively high. Motorcycle lane was installed in AD-2 based on "The Technical Guidelines" (recommended in "the Study on Traffic Operation Plan for Roads in the Kingdom of Thailand").

(3) Field Survey

Field surveys including road inventory survey, topographic survey, soil survey and laboratory test were carried out to collect information on each project area.

a) Road Inventory Survey and Field Reconnaissance

The Phase 1 Study was principally based on the information available from the road data base of DOH. In the Phase 3 Study, supplemental information was collected through the site survey to identify the actual situations of the project sites with a view to better designing and estimating construction works.

Road inventory survey was carried out on the existing highways over a distance of 250 kilometers as shown in Table 5.4.3 for the projects of additional lane construction and widening of carriageway. Major information collected through the road inventory survey includes:

- location, type and dimension of bridges and culvert structures;
- embankment height; and
- width of right-of-way.

Table 5.4.3 ROAD INVENTORY SURVEY

No.	Origin	Destination	Length (km)
AD-1	Intersection with Rt.41 and Rt.4153	Kanchanadit	31
AD-2	Phuket Town	Sarasin Bridge	38
WD7-4	Hua Sai	Songkhla	95
WD6-1	Palian	Khuan Kalong	60
RW7-1	Yala	Da Lo Ha Lo	26
Total			250

Field reconnaissance survey was carried out over a distance of 150 kilometers as shown in Table 5.4.4 for the projects of new construction, realignment and reconstruction. The field reconnaissance survey was carried out to understand:

- Geological features;
- Geographical features;
- River and bridge condition; and
- Land use in the project areas.

Table 5.4.4 FIELD RECONNAISSANCE SURVEY

No.	Origin	Destination	Length (km)
NC-1	Intersection with Rt.4	Chumphon City	9
AD-1-2	Surat Thani Airport	Intersection with Surat Thani Bypass	17
AD-2-2	Intersection with Rt.402	Phuket Town	35
NC-3	Intersection with Rt.4	Intersection with Rt.415	8
WD6-1	Realignment Section	of Rt.417	26
NC-5	Hat Yai Airport	Intersection with Rt.4	7
RW7-1	Da Lo Ha Lo	Intersection with Rt.42	27
Total			146

b) Topographic Survey

Leveling survey was carried out, as shown in Table 5.4.5, to get geographical information for the eleven bridge sites crossing major rivers on the alignment of AD-1, NC-3, WD7-4, WD6-1, NC-5 and RW7-1.

Table 5.4.5 LOCATION OF LEVELING SURVEY SPOTS

Project No.	Route No.	The Name of the River
AD-1-1	4153	Ta Pi River
	401	Khlong Makham Tia
	401	Khlong Tha Thong
AD-1-2	New Link	Khlong Phun Phin
	New Link	Ta Pi River
	New Link	Khlong Tha Kup
NC-3	New Link	Khlong Sai Mat
WD7-4	408	Khlong Thakhen
WD6-1	417	Khlong Lak Khan
NC-5	New Link	Khlong Pom
RW7-1	4107	Sai Buri River

Profile of bridge sites were drawn in the scale of 1:1,000 for horizontal and 1:100 for vertical conditions based on the results of leveling survey while, in the Phase 1 Study, cross sections of the rivers on new construction highways were profiled principally based on a map of 1:50,000 scale.

c) Soil Survey and Laboratory Test

Soil survey was carried out at ten sites, as shown in Table 5.4.6, to design the foundation of bridges and to analyze soft ground behavior.

Boring is composed of: (1) drilling a bore hole with the standard penetration test (SPT); and (2) collecting soil samples of each stratum for laboratory test on the following factors:

- Natural Moisture Contents;
- Specific Gravity;
- Unit Weight;
- Atterberg Limits;
- Grain Size Analysis; and
- Consolidation Test.

Table 5.4.6 BORING SITES

Project No.	Boring No.	Location
NC-1	BH-9	7 km + 175
AD-1-1	BH-12	7 km + 178
	BH-14	29 km + 650
AD-1-2	BH-13	14 km + 440
NC-3	BH-10	4 km + 150
WD7-4	BH-15	11 km + 775
WD6-1	BH-16	79 km + 080
	BH-17	34 km + 150
NC-5	BH-11	7 km + 040
RW7-1	BH-18	20 km + 427

The results of boring log and laboratory test at each site are shown in Appendix. The results indicate that:

- the Ta Pi river delta where AD-1-2 passes is covered by a soft alluvium layer with a depth of about 20 meters; and

- the project sites of NC-3, WD6-1, NC-5 and RW7-1 need some countermeasures against settlement in some depth of soft layers.

In addition to the boring survey, an embankment material survey was carried out at 15 borrow pits as shown in Appendix. The items of the material survey are:

- Natural Moisture Content;
- Specific Gravity;
- Atterberg Limit (Liquid Limit and Plastic Limit);
- Grain Size Analysis; and
- CBR Test.

Based on the CBR test, the design CBR value was calculated as shown in Table 5.4.7.

Table 5.4.7 DESIGN CBR

Project No.	Design CBR (%)
NC-1	6
AD-1-1	10
AD-1-2	10
AD-2-1	10
AD-2-2	10
NC-3	10
WD7-4-1	6
WD7-4-2	6
WD6-1	6
NC-5	6
RW7-1	10

(4) Designing

a) Design Standard

(a) Road Class

Road class was decided based on both the specifications of DOH as shown in Table 5.4.8 and the future AADT estimated for each project.

Table 5.4.8 ROAD CLASS

Class	SD FD	S1 F1	S2 F2	S3 F3
AADT	above 8,000	4,000- 8,000	2,000- 4,000	1,000- 2,000
Width of Carriageway(m)	Divided 2 x 7.00	7.00	6.50	6.00
Width of Shoulder(m)	2.50	2.50	2.25	2.00

(b) Design Speed and Geometric Design Criteria

Design speed and geometric design criteria were decided as shown in Table 5.4.9 based on the specification of the DOH standard depending on terrain conditions.

Table 5.4.9 DESIGN SPEED AND GEOMETRIC DESIGN CRITERIA

Terrain Conditions	Design Speed(km/h)	Minimum Radius of Curvature(m)	Maximum Gradient(%)
Flat and moderately rolling	70 - 90	160 - 280	6
Rolling and hilly	55 - 70	90 - 160	8
Mountainous	40 - 55	50 - 90	10

b) Typical Cross Section

For four-lane section, three types of typical cross section were adopted in accordance with the availability of the right of way as illustrated in Fig. 5.4.4.

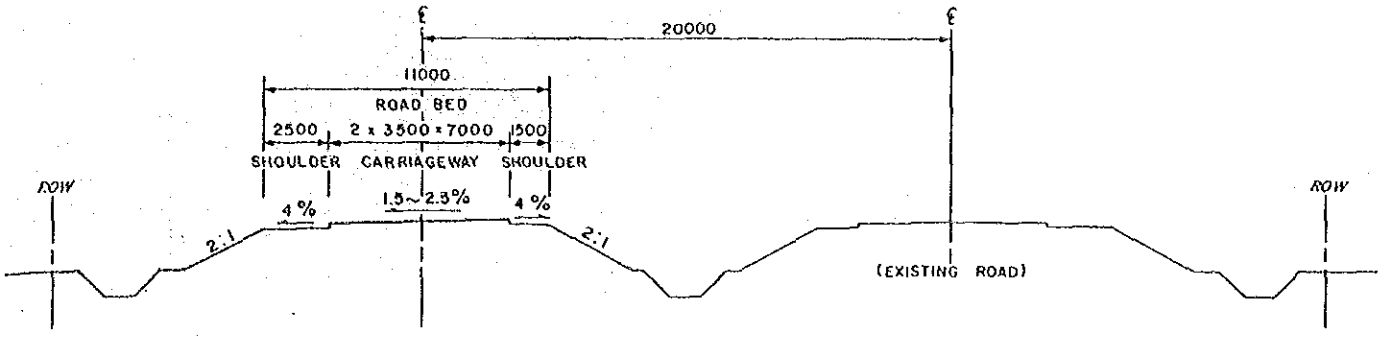
Independent two-lane type was adopted in the sections where following conditions are satisfied:

- width of right of way is wider than 50 meters; and
- land acquisition for right of way has no particular problems.

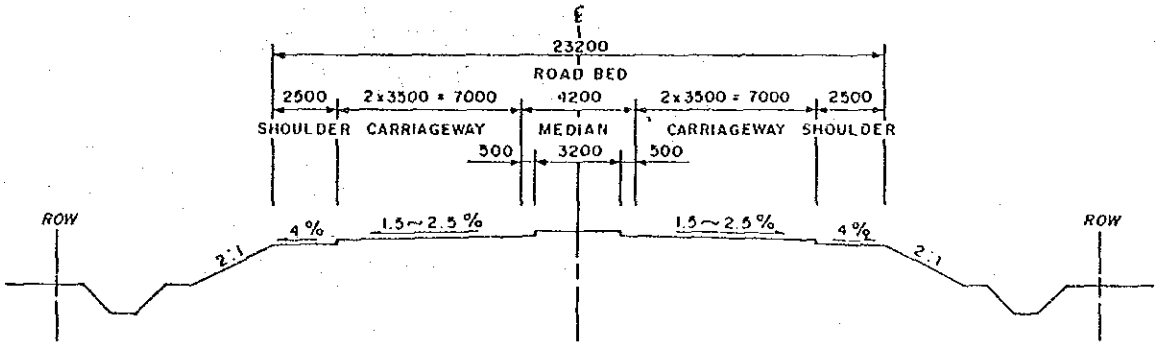
Four lanes with center medium type was adopted in the sections where the width of right of way is less than 40 meters but wider than 30 meters.

Four lanes without center median type was adopted in the urban area where the width of right of way is less than 30 meters but wider than 20 meters, and there is any land acquisition problems.

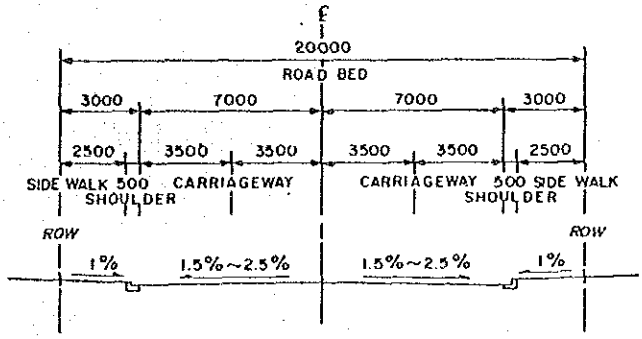
Fig. 5.4.5 illustrates typical cross sections of road class S1, S3 and F1. Even in the case of two lane project, "four lane without center median type" is applied in some sections of town.



(1) Independent Two-Lane Type

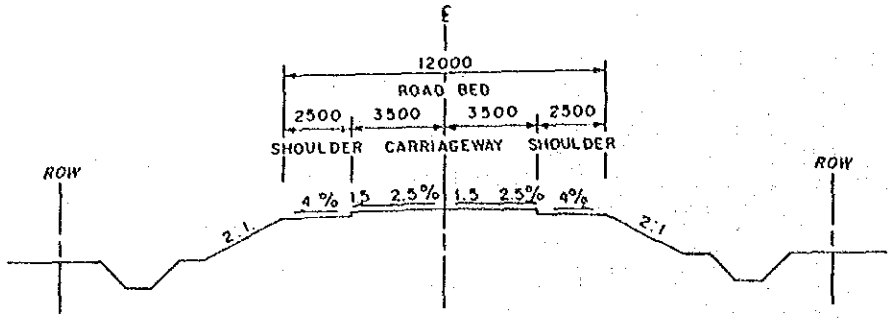


(2) With Center Median Type

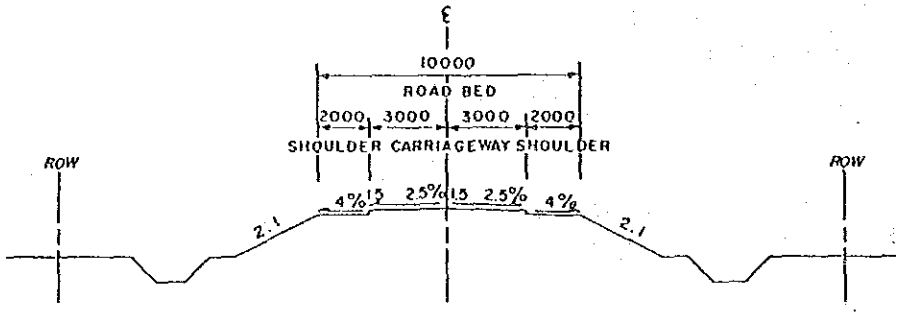


(3) Without Center Median Type

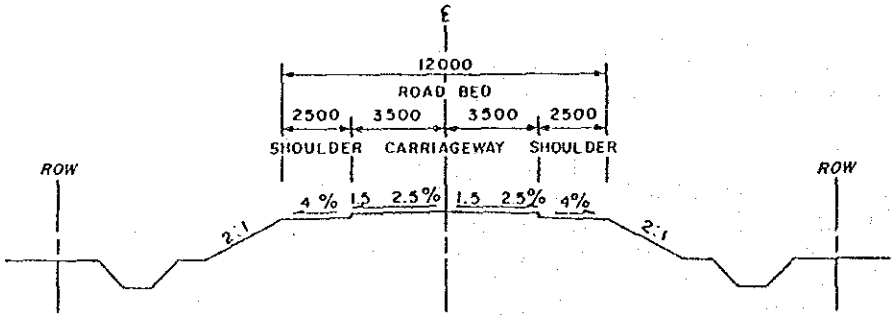
Fig. 5.4.4 TYPICAL CROSS SECTION FOR FOUR-LANE (ROAD CLASS SD)



(1) S1 TYPE



(2) S3 TYPE



(3) F1 TYPE

Fig. 5.4.5 TYPICAL CROSS SECTION FOR TWO-LANE (ROAD CLASS S1,S3,F1)

c) Horizontal Alignment

The horizontal alignment was designed to follow the alignment of the existing highway to the possible extent, except for the new construction and realignment sections.

For the new construction and realignment sections, the radius of curvature was designed as large as possible depending on the geographical conditions.

d) Vertical Alignment

Vertical alignment was designed to follow that of the existing highways to the possible extent, except for the new construction and realignment sections.

The maximum gradient applied for each project is based on the geometric design criteria shown in Table 5.4.9, and 0.3 % was adopted as a minimum gradient for rain water drainage.

In flood-prone areas, road surface was raised higher than the highest flood level in the past by 60 centimeters. On some sections through mountainous terrain, bridges are proposed in place of high embankment and deep cut.

e) Earthwork Design

(a) Embankment

Fill materials for embankment shall be supplied from borrow pit which locates in the vicinity of each project area.

Height of embankment was decided by taking account of: (1) the highest flood level in the past; (2) required vertical clearance at control points; and (3) mechanical stability of embankment. Gradient of embankment slope was decided at 2:1 on an assumption that laterite is used as fill material.

Study on consolidation settlement to be caused by embankment load was required for AD-1-2, NC-3, WD6-1, NC-5 and RW7-1. Sand pile method and sand mat method were proposed for these projects to cope with the possible settlement. Toe of embankment located in flood-prone area was designed to be protected by block sodding.

(b) Cut

Length of cut section, especially deep cut section, was planned to be as short as possible from the following points of view:

- to minimize destruction of forest area;
- to prevent hill-side from slope-failure;
- to prevent cut-slope from slope-failure; and
- to preserve natural scenery.

The gradient of cut slope was decided as follows depending on the kind of soil through a slope stability study.

- Soft Rock	0.8 : 1
- Weathered Rock	1 : 1
- Laterite	1.5 : 1

As shown in Fig. 5.4.6, a berm of 1.5 meter width is to be installed vertically at every 7.0 meter. Earth slope is to be fixed by sodding, while rock slope is to be fixed by shot-crete to prevent them from slope failure.

Cut sections are designed in AD-2-2, WD6-1, NC-5 and RW7-1. Among them, AD-2-2 and RW7-1 are inevitable to have some deep cuts because of their alignment through steep mountainous terrain. Hillside structures were introduced in these sections to reduce cut volume as much as possible.

f) Pavement Design

(a) Design CBR

Design CBR was decided based on the survey results of CBR value, as shown in Table 5.4.7, at the borrow pits located close to each project area.

(b) Design Method

The "AASHTO Design Guide for Pavement Structure 1986" was applied to this study.

(c) Design Period

Design period of 7 years was adopted in this study based on the DOH Standard of "the first seven years after construction".

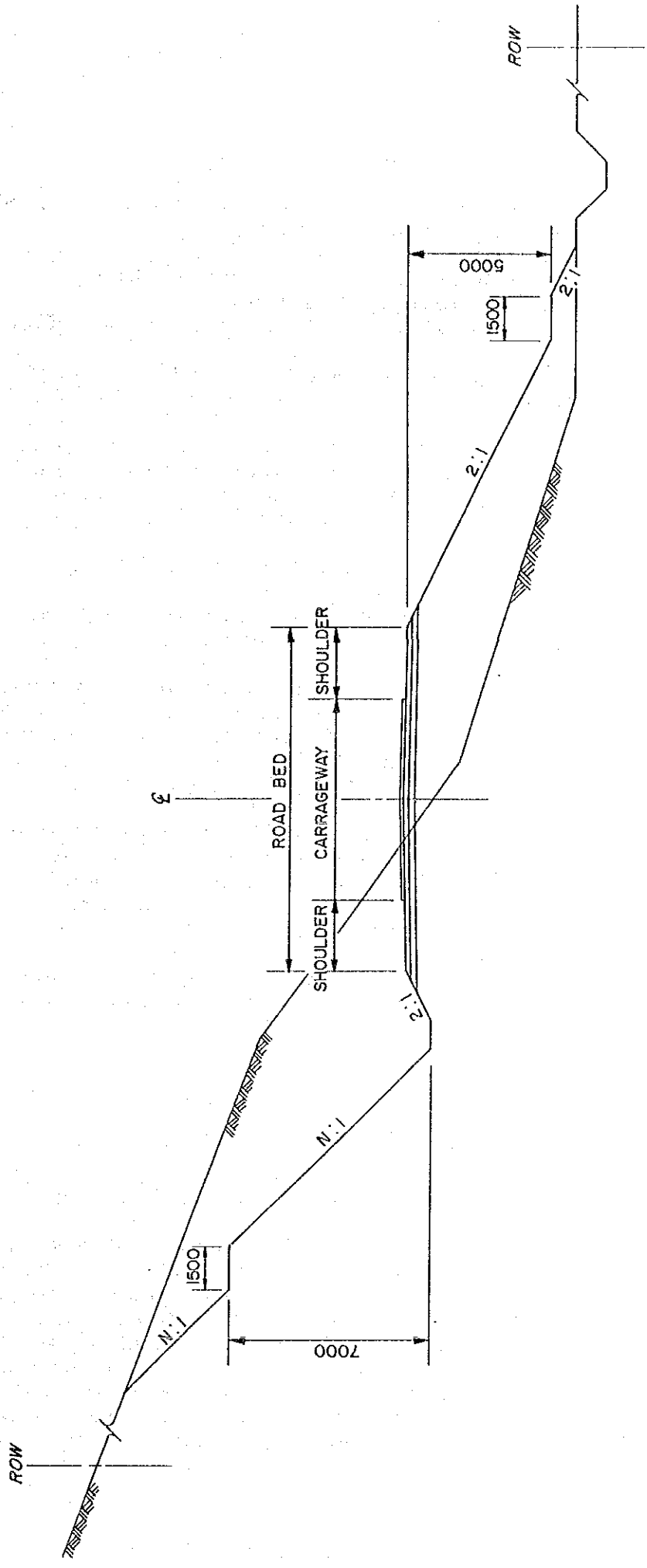


Fig. 5.4.6 TYPICAL CUT AND FILL SECTION

(d) Pavement Type

Asphalt concrete pavement was selected from the following point of view:

- high efficiency of construction;
- easy maintenance ; and
- low cost of construction and maintenance.

Three types of pavement work are required in this study:

- new pavement work for the projects of new construction, realignment, additional lane construction and re-embankment;
- widening pavement work for widening projects; and
- overlay work for the existing pavement.

For widening projects, two types of pavement work were applied:

- in case the existing pavement structure satisfies the required standard, the existing pavement will remain unchanged and be connected with the new pavement structure of widening portion; and

- in case the existing pavement structure is not appropriate for the required standard, the existing pavement will be overlaid to bear the estimated load and connected with the new pavement structure of widening portion.

For re-embankment, earth fill and pavement works will follow the removing work of the existing surface course.

g) Bridge Design

(a) Design concept

- Material and structural system

In view of both material supply in the Southern Region and cost saving, reinforced and prestressed concrete were applied to new bridge construction. Reinforced concrete was used for the slab bridge of which span length is 10 meters or less and for hillside bridge in the mountainous terrain. Prestressed concrete was used for the bridge of which span length is longer than 10 meters.

- Bridges without any improvement work

  Bridges of which existing pavement width is wider than the required width and still in good condition were remained as they are.

- Bridges with widening work

  Bridges of which existing pavement width is narrower than the required width were widened to satisfy the requirement. A temporary bridge is needed during construction period.

- Bridges should be reconstructed after removal

  Bridges of which existing standard is extremely lower than the required standard in terms of width or length were to be removed and reconstructed. Bridges located in re-embankment section were also removed and reconstructed. A temporary bridge is needed during construction period.

- Disaster prevention

  Design conditions on bridge length and span length were fixed in consideration of disaster prevention.

(b) Design Load

HS 20-44 (MS18) are applied based on the DOH Standard.

(c) Roadway Width at Bridge Section

The roadway width at bridge section should accommodate full roadway width, total width of carriageway and shoulders on both sides.

(d) Sidewalk Width

According to the DOH Standard, the width of sidewalk at bridge section is prescribed as follows:

Urban and suburban area	:	1.5 m
Rural area	:	1.0 m
No pedestrian area	:	0.5 m

In this study, the width of sidewalk including handrail are decided as shown below:

Urban area : 2.5 m (densely populated area along AD-2-1)

Suburban area: 1.5 m (whole section of AD-1-1 and not densely populated area along AD-2-1)

Rural area : 1.0 m (remaining six projects)

(e) Bridge Length

Bridge length for new construction was decided based on the discharge calculation not to disturb water flow even in high water season.

(f) Span Length

Blockade of water flow by piers was designed as a rule to be less than 7 % of the cross section of rivers. For additional lane project, however, span length was kept same with the existing bridge to prevent any additional blockade.

(g) Foundation

Foundation of bridge should reach the hard layer of 40 or more of N-value (Value of standard penetration test).

h) Drainage Design

(a) Discharge

Design discharge was calculated based on the map in a scale of 1:50,000 with the following design conditions.

- Rainfall Intensity

  The rainfall intensity duration curve obtained at Chumphon observatory was applied to the design discharge calculation for NC-1, AD-2 and NC-3. The curve obtained at Songkhla observatory was applied to the design discharge calculation for the remaining projects.

- Return Period

  Return periods in designing drainage facilities were determined as follows by taking account of the trade off between disaster prevention and investment efficiency.

Pipe culvert and box culvert	: 10 years
Minor bridge	: 20 years
Major bridge	: 30 years

(b) Drainage Facilities

Drainage facilities are to be provided at:

- crossing with river or canal;
- crossing with hollow or sag;
- minimum intervals of 200 meters in the flat terrain; and
- minimum intervals of 300 meters in the hilly and mountainous terrain.

Reinforced concrete box culverts have one and two cell types of 1.8 m x 1.8 m, 2.1 m x 2.1 m and 2.4 m x 2.4 m, while pipe culvert has four sizes of 0.6 m, 0.8 m, 1.0 m and 1.2 m in diameter to let the calculated discharge flow.

For widening project, the existing box and pipe culverts were basically extended with the same type and size.

i) Disaster Prevention

The Southern Region is the most disaster prone area in the country. In November 1988, most provinces in the region experienced heavy rainfall and widespread flooding, particularly in Nakhon Si Thammarat and Surat Thani provinces. The rainfall recorded 448 mm and 283 mm a day corresponding to 150 years and 55 years of average return period, respectively. In the study, however, returned periods were assumed as mentioned above based on the AASHTO to avoid over-designing. Attentions were paid to prevent road facilities from damages caused by such natural disasters as flooding, mud flow, debris flow and slope-failure.

Disaster prevention measures taken in this study are as follows:

(a) For flooding

- High embankment
- Embankment protection by sodding, stripe-sodding and block-sodding
- Sufficient drainage facilities

(b) For mud flow and debris flow

- High embankment
- Sufficient span
- Abutment protection by concrete cover

(c) For slope-failure

- Avoidance of deep cut
- Slope protection by shot-crete and sodding

j) Intersection Design

Major intersections were designed for the projects of new construction and additional lane construction with a focus on configuration of major intersections and necessity of traffic signals. Control system of each intersection was decided based on "The Technical Guideline for Traffic Signal" (recommended in "the Study on Traffic Operation Plan for Roads in the Kingdom of Thailand" by JICA in 1990).

3) Construction Cost

a) Difference with the Phase 1 Study

Construction cost in the Phase 1 Study was estimated with a focus on preparing cost input to the preliminary evaluation of the nineteen projects. Due to some lack of project site information, a set of standard work items and unit costs was prepared for relative comparison of each project. In the Phase 3 Study, however, series of surveys including road inventory survey, leveling survey and soil survey were carried out as outlined before in this section to get project specific information. In consequence, there are some differences between the pre-feasibility and feasibility studies. Major differences can be articulated as follows:

In terms of work items, road inventory survey on project sites revealed that some work items need further detailed classification while others need simplification. Type of culverts exemplifies the former case while pavement structure does the latter.

In terms of quantities, major difference came out of the fact that the Phase 3 Study relied on site specific information by referring to the survey results, while the Phase 1 Study depended largely on a map of 1/50,000 scale and road data base compiled by DOH. Height of embankment and volume of cut and fill for instance has been revised accordingly.

In terms of unit costs, "Detail Unit Cost for Budget Estimation 1990" prepared by DOH is principally used in the Phase 3 Study as in the Phase 1 Study. Local conditions, however, are introduced in this phase into such units costs as material transport cost and land acquisition cost.

b) Construction Work Items

(a) Subbase and Base

"Subbase (Selected Materials)" is deleted in this phase because CBR value of materials indicates that materials are strong enough to be used as subbase.

(b) Slope Protection and Culverts

Slope protection measures and culverts are designed specifically for each site instead of applying standard measures and types to every project as in the Phase 1 Study.

(c) Bridges

Bearing unit of bridge is introduced at approach to the new bridges to cope with possible subsidence for the future.

(d) Intersection

Construction of main intersections are included in construction work item.

c) Construction Quantities

Quantities were estimated based on a map of scale 1/50,000 coupled with a profile of 1/12,500 and 1/400 and a cross-section of 1/200. The soil survey revealed that "Cut Work" in the project areas produces materials suitable for "Fill Work". Based on this finding, it is assumed that "Required Fill Volume" is supplied firstly by materials produced by "Required Cut Volume" and then by materials from borrow pits.

d) Unit Cost

Unit costs prepared by DOH are principally applied to each construction work item.

Unit costs of asphaltic surfacing and concrete structures in this study represent the costs completed on site. On the other hand, it is assumed that units costs of base courses and prefabricated concrete products represent the market price excluding transportation cost to site. Transportation cost to each project site was estimated based on unit transportation cost per kilometer and distance from a supply center nearest to a project site.

Unit cost of cut includes transport cost of one kilometer and compaction cost because materials produced by cut is suitable for fill and embankment. The materials required for fill and embankment in excess of self-sufficiency at each site are to be supplied from borrow pits at an average distance of 10 kilometers from each project site.

Unit cost of intersection includes costs of earth works, pavement works, lighting works, miscellaneous works and signaling cost where required.

Unit cost of land acquisition is estimated on a basis of land price along a project highway and compensation cost is estimated based on land use along a project highway.

Table 5.4.10 shows a list of unit cost applied in the Phase 3 Study.

e) Maintenance Cost

Maintenance cost was estimated based on the manual titled "Maintenance Work (usual, routine)" prepared by DOH. The manual classifies maintenance cost into three categories of asphaltic pavement, laterite surface and concrete pavement. Three types of formulas are developed based on types of surface:

Maintenance Cost
= factor showing highway specifications
x annual average maintenance cost / km
x factor indicating average material costs
x length of highway (km)

The above formula does not include overhead cost for maintenance. A maintenance overhead cost / maintenance cost ratio is assumed at 0.28 based on an analysis of general administration cost of DOH in 1989.

Periodic maintenance cost was estimated based on the overlay cost of 5 cm in every eighth year.

Table 5.4.10 LIST OF UNIT COSTS

ITEM	Unit	NC-1 Unit Cost Baht	NC-3 Unit Cost Baht	NC-5 Unit Cost Baht	AD-1 Unit Cost Baht	AD-2 Unit Cost Baht	WD7-4 Unit Cost Baht	WD6-1 Unit Cost Baht	RW7-1 Unit Cost Baht
EARTH WORK									
Clearing & Grubbing	SQ.M	1	1	1	1	1	1	1	1
Roadway Excavation(classified)	CU.M	---	---	85	85	85	85	85	85
Embankment(Borrowed Material)	CU.M	100	100	100	100	100	100	100	100
Slope Protection(Stripe Sodding)	SQ.M	6	6	6	6	6	6	6	6
(Sodding)	SQ.M	---	---	---	---	9	---	9	9
(Shot Concrete)	SQ.M	---	---	500	---	500	---	---	500
(Concrete Block)	SQ.M	450	450	450	450	450	450	---	450
Sand Mat (t=0.5m)	SQ.M	---	100	100	100	---	---	100	100
Sand Drain (Ø 0.40cm)	M	---	---	---	200	---	---		
Excavate Existing									
Surface	SQ.M	---	---	---	---	---	---	---	2
Thickness Over 10Cm (2 Lay)	SQ.M	---	---	---	---	14	14	14	14
SUBBASE AND BASE									
Subbase(Soil Aggregate)	CU.M	190	190	190	190	190	190	190	190
Base Coarses(Crush Stone)	CU.M	270	295	295	295	295	440	440	320
Shoulder(Soil Aggregate)	CU.M	190	190	190	190	190	190	190	190
SURFACE									
Asphaltic Prime coat	SQ.M	13	13	13	13	13	13	13	13
Asphaltic Tack coat	SQ.M	7	7	---	7	7	7	7	7
Asphalt concrete Surfacing	CU.M	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900
Overlay (5cm,7.5cm,10cm)	CU.M	---	---	---	1,900	1,900	1,900	1,900	1,900
STRUCTURES(Equivalent)									
RC Pipe Culvert(D= 400 m)	M	---	---	---	---	900	---	---	---
(D= 500 m)	M	---	---	---	---	---	1,200	---	---
(D= 600 m)	M	1,300	1,300	1,300	1,300	1,300	1,380	1,380	1,330
(D= 800 m)	M	1,780	1,780	1,780	1,780	1,780	1,950	1,950	1,850
(D=1000 m)	M	2,445	2,445	2,445	2,445	2,445	2,650	2,650	2,550
(D=1200 m)	M	---	3,575	3,575	3,575	3,575	---	3,850	3,700
(D=1500 m)	M	---	---	4,400	---	4,400	4,900	---	---
RC Box Culvert(1-1.80*1.80 m)	M	4,200	4,200	4,200	4,200	4,200	4,200	4,200	4,200
(1-2.10*2.10 m)	M	---	---	5,000	5,000	5,000	5,000	5,000	5,000
(1-2.40*2.40 m)	M	---	---	5,900	---	5,900	5,900	5,900	5,900
(1-2.50*2.50 m)	M	---	---	---	6,200	---	---	---	---
RC Bridge Wideing	SQ.M	---	---	---	---	9,600	---	---	9,600
RC Bridge (W=12.0 m)	M	---	---	76,800	---	---	---	76,800	---
(W=12.5 m)	M	---	---	---	---	80,000	80,000	---	---
(W=13.0 m)	M	---	---	---	83,200	---	---	---	---
(W=14.0 m)	M	89,600	89,600	---	89,600	89,600	---	---	89,600
PC Bridge (W=12.0 m)	M	---	---	120,000	---	---	---	---	---
(W=12.5 m)	M	---	---	---	---	---	125,000	---	---
(W=13.0 m)	M	---	---	---	130,000	---	---	---	---
(W=14.0 m)	M	---	140,000	---	140,000	---	---	---	---
PC Bridge (W=13.0 m, L>50m)	M	---	---	---	195,000	---	---	---	---
Bearing Unit Of Bridge	Bridge	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000
Remove Of Existing Bridge	SQ.M	---	---	3,000	---	---	---	---	3,000
Temporary Bridge	SQ.M	---	---	5,000	---	---	---	---	5,000
TUNNEL									
Tunnel(Hauntain)	M	---	---	---	---	225,000	---	---	---
(Open Cut & Pipe Roof)	M	---	---	---	---	360,000,000	---	---	---
MEDIAN & SIDE WALK									
Median (W=3.2m)	M	---	---	---	---	1,000	---	---	---
Side Walk (W=2.5m)	M	---	---	---	---	700	---	---	---
INTERSECTION									
T-Intersection (Signal)	Ls	800,000	---	800,000	800,000	800,000	---	---	---
(Unsignal)	Ls	80,000	80,000	80,000	80,000	80,000	80,000	80,000	80,000
Four-Leg Intersection(Signal)	Ls	---	1,000,000	---	---	1,000,000	---	---	---
(Unsignal)	Ls	---	---	---	100,000	---	---	---	100,000
LAND ACQUISITION(Average)	SQ.M	6	14	14	206	1,022	0	8	10
	SQ.M	---	---	---	49	231	0	---	---
COMPENSATION	Ls	5,200,000	4,500,000	8,400,000	3,800,000	5,800,000	0	5,500,000	22,500,000
	Ls	---	---	---	10,800,000	8,200,000	0	---	---

f) Construction Schedule

The following factors were taken into account in preparing construction schedule for each project:

(a) Sections

- highway length of 15 - 20 km per section
- long bridge and tunnel as an independent project
- completion of whole stretch of project in three years

(b) Completion Period by Work Items:

-	Land Acquisition:	2 - 3 months
-	Preparatory Works:	2 - 3 months
-	Earth Works:	30,000 - 40,000 m3 /month
-	Pavement Works:	2 - 3 km / 2 lanes / month
-	Bridge Works:	total span length of 50 meters / 8 months total span length of 100 meters / 12 months
-	Cleaning Up	3 months

5.4.3 Evaluation of the Selected Eight Projects

Feasibility studies were carried out on the selected eight projects based on the framework as outlined in the preceding section. This section summarizes the results of the studies while more details are explained in Volume 3.

Table 5.4.11 summarizes the project cost. Total cost of the projects amounts to 2,517 million baht over a total distance of 351.6 kilometers excluding alternative projects of AD-1-1, AD-2-2 and WD7-4-2.

Project evaluation aims to measure the contribution of the projects to the overall economy of a country. There are several indeces for the measurement, including net present value (NPV), benefit cost ratio (B/C) and economic internal rate of return (EIRR). The NPV indicates a possible discounted gain to be produced by the project. The B/C indicates a discounted efficiency in terms of obtainable benefit per unit cost. The EIRR shows an expected percentage rate of return that the project produces in a national context.

Table 5.4.11 PROJECT FINANCIAL COSTS FOR F/S PROJECTS

No.	Project	Project Length 1/ (km)	Project Cost (mil.baht)
NC-1	Chumphon City Link	9.1	110.2
AD-1-1	Surat Thani Additional Lane	32.0	375.6
AD-1-2	Surat Thani Additional Lane	40.1	468.6
AD-2-1	Phuket Additional Lane	38.4	612.6
AD-2-2	Phuket Additional Lane	35.2	1,401.0
NC-3	Thap Put Bypass	8.0	120.3
WD7-4-1	Hua Sai - Songkhla Highway	96.3	215.6
WD7-4-2	Hua Sai - Songkhla Highway	96.3	271.8
WD6-1	Palian - Khuan Kalong Highway	82.6	318.3
NC-5	Highway 4/406 Short Cut Route	24.1	285.3
RW-7-1	Yala - Narathiwat Highway	53.0	385.9
	Total 2/	351.6	2,516.8

Note: 1/ "Project Length" means the total length of a project. Project Length is not equal to Design Length only for AD-1-2 and WD7-4-2.

2/ AD-1-1, AD-2-2 and WD7-4-2 are not included in "Total".

In the transport sector, project evaluation has generally been based on the benefits perceived by users, including savings on travelling time and vehicle operating cost. Highway projects, however, likely have wider range of impact on project areas including natural environment, flood damages, traffic accidents, land development and so on. Though these impacts are difficult to be clearly identified, preliminary assessment was tried on some projects by taking account of the unique characteristics of the Southern Region.

Table 5.4.12 shows results of the economic evaluation. All of the eight projects are judged viable with the EIRRs ranging from the lowest rate of 19.2 % for WD6-1 to the highest rate of 69.9 % for AD-2-1. The lowest EIRR of 19.2 % is calculated to be further lowered to 14.0 % in the sensitivity test of 20 % benefit down and 20 % cost up.

Table 5.4.12 ECONOMIC EVALUATION OF THE EIGHT PROJECTS

No.	Project	NPV	B/C	EIRR1	EIRR2
NC-1	Chumphon City Link	322	6.3	69.9	52.8
AD-1-1	Surat Thani Additional Lane	1,792	8.8	57.3	45.5
AD-1-2	Surat Thani Additional Lane	1,804	7.7	58.1	45.4
AD-2-1	Phuket Additional Lane	4,260	12.0	69.2	55.3
AD-2-2	Phuket Additional Lane	1,220	2.5	27.4	19.8
NC-3	Thap Put Bypass	76	2.2	23.0	17.0
WD7-4-1	Hua Sai - Songkhla Highway	263	3.1	34.3	25.3
WD7-4-2	Hua Sai - Spngkhla Highway	256	2.7	29.9	21.7
WD6-1	Palian - Khuan Kalong Highway	144	1.8	19.2	14.0
NC-5	Highway 4/406 Short Cut Route	1,146	8.0	52.3	41.4
RW-7-1	Yala - Narathiwat Highway	282	2.2	24.7	17.8

Note:
1) NPV in million baht at 12 % discount
2) B/C at 12 % discount
3) EIRR1 in percentage
4) EIRR2 in percentage with benefit down of 20 % and cost up of 20 %

1) NC-1: Chumphon City Link

The EIRR was calculated at 69.9 % though it was as high as 73.5 % in the pre-feasibility study. The high EIRR is attributable to the fact that the the existing highway capacity of Route 327 (S3 Standard) which is the only highway connecting Chumphon city with the artery of Route 4 is not enough to accommodate the increasing traffic demand in the future.

The EIRR will be lowered to 52.8 % in a sensitivity test of 20 % cost up and 20 % benefit down. In a case of 30 % down of the estimated traffic demand, the EIRR will be lowered to 46.8 %. The results of these tests are still high for this project. Highway capacity between Chumphon city and Route 41, therefore, should be increased at the earliest possible time.

Widening of and additional lane construction along the existing Route 327 would be an alternative with a view to coping with the increasing traffic demand. The proposed "New Highway Construction", however, should firstly be implemented to assure undisrupted transport connection between Chumphon city and Route 41 even in an emergency of flooding or road distruction by natural disaster.
The proposed new highway link lies in a flat land mostly of paddy field, grass land and coconut field. No significant effects on environment would be envisaged. Due to the traffic diversion of heavy trucks in particular from the existing Route 327 to this new highway, it is likely that this project would contribute to reduce traffic accident on Route 327.

2) AD-1: Surat Thani Additional Lane

(1) AD-1-1

The EIRR was calculated at as high as 57.3 % though it was 34.2 % in the pre-feasibility study. This is mainly due to the shortening of the project length from 60.3 kilometers to 32.0 kilometers just concentrating on the sections adjacent to Surat Thani city with greater traffic than the sections distant from the city.

This project is judged viable. Due to a substantial amount of land acquisition cost, however, the viability would be influenced to a considerable extent by the land price hike in the future if the implementation delays.

The highway lies in a flat land mostly with paddy and orchard fields. No significant effects on environment is envisaged because the highway follows the existing alignment without any intrusion into new land. Pavement of soil aggregate shoulders, near city area in particular, will be a good way to reduce accidents by leading motorcycle traffic to the shoulders.

(2) AD-1-2

The unique purpose of this project compared with that of AD-1-1 is to offer better transport linkage between Surat Thani Airport and Surat Thani city. The EIRR was calculated at 58.1 %, almost equal to that of AD-1-1. This alternative project is judged viable as well.

It is likely that better linkage between the airport and the city would contribute to stimulate economic development in the vicinity of Surat Thani city. AD-1-2 would be preferable to AD-1-1 in view of the possible contribution to the economic development.

The new section lies in a flat terrin in the Ta Pi river basin. No significant effects on environment is envisaged though drainage system should be well developed so as not to disturb water flow.

3) AD-2: Phuket Additional Lane

(1) AD-2-1

The EIRR was calculated at 69.2 % though it was as high as 77.6 % in the pre-feasibility study. The reason of this fall can be attributable to the combined effects of higher traffic volume and cost increase, increase of land acquisition cost for realignment section in particular. The EIRR will be lowered to 55.3 % in the combination of 20 % cost up and 20 % benefit down. In a case of 30 % down of the estimated traffic demand, however, the EIRR will still remain at as high as 63.6 %. The results of the sensitivity tests infers that the existing highway of Route 402 (S3 Standard) has not enough capacity to cope with the increasing traffic demand in the Phuket Island.

It is likely that the EIRR would constantly be lowered for the future due to the rapidly rising land price along the highway if the project implementation delays.

No significant effects on environment is envisaged even in the new construction section of 3 kilometers. Attention should be paid to traffic safety, safety of motorcycle traffic in particular. It is most likely that establishment of motorcycle lane on both sides of the carriageway over a distance of 33.5 kilometer contributes to reduce traffic accidents.

(2) AD-2-2

The EIRR was calculated at 27.4 %, extremely lower than that of AD-2-1. This is due to the high construction cost of a new highway on the west coast including an airport tunnel of 1,150 meters and a mountain tunnel of 600 meters.

Total highway capacity of AD-2-2 between Phuket Airport and Phuket Municipality is about a half of AD-2-1: the former comprising Route 402 of two lanes and this new highway of two lanes; and the latter comprising Route 402 of four lanes. Traffic capacity of the former is not enough to accommodate the estimated AADT of 17,100 in 1996 and 26,000 in 2001. The insufficient traffic capacity of AD-2-2 resulted in producing lower benefit than AD-2-1.

It is envisaged that this project would have moderate effects on environment in the mountainous area near Khatu in particular. The mountainous area belongs to the natural reserve forest. Environment impact assessment should be carried out in more detail if this alternative highway is to be implemented.

4) NC-3: Thap Put Bypass

The EIRR was calculated at 23.0 % though it was 30.4 % in the pre-feasibility study. This is mainly because of the increased earth work for embankment. The EIRR will be lowered to 17.0 % in a case of 20 % cost up and 20 % benefit down. This project is judged viable.

The highway lies in a flat land mostly with rubber plantation. Mangrove forest is not found in this upstream of small rivers. No significant effect on environment is envisaged. Traffic safety would be improved particularly at the intersection with Route 4.

5) WD7-4: Hua Sai - Songkhla Highway

(1) WD7-4-1

The EIRR was calculated at 34.3 % though it was 46.3 % in the pre-feasibility study. This was caused mainly due to the introduction of the overlay cost of the existing pavement which was not included in the pre-feasibility study. The EIRR will be lowered to 25.3 % in a case of 20 % cost up and 20 % benefit down. The project is judged viable.

No significant effects on environment is envisaged as the project is just a widening of the existing carriageway. Although the highway is located in a flat low land along the coastal line, there have not been flooding damages except for some section near Hua Sai.

(2) WD7-4-2

The EIRR was calculated at 29.9 %, slightly lower than that of WD7-4-1. The EIRR will be lowered to 21.7 % in a case of 20 % cost up and 20 % benefit down. Though the project is judged viable, WD7-4-1 should firstly be implemented. The timing of introducing WD7-4-2 should secondly be determined through observation of future traffic increase near Hua Sai city.

6) WD6-1: Palian - Khuan Kalong Highway

The EIRR was calculated at 19.2 % though it was 22.4 % in the pre-feasibility study. The reason for the lower EIRR this time is the cost increase incurred by realignment of the existing highway over a distance of 26.1 kilometers. The EIRR would be lowered to 14.0 % in a case of 20 % cost up and 20 % benefit down. The project is judged still viable although the EIRR is the lowest of the eight projects.

The highway passes through a mountainous area of Khao Ya Ra near Khuan Kalong. Small effects on environment are envisaged in this area in terms of erosion and siltation, possible encroachment to ecology and air pollution hazards at climbing sections.

7) NC-5: Highway 4/406 Short Cut Route

The EIRR was calculated at 52.3 % though it was 53.8 % in the pre-feasibility study. The highway sections studied this time are consisted of two sections of "S2" standard: (1) a short cut connection between Route 4 and 406 over a distance of 17.3 kilometers; and (2) an airport connection to Route 4 over a distance of 6.8 kilometers, while only the former section of "S3" standard was designed in the pre-feasibility study. More disaster prevention measures including earth work and structures were introduced this time based on road inventory and field reconnaissance surveys. The project is judged viable.

The short cut route between Route 4 and 406 lies along the foot of the mountain which has been designated as national park and comes across with many small rivers. Small effects on environment is envisaged in terms of encroachment on ecology and erosion and siltation. Attention was paid to protect the highway from natural disasters, mud and debris flow in particular.

8) RW7-1: Yala - Narathiwat Highway

The EIRR was calculated at 24.7 % almost equal to the one calculated in the pre-feasibility study. The EIRR will be lowered to 17.8 % in a case of 20 % cost up and 20 % benefit down. The project is judged viable.

Of the total length of 53.0 kilometers, 36.7 kilometers (69 %) are for widening and reconstruction, and 16.3 kilometers (31 %) are for new construction and realignment. No significant effect on environment is envisaged for the section of widening and reconstruction. For the section of new construction and realignment, however, small or moderate effects on environment are envisaged in terms of encroachment on ecology, erosion and siltation, and environmental aesthetics although special attention was paid to minimize the cut and fill works.

This project is deemed important for stimulating economic development in the Southern Border Provinces. Without the project, economic development would be deferred for many years, inland Yala and Narathiwat in particular. Engineering design in the next stage should fully take into account of the local environmental factors with a view to attaining a better balance between natural conditions and highway construction in the area for regional development.

9) Conclusion of Project Evaluation

Table 5.4.13 shows the outline of the project evaluation from various points of view. In terms of economic evaluation, all the projects are judged viable even in sensitivity tests. In terms of flood prevention and traffic accidents, there is no projects that would have negative effects. In terms of environment impact assessment, however, some projects are likely to have small effects on environment: AD-2-2 and RW7-1 in particular.

Chumphon City Link (NC-1), Phuket Additional Lane (AD-2-1), Surat Thani Additional Lane (AD-1-2), Hua Sai - Songkhla Highway (WD7-4-1) are the promising projects from every point of view. Highway 4/406 Short Cut Route (NC-5), Thap Put Bypass (NC-3) and Palian - Khuan Kalong Highway (WD6-1) are the second promising projects that would have small effects on environment. Yala - Narathiwat Highway (RW7-1) would be the only project that needs policy coordination between development and environmental conservation.

Table 5.4.13 OVERALL PROJECT EVALUATION

No.	Project	EIRR	EIA	FP	TA
NC-1	Chumphon City Link	69.9	0	+1	+1
AD-2-1	Phuket Additional Lane	69.2	0	+1	+1
AD-1-2	Surat Thani Additional Lane	58.1	-2	0	+1
AD-1-1	Surat Thani Additional Lane	57.3	0	+1	+1
NC-5	Highway 4/406 Short Cut Route	52.3	-3	0	0
WD7-4-1	Hua Sai - Songkhla Highway	34.3	0	+1	0
WD7-4-2	Hua Sai - Songkhla Highway	29.9	0	+1	0
AD-2-2	Phuket Additional Lane	27.4	-5	0	0
RW7-1	Yala - Narathiwat Highway	24.7	-4	0	0
NC-3	Thap Put Bypass	23.0	-2	0	+1
WD6-1	Palian - Khuan Kalong Highway	19.2	-3	0	0

Note:
1) EIRR - Economic Internal Rate of Return (%)
2) EIA - Environmental Impact Assessment
"0": No Significant Effects
"-N": Number of Items of Small Effects
3) FP - Flood Prevention
"0": No Significant Change
"+1": Improvement
4) TA - Traffic Accidents
"0": No Significant Change
"+1": Improvement in Urban Area

5.5 Recommendations

5.5.1 Policy for Highway Development in the Southern Region

The Southern Region is mostly mountainous and covered by frangible tropical forests. About 40 percent of the region is designated as national reserve forest. It is very likely that new highway construction in any low density area of highways inevitably intrude into mountainous and/or national reserve forest. In view of the well structured highway network of the region, it is advisable in principle to upgrade the existing highways to cope with the increasing traffic demand for the future, instead of trying to construct new highways.

The highway network of the Southern Region should be upgraded firstly with a focus on the arteries of Route 4 and 41 connecting the region with Bangkok to the north and Malaysia to the south. Upgrading of international as well as inter-regional arteries is essential to promote the economic development of the region in the context of export oriented industrialization.

A focus should secondly be given to the upgrading of the east-west highway links connecting both sides of the Peninsula with a view to providing better access to the arteries of Route 4 and 41 which locate in the center of the Peninsula. North-south highway links should be developed at the same time to make the most of the upgraded east-west highway links.

On top of the regional scope pointed out in the above, a focus should be given thirdly to the development and/or upgrading of the highways which are deemed important to specific areas in the Southern Region particularly in terms of preventing flooding damages, easing traffic congestion in urban areas and stimulating area development.

The highway development master plan toward the year 1996 was established based on the above policies as discussed in Section 5.2, coupled with the appraisal of the existing highway capacity in terms of the estimated future requirement.

5.5.2 Highway Development Projects

Table 5.5.1 summarizes the total length of highway projects proposed by the Study. Out of the 2,622 kilometers of the master plan projects, projects of 900 kilometers were selected as the priority projects by 1996, excluding additional lane construction projects on the arteries of Route 4 and 41 in the center of the Southern Region.

Table 5.5.1 Highway Development Projects by 1996

	F/S Projects	Pre F/S Projects	Remaining Projects	Total
NC Project	41 km	68 km	11 km	120 km
AD Project	79	131	570	780
WD7 Project	96	270	1,094	1,460
WD6 Project	83	0	47	130
Other Projects	53	79	0	132
Total	352	548	1,722	2,622

Note: "Others" includes projects of "reconstruction" and "upgrading to bitumen standard"

Table 5.5.2 lists the proposed highway projects of both the F/S and the pre F/S projects. The total project cost for the master plan by 1996 is estimated at 15,040 million baht including: (1) project costs for the F/S projects at 2,520 million baht; (2) those for the remaining pre F/S projects at 3,860 million baht; and (3) those for the other master plan projects at 8,660 million baht.

Table 5.5.2 PRIORITY PROJECTS IN THE MASTER PLAN 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		35.6	273.9	51.0
10	WD7-1		62.8	166.2	43.3
11	AD-4		95.5	994.0	42.9
12	WD7-2		68.1	200.2	21.8
13	WD7-5		25.9	88.0	18.1
14	WD7-3		49.1	168.7	16.0
15	NC-2		20.5	280.4	12.6
16	NC-4		30.7	383.1	12.3
17	UBS-1		78.7	804.0	12-20
18	WD7-6		64.0	165.6	10.8
19	NC-6		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: 1) Cost for "No. 20 Remaining Projects" was estimated based on the unit project costs derived from the feasibility studies on the eight projects.

5.5.3 Budgetary Requirements

Table 5.5.3 summarizes the budget of DOH for the whole country during the period of the Sixth Highway Development Plan. The total budget of DOH amounted to 73,300 million baht for the five year peiord including budget for "road development" amounted to 35,100 million baht (48 % of the total budget), "road maintenance" budget 15,400 million baht (21 %), and "administration" budget 11,200 million baht (15 %). "Road development" budget for the Southern Region appoximately accounted for 15 % of the national budget, amounting to about 5,300 million baht.

Table 5.5.3 BUDGET OF DOH DURING THE SIXTH HIGHWAY PLAN PERIOD
(Whole Country)

Investment	mil.baht	%
1. Road Development:	**35,068.5**	**47.8**
1.1 Rehabilitation & Reconstruction	9,127.7	
1.2 Improvement of Congested Roads	11,211.9	
1.3 Upgrading to Bitumen Standard	9,178.0	
1.4 New Road Construction	3,250.1	
1.5 Interchanges & Bridges	1,829.8	
1.6 Safety Program	471.0	
2. Road Maintenance:	**15,392.8**	**21.0**
2.1 Routine Maintenance	6,495.7	
2.2 Periodic & Special Maintenance	8,533.5	
2.3 Emergency Maintenance	363.6	
3. Security Roads & New Projects	**11,612.7**	**15.8**
4. Administration	**11,248.7**	**15.3**
Total	73,322.7	100.0

Source: DOH

Table 5.5.4 shows the budget breakdown of DOH in terms of yearly disbursement and financial sources. The yearly disbursement was conspicuously increased toward the end of the period with a steadily rising percentage share of foreign sources. It is likely that most part of the foreign sources has been used for financing "road development" projects.

Table 5.5.4 Yearly Disbursement and Financial Sources of the Budget during the Sixth Five Year Plan Peirod

	Government		Foreign		Total	
	mil.baht	%	mil.baht	%	mil.baht	%
1987	8,462	88	1,134	12	9,596	100
1988	10,007	94	649	6	10,656	100
1989	11,794	88	1,548	12	13,342	100
1990	15,676	83	3,189	17	18,865	100
1991	17,920	75	6,020	25	23,940	100
Total	63,859	84	12,540	16	76,399	100

Source: DOH

As discussed in the preceding section, the total cost of "road development" projects proposed by this Study amounts to 15,040 million baht for the period of 1992 - 1996.

"Road development" budget for the Southern Region during the seventh plan period should substantially be increased: from 5,300 million baht in the sixth plan to 15,040 million baht which is about 2.8 times as large as the budget in the sixth plan. The budgetary requirement, however, is likely in the possible range of attainment if the yearly budget of 20,000 million baht (average of 1990 and 1991 budget) is allocated for the coming five years in the Seventh Plan period and the present percentage share of the Southern Region (about 15 %) is maintained throughout the Seventh Plan period. It is likely as well that foreign finance will be required in the range of 20 - 25 % of the annual budget.

5.5.4 Project Implementation Program

Table 5.5.5 shows a proposed project implementation program of the Southern Region for the Seventh Five Year Plan period. The program is prepared on the assumption that the highest priority projects will be implemented in the first three years (1992-1994), that the second highest priority projects mostly from the second to the fourth year (1993-1995), and that the remaining projects for the five years (1992-1996) to make yearly disbursement as constant as possible.

Table 5.5.5 PROJECT IMPLEMENTATION PROGRAM

unit: million baht

Project	1992	1993	1994	1995	1996	Total
F/S Projects	0.0	960.8	1,079.5	476.6	0.0	2,516.8
AD-2-1		281.8	196.0	134.8		612.6
NC-1		41.9	68.4			110.2
AD-1-2		154.6	187.4	126.6		468.6
NC-5		114.1	105.6	65.6		285.3
WD7-4-1		77.6	138.0			215.6
NC-3		51.7	68.5			120.3
RW7-1		146.7	166.0	73.3		385.9
WD6-1		92.3	149.6	76.3		318.3
Pre F/S Pro.	179.0	467.2	1,132.3	1,190.5	897.3	3,866.4
AD-3			54.8	139.7	79.5	273.9
AD-4	179.0	467.2	347.9			994.0
WD7-1			46.5	74.8	44.9	166.2
WD7-2			64.1	90.1	46.0	200.2
WD7-5			33.5	34.3	20.3	88.0
WD7-3			40.4	82.7	45.6	168.7
WD7-6 1/			38.1	77.8	49.7	165.6
NC-2			114.9	151.4	14.0	280.4
UBS-1 1/			160.8	241.2	402.0	804.0
NC-4			115.0	168.5	99.6	383.1
NC-6 1/			116.4	130.1	95.8	342.3
Master Plan Projects	2,165.0	1,732.0	888.0	1,433.0	2,441.0	8,659.0
Grand Total	2,344.0	3,160.0	3,099.9	3,100.1	3,338.3	15,042.2

Source: Study Team

Note: "Pre F/S Pro." stands for Pre F/S Projects.
"Master Plan Projects" means those excluding F/S and Pre F/S projects.
1/ are the projects of which EIRRs were lower than 12 % in preliminary feasibility study stage. Further studies are required to determine whether or not these projects are to be included in the project implementation program.

CHAPTER 6

Southern Seaboard Development Program (SSDP)

6. SOUTHERN SEABOARD DEVELOPMENT PROGRAM (SSDP)

6.1 Development Framework

Planning framework for the study on the Krabi - Khanom Highway Link was prepared in three steps:

1) The first step was to prepare a planning framework of the Southern Region based on the assumed future economic growth trend of the Southern Region without the Southern Seaboard Development Program (SSDP);

2) The second step was to assume a planning framework of the SSDP which has no official planning framework at present; and

3) The last step was to prepare a planning framework of the Southern Region including the SSDP based on the two kind of planning framework prepared in 1) and 2) above.

The planning framework of the Southern Region without the SSDP was prepared as a basis to estimate future traffic demand all over the Southern Region. The planning framework of the SSDP was prepared as a basis to estimate future traffic demand directly related to the economic activities of the SSDP. A possible diversion of international container transport to the Land Bridge from the Strait of Malacca was assumed separately with the SSDP framework. The combined planning framework of the Southern Region and the SSDP was prepared to assess the possible traffic impact of the SSDP on the existing highway system in the Southern Region, particularly in the Krabi - Khanom Land Bridge Corridor.

Table 6.1.1 and Fig. 6.1.1 show the assumed planning framework for this study.

Table 6.1.1 PLANNING FRAMEWORK

(in billion baht)

Year	without SSDP		SSDP	with SSDP	
	Country	South		Country	South
1988	1,449	144.47	-	1,449	144.47
1996	2,480	262.63	-	2,480	262.63
2001	3,342	367.62	18.08	3,360	385.70
2006	4,504	506.70	60.95	4,565	567.65

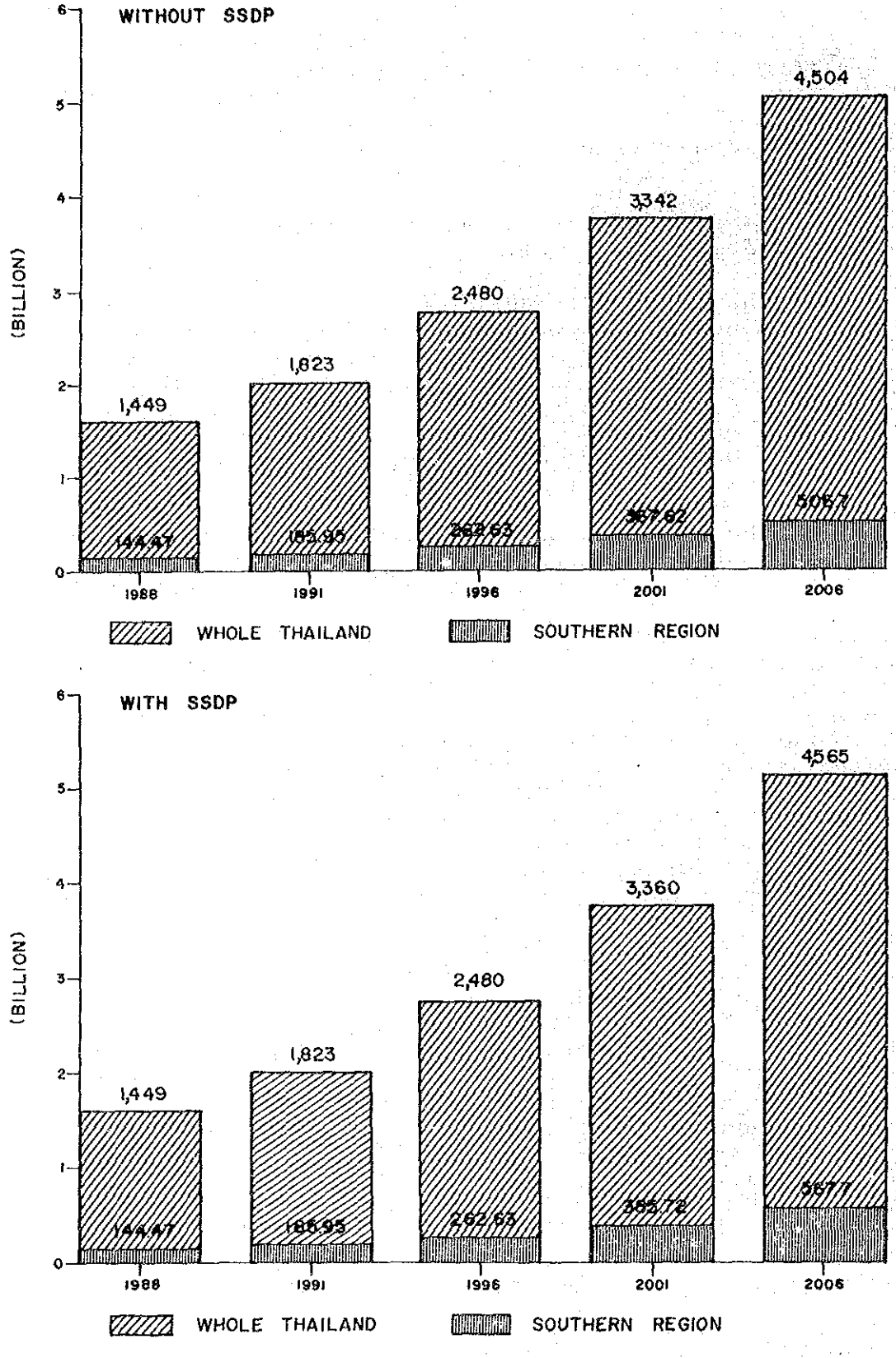


Fig. 6.1.1 PLANNING FRAMEWORK OF SSDP

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, however, differs with the ESDP to a great extent in a sense that its formation will largely be dependent on participation of the international community.

The SSDP places an utmost focus on external orientation to transform the isthmus into a new international economic zone through introducing the "Trans-Thai Land Bridge". The isthmus should have direct economic linkage with the Middle East and the Integrated EC Market to the west and with the economic growth pole of the Pacific Rim to the east.

Once the SSDP is realized in the future, it will certainly give a great impetus to the Southern Region economy. At the present time, however, the SSDP is still in a stage of "Research & Development" to shape the so-called product concept acceptable to the international community.

Under the circumstances, it might be still too early to establish a planning framework of the SSDP. At the same time, due to the nature of the SSDP that does not depend on tangible domestic demand, a planning framework of the SSDP would undergo changes from time to time reflecting behavior of the international participants. It is likely that a planning framework of the SSDP will be prepared through the SSDP master plan study in a flexible way to accept changes in terms of investment scale and timing.

For the analytical purposes of this study, however, the Study Team prepared a planning framework of the SSDP with a main aim to assess the capacity required for the Krabi - Khanom Highway Link which is a part of the "Trans-Thai Land Bridge". The planning framework is based on an assumption that the SSDP will raise per capita GRP of the Southern Region equal to the national average in 2011. This is a target only from a view point of the national economy.

At the beginning stage of the SSDP in 2001, the SSDP was assumed to raise per capita GRP of the Southern Region by 3.7 % to 87.5 % of the national average in comparison with the planning framework of the Southern Region without the SSDP. Based on this assumption, the SSDP framework for the year 2001 was assumed at 18 billion baht which is equivalent to 1.2 % of the national GDP in 1988 or 4.9 % of the estimated GRP of the Southern Region in 2001.

In the year 2006, per capita GRP of the Southern Region was assumed to be improved by 9.2 % to 93.5% of the national average. Based on this assumption, the SSDP framework for the year 2006 was assumed at 61 billion baht which is equivalent to 4.2 % of the national GDP in 1988 or 12.0 % of the estimated GRP of the Southern Region in 2006.