PART I KELANTAN'S CONDITIONS FOR PORT DEVELOPMENT

CHAPTER I GENERAL

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1-1 Natural Conditions

1-1-1 Geographical and Topographical Conditions

The State of Kelantan is situated in the northeastern part of Peninsular Malaysia. Its limits are lat. 4°32″ N. to 6°15″ N. and long. 101°20″ E. to 102°40″ E. It adjoins Thailand and the State of Perak on the west side, the State of Pahang on the south side and the State of Trengganu and the South China Sea on the east side. Fig. 1-1 shows the location of the State of Kelantan.

It has the length about 190 km north to south and 130 km east to west and its area is approximately 15,000 km^2.

By districts, it has the following topographical characteristics: The northern coastal area is an alluvial plain due to Sg. Kelantan. This plain is so flat that it seldom excceds 15 m in altitude anywhere. The coastline is 80 km and the estuary of Sg. Pengkalan Datu — the former estuary of Sg. Kelantan — protrudes most. The sea is shallow to a great distance from the shore, and the seabottom gradient is 1/1500 ~ 1/1000.

There is a range of high mountains on the southern border of the state. Mountains of higher than 500 m run north to south on the west side and mountains of about 1,000 m high run north to south on the east side. On the south side lies the mountainous area of Taman Negara.

The State of Kelantan has Sg. Kelantan and its tributaries whose basin covers about 85% of the total area of the state, Sg. Kemasin and Sg. Semerak in the coastal area, and Sg. Golok which forms the border with Thailand. According to Kelantan River Basin Study, the river bottom gradient is only 0.015% in the lower part of the river. This fact may be one of the causes of the floods that bring heavy damage almost every year. The estuaries of these rivers are all but blocked by drift sand.

1-1-2 Geological Conditions

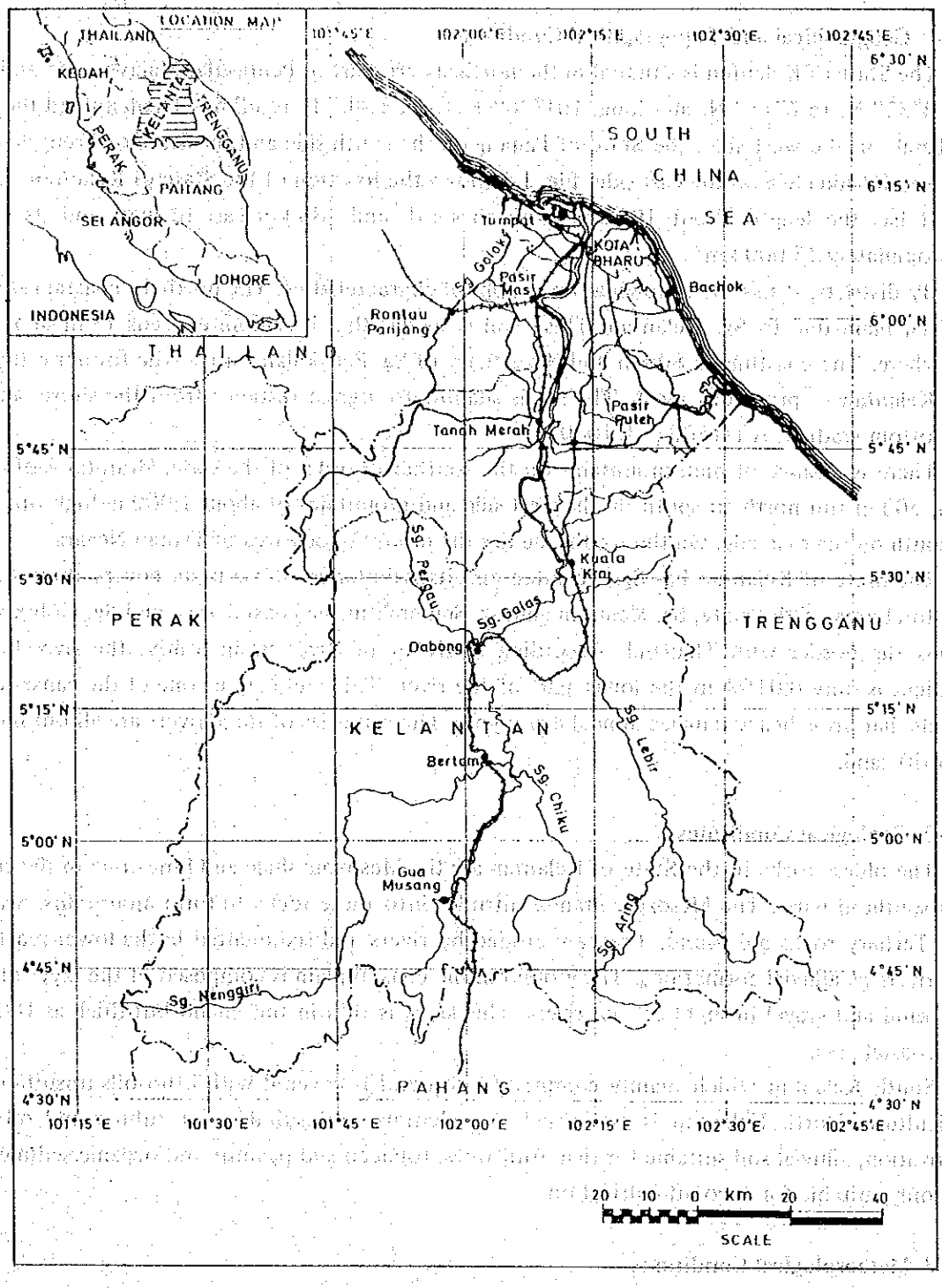
The oldest rocks in the State of Kelantan are the Mesozoic shale and limestone in the central and southern parts. The Mesozoic granite intrudes into these rocks to form mountains. Scarcely any Tertiary rocks are found. They are eroded by rivers and sedimented in the lower reaches of the rivers as alluvial formations. The ground in the coastal plain is composed of the layer of clay, silt, sand and gravel brought by the rivers. This layer is thin in the inland but thick as 180 m in the coastal area.

South Kelantan which mainly comprises forestland is covered with lithosoils unsuitable for agriculture. North Kelantan is composed of sedentary soil suitable for rubber and oil palm cultivation, alluvial soil suitable for rice, fruit trees, tobacco and peanuts and oceanic sedimentary soil only suitable for coconut cultivation.

1-1-3 Meteorological Conditions

Meteorology in the State of Kelantan is affected by the tropical climate, the oceanic climate by the South China Sea, and two monsoons, namely, NE monsoon and SW monsoon. There are great meteorological differences between the northern coastal plain and the southern highland area.

Fig. 1-1 Location of The State of Kelantan



Source: Kelantan River Basin Study

In the northern coastal plain, the annual average rainfall is 3,000 mm and 50% of the total occurs in the NE monsoon season from November to February. In 1979, a daily maximum rainfall of more than 810 mm was recorded. NE or ENE winds of 7 ~ 14 km/h blow during the NE monsoon season. Gales of a maximum wind velocity of 35 km/h was recorded. The annual average temperature is 26.7°C, and the maximum and the minimum are about 35°C and 20°C, respectively. The monthly average temperature is 25 ~ 28°C and there is no great difference by months.

In the southern area, there is no clear distinction between the wet and dry seasons. The skies are usually cloudy in the daytime and there often is a thunderstorm in the afternoon. Rainfall is great in April–May and October–November. The annual average rainfall differs by areas, ranging from 2,200 to 3,400 mm. Winds blow during the monsoon periods at a velocity of 3 ~ 10 km/h but there are sometimes strong winds of 20 km/h.

Fig. 1-2 shows the annual average rainfall for Kelantan.

1-1-4 Oceanographical Conditions

On and about the shores of the State of Kelantan, waves are largest in the NE monsoon season as they are developed by the NE winds of the South China Sea. In the SW monsoon season, the sea is very calm as winds blow from the land side.

The sea current of the east coast of Peninsular Malaysia flows in the SE direction in winter and flows in the NW direction in summer. It is imagined that the coastal current along the shore of the State of Kelantan flows in the same direction with the sea current.

There is active sand drift on the seashore due to the oceanographical condition, and the earth and sand brought by Sg. Kelantan.

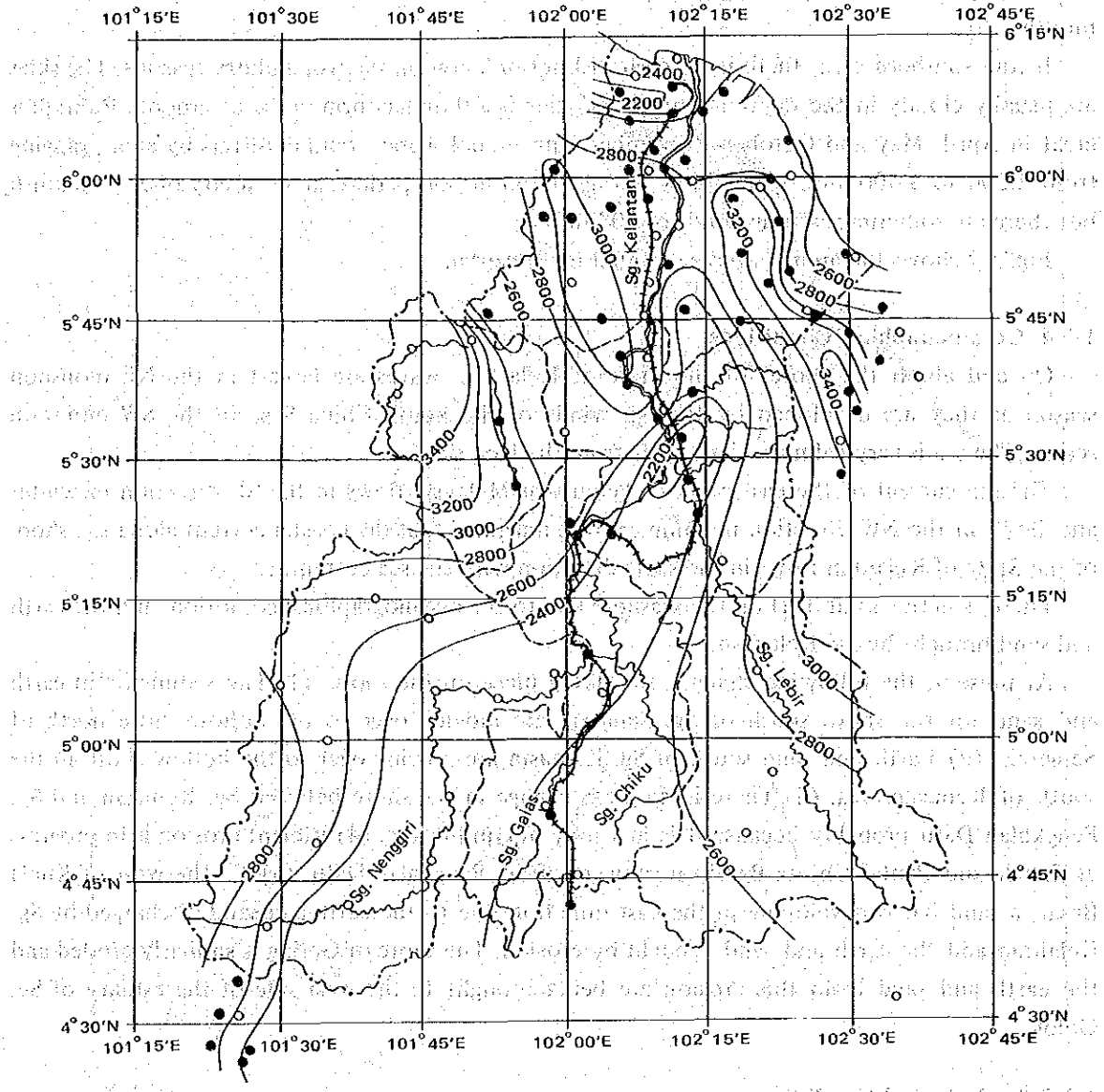
At present, the following changes are taking place on the shore: (1) The sediments of earth and sand on the shore south of Sg. Semerak are moving over to the hollow shore north of Semerak. (2) Earth and sand south of Sg. Kemasin are moving over to the hollow shore in the south of Kemasin area. (3) There is no great change in the shore between Sg. Kemasin and Sg. Pengkalan Datu probably because it is in a state of equilibrium. (4) Violent erosion is in progress at Sabak and Pantai Chinta Berahi northwest of Sg. Pengkalan Datu. (5) To the west of Kuala Besar, a sand bar is developing in the east direction due to the earth and sand discharged by Sg. Kelantan and the earth and sand brought by erosion. The shore of Geting is similarly eroded and the earth and sand from this erosion are being brought to the west side of the estuary of Sg. Golok.

1-1-5 Hydrological Conditions

Sg. Kelantan has four tributaries: Lebir, Galas, Pergau and Nenggiri. According to Kelantan River Basin Study, water flowing from these tributaries averages at 590 m^3/sec in volume at Guillemard Bridge, and the maximum and the minimum are 21,000 m^3/sec and 100 m^3/sec, respectively. Water level of Sg. Kelantan rapidly rises in the case of continuous heavy rainfall. Sg. Kemasin and Sg. Semerak have small basins, and usually flow by the range of tide. These two deep rivers rapidly swell in time of heavy rainfall.

In the State of Kelantan, the natural disaster is usually caused by floods. It suffers flood damage almost every NE monsoon season as the result of local heavy rain in its plains or rainfall

Fig. 1-2 Average Annual Rainfall for Kelantan



Source; Kelantan River Basin Study

in the basins of its rivers.

It is reported that a coastal area of more than 1,500 km^2 was inundated more than 300,000 people suffered heavy damage and 55 were drowned by the flood of 1967.

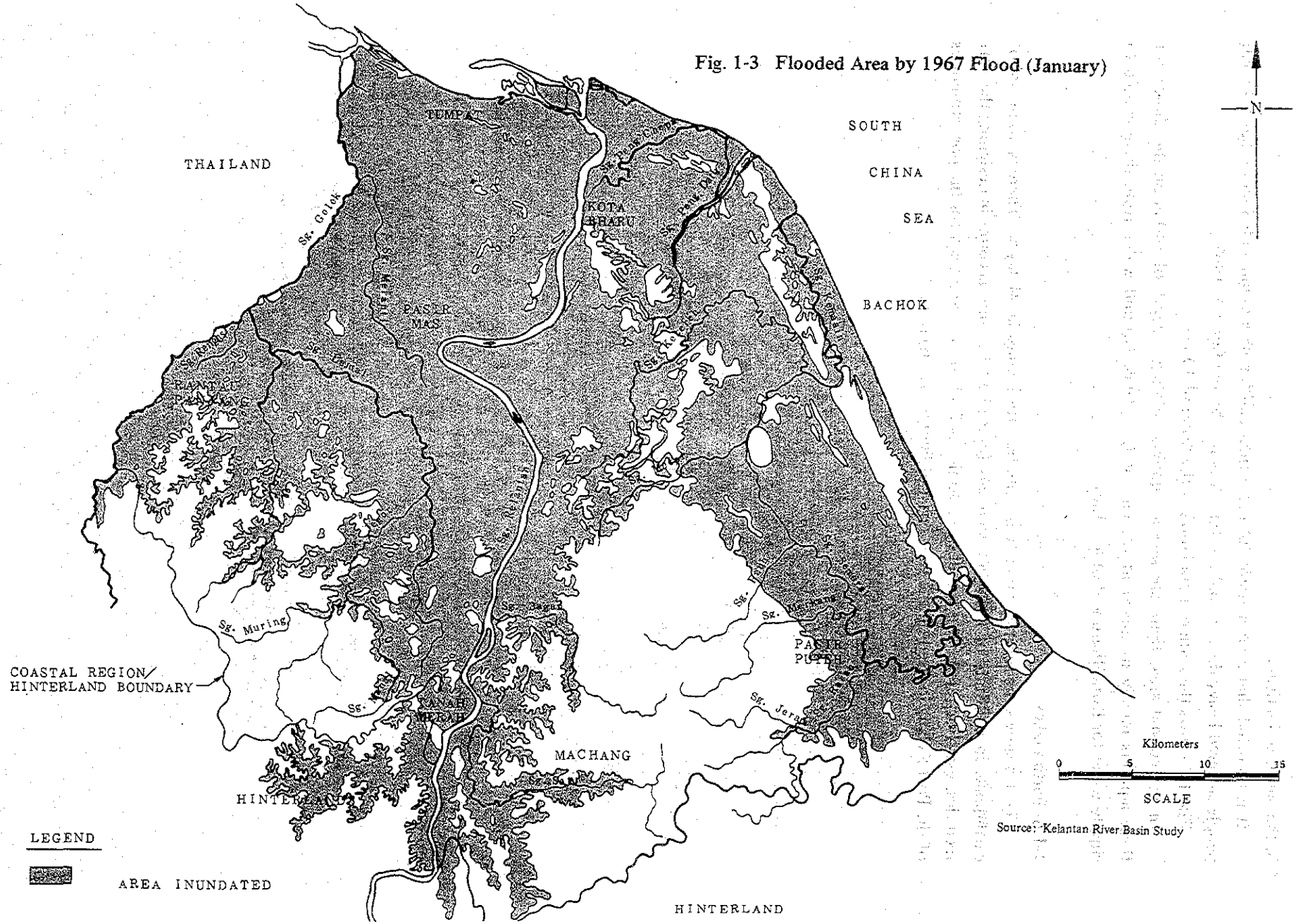
Fig. 1-3 shows the state of inundation in the flood of 1967.

In the coastal area, there are several aquifers totaling a depth of 180 m on the shores but these aquifers mostly disappear at the end of the plains. Ground water from them is used to supply water for Kota Bharu and other cities.

1-1-6 Earthquakes

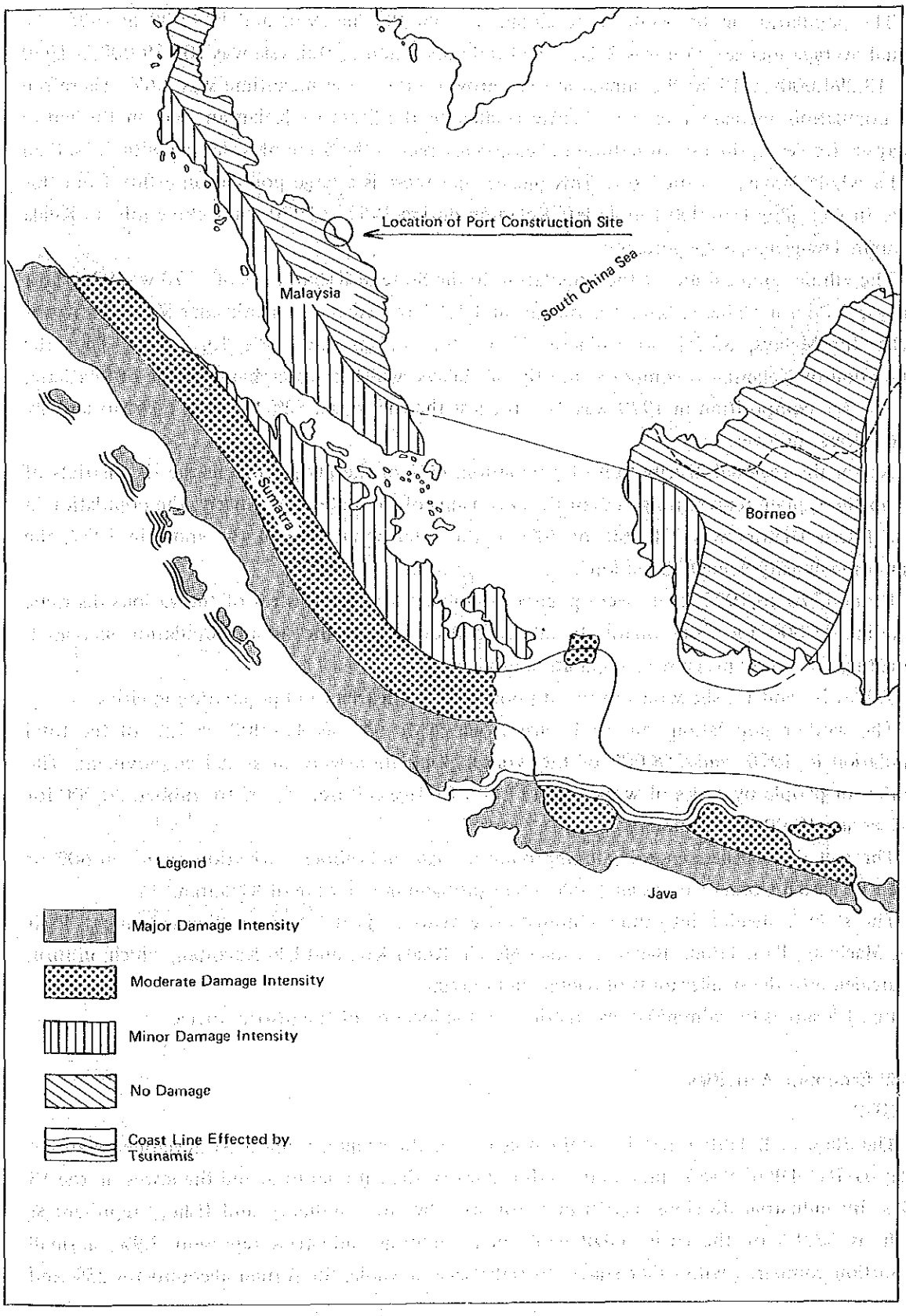
Fig. 1-4 shows the seismic intensity distribution for Peninsular Malaysia. There is no record of earthquake in the State of Kelantan, so it should not be taken into account in designing the port facilities, etc. For references, the design seismic coefficient of zero is used for the port structures of the Port Kelang located on the west coast of Peninsular Malaysia.

Fig. 1-3 Flooded Area by 1967 Flood (January)



Source: Kelantan River Basin Study

Fig. 1-4 Seismic Intensity Distribution for Peninsular Malaysia



1-2 Social and Economic Conditions

1-2-1 Population

The population in the State of Kelantan was 686,000 in 1970 and 844,000 in 1978; the annual average increase rate was 2.4%. The total population of Malaysia was 10,439,000 in 1970 and 13,294,000 in 1978; the annual average growth rate in the meantime was 2.6%. Therefore the population increase rate was slightly smaller in the State of Kelantan than in the entire Malaysia. However, the rate of natural increase was larger in the State of Kelantan with 2.7% than in the whole Malaysia with 2.6%. This means that there is a large population efflux from this state. In fact, about 56,000 people left Kelantan during 1957 ~ 1970 for seeking jobs to Kuala Lumpur, Trengganu, Singapore, etc.

The ethnic composition of the population in the State of Kelantan as of 1970 was 92.4% for Malays, 5.7% for Chinese, 0.8% for Indians and 1.1% for others. In Peninsular Malaysia, it was 53.1% for Malays, 35.5% for Chinese, 10.6% for Indians and 0.8% for others. Thus the population of Kelantan is composed mostly of Malays, which gives a characteristic of this state.

The age composition in 1970 was 44% for less than 15 years, 52% for 15 ~ 64 years and 4% for 65 years and over.

As for the regional distribution of population, 80% of the people live in the six districts of the northern plain representing 16% of the entire area of the state. Particularly, the population in Kota Bharu District was 250,000, or 30% of the total population of the state, in 1977, the population density being 610 per km^2.

From 1970 to 1975, there were population increases in the centres of the various districts, including 11,000 for Kota Bharu. In all, 20,000 or 20% of the urban population increased, indicating the steady progress of population urbanization.

Tables 1-1 and 1-2 show the change of population by districts and population in cities.

The worker population ranging in age from 15 to 64 was 357,000 or 52% of the total population in 1970, and 258,000 of the worker population were in actual employment. The number of people by types of work was 111,000 for rice culture, 55,000 for rubber, 20,000 for services and 18,000 for commerce.

The fact that farmers engaging in unproductive padi and rubber cultivation, represent 60% of the entire actual workers, poses an employment problem in the State of Kelantan.

The state is divided into nine administrative districts (jajahan): Kota Bharu, Tumpat, Pasir Mas, Machang, Pasir Puteh, Bachok, Tanah Merah, Kuala Krai and Ulu Kelantan, which, in turn, are divided into the smaller units of daerah and mukim.

Fig. 1-5 shows the administrative district and the location of the district office.

1-2-2 Economic Activities

(1) GDP

The State of Kelantan may be counted as one of the economically least developed states in Malaysia. Its GDP of M$531 million in 1978 is 2.4% of the national total and the lowest in the 13 states. By industrial divisions, agriculture, forestry, livestock industry and fishery represent as much as 38.9% of the entire GDP while manufacturing industries represent 7.9%, a small proportion compared with other states. In Malaysia as a whole, the former accounts for 25% and

Table 1-1 Population by District

District	Area (km^2)	1970	1977
Kota Bharu	409.2	207,837	249,490
Tumpat	167.1	73,050	85,154
Pasir Mas	578.6	100,689	119,233
Machang	544.7	51,636	63,065
Pasir Puteh	433.6	71,133	84,085
Bachok	264.7	62,182	72,869
Tanah Merah	1,487.4	57,925	76,168
Kuala Krai	2,938.1	49,313	64,676
Ulu Kelantan	8,108.0	12,496	16,169
Total	14,931.4	686,266	830,909

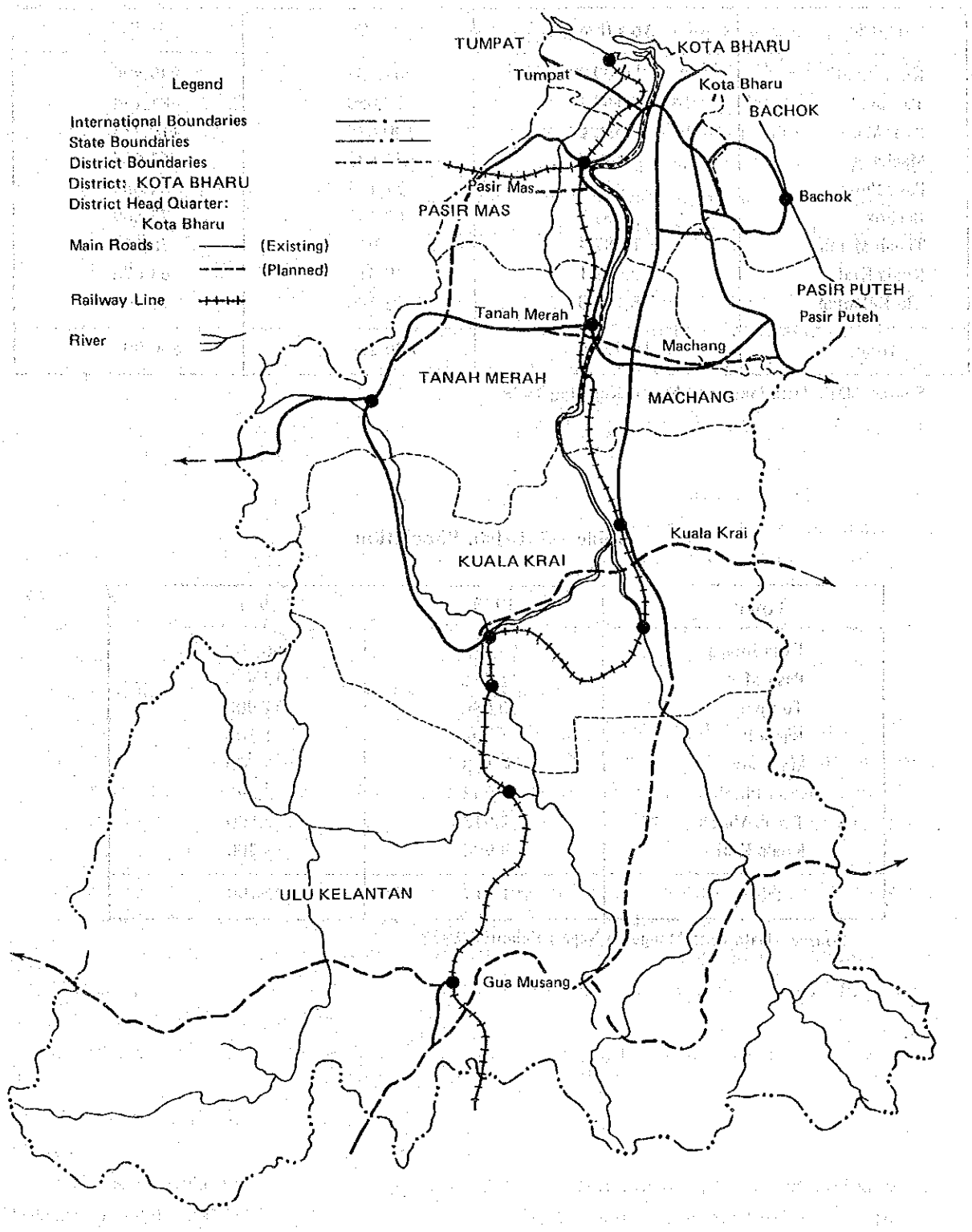
Source: Data Data Mengenai Negeri Kelantan 1978

Table 1-2 Urban Population

Town	1970	1977
Kota Bharu	55,113	66,200
Pasir Mas	11,236	13,400
Tumpat	10,680	11,900
Bachok	1,396	1,500
Machang	4,193	5,700
Pasir Puteh	3,093	3,690
Tanah Merah	7,012	9,500
Kuala Krai	8,994	10,300
Total	101,717	122,190

Source: Data Data Mengenai Negeri Kelantan 1978

Fig. 1-5 Districts and Places of District Head Quarters



the latter 20%. The per-capita GDP is the lowest at 38% of the national average. Generally speaking, the present economy of the State of Kelantan gives an economic image typical of a developing country where agriculture is centered and industrialization is lagged.

Table 1-3 shows the Malaysian GDP in 1978 by state and industry of origin.

(2) Agriculture

In 1978, agriculture including forestry and fishery in the State of Kelantan amounted to M$207 million or 40% of the all-industry GDP of M$531 million. Since this section accounts for 25% of the total GDP of Malaysia, the proportion of agriculture in the State of Kelantan is remarkably high.

The staple agricultural products in this state are rubber, rice, tobacco, fruit, peanuts, coconuts, vegetables, bananas, and oil palms.

Below is the description of the present production of rubber, rice and oil palm that may be handled at the proposed new port in the future.

① Rubber

Rubber may be considered to be the most important agricultural product of the State of Kelantan. A large number of the smallholders and labourers engaged in rubber cultivation belong to the poor class, as in the case of rice farmers. It is, therefore, natural that the increase of productivity in rubber cultivation is included among the main targets of socio-economic development.

In 1976, there were 68 estates cultivating rubber in the State of Kelantan and, of these, 54 or 79% were in the three southern districts. The cultivated area was 1,174 km^2 including 195 km^2 estates representing only 17% of the total. The remaining 83% was owned by smallholders.

As for production, estates and small holders account for 36% and 64%, respectively. The production has not changed much during the past several years. Hereafter, it is expected to increase gradually in the short term through the replacement with high-yield varieties and the increase of fertilization. In the long term, the production will considerably increase through the accomplishment of targets under the FELDA scheme.

Most of the rubber now produced is exported from the Port Klang.

② Rice

Rice is also one of the most important agricultural products in the State of Kelantan. A total of 111,000 farmers, mostly Malay peasants, engage in rice culture and 80% of them own their cultivated lands of less than 9,000 m^2. The local rice production was steady at about 200,000 tons during the past several years.

There are wet padi and dry padi, but the former is overwhelmingly predominant at 99% in output. As for the cultivated area, main-season padi accounts for 66,00 ha, off-season padi accounts for 23,000 ha, and dry padi accounts for only 3,000 ha. In the future the rice production is expected to increase with the progress of flood control and irrigation projects, the expansion of double cropping, increased fertilization, and the use of high-yield rice verieties.

About 25% of rice produced in this state is transported to the States of Trengganu, Pahang and Johor.

③ Oil Palm

Oil palm has not been cultivated and produced on a large scale in the State of Kelantan not

Table 1-3 Malaysia: Gross Domestic Product by State and Industry of Origin, 1978 (MS million in constant 1970 prices)

Sector State	Johor	Kedahl Perlis	Kelantan	Melaka	Negeri Sembilan	Pahang	Perak	Pulau Pianng	Sabah	Sarawak	Selangor[1]	Trengganu	Total Malaysia
Agriculture, forestry, Livestock and Fishing	903.1	581.0	206.8	143.4	337.7	458.2	658.3	168.2	847.0	460.0	544.3	223.0	5,531
Mining and Quarrying	15.9	9.2	1.6	3.2	4.3	25.6	307.7	4.5	181.3	260.7	211.5	57.5	1,083
Manufacturing	594.7	147.5	41.9	91.9	166.1	213.5	506.7	480.5	58.0	134.0	1,782.8	40.4	4,258
Construction	78.3	19.1	9.5	13.3	18.0	54.1	68.5	72.2	78.0	92.0	375.0	18.0	896
Services[2]	995.0	440.8	271.5	368.2	385.6	487.7	1,183.8	1,091.6	647.0	592.0	3,862.8	190.0	10,516
Gross Domestic Product (G.D.P.)	2,587.0	1,197.6	531.3	620.0	911.7	1,239.1	2,725.0	1,817.0	1,811.3	1,538.7	6,776.4	528.9	22,284
Population (000)	1,645	1,330	844	509	615	712	1,927	956	824	1,208	2,198	526	13,294
Per Capita G.D.P. (M$)	1,572.6	900.5	629.5	1,218.1	1,482.4	1,740.3	1,414.1	1,900.6	2,198.2	1,273.8	3,083.0	1,005.5	1,676.3
Ratio to Malaysian Average	0.94	0.54	0.38	0.73	0.88	1.04	0.84	1.13	1.31	0.76	1.84	0.60	1.00

[1] Includes Federal Territory.

[2] Includes – (a) Utilities;
(b) Transport, storage and communications;
(c) Wholesale and retail trade;
(d) Banking and insurance;
(e) Public administration and defence;
(f) Ownership of dwellings and real estate;
(g) Other services.

Source: Mid-Term Review of the Third Malaysia Plan (1976–1980)

only because the local geology is unsuitable for oil palm but because oil palm is unsuitable to cultivate on steep sloped lands.

According to 1976 statistics, the State of Kelantan has 12 oil palm estates and four mills.

The area under oil palm cultivation in 1977 was 115 km^2 including estates accounting for about 50% and FELDA accounting for 40%.

The production of FFB (fresh fruit bunches) in 1976 was 105,000 tons. In 1975, estates and RISDA accounted for 86% and 14%, respectively, of the production.

In the future, the production is expected to increase in spite of some adverse natural conditions because palm oil has many applications and is a highly profitable agricultural product and because oil palms cultivated under the FELDA Plan will soon be ripening.

Crude palm oil is now exported after refined as mills near the Port Kelang.

(3) Forestry

The State of Kelantan abounds in forest resources as 11,200 km^2 or 75% of the total area of the state are forests. Especially, the Southern Kelantan is mostly mountainous and covered with forests.

In 1970, 1,600 people were engaged in forestry work including sawmill work.

The production of logs was 390,000 tons in 1976 and 450,000 tons in 1977. Sixty percent of the produced logs were transshipped into other states to be processed at sawmills, etc.

Industries based on forestry will play a key function to the future economic development of the State of Kelantan, and forestry will become more important than ever. Forest roads have been improved, and other measures to cope with the increased timber production are to be taken. However, since, forests are being managed so as to restrict cutting as a matter of policy with a view to the protection of forest resources and flood control for Sg. Kelantan, there will be a certain limit to timber production in the future.

(4) Fishery

Fishery in the State of Kelantan, like agriculture in this state, is considerably less productive than in other states because of the delay in introducing modern techniques. The state government makes a point of eliminating poverty for fishermen in view of their low income level.

In 1978, there were 6,475 fishermen in 13 fishing villages located in the four districts of Kota Bharu, Tumpat, Bachok and Pasir Puteh.

In 1978, there were 1,558 registered fishing boats: 1,048 boats with inboard engine, 228 boats with outboard engine, and 282 nonpowered boats. They were distributed as follows: 376 at Kota Bharu, 671 at Tumpat, 434 at Bachok and 77 at Pasir Puteh. Seventy percent of all powered boats were small vessels of less than 10 G.R.T.

The principal types of fishing methods used are seine-net fishing, drift/gill-net fishing, lift-net fishing, line fishing and trawling. Seine nets and lift nets are used for horse mackerel and mackerel, drift/gill nets are used for Spanish mackerel, lines are used for bonitoes and trawling is used for bream, shrimps and flatfish. Fishing activities peak in August to October and fish catches are small in the NE monsoon period from November to March. In recent years, catches have gradually increased with the exception of 1977 with 6,500 tons and amounted to 14,519 tons in 1978.

(5) Manufacturing Industry

Manufacturing industry in the State of Kelantan in 1978 amounted to M$41.9 million in terms of GDP, or 8% of the M$531 million GDP of all industries. In the entire Malaysia, the share of manufacturing industry is 19%. The development of manufacturing industry is clearly delayed in this state.

From the 1973 census on manufacturing industry, the type and the scale of manufacturing industry, and the characteristic of the form of ownership in Kelantan are as follows:

There were 424 manufactories in this state and, of which, 77% produced foodstuffs, tobacco, furniture, lumber, wooden products and textiles. As for value added, lumber, wooden products, products related to petroleum and coal, foodstuffs and tobacco accounted for 80% of the M$28 million value added for all manufactories. Further, these items represented 87% of all sales.

Regarding the scale of enterprises, 255 manufactories, or 60% of all, sold more than M$50 million a year. Manufactories employing fewer than 10 workers numbered 273 or 64%.

Malays owned 411 manufactories or 97% of all, and these manufactories accounted for 82% of all sales.

391 manufactories were distributed in the six districts of the northern plain including Kota Bharu. They represented 92% of all manufactories in the state and sold M$87 million worth or 80% of all sales.

On the whole, manufacturing industry in the State of Kelantan is run by small manufactories owned by Malays, and producing primary-industry products with low value added.

To raise the economic level of this state in the future, it is necessary ppsitively to develop new industries while expanding existing manufactories at the same time. Fig. 1-6 shows the industrial estates that are going to be developed in the State of Kelantan in accordance with the Third Malaysia Plan.

(6) Construction Industry

Construction industry in the State of Kelantan in 1978 amounted to M$9.5 million in terms of GDP, or only 1.8% of the total GDP. Its share in the construction industry of the entire Malaysia was 1% the lowest share among the 13 states.

According to 1974 statistics, the number of construction companies was 28 including 11 companies of housing and they were all small companies.

Since the Third Malaysia Plan and subsequent development projects stress the improvement of infrastructures and other works closely related to construction industry, this sector is expected to develop in the future. This means that the consumption of steel, cement, concrete products, lumber, sand and limestone will increase, and ports and other infrastructures suitable for mass transportation will become more necessary than ever.

(7) Mining

GDP in mining sector in 1978 is M$1.6 million, only 0.3% of all industries.

Iron ore was once exported from Tumpat Port to Japan but it was discontinued due to exhaustion of resources. Sand, gravel (as road construction materials), barite, and limestone are produced but their quantities are small. Limestone in the mountain area is expected to be used as raw materials for cement production in the future. In accordance with the Third Malaysia Plan,

the Central Belt Project is presently being carried out to survey mineral resources, and there will be a possibility of mining of manganese, gold and lead for which their presence were already confirmed. In addition, possibility of development of off-shore natural gas in the South China Sea is also being examined.

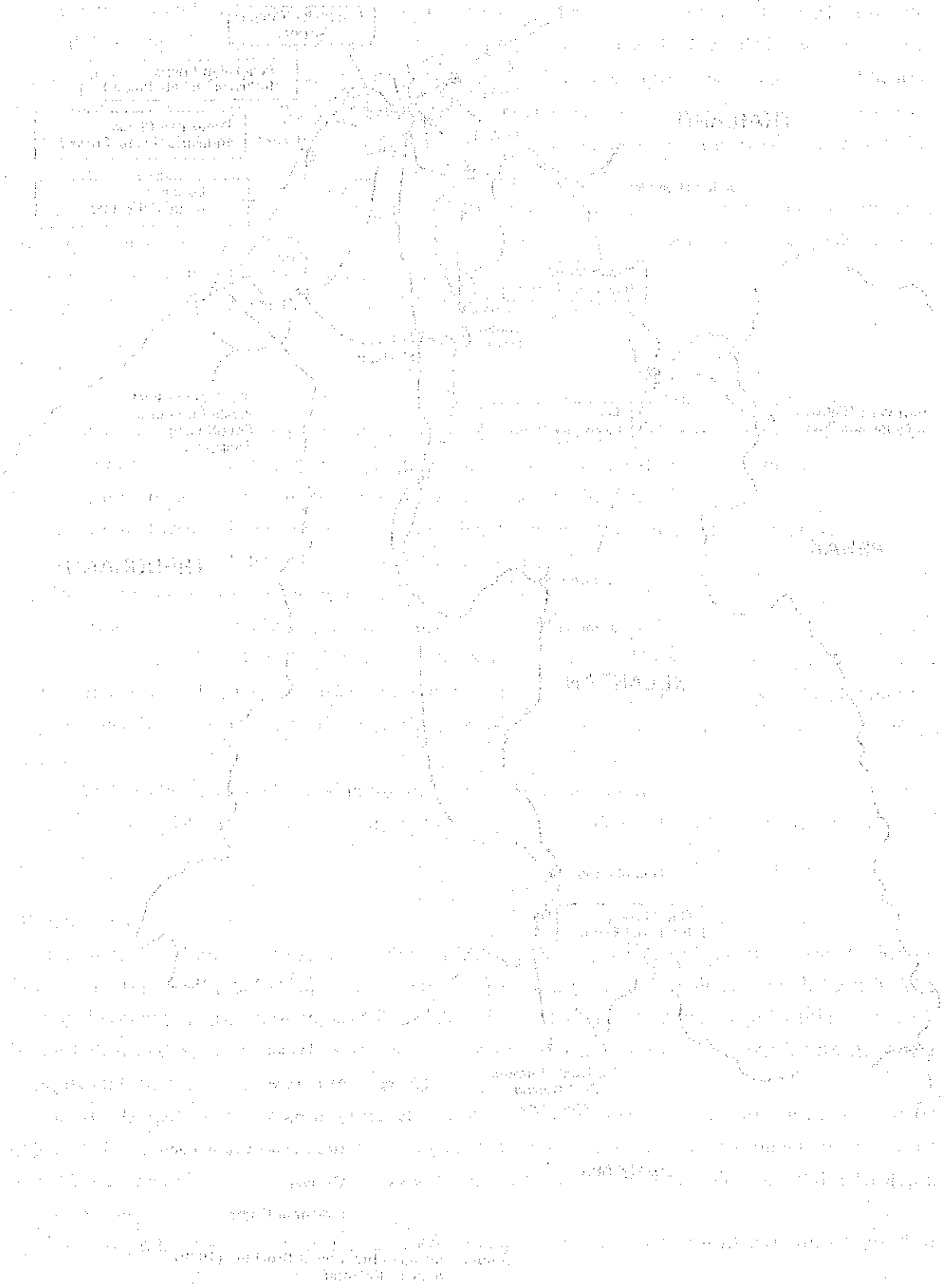
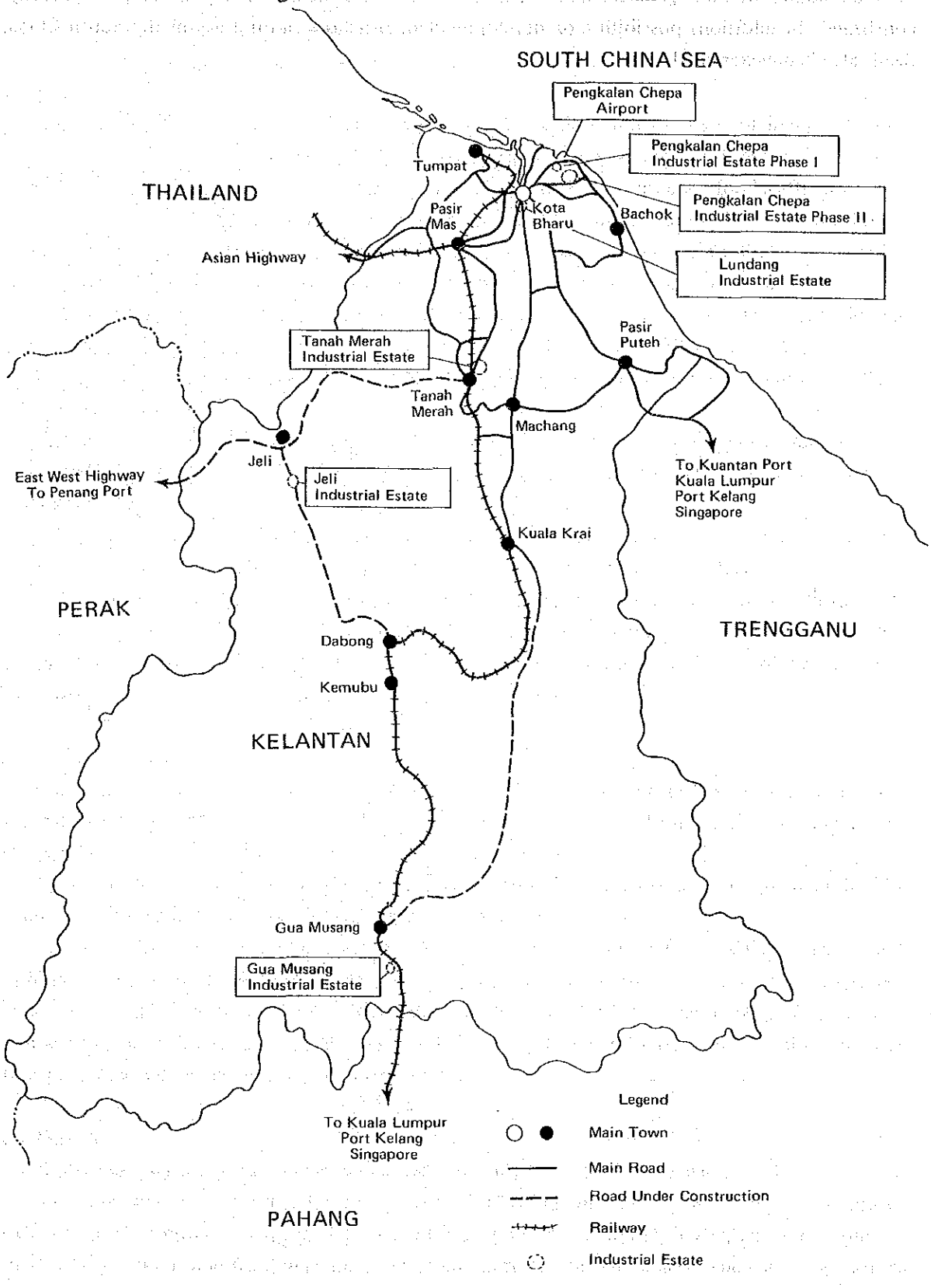


Fig. 1-6 New Industrial Estates in Kelantan



Source: Kelantan Investment Brochure (1979)
State of Kelantan

1-3 Present Conditions of Infrastructures

(1) Port

In the State of Kelantan, there is Tumpat Port at the estuary of Sg. Kelantan. This port formerly functioned in the export of iron ores to Japan but can no longer be used because sand and soil from Sg. Kelantan accumulated to make the anchorage shallow, drift sand made the estuary of the river shallow, and sand bars rapidly developed westernly in recent years. Without immense dredging, the port would be inaccessible to coastal and ocean-going ships in the future as at present. Therefore it would be economically impossible to keep Tumpat Port available for use by large ships.

Though the State of Kelantan has a coastline of about 80 km, at present there are no port that can replace Tumpat Port. Hence, the development of a new port as an infrastructure is essential to the economic development of the State.

Fig. 1-7 shows the location of ports of Peninsular Malaysia.

(2) Roads

The road network in the State of Kelantan is composed of the following main roads:

① Asian Highway No. 18, namely, Route III which, running through Kota Bharu, links Thailand to the north with Trengganu to the south and Johor Bharu located further south.
② Federal highway running north to south between Kota Bharu and Kuala Krai.
③ Federal highway linking Jeli, Tanah Merah, Machang and Pasir Puteh and joining Route III.
④ Federal highway linking Kota Bharu and Pengkalan Chepa.
⑤ Federal highway linking Jeli and Dabong.

This road network is joined by state roads.

There are the East-West Highway and the Kuala Krai-Gua Musang-Kuala Lipis Highway as federal highways either under construction or already planned to be constructed. The completion of these speedways will greatly increase the possibility of economic development in the State of Kelantan.

Further, a plan of a road crossing South Kelantan is now examined.

Fig. 1-8 and 1-9 show the road and railway networks in Peninsular Malaysia and the State of Kelantan.

(3) Railways

The Malayan Railway crosses the State of Kelantan approximately north to south, linking Tumpat in the north, Pasir Mas, Tanah Merah, Kuala Krai and Gua Musang in the south. The railway branches north from Pasir Mas, leading into Thailand. Further, it links this state with Johor Bahru and Singapore after passing through the southern State of Pahang, and with Kuala Lumpur and other main cities on the west coast.

As for freight transportation, the railway was formerly used to transport iron ores to be exported to Japan but, by now, iron ores have been exhausted, and are no longer on the list of railway cargoes. The railway now transport cement, lumber, rice, palm oil and petroleum products, etc.

Railway transportation is losing to motor transportation as the result of the improvement of

Fig. 1-7 Ports of Peninsular Malaysia

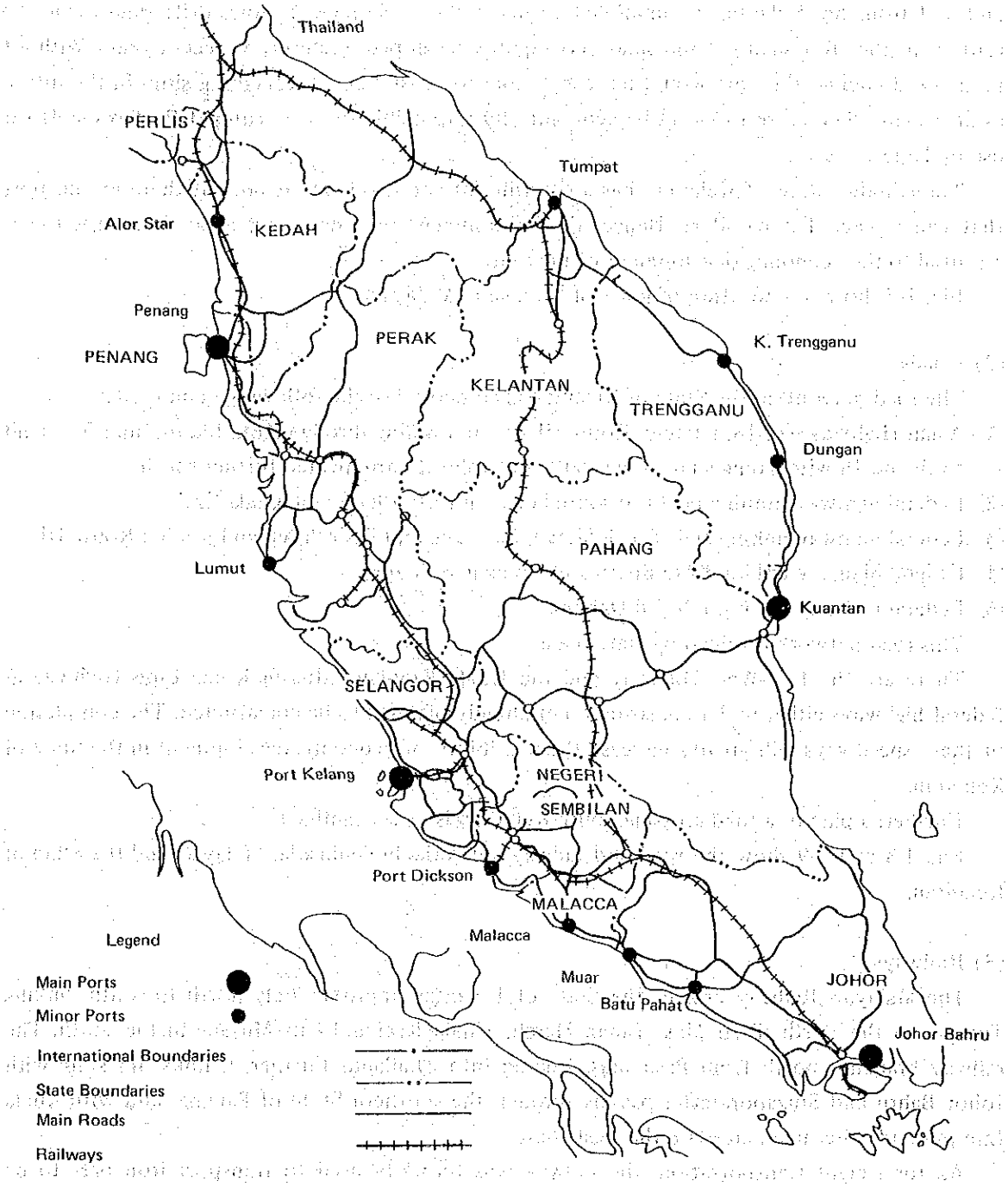


Fig. 1-8 Road and Railway Network of Peninsular Malaysia

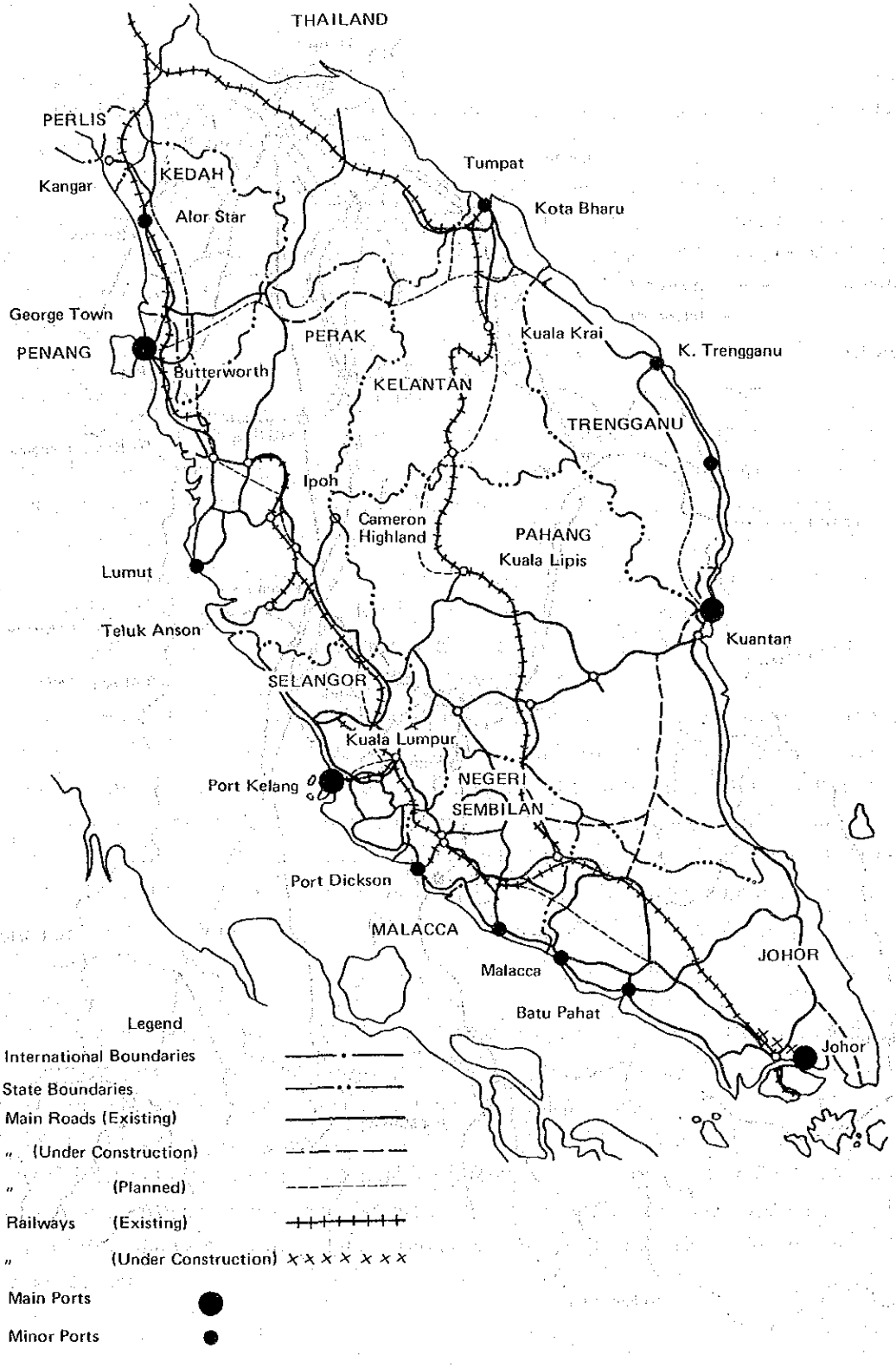
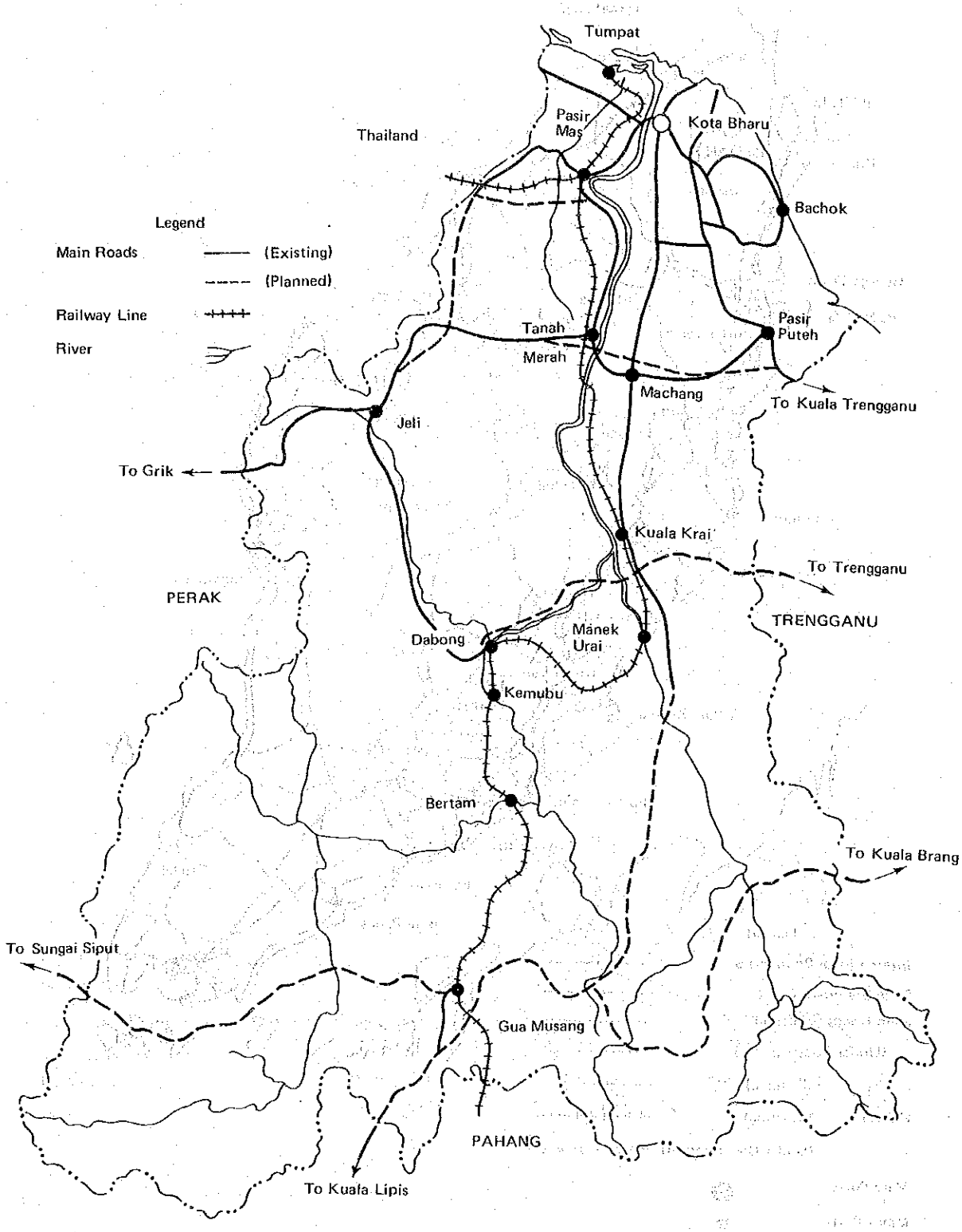


Fig. 1-9 Road and Railway Network in Kelantan



roads and the increase of automobiles. Judging from the fact that the government stresses roads in the improvement of infrastructures, the present decline of railway transportation will continue unless there are mass freights in which railway transportation has the advantage over motor transportation.

(4) Airports

In the State of Kelantan, there is Kota Bharu Airport (Pengkalan Chepa Airport) 15.5 km east-northeast of Kota Bharu.

At present, airline services connecting Kota Bharu with Kuala Lumpur, Penang, Alor Star and Ipoh are available. Air passengers are increasing because of the time taken to move to cities on the west coast by road or railway. The existing runway can be used by aircraft of the B727 class but the government is studying to expand it under the Thrid Malaysia Plan so as to use for the B747 class aircraft.

(5) Electricity

Electricity in the plain in the State of Kelantan is supplied not only from the Lundang and Lemal Thermal Powerplants but from 16 smaller powerplants which supply the rural areas. The power generating capacities of the Lungdang and Lemal Thermal Powerplants are 24MW and 5 MW, respectively.

The power supply network is divided into several areas. The main trunk network is of 33 KV, and secondary trunk network of 11 KV branch from it.

The state, as a whole, is not yet adequately electrified, and the electrification of rural villages is being actively propelled under the Third Malaysia Plan.

From 1982, electricity will be supplied by the national grid from the hydraulic powerplant at Temmengor in the State of Perak. Thus the power situation in the State of Kelantan will drastically improve, depending on the improvement of the local power supply network.

In the State of Kelantan itself, surveys are being conducted with a plan to construct multipurpose dams involving hydraulic power generation by Sg. Kelantan and its tributaries. If this plan is realized, it will be easy to develop big scale industrial complexes consuming large amounts of power in this state.

(6) Waterworks

The present waterworks in the State of Kelantan are inadequate. But the local waterworks have been improved under the Thrid Malaysia Plan. The water resources consist of ground water, and the present demand can be sufficiently met by drilling wells.

In the future, large quantity of industrial water will become necessary as the result of industrial development to be vigorously carried out in different parts of the State. In such case, not only the surface water of Sg. Kelantan but also its underflow may well be used. Besides, if multipurpose dams are constructed on the tributaries of this river, considerable water will become available.

1-4 Development Policies and Plans

1-4-1 Outline of Malaysian Development Plans and Present Development Situation

(1) New Economic Policy

The New Economic Policy is a basic policy of the Third Malaysia Plan for the socio-economic development of Malaysia. This New Economic Policy was propounded as policy targets when the Second Malaysian Plan was established in 1970. With the "Eradication of Poverty" and the "Restruction of Society" as its two major objectives, the policy is ultimately aimed to unite the nation.

(2) Overall Perspective Plan

The Overall Perspective Plan was established at the Mid-Term Review of the Second Malaysia Plan and envisages the socio-economic frame for 1990 as the guideline for five-year socio-economic development plans – Malaysia Plans – and with the object of accomplishing the two major targets of the New Economic Policy.

Table 1-4 and Table 1-5 show GDP by sector of origin and state in 1970 and 1990.

(3) *Outline of The Third Malaysia Plan and Major Projects*

The Third Malaysia Plan was established in 1975 as phase two of the development activities designed to realize the New Economic Policy. It is a five-year plan with 1980 as the target year and its costs totaled M$18,550 million.

This plan was reviewed in 1979 and, it was modified as follows;

① The total costs were increased to M$32,076 million by increasing development expenses 73%.
② The annual average growth rate of the real GDP was cut to 8.3% from 8.5%, as originally planned.
③ The annual average growth rate of exports was increased from 13.6% to 17.3%.
④ The increase rate of consumer prices was raised from 5.0% a year to 5.2%.
⑤ The increase rate of private investments was cut from 9.9% to 8.5%.

Table 1-6 shows the modified expenditure of public development for transportation and communications including ports. Table 1-7 shows expenditures related to transportation in states where major Malaysian ports are located.

1-4-2 Outline of Development Plans of the State of Kelantan and Present Development Situation

(1) Purpose of Development in the State of Kelantan and Initiatives of Development

The purpose of development in the State of Kelantan is to realize the national targets: "Eradication of Poverty" and "Restruction of Society". The State Government of Kelantan mentioned the following development targets in "Kelantan: An Economic Survey and Implementation Programme" announced in 1979:

① To make a point of reducing the poverty of small farmers, fishermen, young unemployed people and poor people living in cities and villages.
② To promote development of certain areas as centers of rapid economic growth.
③ To create highly productive jobs that will bring incomes of, at least, the level of incomes used as a target under the Third Malaysia Plan and, at the same time, increase the productivity of

Table 1-4 Malaysia: GDP by Sector of Origin and State, 1970 (M$ million in 1970 prices)

Sector	Johor	Kedah/ Perlis[1]	Kelantan	Malacca	Negeri Sembilan	Pahang	Penang	Perak	Sabah	Sarawak	Selangor[2]	Trengganu	Malaysia
Agriculture, forestry, fishing etc.	489.6	426.3	139.6	105.4	181.9	224.0	155.0	486.2	405.0	319.0	399.4	100.8	3,432
Mining and quarrying	26.9	4.0	0.4	0.2	2.4	55.0	1.1	301.7	2.0	30.0	154.6	34.6	613
Manufacturing	166.7	46.5	17.9	19.8	75.9	38.5	101.2	142.4	19.0	81.0	586.0	12.4	1,307
Construction	24.2	37.2	19.2	4.8	27.6	11.5	45.9	39.8	48.0	46.0	172.4	4.8	481
Utilities	23.9	6.5	4.0	8.3	11.1	5.6	24.8	59.0	10.0	11.0	78.7	1.6	245
Transport, storage and communications	70.6	26.4	25.0	15.7	31.8	25.5	59.6	66.4	36.0	56.0	183.1	10.1	606
Wholesale and retail trade	130.1	41.7	35.6	77.5	45.4	36.9	212.5	187.7	79.0	116.0	443.1	17.2	1,423
Ownership of dwellings, banking, insurance and real estate	84.3	56.8	29.6	27.3	33.7	40.3	77.1	114.2	58.0	66.0	220.6	27.8	836
Public administration and defence	89.4	46.1	28.4	36.9	43.4	46.0	34.0	83.0	40.0	45.0	280.9	21.2	794
Other services	88.2	51.8	29.9	38.6	36.5	28.7	83.5	117.8	73.0	90.0	217.9	18.6	874
Statistical discrepancy	–	–	–	–	–	–	–	–	–	–	–	–	+97
Gross domestic product (GDP)	1,193.9	743.3	329.6	334.5	489.7	512.0	794.7	1,598.2	770.0	860.0	2,736.7	249.1	10,708[3]
Population (000)	1,326	1,117	712	419	500	525	805	1,629	654	976	1,693	421	10,777
Per capita GDP (M$)	900.4	665.4	462.9	798.3	979.4	975.2	987.2	981.1	1,177.4	881.1	1,616.5	591.7	993.6
Ratio to Malaysian average	0.91	0.67	0.47	0.80	0.99	0.98	0.99	0.99	1.19	0.89	1.63	0.60	1.00

[1] Kedah and Perlis are two distinct States but are shown together here because much of the available statistical data for the two States are combined.

[2] Includes the Federal Territory of Kuala Lumpur.

[3] The GDP for individual States do not add up to the total of Malaysia because of the statistical discrepancy of M$97 million

Source: *The Third Malaysia Plan (1976~1980)*

Table 1-5 Malaysia: GDP by Sector of Origin and State, 1990 (M$ million in 1970 prices)

Sector	Johor	Kedah/ Perlis[1]	Kelantan	Malacca	Negeri Sembilan	Pahang	Penang	Perak	Sabah	Sarawak	Selangor[2]	Trengganu	Malaysia
Agriculture, forestry, fishing, etc.	1,489.3	968.9	474.2	238.2	613.4	1,445.1	299.9	1,067.8	914.0	812.0	786.6	784.5	9,858
Mining and quarrying	42.5	20.4	5.6	6.3	11.7	40.8	11.9	423.5	195.0	269.0	241.0	11.8	1,280
Manufacturing	1,775.9	824.9	461.8	346.1	565.8	908.1	1,593.3	1,533.7	452.0	1,106.0	3,164.6	412.7	13,144
Construction	198.5	150.7	106.9	98.4	140.8	128.7	214.3	212.5	235.0	209.0	574.9	76.3	2,346
Utilities	191.6	111.2	72.3	72.3	83.0	93.4	189.9	244.7	61.0	71.0	375.8	47.1	1,613
Transport, storage and communications	424.5	274.6	180.6	97.2	137.7	185.1	365.4	448.0	225.0	323.0	887.5	82.5	3,631
Wholesale and retail trade	740.8	411.9	252.9	301.0	309.5	334.5	656.9	826.4	460.0	518.0	2,014.5	167.4	6,994
Ownership of dwellings, banking, insurance and real estate	377.5	263.3	165.7	161.7	185.8	206.7	282.2	414.2	258.0	290.0	920.2	120.6	3,646
Public administration and defence	463.6	239.3	165.7	173.2	224.4	239.3	176.3	430.4	221.0	230.0	1,457.0	110.4	4,131
Other services	413.6	293.3	188.0	161.0	208.3	196.7	386.7	485.6	361.0	424.0	962.1	122.2	4,203
Statistical discrepancy	–	–	–	–	–	–	–	–	–	–	–	–	–749
Gross domestic product (GDP)	6,117.8	3,558.5	2,073.7	1,655.4	2,480.4	3,778.4	4,176.8	6,086.8	3,382.0	4,252.0	11,384.2	1,899.5	50,097[3]
Population (000)	2,228	1,657	1,104	652	833	1,069	1,350	2,505	1,237	1,766	3,008	694	18,103
Per capita GDP (M$)	2,745.9	2,147.6	1,878.4	2,539.0	2,977.7	3,534.5	3,093.9	2,429.9	2,734.0	2,407.7	3,784.6	2,737.0	2,767.3
Ratio to Malaysian average	0.99	0.78	0.68	0.92	1.08	1.28	1.12	0.88	0.99	0.87	1.37	0.99	1.00
Population growth rate, 1971–90	2.6	2.0	2.2	2.2	2.6	3.6	2.6	2.2	3.2	3.0	2.9	2.5	2.6

1 Kedah and Perlis are two distinct States but are shown together here because much of the available data for the two States are combined.

2 Includes the Federal Territory of Kuala Lumpur.

3 The GDP for individual States do not add up to the total for Malaysia because of the statistical discrepancy of M$749 million.

Source: The Third Malaysia Plan (1976 ~ 1980)

Table 1-6 Malaysia: Public Development Expenditure for Transport and Communications, 1976–80

(M$ million)

	Original TMP allocation, 1976–80	Estimated expenditure, 1976–78	Achievement, (%)	Revised TMP allocation, 1976–80	Balance to complete, 1979–80
Roads[1]	1,532.34	1,429.77	93.3	3,089.74	1,659.97
Peninsular Malaysia	1,172.34	1,039.65	88.7	2,344.36	1,304.71
Sabah	180.00	256.82	142.7	456.01	199.19
Sarawak	180.00	133.30	74.1	289.37	156.07
Railways[2]	200.00	101.09	50.5	350.00	248.91
Ports and Marine	630.31	412.63	65.5	982.26	569.63
Peninsular Malaysia	475.25	364.55	76.7	618.86	254.31
Sabah	55.05	29.10	52.9	86.58	57.48
Sarawak	100.01	18.98	19.0	276.82	257.84
Civil Aviation	211.00	129.07	61.2	446.69	317.62
Peninsular Malaysia	118.40	78.40	66.2	264.93	186.53
Sabah	46.70	27.16	58.2	109.28	82.12
Sarawak	45.90	23.51	51.2	72.48	48.97
Telecommunications	1,080.00	865.00	80.1	2,000.00	1,135.00
Peninsular Malaysia	960.63	758.10	78.9	1,773.60	1,015.50
Sabah	61.64	47.50	77.1	101.08	53.58
Sarawak	57.73	59.40	102.9	125.32	65.92
Postal Services	36.00	13.05	36.3	41.35	28.30
Peninsular Malaysia	30.79	9.68	31.4	35.09	25.41
Sabah	0.92	0.36	39.1	1.77	1.41
Sarawak	4.29	3.01	70.2	4.49	1.48
Meteorological Services	8.53	4.34	50.9	10.42	6.08
Peninsular Malaysia	6.66	3.76	56.4	7.47	3.71
Sabah	0.80	0.44	55.5	2.01	1.57
Sarawak	1.07	0.14	13.1	0.94	0.80
Broadcasting	67.50	32.82	48.6	86.50	53.68
Total	3,765.68	2,987.77	79.3	7,006.96	4,019.19

1 Federal roads including PWD plant and equipment.
2 Malayan Railway
Source: Mid-Term Review of the Third Malaysia Plan

Table 1-7 Transportation Investment (1976 ~ 80)

	P. Penang	Selangor	Malacca	Johor	Pahang
Roads and Bridges	91.12	180.31	25.93	264.57	357.76
Plant and Equipment	2.28	7.83	1.70	7.48	19.70
Railways	0.85	0.85		30.00	16.00
Ports and Marine	149.28	164.46	8.00	41.60	205.34
Civil Aviation	65.64	83.21	1.22	11.31	3.10
Total	309.17	436.66	36.85	354.96	601.90

Source: Ibid
P. Penang – Penang Port
Selangor – Port Klang
Malacca – Malacca Port
Johor – Johore Port
Pahang – Kuantan Port

existing jobs so as to enable them to bring more incomes.

④ To generally assign Kota Bharu as the site of export-oriented industries not using local materials and raw materials.

⑤ To assign areas distant from cities as sites of industries serving the interests of the state and other local interests if this is economically and technically possible. However, these industries should be located in settlements where labor is readily available.

⑥ In the southern part of the State of Kelantan, stress will be laid on the improvement of infrastructures required by primary and secondary industries.

⑦ In the coastal plain, stress will be laid on water management, demarcation and the rationalization of rural population, and industries based on agriculture.

⑧ In education, stress will be placed on vocational training.

To accomplish these targets of development following initiatives are being taken about industries, local development and infrastructures;

① To increase the productivity of agriculture through the satisfactory management and supply of water.

② To construct large fishing boats for the purpose of exploiting abundant pelagic fishery resources, improve littoral and pelagic fishing techniques and cause inland-water fishermen to swith to other jobs because inland water fishery resources are being exhausted.

③ To suppress population increase to prevent them from reducing per-capita production incomes from agriculture and manufacturing industry.

④ In southern Kelantan where rubber, oil palms and forestry are basic to economy, ecological and evrironmental destruction must be avoided in settling and developing estates. The target population in southern Kelantan is 200,000.

⑤ Large, labor-intensive industries must be rapidly developed by inducing foreign capital. Products from manufacturing industries based on agriculture and forestry will be sold to the ASEAN countries.

⑥ Tourism will be developed, taking advantage of seashores, jungles and handicraft products.

⑦ Manufacturing industries must be actively developed at Kota Bharu (Pengkalan Chepa). Also, industry-oriented medium-scale settlements (Machang, Tanah Merah, Gua Musang and Jeli)

and service-oriented medium-scale settlements (Eastern Ulu Kelantan, Pasir Putch, Kuala Krai and Jeli) must be developed.

⑧ To improve epidemics prevention, medical care, vocational training and technical education.

⑨ To improve and expand infrastructures.

- o In improving infrastructures, stress must be laid on the construction, improvement and maintenance of branch roads providing access to highly productive agricultural areas.
- o Completely equip all dwelling areas with waterworks by 1990.
- o Proceed with the electrification of rural villages.
- o Cause the east-coast railway to continue in operation.
- o Step up overall development of the state of Kelantan by constructing the East-West Highway and the Kuala Krai-Kuala Lips Highway.

(2) Main Projects Under the Third Malaysia Plan

It was first expected that M$1,020 million would be invested in the development of the state of Kelantan under the Third Malaysia Plan but the amount was later increased to M$1,740 million when the Plan was reviewed in 1979. This increase rate of 72% was higher than in any other state of the country.

Table 1-8 shows the projects in Kelantan under the Third Malaysia Plan.

Table 1-8 Projects in Kelantan under The Third Malaysia Plan (1976 ~ 1980)

Allocation (M$ Million)

No.	Item	Kelantan	Malaysia
I	Economic Sector	1,316.83	21,501.37
A	Agricultural and Rural Development	550.88	7,585.23
B	Mineral Resources Development	4.80	20.00
C	Commerce and Industry	218.28	3,205.48
D	Feasibility Study	15.14	91.58
E	Transportation	358.00	5,017.30
F	Communications	44.63	2,138.27
G	Utilities	125.10	3,443.50
II	Social Sector	219.53	5,561.00
A	Education and Training	85.93	2,116.23
B	Health and Population Health	57.43	529.72
C	Social and Community Service	76.17	2,915.15
III	General Administration	84.69	1,229.32
IV	Security	123.02	3,784.00
Total		1,744.07	32,075.68

Source: Mid Term Review of the Third Malaysia Plan

CHAPTER 2 NATURAL CONDITIONS OF THE PROPOSED PORT DEVELOPMENT SITES

CHAPTER 2 NATURAL CONDITIONS OF THE PROPOSED PORT DEVELOPMENT SITES

2-1 General

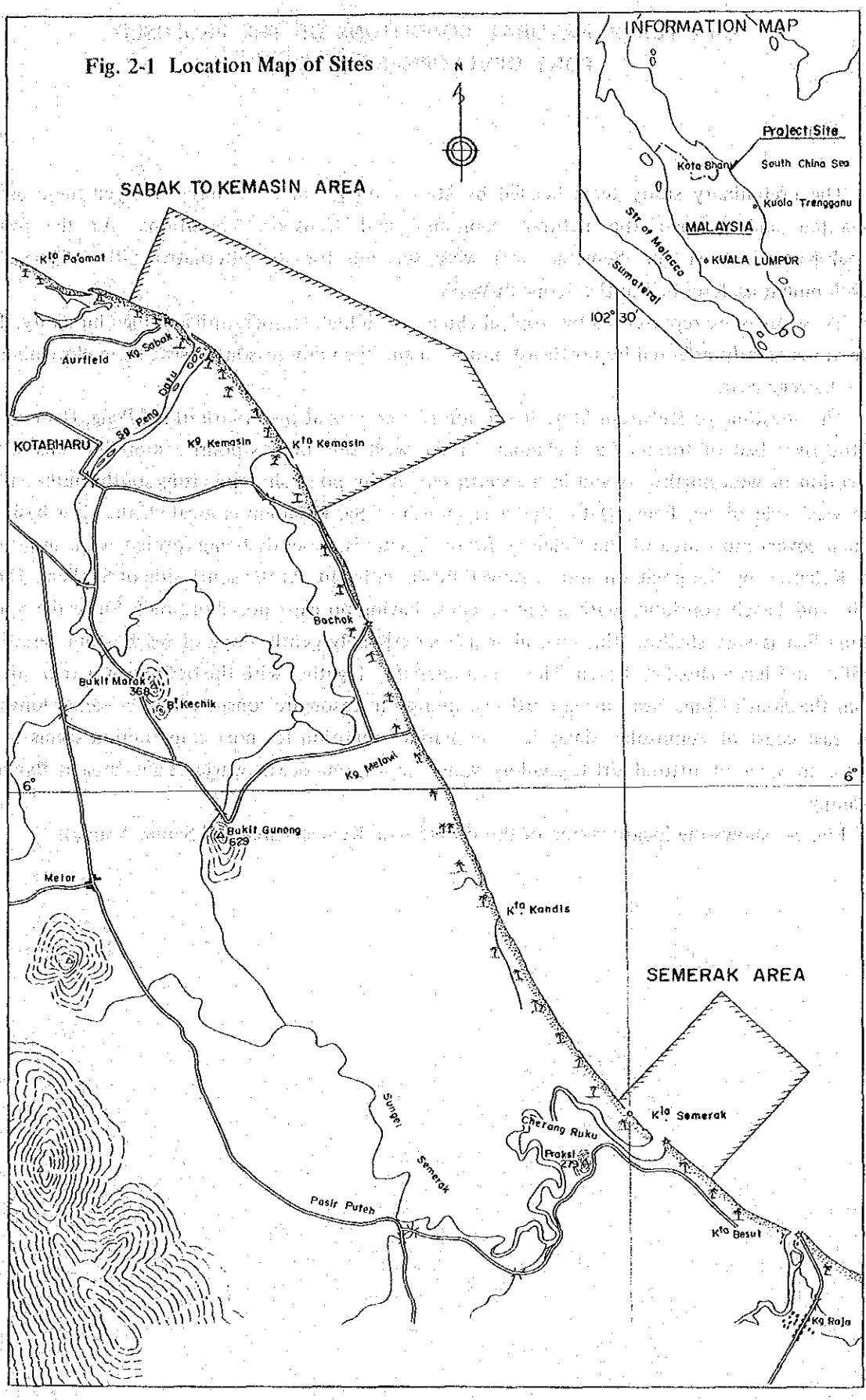
The preliminary study team headed by Mr. Akio Ogo, in 1979 May, surveyed the coast of Kelantan and grasped the natural, economic and transport conditions. As the result, Sabak-Kemasin area and Semerak area were selected for the alternative sites of the port development as described in the Scope of Work.

These areas are represented by tropical climate with high temperature and high humidity. The climate is greatly affected by northeast monsoon and the rainy season persists from November to March every year.

The coastline of Kelantan State has a point of convex at the mouth of Sg. Peng. Datu which is the river bed of former Sg. Kelantan. In the west side of this point a shoreline runs in the direction of west-northwest and in the south side of this point shoreline runs south-southeast. At the west side of Sg. Peng. Datu, the river mouth of Sg. Kelantan is located, the river basin of which covers most area of the Kelantan State. A delta is presently being formed at the mouth of Sg. Kelantan by the great amount of flowed down sediment. At the south side of Sg. Peng. Datu, rich sand beach continues with a simple coast having no cape nor shore reef. Since the South China Sea is very shallow, this coastal area has extremely gentle slope of sea bottom, less than 1/500, and has a shoaling beach. These characteristics together with the ocean waves transmitted from the South China Sea during northeast monsoon season are considered to be same alongside the east coast of Peninsular Malaysia. The marine condition for port construction seems to be severe in view of littoral drift, shallow water depth and ocean waves. Land area is flat and swampy.

Fig. 2-1 shows the location map of the sites (Sabak-Kemasin area and Semerak area).

Fig. 2-1 Location Map of Sites



2-2 Meteorological Conditions

2-2-1 Temperature and Humidity

In Sabak-Kemasin area and Semerak area, meteorological observation date have not been collected. Therefore, the meteorological condition in these areas can be comprehended from the observation data obtained at Kota Bharu Aerodrome. It is located about 6 km away from the center of Kota Bharu to the direction of northeast, about 10 km away from the river mouth of Sg. Kemasin to west-northwest, and also about 3 km away from coastline toward land.

The annual mean temperature is 26.7°C and almost uniform temperature continues throughout the year. The annual mean humidity is 81.3%.

2-2-2 Rainfall

The records of rainfall and rainy days are shown in Table 2-1. The annual mean rainfall for 27 years (1951 ~ 1977) is 2,760 mm. The rainfall exceeds 300 mm per month in October, November and December, and particularly in November and December, a monthly mean rainfall of about 600 mm was sometimes recorded. More than 20 rainy days per month are recorded in NE monsoon season.

From May to September in SW monsoon season, the monthly mean rainfall is within the range between 100 mm and 200 mm. The minimum rainfall and the smallest number of rainy days per month occur in February or March.

The maximum rainfall per hour is 111.8 mm and the maximum rainfall per day is 467.9 mm, both of which were recorded on November 30, 1969.

2-2-3 Wind

The mean wind velocity per hour taken 24 times per day throughout the year is shown in Fig. 2-2. The wind direction between east and northeast due to NE monsoon is the most prevailing (about one-third of all frequency distribution), followed by the wind direction between south and southwest (about one-fifth of all frequency distribution). The percentage of appearance of calmness is 30.4%.

The frequency distribution of strong wind indicates that wind direction between east and northeast due to NE monsoon is the most prevailing, and the strong wind is not appearing during SW monsoon.

The characteristics of the wind based upon other statistic data are as follows:

(1) It is calm during the night throughout the year, especially in the SW monsoon season.

(2) The wind direction in the morning is different from that in the afternoon.

(3) Particularly in the afternoon, the wind blowing from the direction between east and northeast becomes prevailing and the wind velocity increases.

(4) Because Kota Bharu faces to the South China Sea, the influence of NE monsoon is much greater than that of SW monsoon.

(5) From November to March as the influence of NE monsoon dominates the climate, the wind mainly from E direction is prevailing throughout the day.

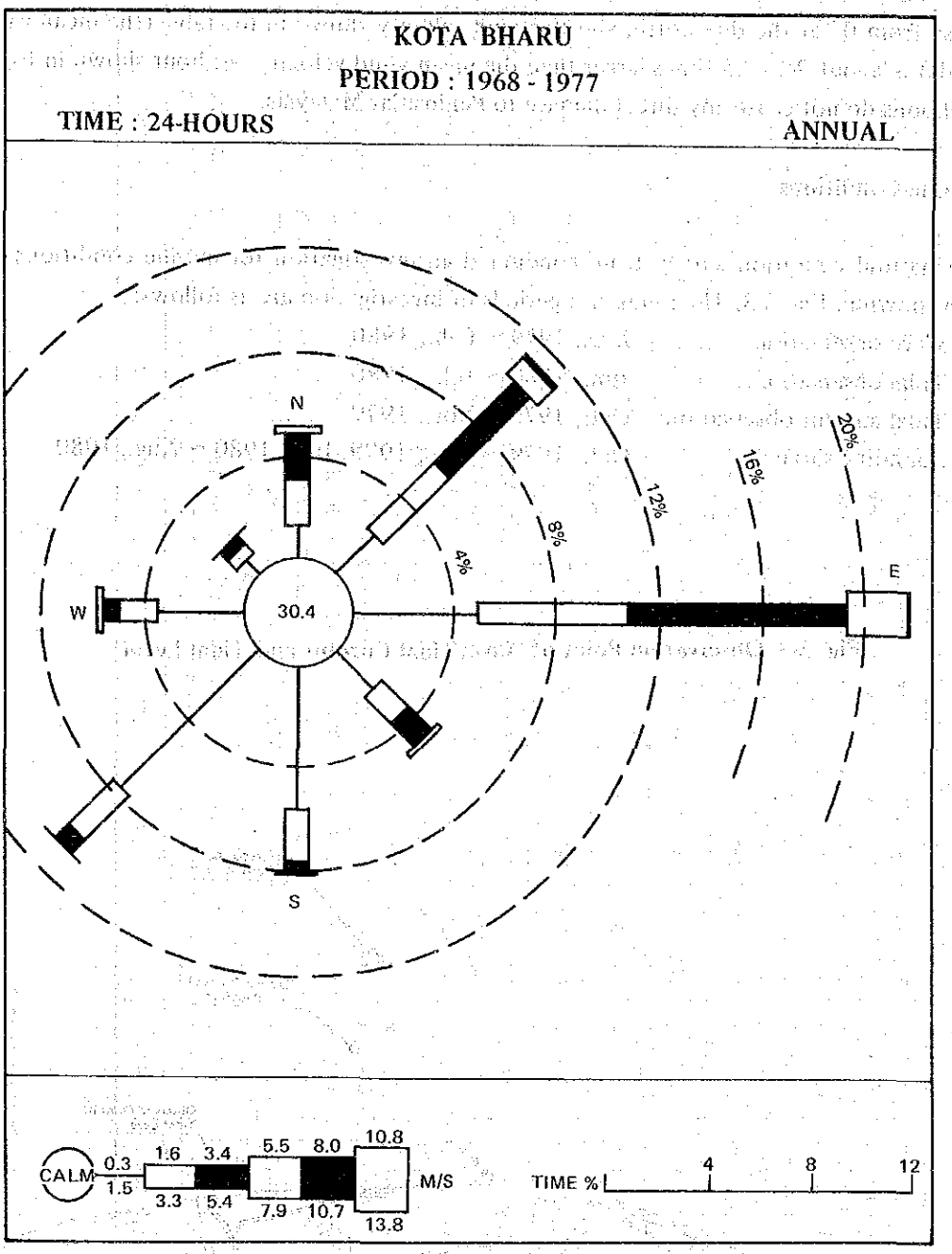
(6) During SW monsoon season, the wind blowing from the direction between south and southwest is prevailing from midnight to morning. And this direction is reversed in the afternoon.

Table 2-1 Records of Mean, Highest and Lowest of Monthly and Annual Rainfall and Rainy Days

Station: Kota Bharu Aerodrome (Pengkalan Chepa)
Lat: 6°10′
Long: 102°17′
Ht. above M.S.L.: 5m

Period		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Rainfall (mm)														
Mean	1951–1977	195.2	64.3	96.0	83.1	117.3	137.3	152.7	169.8	187.3	303.7	682.1	570.7	2759.5
Highest	1930–1940 1948–1977	1397.8	227.1	296.9	282.2	247.6	294.6	321.5	338.8	404.8	677.6	1387.6	1214.6	3989.6
Year of Highest		1967	1953	1973	1970	1951	1965	1954	1972	1957	1936	1976	1973	1936
Lowest		0.3	0.5	5.3	0.3	4.6	41.7	46.2	52.1	70.1	104.4	226.3	87.9	1810.6
Year of Lowest		1965	1962	1968	1971	1963	1970	1955	1953	1974	1940	1957	1958	1963
Number of Rainy Days														
Mean	1951–1977	13	8	8	7	11	11	13	14	15	21	23	22	168
Highest	1930–1940 1948–1977	26	18	20	17	20	20	18	22	23	29	28	30	204
Year of Highest		1933	1964	1936	1937	1966	1932	Sev.	1936	1948, 1968	1966	1961	1965	1936, 1966
Lowest		1	2	Nil	1	5	5	8	9	9	15	16	15	152
Year of Lowest		1965	1964	1940	1963, 1971	1963	1964	1971	1961	1969	Sev.	1968	Sev.	1963

Fig. 2-2 Wind Rose



The record of strong winds are shown in Table 2-2. The observation period is 26 years (1939 to 1941, and 1956 to 1978). In this table, the wind direction is shown in degrees measured clockwise from 0° at the due north, and the wind velocity shown in the table (the mean value of 2 seconds) is about 2 to 2.5 times larger than the mean wind velocity per hour shown in Fig. 2-2.

Typhoons do not cause any direct damage to Peninsular Malaysia.

2-3 Marine Conditions

The natural condition survey team conducted an investigation for marine conditions at the location shown in Fig. 2-3. The items and periods of investigation are as follows;

- Wave observation: Dec., 1979 ~ Feb., 1980
- Tidal observation: Jun., 1980 ~ Jul., 1980
- Tidal current observation: Oct., 1979 ~ Nov., 1979
- Sounding survey: Oct., 1979 ~ Nov., 1979, Jun., 1980 ~ Aug., 1980

Fig. 2-3 Observation Point of Wave, Tidal Current and Tidal Level

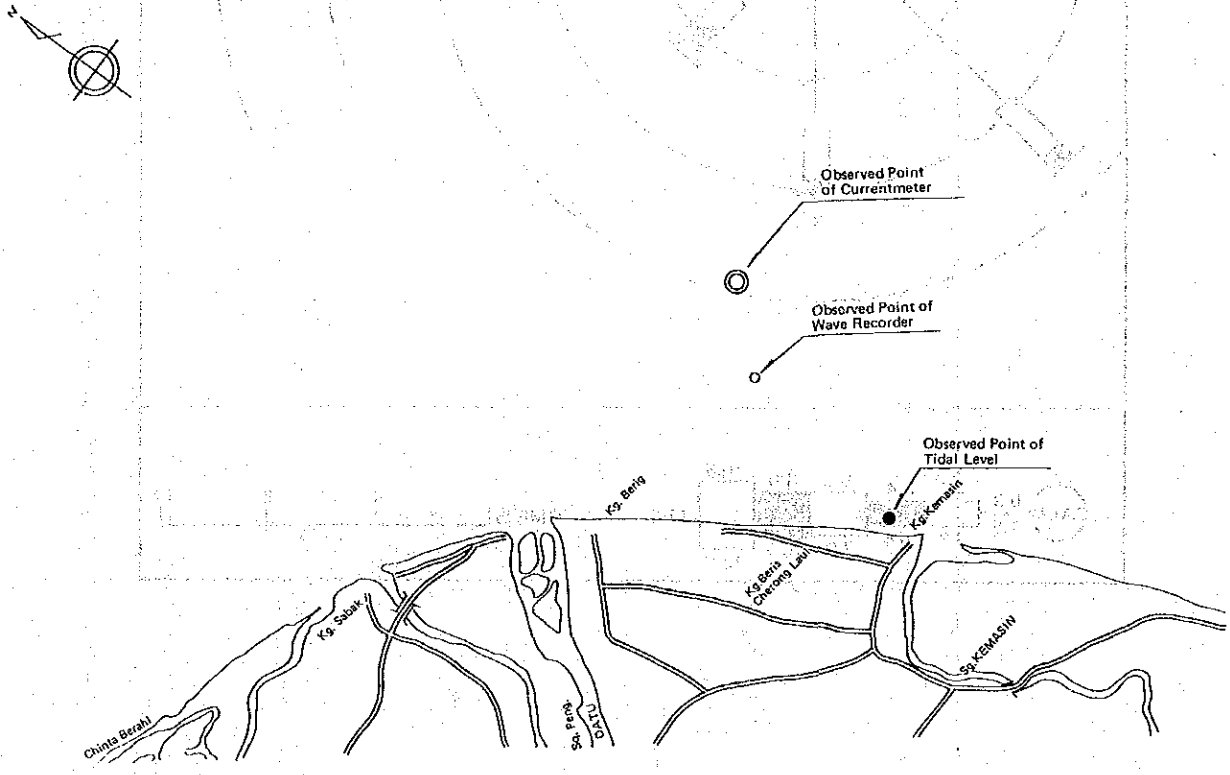


Table 2-2 Records of Maximum Surface Wind
(Direction in Degrees/Speed in m/s)

Station: KOTA BHARU AERODROME (PENGKALAN CHEPA)
Lat: 6°10'N
Long: 102°17'E
Ht. above MSL: 5m.

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Extreme
1939	070/16.5	120/11.2	090/12.1	110/17.0	310/19.7	300/15.6	320/18.3	160/16.1	270/12.5	290/15.6	320/12.5	060/13.0	310/19.7
1940	090/11.6	060/11.2	100/ 8.9	090/10.3	080/13.4	320/20.1	320/18.3	290/27.3	200/19.7	310/17.9	050/11.2	080/12.5	290/27.3
1941	050/13.4	060/18.8	090/ 9.4	060/12.5	140/13.9	260/18.3	310/17.0	250/16.5	280/13.9	220/14.3	N.A.	N.A.	N.A.
1956	090/13.9	080/13.4	090/13.0	270/17.9	320/16.5	350/17.9	340/25.5	250/20.6	260/20.6	060/13.9	070/16.5	100/13.9	340/25.5
1957	090/15.6	100/14.3	180/13.9	140/11.6	240/11.2	360/13.9	270/22.3	270/24.6	280/17.9	120/16.5	070/15.6	060/17.0	270/24.6
1958	070/18.8	070/14.7	080/16.5	080/13.0	280/14.7	230/25.5	230/25.5	220/18.8	300/18.3	270/15.2	120/17.4	060/13.9	230/25.5
1959	070/15.6	090/13.9	100/13.0	200/13.0	230/16.1	330/17.9	230/20.6	260/18.8	230/16.5	270/15.6	050/22.8	060/17.0	050/22.8
1960	080/14.3	070/14.3	070/12.1	130/18.8	270/19.2	240/18.8	300/19.2	180/22.3	250/18.3	110/15.6	340/13.9	070/21.5	180/22.3
1961	060/15.6	080/12.1	090/13.9	260/13.9	300/12.5	250/14.3	270/16.1	280/27.7	230/17.4	290/16.5	080/13.4	100/15.6	280/27.7
1962	080/14.3	080/12.1	060/12.5	230/12.1	250/17.0	270/19.2	290/21.0	320/18.3	270/19.2	300/16.1	070/11.6	040/16.1	290/21.0
1963	070/11.1	090/12.1	080/12.1	090/17.0	280/13.0	270/18.3	190/17.9	270/17.9	270/18.3	260/14.3	070/14.7	070/13.9	270/18.3
1964	090/16.1	090/17.9	070/17.0	150/14.3	220/17.4	240/16.1	260/18.8	280/21.9	270/18.8	260/19.7	300/15.2	080/16.1	280/21.9
1965	110/14.3	080/24.1	090/13.9	110/15.6	290/15.2	300/21.0	260/19.2	280/16.1	240/19.7	270/16.5	060/16.1	070/21.0	080/24.1
1966	040/24.6	060/12.5	230/16.1	260/14.3	080/18.3	290/21.5	270/18.3	270/17.9	250/17.0	200/26.8	300/17.0	060/26.4	200/26.8
1967	040/20.6	060/15.6	060/16.5	090/12.5	230/15.6	250/26.8	250/19.2	310/21.5	180/17.9	300/18.8	040/18.3	040/17.9	250/26.8
1968	060/14.0	080/13.4	060/15.0	170/16.7	270/19.4	200/17.5	110/16.3	270/20.2	270/20.3	140/15.6	130/18.0	090/15.5	270/20.3
1969	100/16.8	110/16.0	080/12.9	130/15.7	290/12.1	300/20.8	310/19.2	330/19.8	270/18.5	030/12.8	070/19.3	070/15.9	300/20.8
1970	070/16.9	110/12.7	110/13.1	080/13.0	290/15.1	240/21.3	310/21.5	300/17.7	260/21.7	320/14.3	310/17.0	040/17.7	260/21.7
1971	070/20.7	070/12.5	050/15.0	110/10.8	320/17.5	280/17.4	250/27.0	220/16.7	260/14.3	260/27.0	330/14.0	070/15.8	250/27.0
1972	090/12.6	330/16.0	080/11.5	080/16.3	270/17.0	240/17.3	220/25.0	220/16.5	260/21.5	160/15.1	100/14.8	070/19.6	220/25.0
1973	090/18.0	060/13.5	060/13.7	020/11.0	330/11.1	320/19.1	320/21.6	300/20.3	320/20.4	330/20.7	350/15.8	130/23.6	130/23.6
1974	130/12.1	120/15.8	090/14.9	270/15.1	030/22.5	310/17.3	230/16.4	240/15.9	010/14.1	340/17.6	300/17.6	080/16.8	030/22.5
1975	100/14.5	090/15.8	010/10.3	260/13.0	300/21.6	290/23.6	270/17.3	330/18.2	350/19.1	340/19.3	110/17.3	090/14.6	290/23.6
1976	100/13.2	080/11.5	090/12.2	060/14.1	230/17.9	230/16.3	260/24.1	300/19.3	260/20.8	270/17.3	070/15.8	050/15.6	260/24.1
1977	100/12.8	090/17.6	090/15.6	100/12.3	260/18.6	320/18.5	020/23.0	060/18.3	360/23.3	270/15.7	110/13.0	120/19.5	360/23.3
1978	090/16.2	110/12.0	180/13.6	250/11.0	260/19.1	280/17.6	330/15.6	300/19.8	310/24.3	340/21.6	320/15.7	N.A.	N.A.
Extreme (1939–1941) (1956–1978)	040/24.6	080/24.1	070/17.0	130/18.8	030/22.5	250/26.8	250/27.0	280/27.7	310/24.3	260/27.0	050/22.8	060/26.4	280/27.7
Year of Extremes	1966	1965	1964	1960	1974	1967	1971	1961	1978	1971	1959	1966	1961

2-3-1 Waves

The ocean waves were observed by using the pressure type wave recorder at the point where water depth is about −6 m offshore of Tawang. The wave observation period were as follows;

Dec. 10, 1979 ~ Dec. 18, 1979　　Dec. 25, 1979 ~ Jan. 2, 1980

Jan. 18, 1980 ~ Feb. 2, 1980　　Feb. 24, 1980 ~ Feb. 29, 1980

The wave height frequency distribution by period is shown in Table 2-3. The percentage of appearance for the period of 8 sec is the highest and most waves have periods between 7.1 sec and 9.0 sec (percentage of appearance is about 70%).

The maximum wave height (Hmax) during the observation period was 2.84 m observed at 18:00 on December 13, and the maximum significant wave height (H1/3) was 1.61 m observed at 20:00 on December 13. According to the visual observation, waves in the direction between northeast and east-northeast were prevailing during the period.

For estimating the design wave height by using all data recorded in the observation period, the values of maximum waves are abstracted from a series of significant waves of 20 minutes as shown in Table 2-4.

Calculations for the probable wave height shall be performed by the Petruaskas Aagaard's method. The subject period of calculations is assumed to be K months and N-numbers of maximum waves larger than a certain limit value which were generated during this subject period. Then after sorting these wave heights, the order "m" shall be given from the largest wave height. Basing upon these data, the probability of nonexceedence shall be calculated from the following formula:

$$P(H \leqq X_{m,n}) = 1 - \frac{m - \alpha}{N + \beta} \qquad (1)$$

where, $X_{m,n}$ is m-th maximum wave height (m = 1,2,3,.....N) of N-numbers of maximum wave heights, and the values of α and β shown in Table 2-5 should be determined by the assumed distribution function.

For the selection of the distribution functions, the double exponential distribution (Gumbel distribution) and seven kinds of exponents ranging from 0.75 to 2.00 of Weibull distribution shall be applied, and the optimum value shall be selected after reviewing appropriateness. The distribution function is given by the following formula:

Double exponential distribution:

$$P(H \leqq X) = \exp\left[-\exp\left\{-\left(\frac{X - B}{A}\right)\right\}\right] \qquad (2)$$

Weibull distribution:

$$P(H \leqq X) = 1 - \exp\left[-\left(\frac{X - B}{A}\right)^k\right] \qquad (3)$$

For applying the distribution function, P ($H \leqq X$) is converted to variable $\gamma_v = (X - B)/A$ by using the following equations, and the relation between X and γ_v shall be changed linearly as shown below to estimate coefficients A and B.

$$X = \hat{A}\gamma_v + \hat{B} + e \tag{4}$$

where, mark "^" means that the value is an assumed value. Also, "e" indicates the portion that is unable to explain by using $\hat{A}\gamma_v + \hat{B}$, and this is called error term. Both X and e are probability variables.

The return period R_p of maximum wave height shall be calculated by using probability of nonexceedence P ($H \leqq X$) in the following formula:

$$R_p = \frac{K}{N} \frac{1}{1 - P(H \leqq X)} \tag{5}$$

Distribution parameters (α,β) for distribution type is shown in Table 2-5. Weibull's distribution type (K = 2.00) which gives the heighest correlation coefficient of 0.98266 between measured value and assumed value, was adopted and the probability of nonexceedence and the return period for the measured values were calculated as indicated in Table 2-6.

The values of probable wave heights for the required return period should be derived by the following procedure:

① Probability of nonexceedence P ($H \leqq X$) for required return period R_p should be calculated by using Eq. (5)

② The conversion probability γ_v should be calculated by using the following formula.
Weibull's distribution

$$\gamma_v = [-l_n \{1 - P(H \leqq X)\}]^{1/k} \tag{6}$$

③ γ_v calculated in step ② should be substituted in Eq. (4) to estimate X, then X shall become probable wave height corresponding to R_p.

This probable wave height for each return period was calculated and the results are shown in Table 2-7.

The sea has relative high waves only in the NE monsoon season of 5 months from November to March, but the sea is rather calm in the season excent for this. If 5 months of return period of waves is considered to be equivalent to one year, the probable wave height for 50 years will become $H_{1/3} = 2.15$ m. Taking the proper allowance into account, $H_{1/3} = 2.50$ m and T = 8.0 sec should be adopted for the design wave height and period. As the observation data used for the calculations are insufficient, it should be required to review the values of probable wave height when further data would become available in future.

Table 2-3 Distribution of Wave Height and Period

Wave Height (H1/3) / Wave Pediod (T)	0.00 ≀ 0.40 (m)	0.41 ≀ 0.50	0.51 ≀ 0.60	0.61 ≀ 0.70	0.71 ≀ 0.80	0.81 ≀ 0.90	0.91 ≀ 1.00	1.01 ≀ 1.10	1.11 ≀ 1.20	1.21 ≀ 1.30	1.31 ≀ 1.40	1.41 ≀ 1.50	1.51 ≀ 1.60	1.61 ≀ 1.70	1.71 ≀	Total
0.0 ~ 5.0 (sec)																
5.1 ~ 6.0	1 (0.2)															1 (0.2)
6.1 ~ 7.1	45 (10.9)	2 (0.5)	1 (0.2)	8 (1.9)	2 (0.5)		1 (0.2)	3 (0.7)	3 (0.7)							65 (15.7)
7.1 ~ 8.0	37 (9.0)	10 (2.4)	17 (4.1)	25 (6.1)	20 (4.8)	11 (2.7)	20 (4.8)	13 (3.1)	15 (3.6)	10 (2.4)		2 (0.5)	2 (0.5)	1 (0.2)		183 (44.3)
8.1 ~ 9.0	6 (1.5)	1 (0.2)	19 (4.6)	26 (6.3)	23 (5.6)	11 (2.7)	10 (2.4)	7 (1.7)	6 (1.5)	1 (0.2)						110 (26.6)
9.1 ~ 10.0	3 (0.7)	3 (0.7)	11 (2.7)	10 (2.4)	8 (1.9)	7 (1.7)	3 (0.7)	2 (0.5)								47 (11.4)
10.1 ~ 11.0		2 (0.5)	2 (0.5)					1 (0.2)								5 (1.2)
11.1 ~	1 (0.2)		1 (0.2)													2 (0.5)
Total	93 (22.5)	18 (4.4)	51 (12.4)	69 (16.7)	53 (12.8)	29 (7.0)	34 (8.2)	26 (6.3)	24 (5.8)	11 (2.7)		2 (0.5)	2 (0.5)	1 (0.2)		413 (100.0)

Note: Observation period; Dec., 10, 1979 – Dec., 18, 1979 Dec., 25, 1979 – Jan., 2, 1980 Jan., 18, 1980 – Feb., 2, 1980 Feb., 24, 1980 – Feb., 29, 1980
Observation frequency, 24 times/day

Table 2-4 List of Maximum Waves

No.	Wave Height H1/3 (m)	Wave Period T1/3 (sec)	Observation	
			Time	Date
1	1.610	7.3	20	Dec. 13, 1979
2	1.300	8.0	12	Dec. 15, 1979
3	1.300	9.0	22	Dec. 25, 1979
4	1.300	7.7	6	Jan. 19, 1980
5	1.250	8.0	12	Dec. 14, 1979
6	1.170	7.7	4	Dec. 16, 1979
7	1.170	7.2	6	Dec. 17, 1979
8	1.110	7.4	6	Dec. 18, 1979
9	1.090	9.4	10	Dec. 26, 1979
10	1.060	7.2	10	Dec. 13, 1979
11	1.010	8.1	12	Dec. 10, 1979
12	0.940	7.1	18	Jan. 26, 1980
13	0.900	9.4	8	Jan. 21, 1980
14	0.890	9.0	14	Dec. 12, 1979
15	0.860	7.8	20	Jan. 22, 1980
16	0.850	8.3	22	Dec. 11, 1979
17	0.830	7.6	10	Dec. 11, 1979
18	0.770	7.3	20	Jan. 23, 1980
19	0.710	7.5	16	Jan. 24, 1980
20	0.710	9.4	2	Dec. 28, 1979
21	0.670	7.6	8	Dec. 31, 1979
22	0.640	7.9	12	Jan. 25, 1980

Table 2-5 Distribution Parameters

Type of distribution	α	β
Gumbel	0.44	0.12
Weibull (K=0.75)	0.54	0.64
(K=0.85)	0.51	0.59
(K=1.00)	0.48	0.53
(K=1.10)	0.46	0.50
(K=1.25)	0.44	0.47
(K=1.50)	0.42	0.42
(K=2.00)	0.39	0.37

Table 2-6 Probability of Nonexceedence and Return Period
(Weibull's Distribution Type K = 2.00)

No.	Wave Height H1/3 (m)	Conversion Probability	Probability of Nonexceedence	Return Period
1	1.610	1.89790	0.97273	1.66692
2	1.300	1.62219	0.92803	0.63156
3	1.300	1.46573	0.88333	0.38959
4	1.300	1.35056	0.83862	0.28167
5	1.250	1.25678	0.79392	0.22057
6	1.170	1.17608	0.74922	0.18125
7	1.170	1.10415	0.70451	0.15383
8	1.110	1.03839	0.65981	0.13362
9	1.090	0.97714	0.61511	0.11810
10	1.060	0.91919	0.57041	0.10581
11	1.010	0.86367	0.52570	0.09584
12	0.940	0.80985	0.48100	0.08758
13	0.900	0.75712	0.43630	0.08064
14	0.890	0.70492	0.39160	0.07471
15	0.860	0.65270	0.34689	0.06960
16	0.850	0.59984	0.30219	0.06514
17	0.830	0.54563	0.25749	0.06122
18	0.770	0.48914	0.21278	0.05774
19	0.710	0.42898	0.16808	0.05464
20	0.710	0.36288	0.12338	0.05185
21	0.670	0.28626	0.07868	0.04934
22	0.640	0.18592	0.03397	0.04705

Table 2-7 Probable Wave Height for Return Period

No.	Return Period (Month)	Conversion Probability	Probable Wave Height H1/3 (m)	Remarks
1	1.0	1.75814	1.49298	
2	2.0	1.94530	1.59743	
3	3.0	2.04686	1.65411	
4	4.0	2.11597	1.69267	
5	5.0	2.16806	1.72174	1 year
6	10.0	2.32242	1.80788	
7	15.0	2.40813	1.85571	
8	20.0	2.46714	1.88864	
9	25.0	2.51196	1.91365	
10	50.0	2.64633	1.98864	10 years
11	100.0	2.77421	2.06000	
12	250.0	2.93471	2.14957	50 years

2-3-2 Tidal Levels

The tidal observation was performed using a pressure type tide gauge (Type: LPT-3) at the point with about 2.5 m water depth off Kemasin as shown in Fig. 2-3. This tide gauge records continuously the height of sea water.

The record was obtained for thirty three days and nights continuously from June 26, to July 29, 1980. Fig. 2-4 shows the tide diagram.

The Reduce Level, (R.L: the level for on-land survey in Peninsular Malaysia) is 0.957 m above the Datum Level (D.L: Chart Datum).

The maximum flood level observed during a big flood occurred in 1967 was as follows;

Sabak D.L + 4.45 m, Kemasin D.L + 3.51 m, Semerak D.L + 3.70 m

2-3-3 Tidal Current

The observation for tidal current was conducted at a point 1 m above the sea bottom by using Ono-type current meter in the area about −8 m deep offshore of Tawang as shown in Fig. 2-3. The period of observation is between October 23 and November 10, 1979 and the records of consecutive observation throughout 18 days and nights were obtained. Table 2-8 and Fig. 2-5 show the frequency of wave occurence by direction and velocity.

Prevailing current direction is generally parallel with shoreline; SE to SSE during south current (current direction flows to SE or SSE) and NW to NNW during north current.

Table 2-9 shows the maximum current speed, current direction and observation time. According to this table, the maximum current speed was 0.60 m/sec, the current velocity had a tendency to increase during the southward current, and the speed of southward current is higher than that of northward current.

2-3-4 Sounding Survey

Fig. 2-6, Fig. 2-7 and Fig. 2-8 show the sounding maps of Sabak Kemasin area (survey in 1979), Semerak area (survey in 1979) and Sabak Kemasin area (survey in 1980) respectively.

All water depth are given based on the Datum Level.

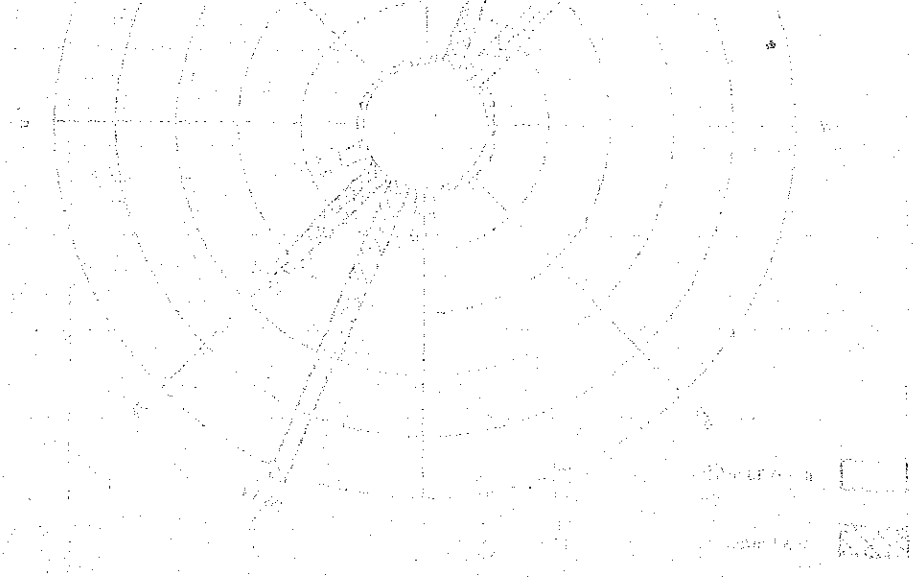


Fig. 2-4 Tide Diagram

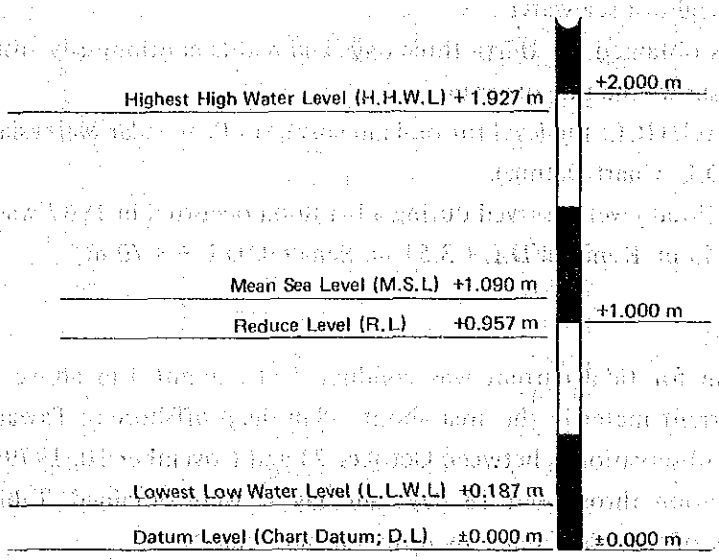


Fig. 2-5 Frequency of Occurrence for Current Direction

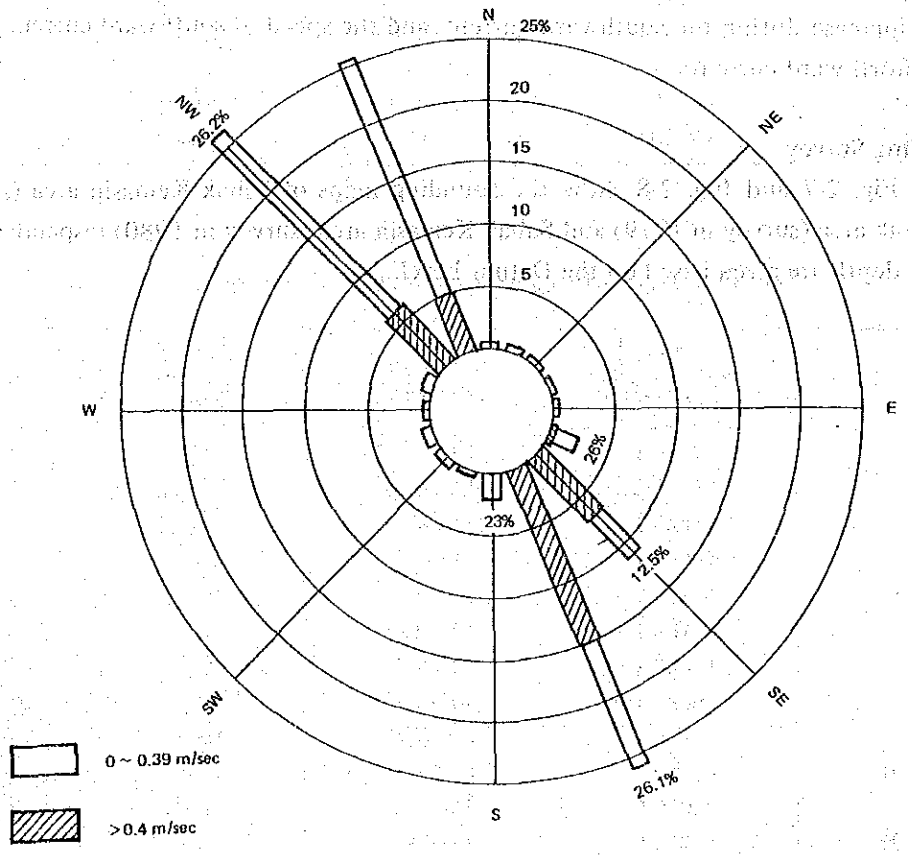


Table 2-8 Frequency of Occurrence for Current Velocity

Depth: 1.0m (Above sea bottom)
Unit: percentage

Direction / Velocity	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
0.0 ~ 0.04 (m/sec)	8 (0.3)	8 (0.3)	4 (0.2)	5 (0.2)	8 (0.3)	12 (0.5)	18 (0.7)	30 (1.2)	26 (1.0)	7 (0.3)	9 (0.4)	6 (0.2)	3 (0.1)	10 (0.4)	38 (1.5)	34 (1.3)	226 (9.0)
0.05 ~ 0.09	3 (0.1)	2 (0.1)	2 (0.1)	1 (0)	2 (0.1)	14 (0.6)	23 (0.9)	45 (1.8)	22 (0.9)	3 (0.1)	10 (0.4)	5 (0.2)	4 (0.2)	4 (0.2)	45 (1.8)	54 (2.1)	239 (9.5)
0.10 ~ 0.14	2 (0.1)	1 (0)	1 (0)	1 (0)	2 (0.1)	12 (0.5)	17 (0.7)	44 (1.8)	9 (0.4)		2 (0.1)	12 (0.5)	9 (0.4)	5 (0.2)	68 (2.7)	98 (3.9)	283 (11.2)
0.15 ~ 0.19	1 (0)					7 (0.3)	14 (0.6)	59 (2.3)	1 (0)					1 (0)	81 (3.2)	108 (4.3)	272 (10.8)
0.20 ~ 0.24						5 (0.2)	19 (0.8)	58 (2.3)							110 (4.3)	112 (4.4)	304 (12.1)
0.25 ~ 0.29						5 (0.2)	26 (1.0)	46 (1.8)							162 (6.4)	115 (4.6)	354 (14.0)
0.30 ~ 0.34						4 (0.2)	27 (1.1)	67 (2.7)							88 (3.5)	88 (3.5)	274 (10.9)
0.35 ~ 0.39						1 (0)	33 (1.3)	71 (2.8)							45 (1.8)	36 (1.4)	186 (7.4)
0.40 ~ 0.44							43 (1.7)	65 (2.6)							23 (0.9)	1 (0)	132 (5.2)
0.45 ~ 0.49						6 (0.2)	51 (2.0)	92 (3.7)									149 (5.9)
0.50 ~ 0.74							20 (0.8)	81 (3.2)									101 (4.0)
Total	14 (0.6)	11 (0.4)	7 (0.3)	7 (0.3)	12 (0.5)	66 (2.6)	291 (11.5)	658 (26.1)	58 (2.3)	10 (0.4)	21 (0.8)	23 (0.9)	16 (0.6)	20 (0.8)	660 (26.2)	646 (25.6)	2,520 (100%)

Table 2-9 List of the Daily Max. Current

	Date	Southward current			Northward current		
		Max. current speed	Current direction	Observation time	Max. current speed	Current direction	Observation time
		m/s	°	h m	m/s	°	h m
1	10/23	0.46	150	15:20	–	–	–
2	24	0.57	150	18:00	0.30	332	7:20
3	25	▲0.60	154	17:40	0.19	339	8:00
4	26	0.52	155	18:00	0.39	331	8:40
5	27	0.56	156	17:00	0.36	337	8:40
6	28	0.50	154	18:00	0.28	338	4:00
7	29	0.50	125	21:00	0.40	314	5:20
8	30	0.47	145	20:40	0.38	316	5:40
9	31	0.25	148	21:40	0.33	314	5:40
10	11/ 1	0.31	147	21:40	▲0.41	318	6:00
11	2	0.19	162	12:40	0.22 0.16	312 316	5:20 19:20
12	3	0.32	153	12:00	0.33	312	5:00
13	4	0.41	148	13:00	0.20	315	5:40
14	5	0.42	148	15:20	0.23	333	7:20
15	6	0.45	148	16:00	0.36	329	1:00
16	7	0.53	150	17:20	0.32 0.30	322 325	2:20 9:20
17	8	0.54	141	19:40	0.27 0.26	314 309	3:40 9:20
18	9	0.49	136	21:40	0.30 0.33	322 323	6:00 11:40
19	10	–	–	–	0.29	324	7:40

Note; ▲; maximum current speed

Fig. 2-6 Sounding Map (Sabak ~ Kemasin Area; Survey in 1979)

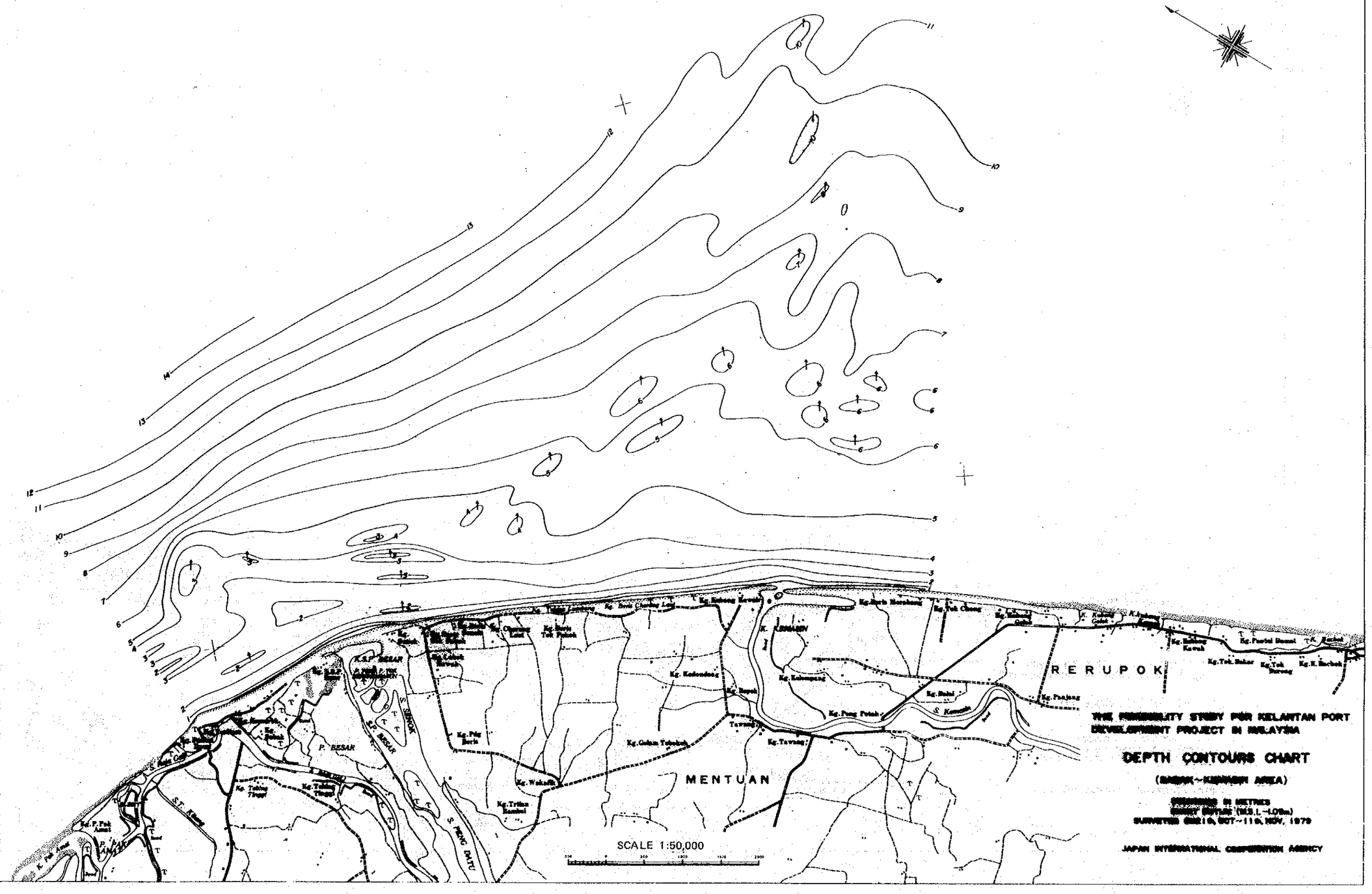


Fig. 2-7 Sounding Map (Semerak Area; Survey in 1979)

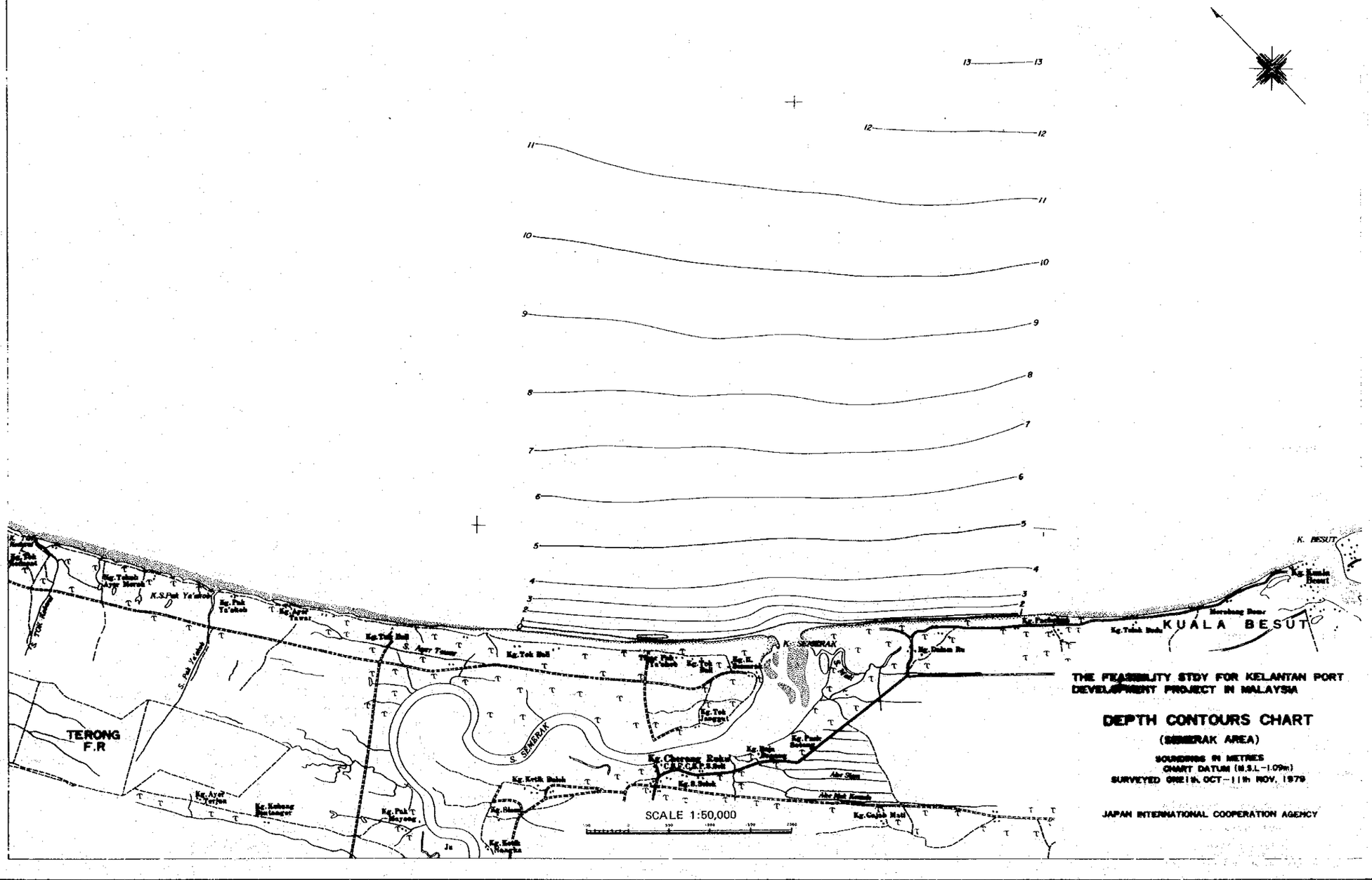
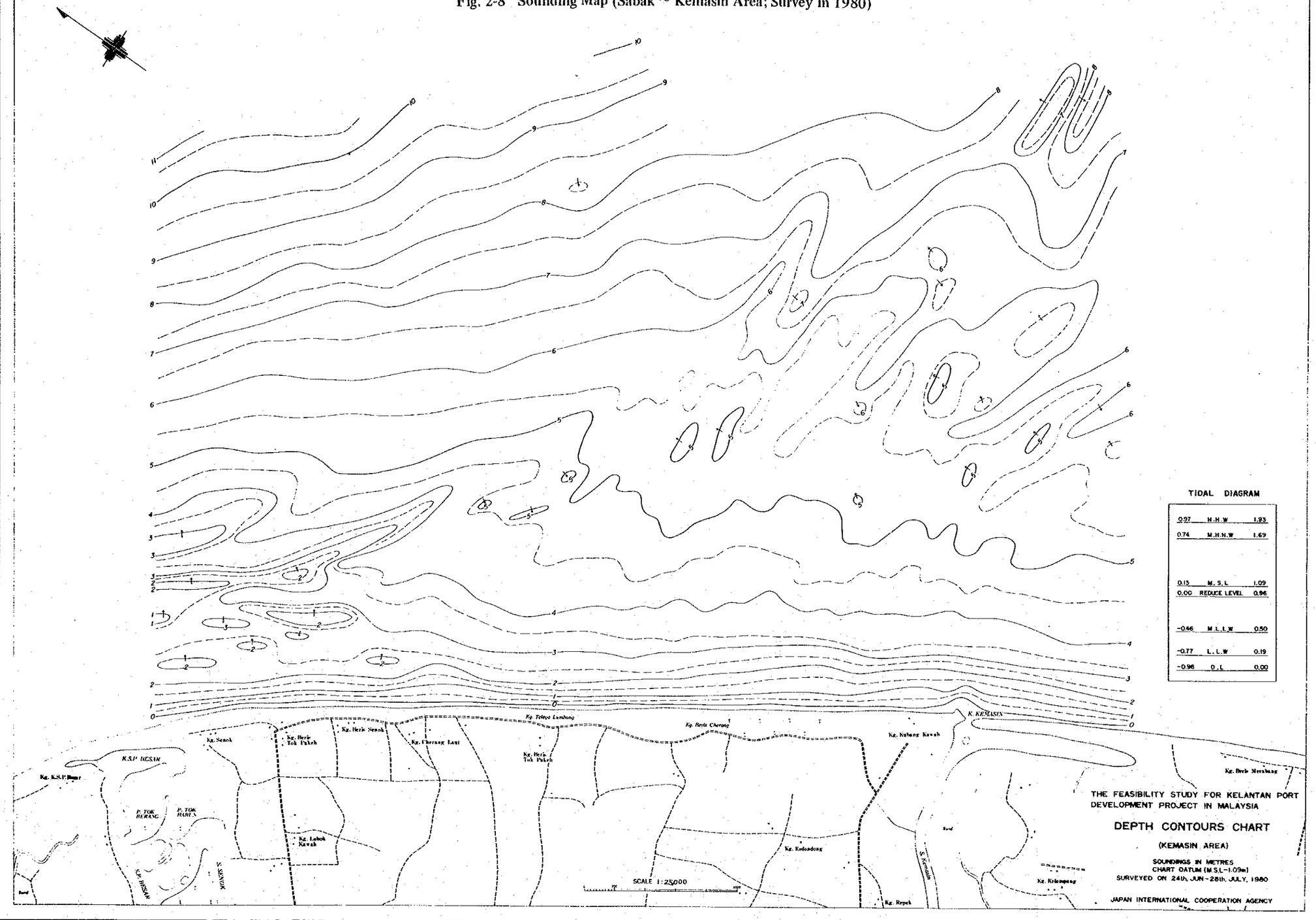


Fig. 2-8 Sounding Map (Sabak ~ Kemasin Area; Survey in 1980)



2-3-5 Littoral Drift

The littoral drift of Kelantan coast is qualitatively described hereinafter. The coastline of Kelantan State can be generally devided into two areas. They are the west side and the south side of Sg. Peng. Datu which was the river bed of former Sg. Kelantan. In the west side of the river mouth of Sg. Peng. Datu, the littoral drift tends to move westerly because of the relationship between waves and their angle against the coastline during NE monsoon season. Since the river mouth of Sg. Kelantan shifted to west side, Sg. Peng Datu does not discharge sand and soil as the source of the littoral drift any more. Thus, the west coast of Sg. Peng. Datu tends to be eroded in overall viewpoint. This phenomenon is outstanding at the Pantai Chinta Berahi.
In addition, farther westward of Sg. Kelantan has presently a tendency that sediments flown down from Sg. Kelantan and littoral drift from the beach move toward west in a large quantity, because of the relationship between the coastline and the angle of incident waves. This movement has contributed to the development of sand spits in front of Tumpat and the river mouth of Sg. Golok. At present, since the sand spit in front of Tumpat has completely closed except a few portions, it is considered that the inner water basin has been silted by sediment from Sg. Kelantan and a delta is developing there.

On the other hand, in the south side of Sg. Peng. Datu, littoral drift seems to be not so large, since the angle of incident waves to the shoreline is not so large, and there is no river as large as Sg. Kelantan.

The river mouth of Sg. Peng. Datu is completely closed by the littoral drift, and river mouths of both Sg. Kemasin and Sg. Semerak are presently very shallow. However, the north beach of the mouth of Sg. Kemasin has some local and progressing erosion.

As reported in "The Kelantan River Basin Study" by ENEX, Sabak-Kemasin area seems to be the neutral zone of littoral drift, because the amount of littoral drift from parallel direction and perpendicular direction to the coast maintains a delicate balance as a whole.

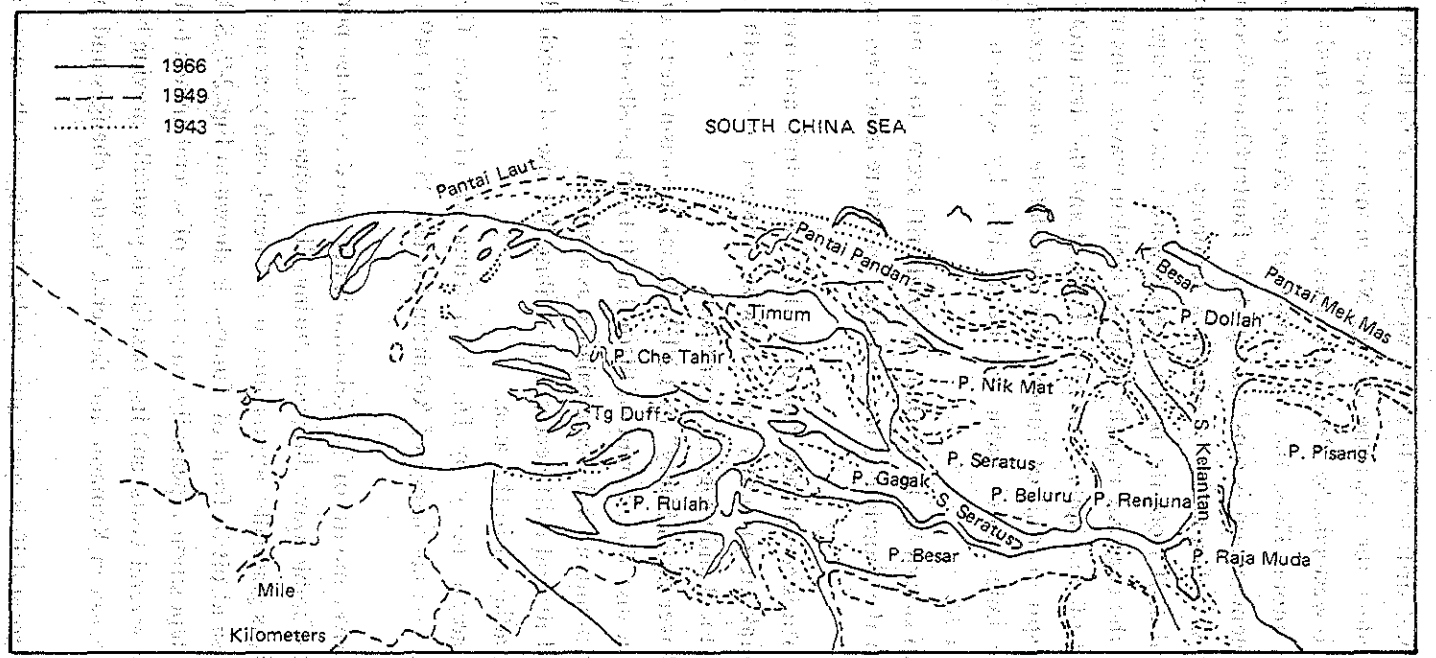
In Semerak area, the northward littoral drift becomes prevailing because of beach deformation at the river mouth of Sg. Besut adjacent to this area.

According to the aerial photograph survey by Dr. John Kuna Raj (Lecturer, Geological Department, University of Malaya), coastal change of Kelantan for last 25 years (1949 to 1974) can be outlined as follows:

The sediment flowed from the river mouth of Sg. Kelantan is deposited as a huge permanent sand spit offshore of Tumpat by the stable wave direction during NE monsoon season, and this spit is gradually moving westerly. It is gradually approaching to the beach each year and Tumpat Port is closed. The deformation of sandspit in front of Tumpat is shown in Fig. 2-9. Sabak area has been subjected to erosion and deposition repeatedly, in a range of several meters to hundred meters, this repetition occurs every several years, and its coastline is gradually moving backward. On the other hand, the coastline between Kemasin and Semerak hardly changes and has been stable throughout these years.

The above description of the littoral drift is qualitative understanding, so the more detailed periodic investigation should be carried out in order to grasp the littoral drift quantitatively.

Fig. 2-9 The Deformation of Sandspit in front of Tumpat



Source: Sedimentation in the Kelantan Delta (Malaysia) by B.N. KOOPMANS

2-4 Soil Conditions

The natural condition survey team conducted boring tests, using a rotary type boring machine, at the locations shown in Fig. 2-10, Fig. 2-11 and Fig. 2-12. The number of bore holes and survey periods were as follows;

Saback to Kemasin Area (No. A1 ~ No. A8, Oct., 1979 ~ Nov., 1979)

Semerak Area (No. A9 ~ No. A12, Oct., 1979 ~ Nov., 1979)

Saback to Kemasin Area (No. B1 ~ No. B6, Jun., 1980 ~ Aug., 1980)

Subsoil sonic prospecting by using sparker was conducted on the sea at the same time as sounding survey along the traces shown in Fig. 2-13 and Fig. 2-14, to investigate the soil layer below the sea bottom.

Sampling of sea bottom soil was conducted at the locations shown in Fig. 2-13, Fig. 2-14 and Fig. 2-15, to investigate the grain size of bottom material.

2-4-1 Boring Tests

Drilling logs are shown in Fig. 2-16, Fig. 2-17 and Fig. 2-18.

The standard penetration test was done at every one meter or every 2 meters for each bore hole.

Undisturbed sampling was carried out by using the thin wall sampler for the cohesive soil. Using the undisturbed samples and samples of the standard penetration tests, the laboratory tests (physical test, unconfined compression test, consolidation test and triaxial compression test) were performed.

Judging from the drilling logs of No. A1 ~ No. A12, the soil compositions of the layer are similar although the thickness varies.

Existing sea bed

1st layer: Sandy soil N = 10 to 20

2nd layer: Cohesive soil (silt); N = 3 to 4

3rd layer: Cohesive soil (clay); N = 10 to 20

Below 4th layer: Alternate layers of sandy soil & cohesive soil

As bore holes were close to river mouths, the influence of river erosion was seen; particularly at Sabak area and Semerak area, unconformity between the 2nd silty layer and the 3rd clay layer is outstanding.

The specific gravity of sandy soil is mainly 2.6. The grain size distribution curve are shown in Fig. 2-19. The layer of sandy soil can be divided into 2 layers, and the mean grain size D_{50} of upper layer distributes between 0.5 mm and 1.00 mm, the D_{50} of lower layer distributes between 0.09 mm and 0.3 mm.

Layer of cohesive soil is soft clayey layer including silt.

The relationship between natural water content for void ratio and wet density are shown in Fig. 2-20 and Fig. 2-21. They indicate that the natural water content is within the range from 35% to 55%, and the void ratio distributes from 0.85 to 1.45. Thus, the values of wet density indicate relatively large about 1.8 t/m^3.

Fig. 2-22 shows the relationship between the depth and the unconfined compressive strength. It shows some dispersion but the value of q_u tends to increase as the depth becomes larger, so

that the soil will be regarded as the normally consolidated cohesive soil.

The increasing rate of unconfined compressive strength and cohesion should be expressed by the following equations;

$$qu = 0.03Z + 0.18 \ (kg/cm^2)$$
$$C = 0.15Z + 0.9 \ (t/m^2)$$

where qu; Unconfined compressive strength (kg/cm^2)

C; Cohesion (t/m^2)

Z; Depth, Z=0 is equal to the ground level

Fig. 2-23, Fig. 2-24 and Fig. 2-25 show the results of consolidation test.

2-4-2 Subsoil Sonic Prospecting

According to the on-shore boring test, the soil configuration below the sea bottom in Sabak-Kemasin area is similar to that of the on-shore, and the thickness of the 1st-layer becomes thinner as the location approaches to Sg. Peng. Datu, while the 2nd-layer becomes thicker.

Soil configuration below sea bottom in Semerak is approximately the same as that of Sabak-Kemasin. However, when the water depth exceeds −5 m, the 1st-layer gradually deminishes, and the 2nd-layer appears on the sea bottom. The depth of boundary between alluvial and diluvial strata is distributed between −15 m and −25 m, in extremely complicated shapes.

2-4-3 Sampling of Sea Bottom Soil

Fig. 2-26 shows the grain size distribution curves by area.

Specific gravity and mean diameter of subsoil are shown in Table 2-10 and Table 2-11.

The grain size of the bottom materials near the shoreline in Sabak-Kemasin is larger than that of the offshore area. The mean diameter (D_{50}) has a considerable dispersion but it is about 0.1 mm at the mouth of Sg. Kemasin and the offshore of intermediate point of Sabak-Kemasin, and about 0.4 mm to 0.7 mm at the offshore of Sabak. In Semerak, the mean diameter (D_{50}) is 0.025 mm to 0.035 mm. The grain size is one-order smaller than that of Sabak-Kemasin. The specific gravity of Semerak is slightly smaller than that of Sabak-Kemasin.

Fig. 2-10 Location Map of Boring Tests (No. A1 ~ No. A8; Sabak to Kemasin Area)

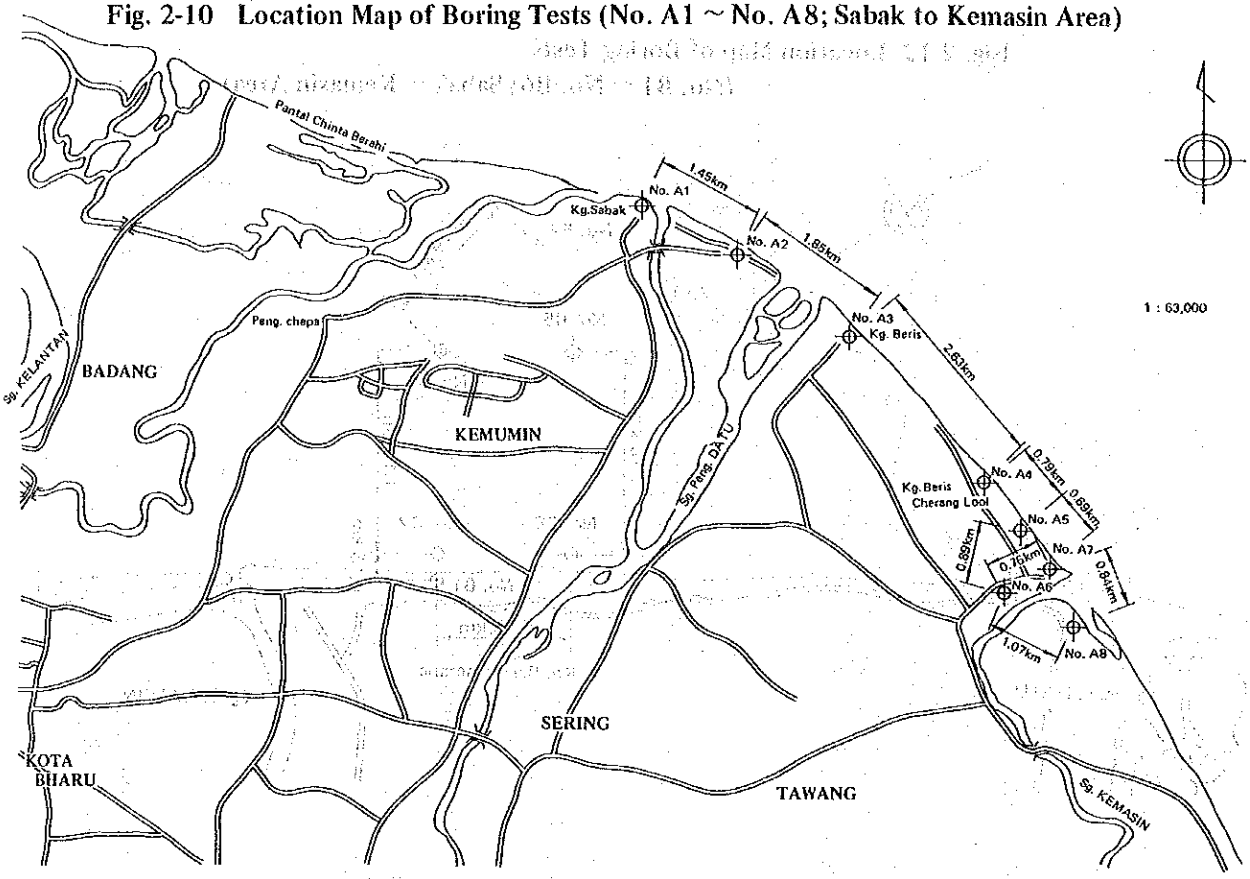


Fig. 2-11 Location Map of Boring Tests (No. A9 ~ No. A12; Semerak Area)

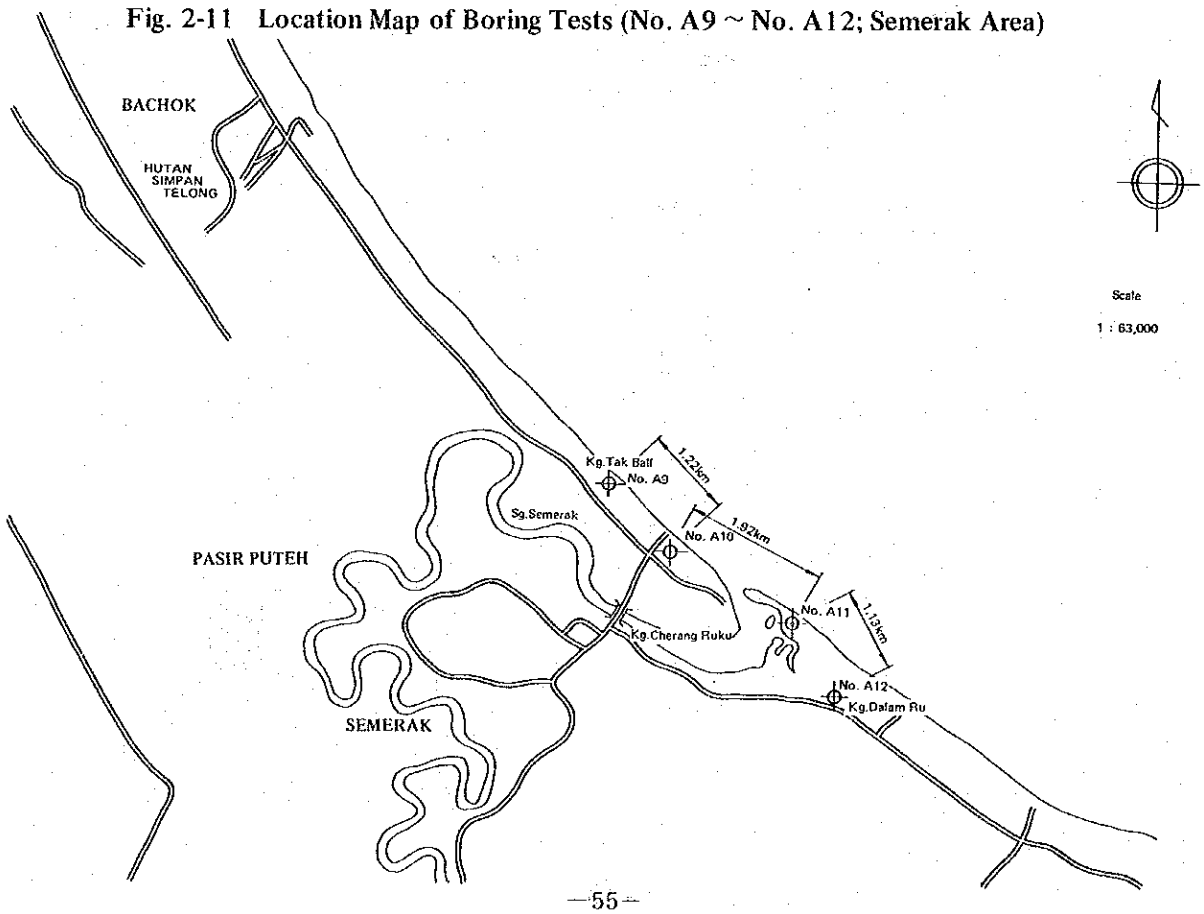
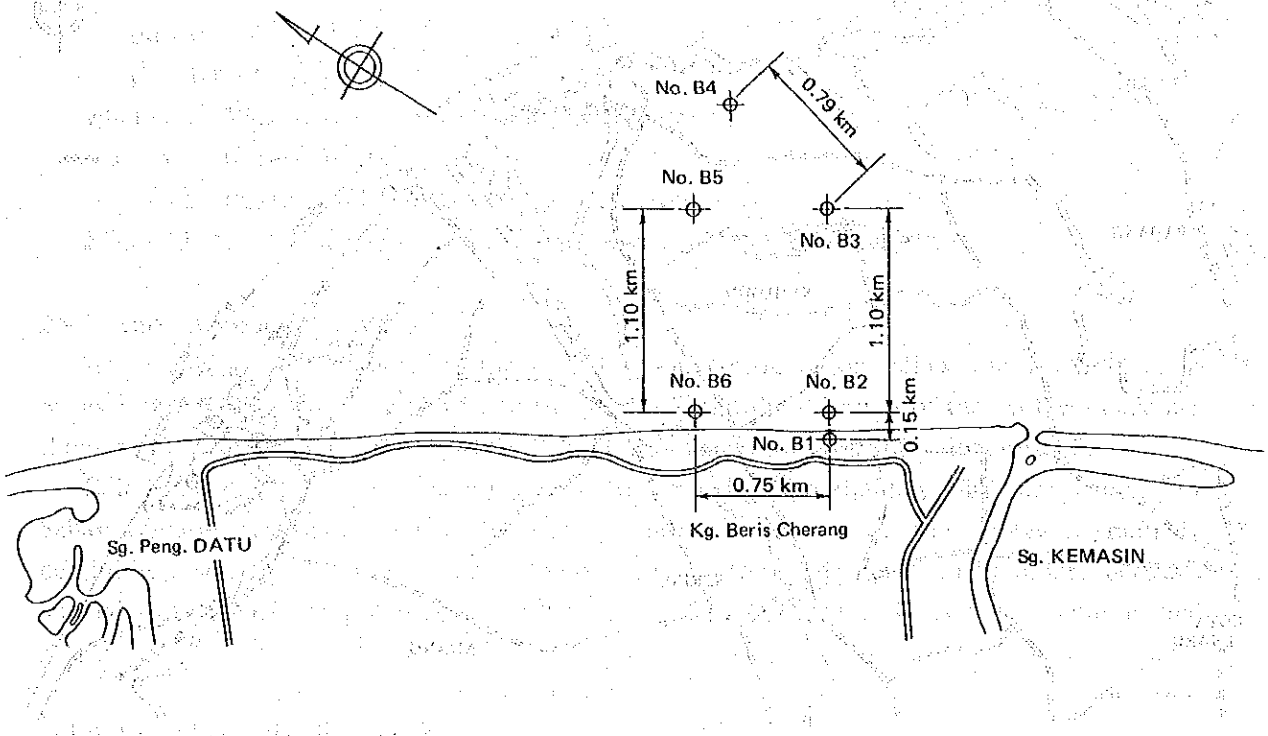


Fig. 2-12 Location Map of Boring Tests
(No. B1 ~ No. B6; Sabak ~ Kemasin Area)



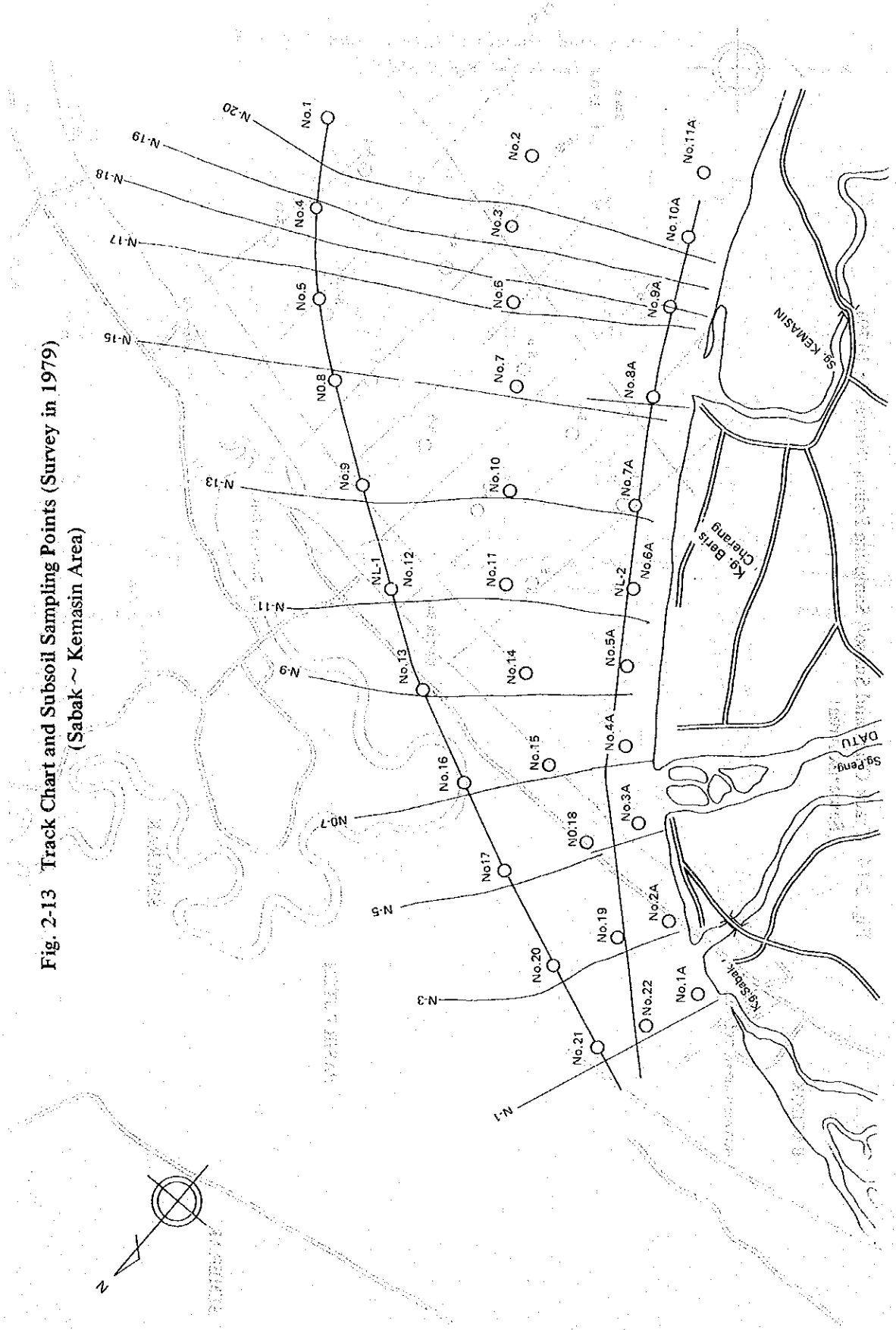


Fig. 2-13 Track Chart and Subsoil Sampling Points (Survey in 1979)
(Sabak ~ Kemasin Area)

Fig. 2-14 Track Chart and Subsoil Sampling Points (Survey in 1979)
(Semerak Area)

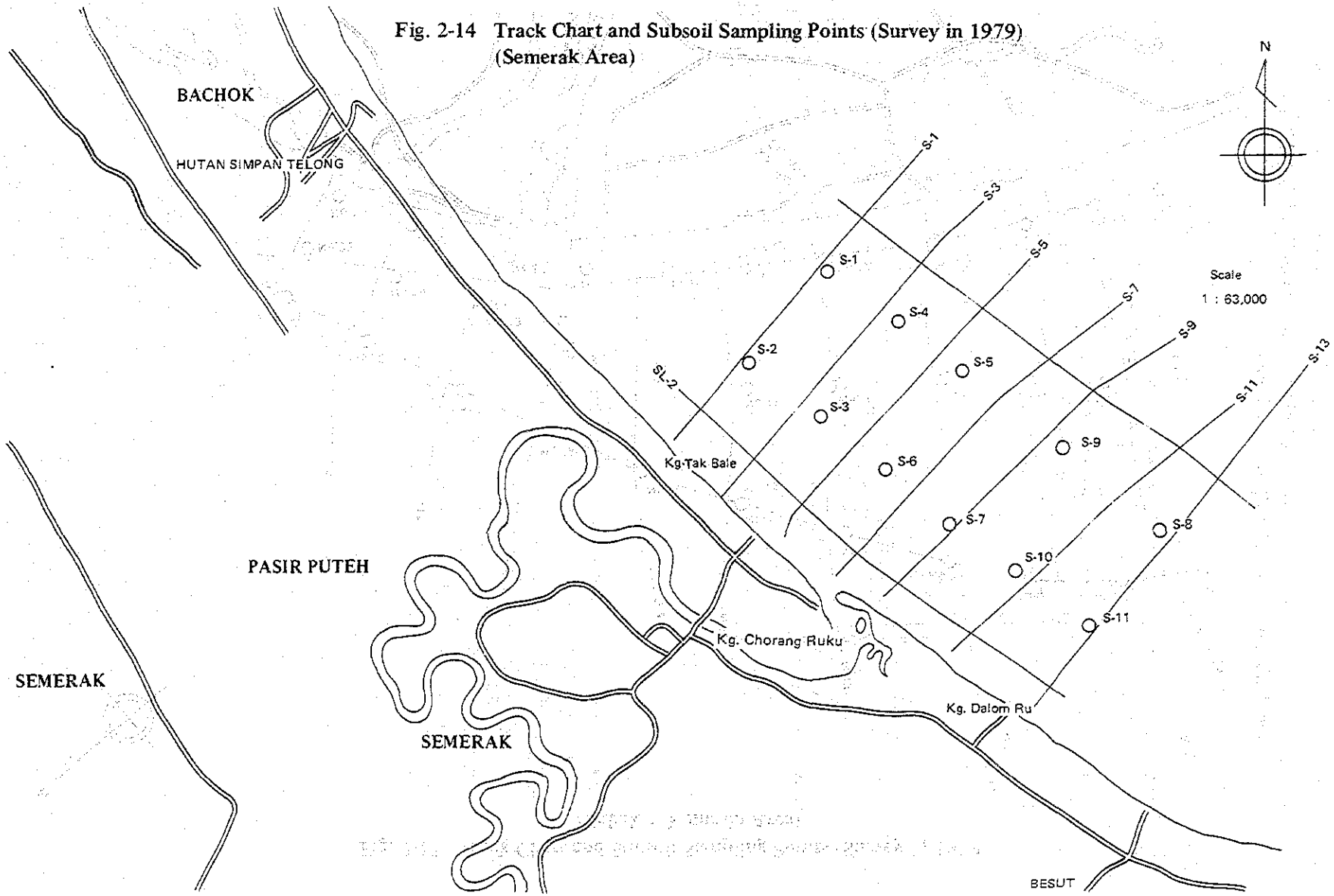


Fig. 2-15 Subsoil Sampling Points (Survey in 1980)
(Sabak ~ Kemasin Area)

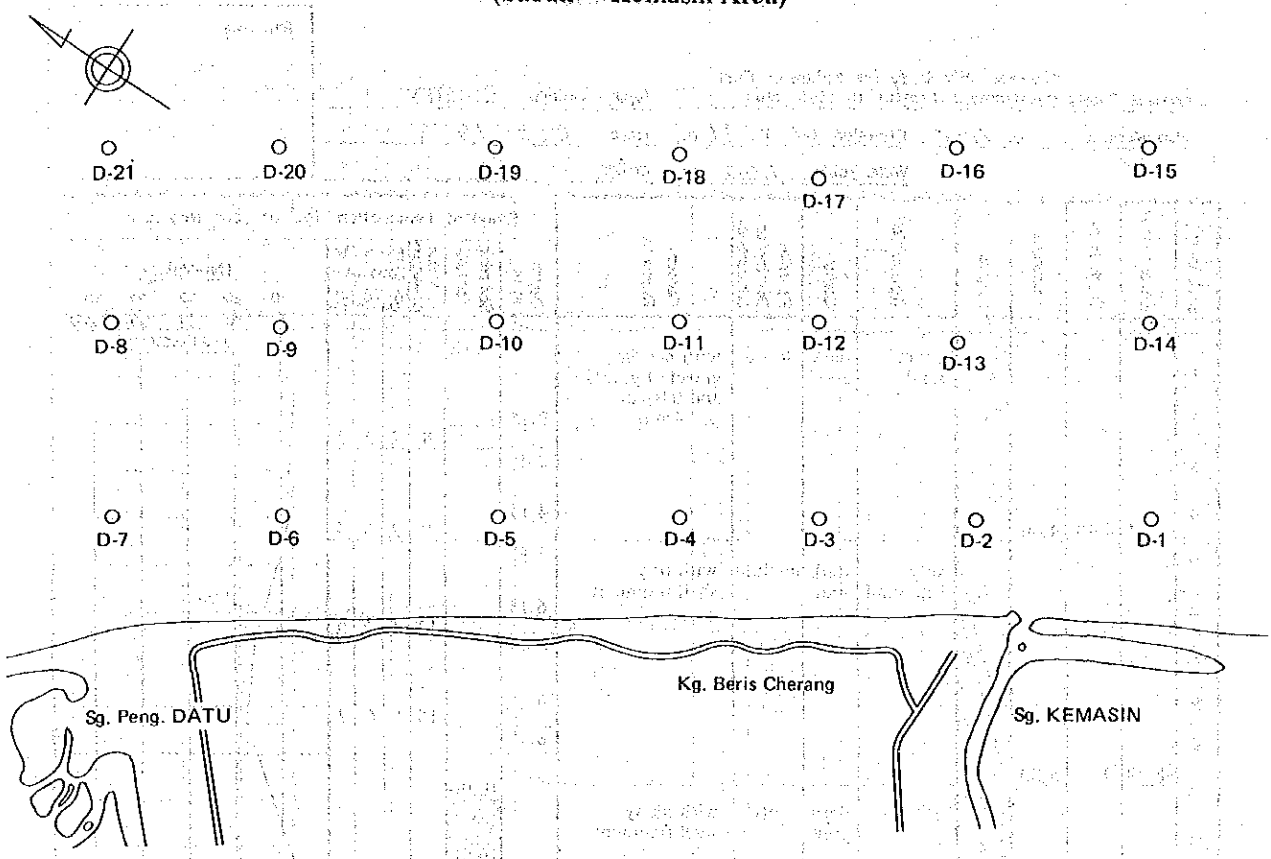


Fig. 2-16 Drilling Log (Sabak ~ Kemasin Area)

Remarks

Name of Project: The Feasibility Study for Kelantan Port Development Project in Malaysia
Type of Drilling: Rotary
Hole Number: No. A-7
Elevation: DL +1.31 m
Date: Oct. 1979
Water Table: -1.60 m
Driller:

Elevation in m	Depth in m	Thickness	Type of Soil	Colour	Relative Density or Consistency	General Remarks
-3.09	4.40	4.40	coarse sand	dark grey	loose	with pebble gravel of guartz and felspar φ2~4mm
-8.39	9.70	5.30	silty fine sand	dark grey	medium	with tiny shell fragment
-14.49	15.80	6.10	silt	dark grey	soft	with many shell fragment; with mica
-19.14	20.45		silt	dark grey	medium stiff	with low water content; with orgnic matter and tiny shell fragment

Standard Penetration Test or Core Recovery

Depth in m	Sampling for Lab	N Value (Blows/30cm)	Blows Per Each 10cm		
2.15		8	2	3	3
2.45					
4.15		9	2	3	4
4.45					
6.15		15	4	5	6
6.45					
8.15		18	5	6	7
8.45					
	10.00				
	10.90				
12.15		3	1	1	1
12.45					
14.15		4	1	1	2
14.45					
16.15		6	2	2	2
16.45					
18.15		7	2	2	3
18.45					
20.15		9	3	3	3
20.45					

(N-Value) 10 20 30 40 50

Core Recovery 20 40 60 80 100 %

Fig. 2-17 Drilling Log
(Semerak Area)

Remarks

Name of Project: The Feasibility Study for Kelantan Port Development Project in Malaysia
Type of Drilling: Rotary
Hole Number: No. A-11
Elevation: DL +1.90 m
Date: Nov. 1979
Water Table: −0.30 m
Driller:

Scale in m	Elevation in m	Depth in m	Thickness	Legend	Type of Soil	Colour	Relative Density or Consistency	General Remarks	Depth in m	Sampling for Lab	N Value Blows/30cm	Blows Per Each 10cm 0~10 cm	10~20 cm	20~30 cm
1					coarse sand	yellowish grey		with high water content						
2							medium to loose	with pebble gravel of quartz	2.15		18	6	6	6
3									2.45					
4									4.15		23	7	7	9
5									4.45					
6	-4.10	6.00	6.00						6.15		3	1	1	1
7	-4.80	6.70	0.70		silty fine sand	dark grey	loose	with shell fragment	6.45	7.00				
8					silt	dark grey	soft	with shell fragment		7.90				
9									9.15		3	1	1	1
10								with little fine sand	9.45					
11									11.15		3	1	1	1
12									11.45					
13	10.90	12.80	6.10						13.15		19	6	6	7
14					clay	brown and light grey	stiff	stiff clay mixed colours of brown and light grey	13.45					
15									15.15		21	7	7	7
16									15.45					
17									17.15		19	5	7	7
18									17.45					
19	-16.80	18.70	5.90						19.15		9	3	3	3
20					silt	dark grey	medium stiff	with much organic matter	19.45					
21									21.15		10	3	3	4
22	19.55	21.45							21.45					
23														
24														
25														
26														
27														
28														

Standard Penetration Test or Core Recovery

(N—Value) 10 20 30 40 50

Core Recovery 20 40 60 80 100 %

Fig. 2-18 Drilling Log

No. B - 3

Location Sabak ~ Kemasin Area

Elevation D.L. -4.94 m

Date 2.7 1980 ~ 7.8 1980

Wate Table m

Scale in m	Elevation in m	Depth in m	Thickness	Legend	Colour	Type of soil	General Remarks	Relative Density or Consistency	Standard Penetration Test: Depth in m	N-Value (Blows / 30cm)	Blows Per Each 10cm: 10	10	10	N-Value / Core Recovery	Sampling Depth in m	In-situ Test Depth in m
1					grey	fine sand	very loose sand layer with shell fragments and high water contents, clayey at a depth of 2m.		1.15	2/30	1/15	1/15				
2	-7.54	2.60	2.60						1.45							
3	-8.44	3.50	0.90		grey	coarse sand with gravels	with high water content and shell fragment with quartz pebble		2.15	3/30	1	1	1			
4					grey	silty fine sand	with high water content with shell fragments and biotite flakes		2.45							
5	-8.99	5.05	1.55						3.15	3/30	1	1	1			
	-10.44	5.50	0.45		grey	silty medium sand	with shell fragment		3.45							
6					grey	silty fine sand	with medium water content and a little shell fragment, with biotite flakes		4.15	3/30	1	1	1			
7									4.45							
8									5.15	5/30	1	2	2			
9									5.45							
10	-14.79	9.85	4.35						6.15	5/30	1	2	2			
									6.45							
11					grey	fine ~ medium sand	with high water content with shell fragment and pebble of quartz with biotite flakes pebble is 3mm in maximum diameter		7.15	3/30	1	1	1			
12									7.45							
13									8.15	5/30	1	2	2			
14	-19.09	14.15	4.30						8.45							
	-19.64	14.60	0.45		grey	organic silt	with much organic matters		9.15	4/30	1	1	2			
15									9.45							
16					grey	silt	with organic matters and mica flakes very soft layer with high water content		10.15	7/30	2	3	3			
17									10.45							
18									11.15	8/30	2	3	3		17.50	
19									11.45						18.10	
20									12.15	8/30	2	3	3			
21	-26.54	21.60	7.00						12.45							
22					light grey	clay	with less water content, medium stiff clay layer		13.15	6/30	2	2	2			
23	-28.04	23.10	1.50						13.45							
24					light grey	fine to coarse sand	with less water content, very stiff layer with pebble of quartz		14.15	4/30	2	1	1			
25	-30.09	25.15	2.05						14.45							
26									15.15	4/30	1	1	2			
27									15.45							
28									16.15	6/30	2	2	2			
29									16.45							
30									19.15	2/30	0	0	2			
									19.45							
									20.15	0/30						
									20.45							
									21.15	0/30						
									21.45							
									22.15	5/30	1	2	2			
									22.45							
									23.15	50/25	17	20	13/5			
									23.45							
									24.00	50/17	26	24/2				
									24.17							
									25.00	50/15	28	22/5				
									25.15							

Fig. 2-19 Grain-Size Distribution Curves of Sandy Layer

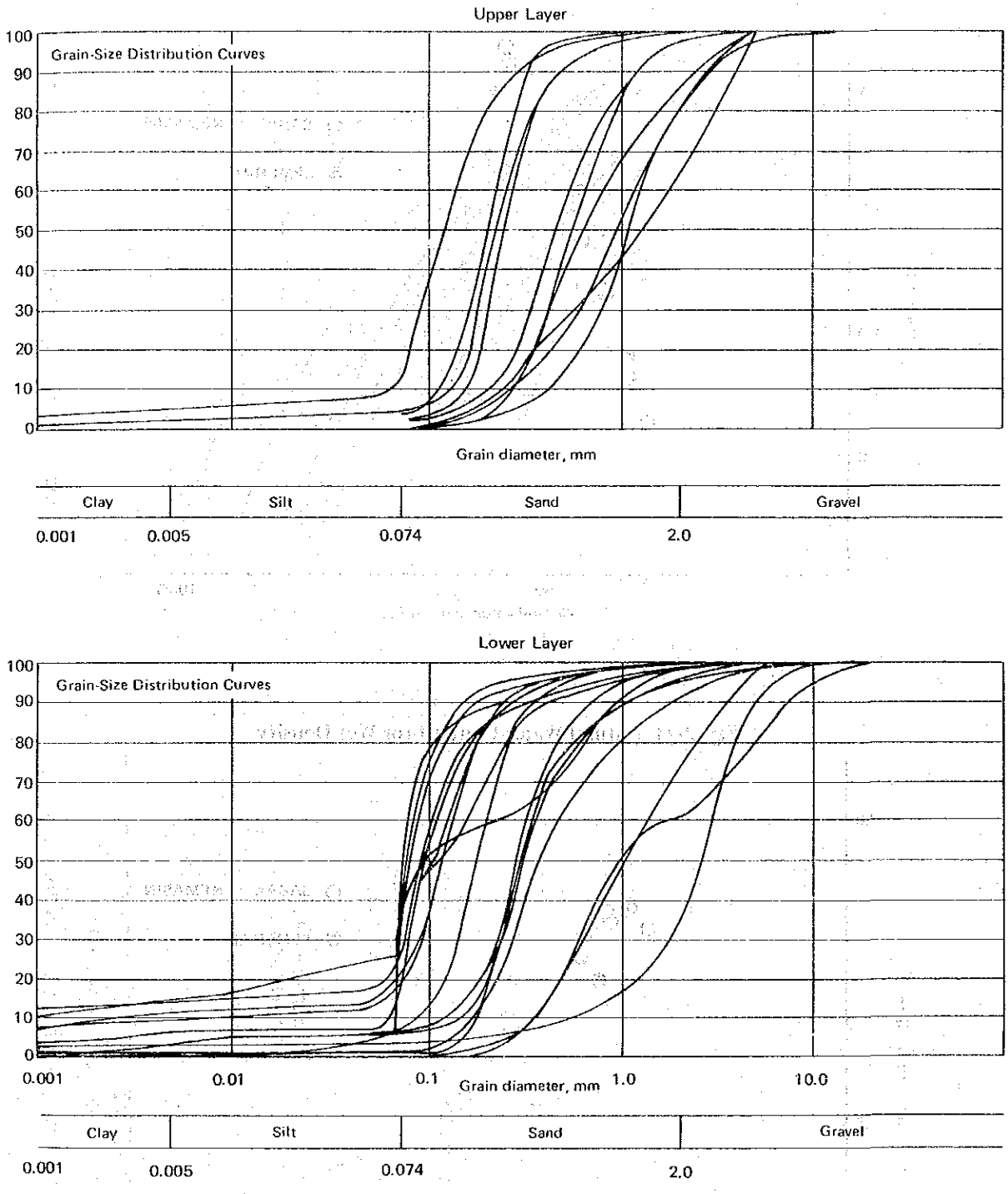


Fig. 2-20 Natural Water Content for Void Ratio

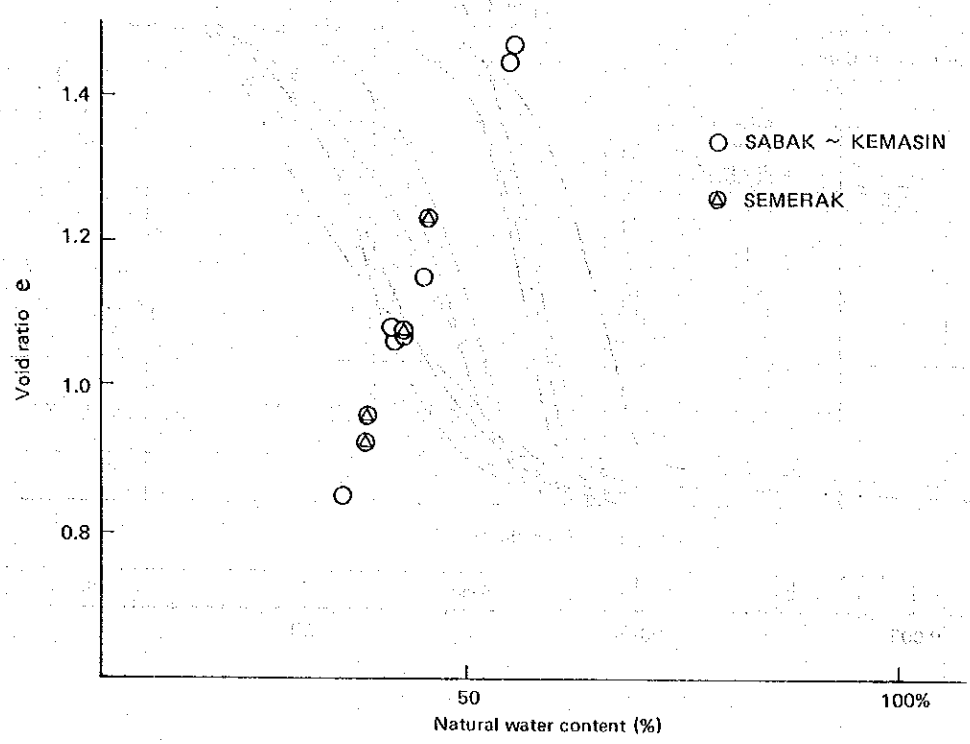


Fig. 2-21 Natural Water Content for Wet Density

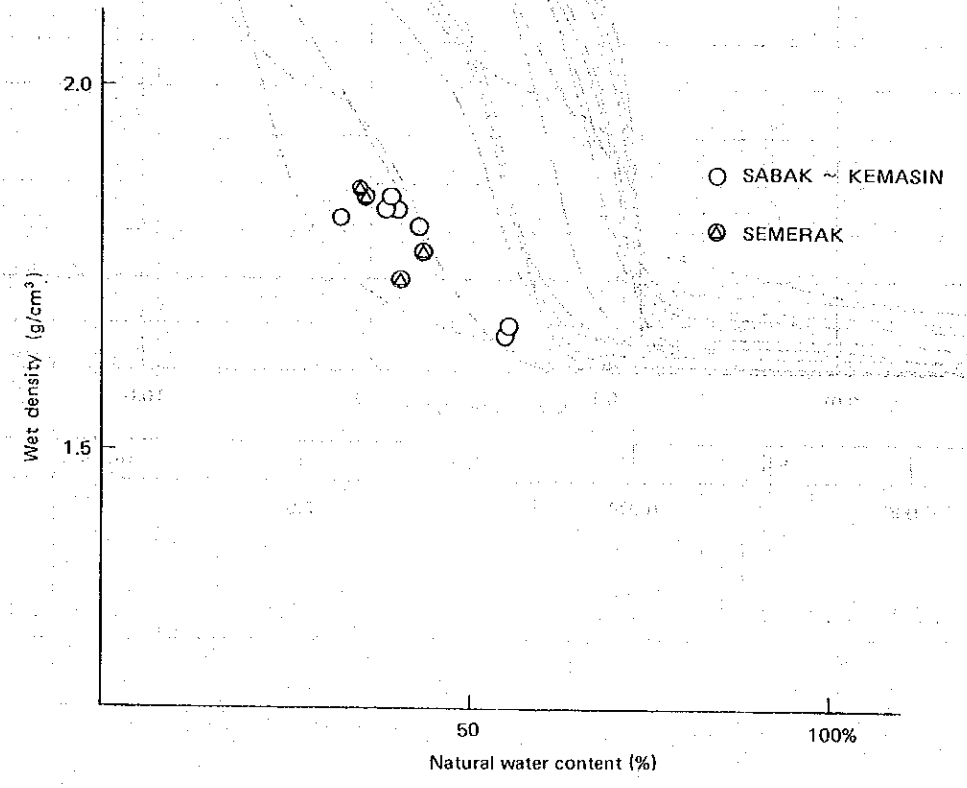


Fig. 2-22 Unconfined Compressive Strength for Depth

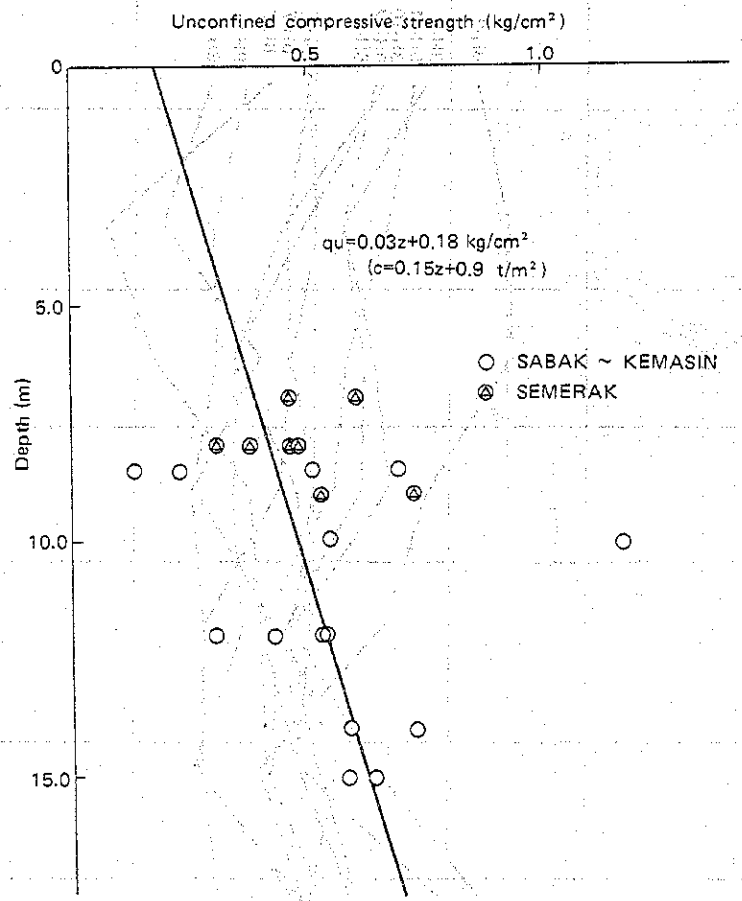


Fig. 2-23 Consolidation Test (e ~ log P Curves)

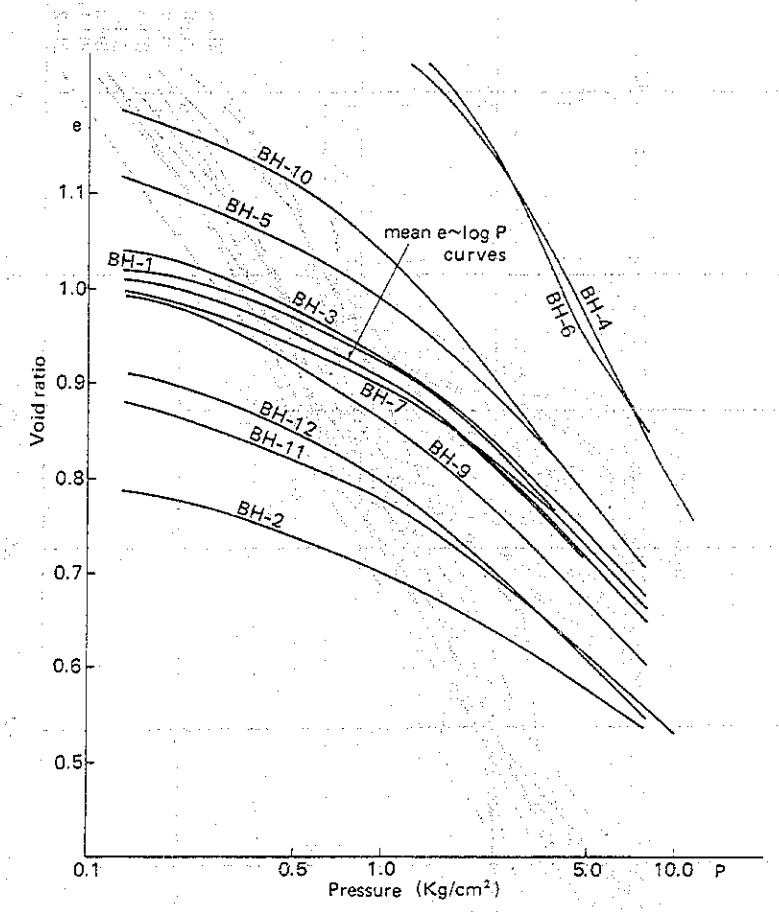


Fig. 2-24 Consolidation Test (log $\bar{P}$ ~ log Mv Curves)

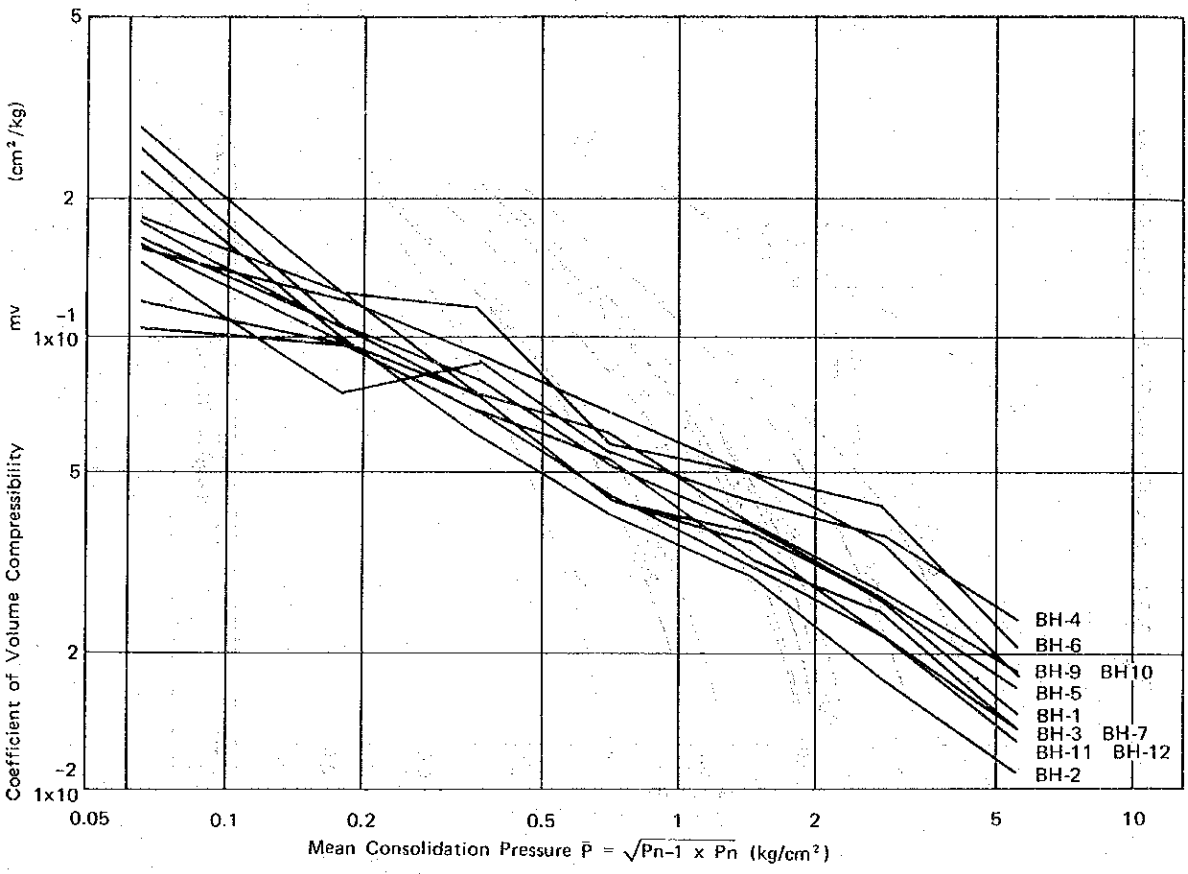


Fig. 2-25 Consolidation Test (log $\bar{P}$ ~ log Cv Curves)

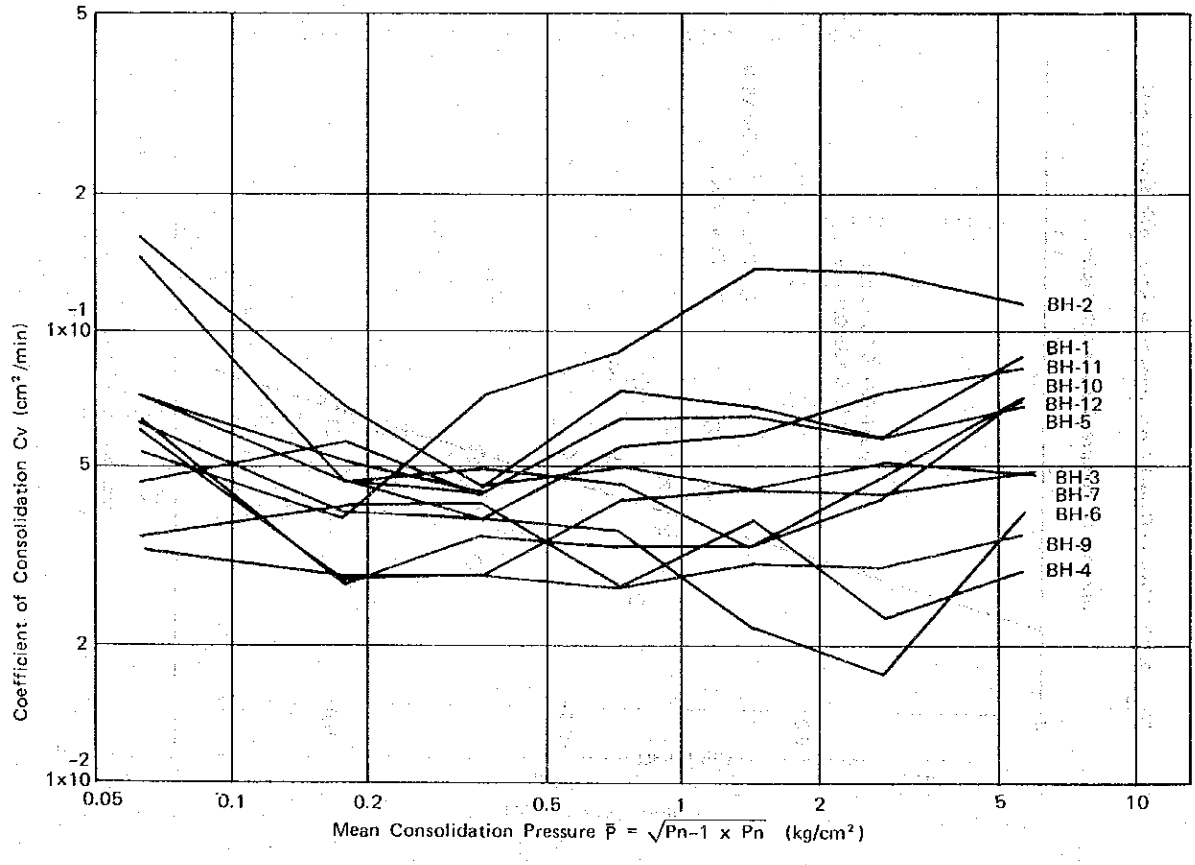
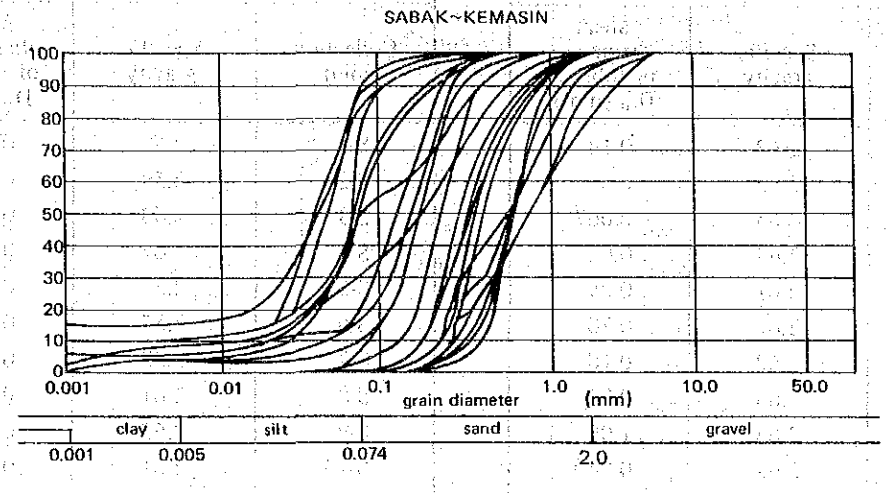


Fig. 2-26 Grain-Size Distribution Curves by Area (Subsoil Sample)



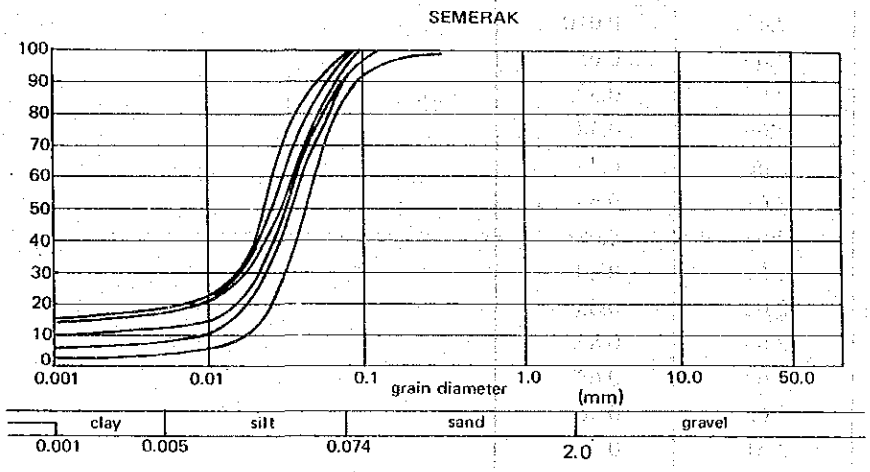


Table 2-10 Specific Gravity and Mean Diameter of Subsoil (Survey in 1979)

Sabak – Kemasin Area		
Collection point	Specific gravity	Mean diameter of subsoil D_{50} (mm)
1	2.63	0.14
2	2.62	0 072
3	2.65	0.067
4	2.64	0.62
5	2.61	0.24
6	2.63	0.70
7	2.62	0.18
8	2.63	0.38
9	2.63	1.00
10	2.62	0 040
11	2.65	0.072
12	2.58	0.073
13	2.62	0.20
14	2.62	0.046
15	2.65	0.040
16	2.63	0.65
17	2.65	0.38
18	2.66	0.38
19	2.65	0.43
20	2.61	0.64
21	2.63	0.68
22	2.61	0.40
1A	2.62	0.83
2A	2.63	0.87
3A	2.62	0.62
4A	2.63	0.36
5A	2.61	0.62
6A	2.63	0.62
7A	2.59	0.53
8A	2.62	0.32
9A	2.62	0.57
10A	2.58	0.18
11A	2.60	0.17

Semerak Area		
Collection point	Specific gravity	Mean diameter of subsoil D_{50} (mm)
S-1	2.57	0.034
S-2	2.59	0.022
S-3	2.63	0.025
S-4	2.62	0.028
S-5	2.57	0.030
S-6	2.57	0.027
S-7	2.58	0.024
S-8	2.61	0.029
S-9	2.62	0.026
S-10	2.61	0.026
S-11	2.60	0.022

Table 2-11 Specific Gravity and Mean Diameter of Subsoil (Survey in 1980)

Sabak ~ Kemasin Area				
Collection Point	Specific Gravity	Mean diameter of Subsoil D50 (mm)	Diameter of Subsoil D25 (mm)	Diameter of Subsoil D75 (mm)
D-1	2.68	0.05	0.037	0.063
D-2	2.57	0.05	0.042	0.059
D-3	2.65	0.053	0.043	0.066
D-4	2.68	0.046	0.033	0.058
D-5	2.65	0.053	0.033	0.074
D-6	2.64	0.53	0.034	0.88
D-7	2.67	0.50	0.38	0.66
D-8	2.70	0.047	0.033	0.065
D-9	2.66	0.052	0.034	0.25
D-10	2.66	0.048	0.037	0.063
D-11	2.66	0.35	0.05	0.55
D-12	2.71	0.42	0.056	0.66
D-13	2.67	0.32	0.26	0.40
D-14	2.67	0.32	0.26	0.40
D-15	2.65	0.50	0.31	0.63
D-16	2.67	0.45	0.17	0.63
D-17	2.66	0.30	0.05	0.50
D-18	2.67	0.057	0.046	0.35
D-19	2.67	0.046	0.040	0.055
D-20	2.65	0.24	0.040	1.05
D-21	2.65	0.048	0.034	0.06

CHAPTER 3 SITE SELECTION

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Two areas of Sabak-Kemasin and Semerak were selected for the proposed sites of the port development as described in Scope of Work (S/W). Technical evaluation and socio-economic evaluation are executed in order to select the most suitable site.

3-1 Technical Evaluation

The comparison is made between both areas on the following comparative items;

(1) *Length of Breakwaters*

The water depth of Sabak-Kemasin area and semerak area is so shallow that the necessary length of breakwaters becomes long, and this will cause the increase of the construction cost of the port project. The necessary length of breakwaters under the First Phase Development Plan is estimated approximately as follows;

Sabak-Kemasin area; L = 1,810 m – 2,250 m

Semerak area; L = 2,050 m

(2) Amount of Capital Dredging

The amount of capital dreging under the First Phase Development Plan is estimated approximately as follows;

Sabak-Kemasin area; V = 1,800,000 m^3 – 2,300,000 m^3

Semerak area; V = 2,900,000 m^3

(3) Soil Conditions

There are no outstanding difference of the soil conditions between Sabak-Kemasin area and Semerak area, but the grain size of sea bottom materials of Semerak area is one-order smaller than that of Sabak-Kemasin area. (Reference should be made to "2-4. Soil Conditions")

(4) Land Use for a Port Area

A sufficient area of flatland is necessary for port development. The hinterlands of Sabak-Kemasin area and Semerak area are swampy and were inundated by the flood in 1967. To use these lands as a port area, the ground level should be raised by earth filling.

3-2 Socio-Economic Evaluation

The comparison is made between Sabak-Kemasin area and Semerak area on the following comparative items;

(1) Geographical Conditions

Sabak-Kemasin area is located in the center of Kelantan coast and adjoins the densely populated coastal plain where the state capital of Kota Bharu is located. The straight distance from Kota Bharu approximately 10 km. Semerak area, meanwhile, is located near the boundary of the States of Kelantan and Trengganu, 40 km from Kota Bharu, this is a geographical disadvantage as the site of Kelantan Port.

(2) Land Transport Conditions

① Roads

The present road network in the State of Kelantan spreads radially from Kota Bharu. Roads in the coastal plain, particularly the east part of Sg. Kelantan, are well-developed, compared with other areas. So, Sabak-Kemasin area is favourable if goods are transported to consuming areas from the port by the existing road network. However, some improvements such as widening the existing roads are necessary to cope with the increase of the cargo transportation in the future.

② Railways

The present railway, running through the central part of the Peninsular Malaysia, passes through the State of Kelantan and its branch reaches to Tumpat. Extending this railway directly to the port is unpractical because the immense investment for a bridge construction, etc. are necessary for this purpose.

The transportation combined trucks and railways may be available to make effective use of railway transport. In this case also, Sabak-Kemasin area has an advantage because of its proximity to the existing railway.

The shortest distances from two areas to the existing railway are approximately as follows:

Sabak – Kemasin		20 km
	Semerak	40 km

(3) Relationship to Other Development Projects

The development projects for the transportation, the industrial estates, the south Kelantan region, etc. may be mentioned as development projects related to the port project.

① Transportation Projects

In the State of Kelantan, the projects of the North-South Highway from Kuala Krai to Kuala Lumpur and Port Kelang via Gua Musang, and the East-West Highway are in progress.

The shortest distances from two areas to East-West Highway are approximately as follows:

Sabak – Kemasin	50 km
Semerak	15 km

No railway projects are planned at present.

As for the airport, the existing airport of Kota Bharu is now being expanded.

② Industrial Estates Projects

Industrial estates projects are being planned and constructed at Pengkalan Chepa, Tanah Merah, Jeli and Gua Musang. These industrial estates consist mainly of light industries, and efforts of inducing for manufacturing companies are now being made. In the future, it will be expected that some products will be transported by sea from the port.

Sabak-Kemasin area has an advantage of the short distance from the industrial estate of Pengkalan Chepa, which adjoins Kota Bharu and is the largest of the four.

The road distances from two areas to those industrial estates are approximately as follows:

	Sabak – Kemasin	Semerak
Pengkalan Chepa	7 km	70 km
Tanah Merah	65 km	55 km
Jeli	120 km	100 km
Gua Musang	190 km	185 km

③ South Kelantan Development Project

Semerak area has an advantage of short distance from South Kelantan.

④ Kemasin-Semerak Integrated Rural Development Project

The survey on the Kemasin-Semerak Integrated Rural Development Project is being conducted by the study team of SCET International. The report submitted by this team says that irrigation and drainage projects are being planned to accelerate agricultural development in Kemasin-Semerak area, and the construction of training walls is being planned for the estuaries of Sg. Pengkalan Datu, Sg. Kemasin and Sg. Semerak. If this project is carried out in the future, it is better to use the training wall as a part of seawall. But to achieve such dual-purpose utilization of facilities, it is necessary to adjust the schedule of both projects.

(4) Distance to the Consuming Area

The consuming area is located in the northern part of the State of Kelantan. Sabak-Kemasin area has an advantage of the short distance from the consuming area.

(5) Distance to the Producing Area

According to Census of Manufacturing Industries, Peninsular Malaysia 1973 Vol. 1, 70% of industrial products of the State of Kelantan was produced in Kota Bharu area and 90% in the north-western part of the state around Kota Bharu. But these proportions will change if, in the future, the inland industrial estates start production. Since, however, the industrial estate of

Pengkalan Chepa occupies about 50% of their total area, the change of the proportion will be rather small.

(6) Distribution of Fishermen

The total number of fishermen in the State of Kelantan is 6,475 and a half of them live around Tumpat. In Tumpat area, fishing port facilities are being constructed at Geting in order to improve the life of local fishermen.

There are many fishing villages at the north side of Kota Bharu and Bachok area. For these fishermen, Sabak-Kemasin area is closer than Semerak area and they will be able to remove there easily.

(7) Competition with Other Fishing Ports

Other fishing ports which have the possibility of competition with this fishing port are Geting and Besut of the State of Trengganu. In particular, Besut is only 7 km from Semerak area and may compete with the proposed new fishing port. Therefore, Sabak-Kemasin area is the most favorable site for the fishing port. As for the Geting port, it will be possible to develop by itself, because there is sufficient distance from Kota Bharu and that is located on the opposite side of Sabak-Kemasin area.

(8) Distribution of Laborers

The population of the State of Kelantan is concentrated around Kota Bharu. The development of Kelantan Port can provide the opportunities of employment to the unemployed and workers in unproductive industries.

If the port is constructed in Sabak-Kemasin area, many workers can go to work from existing dwelling places.

(9) Distribution of Natural Resources

In the future, with the progress of mining in inland, export-oriented industries using these natural resources may start near the port.

Since natural resources are distributed mainly in the mountainous southern part of the state, Semerak area has an advantage of short distance.

(10) Prospect of Future Development

Sabak-Kemasin area is located approximately in the central part of the Kelantan coast and is closer to the state capital of Kota Bharu than Semerak area. It is expected that this area will be developed further as one of the economic centers of the State of Kelantan. There is a great possibility of the future development in Sabak-Kemasin area.

3-3 Overall Evaluation

Table 3-1 shows the comparison of Sabak-Kemasin area and Semerak area as a port development site. The evaluation is expressed by the following marks;

Very good: AAA
Good: AA
Not so good: A

From the result of overall evaluation, Sabak-Kemasin area is selected as the most suitable site for a proposed port.

Table 3-1 Comparison of Sabak ~ Kemasin Area and Semerak Area as A Port Development Site

Item No.	Comparative Items	Sabak ~ Kemasin Area	Semerak Area
1	Technical Evaluation		
1-1	Length of breakwater	A[1)]	A[1)]
1-2	Amount of capital dredging	A	A
1-3	Soil conditions	AA	A
1-4	Land use for a port area	AAA	AA
2	Socio-Economic Evaluation		
2-1	Geographical conditions	AAA	A
2-2	Land transport conditions	AAA	AA
2-3	Relationship to other development projects	AAA	AA
2-4	Distance to the consuming area	AAA	A
2-5	Distance to the producing area	AAA	AA
2-6	Distribution of fishermen	AAA	A
2-7	Competition with other fishing ports	AAA	A
2-8	Distribution of laborers	AAA	A
2-9	Distribution of natural resources	A	AA
2-10	Prospect of future development	AAA	A

Note: 1) This evaluation A means that the required length of the breakwater in Kelantan Port is much longer than that of a usual port in order to secure the calm basin.