

**The Government of Malaysia
The State of Pahang**

PAHANG TENGGARA

Regional Masterplanning Study

**Wildlife, Conservation
and Tourism**

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HUNTING TECHNICAL SERVICES

PAHANG TENGGARA REGIONAL MASTERPLANNING STUDY

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Wildlife, Conservation and Tourism in Pahang Tenggara

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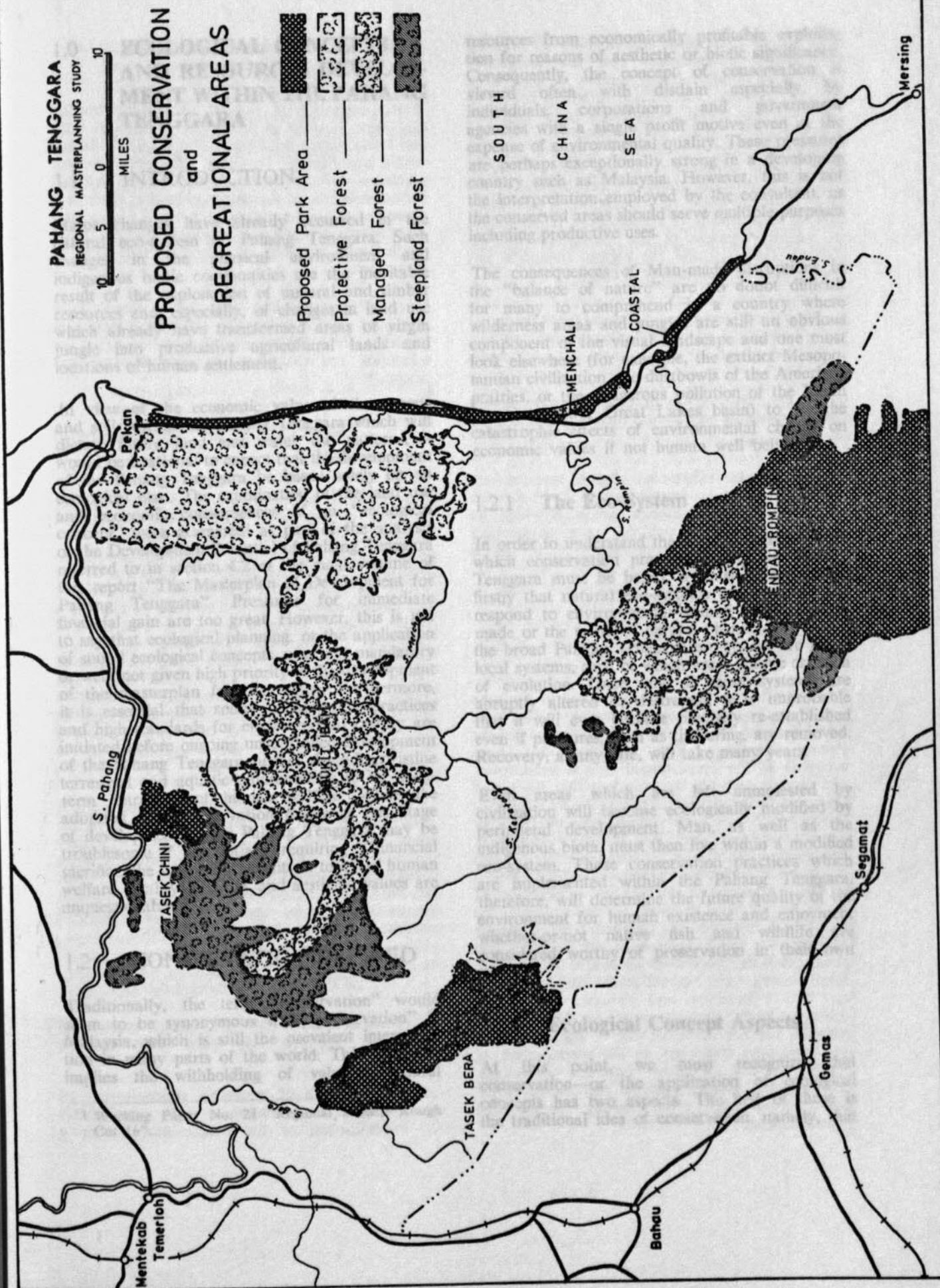
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1.0 ECOLOGICAL CONCEPTS AND RESOURCES DEVELOPMENT WITHIN THE PAHANG TENGGARA

1.1 INTRODUCTION

Major changes have already occurred in the natural eco-system of Pahang Tenggara. Such changes in the physical environment and indigenous biotic communities are the inevitable result of the exploitation of mineral and timber resources and, especially, of changes in land use which already have transformed areas of virgin jungle into productive agricultural lands and locations of human settlement.

In view of the economic value of the forests and soils within the Pahang Tenggara which will dictate future land and water use patterns, it would be irrational to expect that the development of the Pahang Tenggara be based solely on an ecological plan. The examination of the land use and economic consequences of an "ecological concept" were examined¹ as part of the analysis of the Development Potential of Pahang Tenggara referred to in section 4.2 of the main volume of this report "The Masterplan of Development for Pahang Tenggara". Pressures for immediate financial gain are too great. However, this is not to say that ecological planning, or the application of sound ecological concepts, were not mandatory or were not given high priority in the development of the masterplan for the region. Furthermore, it is essential that sound conservation practices and high standards for environmental quality are initiated before ongoing uncontrolled development of the Pahang Tenggara further degrades pristine terrestrial and aquatic environments to the long-term detriment of human welfare. While the adoption of a conservation policy at this stage of development of the Pahang Tenggara may be troublesome if not initially requiring a financial sacrifice, the long term benefits in terms of human welfare, quality of living, and aesthetic values are unquestionable.

1.2 CONSERVATION DEFINED

Traditionally, the term "conservation" would seem to be synonymous with "preservation" in Malaysia, which is still the prevalent interpretation in many parts of the world. This definition implies the withholding of valuable natural

resources from economically profitable exploitation for reasons of aesthetic or biotic significance. Consequently, the concept of conservation is viewed often with disdain especially by individuals, corporations and government agencies with a single profit motive even at the expense of environmental quality. These pressures are perhaps exceptionally strong in a developing country such as Malaysia. However, this is not the interpretation employed by the consultant, as the conserved areas should serve multiple purposes including productive uses.

The consequences of Man-made disruptions in the "balance of nature" are no doubt difficult for many to comprehend in a country where wilderness areas and jungles are still an obvious component of the visual landscape and one must look elsewhere (for example, the extinct Mesopotamian civilization, the dustbowls of the American prairies, or the dangerous pollution of the North American lower Great Lakes basin) to see the catastrophic effects of environmental change on economic values if not human well being.

1.2.1 The Eco-System

In order to understand the ecological concepts on which conservation practices within the Pahang Tenggara must be based, it must be recognized firstly that natural eco-systems are dynamic and respond to environmental stimuli whether man-made or the result of natural phenomena. Within the broad Pahang Tenggara eco-system are many local systems, each of which are a unique creation of evolution. Once any of these systems are abruptly altered or destroyed, it is improbable that it will ever become precisely re-established even if pressures, such as timbering, are removed. Recovery, at any rate, will take many years.

Even areas which are left unmolested by civilization will become ecologically modified by peripheral development. Man, as well as the indigenous biota, must then live within a modified eco-system. Those conservation practices which are implemented within the Pahang Tenggara, therefore, will determine the future quality of the environment for human existence and enjoyment whether-or-not native fish and wildlife are considered worthy of preservation in their own right.

1.2.2 Ecological Concept Aspects

At this point, we must recognize that conservation—or the application of ecological concepts has two aspects. The first of these is the traditional idea of conservation, namely, that

¹ Working Paper No. 21 "Regional Model—Rough Cut 1b".

Man has an irrevocable responsibility to pressure the natural environment and the indigenous plants and animals living therein as part of a national heritage. The second aspect is rooted in the growing world recognition—and resulting concern—that Man may ultimately be the permanent loser if ecological concepts are not given greater attention in the way that we develop and use our natural resources, and dispose of the many waste products of civilization. A consideration of both aspects of conservation is imperative in the development of the masterplan for the Pahang Tenggara and the region, therefore, has been evaluated ecologically in terms of:

- (a) the conservation of natural phenomena of primarily scientific, cultural, and aesthetic value, and
- (b) the conservation of environmental quality consistent with future human welfare.

Neither of these aspects are distinct and, in fact, are intricately inter-related within a framework now popularly called *human ecology* in which the interaction of Man and the physical-chemical environment are recognized as vital to public health and social welfare.

1.2.3 Wise use of Resources

The definition that "*Conservation means the wise use of natural and human resources*" has been adopted in the conservation plan proposed for the Pahang Tenggara. This definition has been accepted in the development of the masterplan, and thus it presents the mandate that *integrated resources development* is essential. No longer is it acceptable that each resource person (whether agriculturist, production forester, biologist, economist, industrialist, hydrologist, or other) can promote optimum exploitation of his interest to the exclusion of all others irrespective of resulting ecological damage. As an example, the future of wildlife management in Malaysia depends on an amalgamation of forestry and game personnel objectives to evolve a policy of forest management relative particularly to wildlife and Forest Reserves, and National Parks. This concept, while perhaps new to Malaysia, is essential for the optimum use of forest, wildlife and landscape resources, in the management of which *forestry, wildlife, fisheries, hydrology, environmental quality, national parks, and recreation should be given strong professional representation.*

1.2.4 Preservation of Natural Phenomena

The *conservation of natural phenomena* implies that there is merit in preserving indigenous flora and fauna, jungle wilderness, and scenic landscape within the Pahang Tenggara. The proposals for Nature and Forest Reserves and a new National Park are based on the assumption that there is a place for the preservation of natural phenomena in Malaysia as a *living national heritage* to be studied and enjoyed by future generations of Malaysians.

Each of the Reserves and the National Park proposed in this Report (see Part IV) are expected, in addition being of National value for education and recreation, to draw international attention.

1.2.5 Conservation of Environmental Quality

The *conservation of environmental quality* should, in view of the many serious world pollution problems, require no formal justification. The need to take strong action to minimize despoilation of the living environment by human activities within the Pahang Tenggara would seem obvious; but environmental control is unlikely to become a reality without stringent regulatory controls and persistent enforcement supported by severe penalties to those who would defile the rights of others to live in an impotent, safe, and aesthetically-pleasing environment. However, a public conscience (or public defamation) may be an adequate justification for industry and resource developers to assume their responsibilities in environmental control.

While it is inevitable that most of the natural ecological systems will change with development and, indeed, there is no valid reason why they should not, neither is there any reason why those remaining components of the environment which are not directly utilized should be debased to such an extent as to be obnoxious to the aesthetic standards of people living in the region.

1.3 CONSERVATION CONTROLS

In practical terms, within the regional masterplan particular attention has been paid to the following:

- (a) Avoidance of excessive concentration of human population, and particularly industries, to the extent that within a

limited locality there is insufficient capacity for all waste material to be dissipated efficiently. In other words, there should be sufficient space for discharge of atmosphere pollutants, and adequate measure taken to treat solid and liquid wastes potentially entering natural watercourses.

(b) Security of water supplies—provision to ensure that adequate water resources within a given region are maintained through management of the catchment and protection from physical and chemical pollution.

(c) Adequate measure for river bank protection to minimize erosion and silting with subsequent adverse results on settlements, agricultural land and fisheries resources.

(d) Maintenance of the rivers in a relatively clean state to permit their potential development for recreational use including sport fishing, swimming, boating or other forms of outdoor recreation. For instance, the calm estuaries reaches of the larger rivers could probably be developed for yatching and other water sports if they are kept clean and aesthetically pleasant.

(e) Effective measures to avoid indiscriminate dumping of refuse with untoward aesthetic if not public health dangers.

The above are but a few of the general ecological objectives worth achieving. Adequate foresight and planning is necessary to attain these and, in practice, legislation with supporting enforcement agencies will be the most effective tool.

1.3.1 Conservation Controls for Pahang Tenggara

The conservation proposal for the Pahang Tenggara develops an ecological concept unique for Malaysia. This concept entails the integration of nature reserves and a new national park within managed forest reserves. Further, it stresses optimum multi-purpose use of all reserves for optimum educational, recreational, and economic benefit. The organizational implications of this are expanded subsequently in section 5.5.

1.3.2 Nature Reserves

The sizes of the proposed Nature Reserves and the National Park are kept to a minimum in this plan which preserves from exploitation only those areas believed essential to meet the objectives proposed. It is anticipated that environmental manipulation will be a technique employed in all Reserves either to improve the quality of fish and wildlife habitat, or to increase the educational and recreational potentials. The selective, or even clear-cutting, of timber and other flora, and the reforestation or cultivation of land are likely wildlife management techniques. The commercial harvest of timber, however, would be at the discretion and rigidly controlled by a professional biologist within the proposed Nature Preserves and National Park. The ecological concept requires the buffering of the reserves and park from civilization by forests under perpetual management. The presence of peripheral jungle roads will provide access to wilderness areas which complements the policy of *optimum public use* of the reserves and park consistent with the preservation of special floral and faunal features.

Also, within the ecological concept is the recognition that isolated areas of jungle will remain within agricultural areas. These areas can be managed for the production of birds and small animals. The concept recognizes that the control of nuisance animals may become necessary interfaces between jungle and civilization but such control should not endanger the persistence of native fauna with the sanctuaries provided by the conservation areas and forest reserves.

1.4 RECYCLING OF NUTRIENT WASTES

One final aspect of the ecological concept which should be noted is the need to develop systems which utilize (or recycle) nutrient wastes. In view of the relative low fertility of soil within the Pahang Tenggara, enrichment with treated organic wastes (e.g. melorganite) will serve the dual purposes of waste disposal and increased soil fertility for cash crops. In this way, the costs of adequate sewage and waste water treatment can be recovered, in part at least, by their use within the agricultural economy.

2.0 PRESENT AND FUTURE STATUS OF WILDLIFE CONSERVATION WITHIN THE PAHANG TENGGARA REGION

2.1 PRESENT STATUS OF WILDLIFE

Land use and forestry practices within the Pahang Tenggara have modified already the jungle ecology although actual development of the region for human settlement is still in its infancy.

2.1.1 The Effect of Settlement

Settlement of the coastal region has more-or-less destroyed the beach forest of the east coast and coupled with the coastal highway, has undoubtedly modified the indigenous fauna although many indigenous species still persist in the area. The gradual settlement, and accompanying peasant farming, along the major rivers has altered the peripheral vegetation of the Pahang River and the lower reaches of the major river systems of the east coast causing changes in natural wildlife habitat. Indigenous wildlife have to accommodate themselves to the changing environment and in the interface between jungle and settlement, the control of some species of wildlife has become necessary for the preservation of property and even human life.

2.1.2 The Effect of Lumbering Operations

Timbering operations have made substantial inroads into jungle with totally unexploited forest only in the highlands of the northeast, the plateau region of the Lesong Reserve to the south, and the extensive swamp forest of the eastern region between the Pahang and Merchong Rivers. In addition to causing significant changes in the ecology of the jungle through the harvesting of timber, accessory factors including the construction of roads, the location of mining camps, the local exploitation of game by workers, and noise pollution, have altered the distribution, if not the abundance, of indigenous wildlife. Particularly affected are animals of the forest canopy, and especially these large animals (seladang, elephant, and rhinoceros) which demand space and solitude as part of their habitat requirements.

2.1.3 Survival of Indigenous Animals

Actual numbers of the more spectacular large mammals (or in truth, any species of wildlife) are unknown in the Pahang Tenggara. Standing populations of rhinoceros are estimated at as low as two or three individuals restricted to the south east area. Seladang are believed to be confined to the area around, and to the south of Tasek Bera where two known herds may total about 40 animals. Elephants are not uncommon sightings within the Pahang Tenggara region, especially in the Tasek Bera area and the south west highland and coastal area. No doubt the elephant is still widely distributed and its presence may become better known as land settlement impinges on its range. A unique faunal feature of the east coast swamp forest is the bearded pig which migrates annually through the Pahang Tenggara, ranging from within Johor State to as far north as the Pahang River.

The survival of most species of indigenous animals would not seem to be threatened at the present time and, in fact, many species of birds and mammals may be expected to thrive on the fringes of settlement and agricultural development. Animal control may be expected to become a consequence of land settlement within the Pahang Tenggara.

2.1.4 The Effect of Mining

Surface mining for iron, although as yet limited essentially to areas near and to the south of Tasek Chini, the Rompin Mine, and headwaters of the Endau and Pontian Rivers in the southeast, have left scars on the landscape wherever they occur and typically lead to excessive turbidity and siltation of local river systems. Undoubtedly, noise pollution is also a factor acting to disturb the more sensitive and larger animals.

2.1.5 The Effect of Agriculture

Major agricultural encroachment on jungle forest to the west of Tasek Bera and in the central south area is undoubtedly driving many species of boreal fauna and large mammals inland to the sanctuary of swamp forest and primitive highlands which, fortunately, still exist within the Pahang Tenggara and some of which must be preserved if the unique wildlife species of Malaysia are to be saved from extinction. Conversely, however, many species of wildlife, such as jungle fowls and wild pigs, may be expected to prosper and, along with domesticated animals, will surely attract carnivorous jungle

animals like the tiger to the clearings and plantation, especially if the natural habitat of these predators are reduced or eliminated. Similarly, herbivores and omnivores, like the elephant, rodent, porcupine, and Rusa deer, may be expected to emerge from the jungle to feed on agricultural crops in nuisance proportions, especially if their natural ecology becomes unduly modified.

2.1.6 Survival Summary

In summary, an abundance of wildlife representing most species of the southeastern Malay Peninsula's culture is expected to thrive within the Pahang Tenggara. Large mammals have been the most seriously affected with the rhinoceros, seladang, and perhaps the elephant approaching the status of threatened animals. The natural distribution of wildlife of the forest canopy have undoubtedly been altered but no current threat to their survival is evident. Most species of jungle animals (amphibians, reptiles, birds, and mammals) seem capable of adapting to a modified forest habitat, while some species thrive on the fringes of agricultural settlement.

2.2 FUTURE STATUS OF WILDLIFE

Areas of special ecological significance must be preserved from development if native flora and fauna are to be considered a part of the national

heritage of Malaysia. These Reserves are described elsewhere under the subjects of Parks and of Forestry and, regardless of primary purpose, will serve as sanctuaries for indigenous wildlife.

Although the designation of permanent Nature Reserves to serve as sanctuaries (or gene pools) for indigenous wildlife is essential, this is only one component of the proposed wildlife management plan for the Pahang Tenggara. In recognition of the desirability to exploit high quality timber and use prime agricultural land for that purpose, the boundaries of the proposed Nature and Forest Reserves and National Park have been kept to the minimum. The location of these Reserves is based on the understanding that their locations will be contiguous with Forest Reserves (i.e., managed forest units) which, although selectively harvested for timber, will provide large ranges of perpetual jungle capable of supporting significant wildlife populations. Further, it is anticipated that pockets of unproductive soil capable of sustaining many kinds of birds and animals, will continue to exist in the primitive state within or adjacent to lands under intensive cultivation. The network of forest roads in non-Nature Reserve areas will be an asset in making the jungle forests and their wildlife resources more available for public use.

3.0 PRESENT AND FUTURE STATUS OF FISHERIES RESOURCES OF PAHANG TENGGERA REGION

3.1 MARINE FISHERIES

3.1.1 Commercial Fishing Landed Catches

The waters of the South China Sea provide the east coast of the Malay Peninsula with abundant fisheries resources supported by a variety of species.

An analysis of the reported landed commercial catch for Pahang State in 1969 identified 40 species of marketable fish, two crustaceans, and one mollusc (Table 3.1a). Total weight was 140,757 piculs (8,378 tons) of which some 20 percent were Clupeiformes (herring-like fishes) and 66 percent Perciformes (higher spiny-rayed fishes). Because of the continuing use generally

of traditional fishing gear (with some innovations especially trawls), the available east coast fishery is believed to be greatly underexploited although the extent of the resource remains unknown. Present harvests by fishermen of Pahang State made up approximately 6 percent of the total marine catch for West Malaysia in 1969.

3.1.2 Fishing Villages

Commercial fishing along the east coast of Pahang Tenggara is restricted to limited activity at the six villages of Tanjong Batu, Nenasi, Merchong, Kuala Rompin, Kuala Pontian, and Endau. Of the annual catch at these villages of 23,906 piculs in 1969, some 60 percent of the harvest (by weight) was landed at Kuala Rompin. Maximum harvests occurred during the autumn months. Principle fish species now harvested from Pahang Tenggara coastal villages are the Tamban (sardine), Kembong (mackerel), Tongkol (tunny), of variety of Baja, and the Udang (prawn). Most, if not all of the species, harvested by Pahang State fishermen to the north and other species are no doubt available to Pahang Tenggara fishermen should they be equipped with the necessary gear and technology.

**Table 3.1a—Commercial Harvests of Marine Fish, Crustaceans, and Molluscs from
Pahang State, 1969**

Common Name	Piculs	Common Name	Piculs
Selar Kuning (scad)	.. 35,084	Bawal (pomfret)	.. 168
Bilis (anchovy)	.. 12,048	Belanak (mullet)	.. 175
Tamban (sardine)	.. 8,564	Chermin (trevally)	.. 156
Kembong (mackerel)	.. 7,522	Talang (queenfish)	.. 119
Tenggiri (Spanish mackerel)	.. 7,233	Kurau (threadfin)	.. 103
Duri (Catfish)	.. 6,509	Gerut (grunter)	.. 96
Pari (skates and rays)	.. 5,629	Aruam Tasek (Kingfish)	.. 78
Selayang (scad)	.. 5,026	Puput (Shad)	.. 31
Kerisi (bream)	.. 4,202	Jenehak (snapper)	.. 26
Kekek (pony fishes)	.. 3,428	Kebasi (gizzarshad)	.. 19
Gelama (jew fishes)	.. 2,268	Malong (eel)	.. 12
Selar Caranx (scad)	.. 1,824	Timah (ribbon fish)	.. 9
Parang (wolf herring)	.. 1,809	Lidah/Sebelah (Sole)	.. 6
Yu (Sharks)	.. 1,699	Gerong gerong (trevally)	.. 3
Aya/Tongkol (bonito)	.. 1,517	Delah (sea bream)	.. 2
Chencharu (trevally)	.. 878	Buat Baja	.. 17,261
Merah (red snappers)	.. 874	Ikan Champor (mixed fish)	.. 7,538
Dembudok (horse mackerel)	.. 459		
Kerapu (groupers)	.. 401	Udang (crustacean)	.. 4,199
Kachi (sweetlip)	.. 374	Ketam (crustacean)	.. 134
Daun (batfish)	.. 315	Sotong (mollusc)	.. 2,048
Dinkis (rabbitfish)	.. 287		
Alu (barracuda)	.. 235		
Biji Nangka (red mullet)	.. 190		
Remong (snapper)	.. 189		

Total Processed	.. 18,401
Fresh Consumption	.. 122,356

140,757 (8,378 tons)

3.1.3 Anticipated Increased Catches

Greatly increased exploitation of the pelagic and demersal marine fisheries of the South China Sea is anticipated in the near future. It is questionable if present fishermen in local villages along the Pahang Tenggara coast will share in this economic growth unless increased efforts are made to modernize local fishing vessels and gear, to adopt more fully modern technology of fish storage and transportation, and to make available more suitable docking and harbour facilities for local and transient fishing vessels.

Table 3.1b—Commercial harvests of marine fish from fishing villages on Pahang Tenggara Coast reported for 1970

Fishing Villages				Piculs
Tanjong Batu	...	...	...	160
Nenasi	...	...	...	4,019
Merchong	...	...	...	184
Kuala Rompin	...	...	...	14,302
Kuala Pontian	...	...	...	37
Endau	...	...	...	5,204
Total				23,906

Table 3.1c—Monthly Catches of Marine Fishes and Invertebrates from K. Nenasi and K. Rompin reported for 1969 and 1970

Month	Tamban (sardine)		Kembong (mackerel)		Udang (prawn)		Tongkol (tunny)		Baja	Total	
	1969	1970	1969	1970	1969	1970	1969	1970	1970	1969	1970
CATCH IN PICULS											
January	..	8	—	—	269	701	3	—	122	272	831
February	..	15	—	—	300	541	—	2	77	300	635
March	..	15	132	—	124	310	2	—	73	141	515
April	..	100	348	90	30	111	395	—	—	303	1,076
May	..	40	576	250	120	45	113	2	4	751	337
June	..	73	321	408	800	1	3	5	17	567	487
July	..	102	290	95	517	1	1	75	114	561	273
August	..	107	314	150	685	6	1	—	102	772	263
September	..	180	132	260	1,232	1	9	—	48	587	441
October	..	132	237	800	2,120	9	3	2	6	1,039	943
November	..	108	180	340	393	20	156	1	26	456	469
December	..	36	60	—	—	130	192	—	—	185	166
TOTAL	..	893	2,613	2,393	5,897	1,017	2,425	90	319	5,493	4,393
											16,747

3.1.4 Recommendations for Marine Fishing

The following *recommendations* are made relative to commercial marine fisheries of the Pahang Tenggara coast:

- (1) that a feasibility study be undertaken to determine the extent to which Pahang Tenggara fishermen should be encouraged to participate in the future exploration of the South China Sea fisheries resources and potential benefits to local economy.

Alternatives for study:

- (a) Exploitation of the valuable local South China Sea fishery by non-resident fishing vessels based at other ports (resulting in no economic benefit to Pahang Tenggara

Region and likely in a diminution of local catch).

- (b) Creation of a modern fishing port on Pahang Tenggara coast to accommodate and service newest onshore and offshore fishing vessels to be equipped for fish storage, processing, and distribution. (Such a port to be integrated into the economic development of a viable coastal community).
- (2) that exploration be undertaken to enumerate the speciation, ecology, and relative abundance of udang (prawns) presently or currently available for exploitation along the Pahang Tenggara coast, and that local fishermen be encouraged to utilize available prawn production in view of the economic potentials

Table 31b—Commercial catches of marine fish from fishing villages on P. Yangtze Coast, 1950-1959

Fishing Village	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Taipei Bay	160	...	...	...	...	...	...	...	...	...
Nanshan	4,019	...	...	...	...	...	...	...	...	...
Meishan	181	...	...	...	...	...	...	...	...	...
Kaohsiung	14,302	...	...	...	...	...	...	...	...	...
Kaohsiung	37	...	...	...	...	...	...	...	...	...
Kaohsiung	2,304	...	...	...	...	...	...	...	...	...
Total	27,000	...	...	...	...	...	...	...	...	...

Table 31c—Monthly catches of marine fish and invertebrates from P. Yangtze Coast, 1950-1959

Month	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
January	100	100	100	100	100	100	100	100	100	100
February	100	100	100	100	100	100	100	100	100	100
March	100	100	100	100	100	100	100	100	100	100
April	100	100	100	100	100	100	100	100	100	100
May	100	100	100	100	100	100	100	100	100	100
June	100	100	100	100	100	100	100	100	100	100
July	100	100	100	100	100	100	100	100	100	100
August	100	100	100	100	100	100	100	100	100	100
September	100	100	100	100	100	100	100	100	100	100
October	100	100	100	100	100	100	100	100	100	100
November	100	100	100	100	100	100	100	100	100	100
December	100	100	100	100	100	100	100	100	100	100
Total	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000

Recommendations for Marine Fishing

The following recommendations are made relative to commercial marine fisheries of the Yangtze coast:

- (1) That a feasibility study be undertaken to determine the extent to which P. Yangtze fishermen should be encouraged to participate in the future expansion of the South China Sea fisheries resources and potential benefits to local economy.

Alternatives for study:

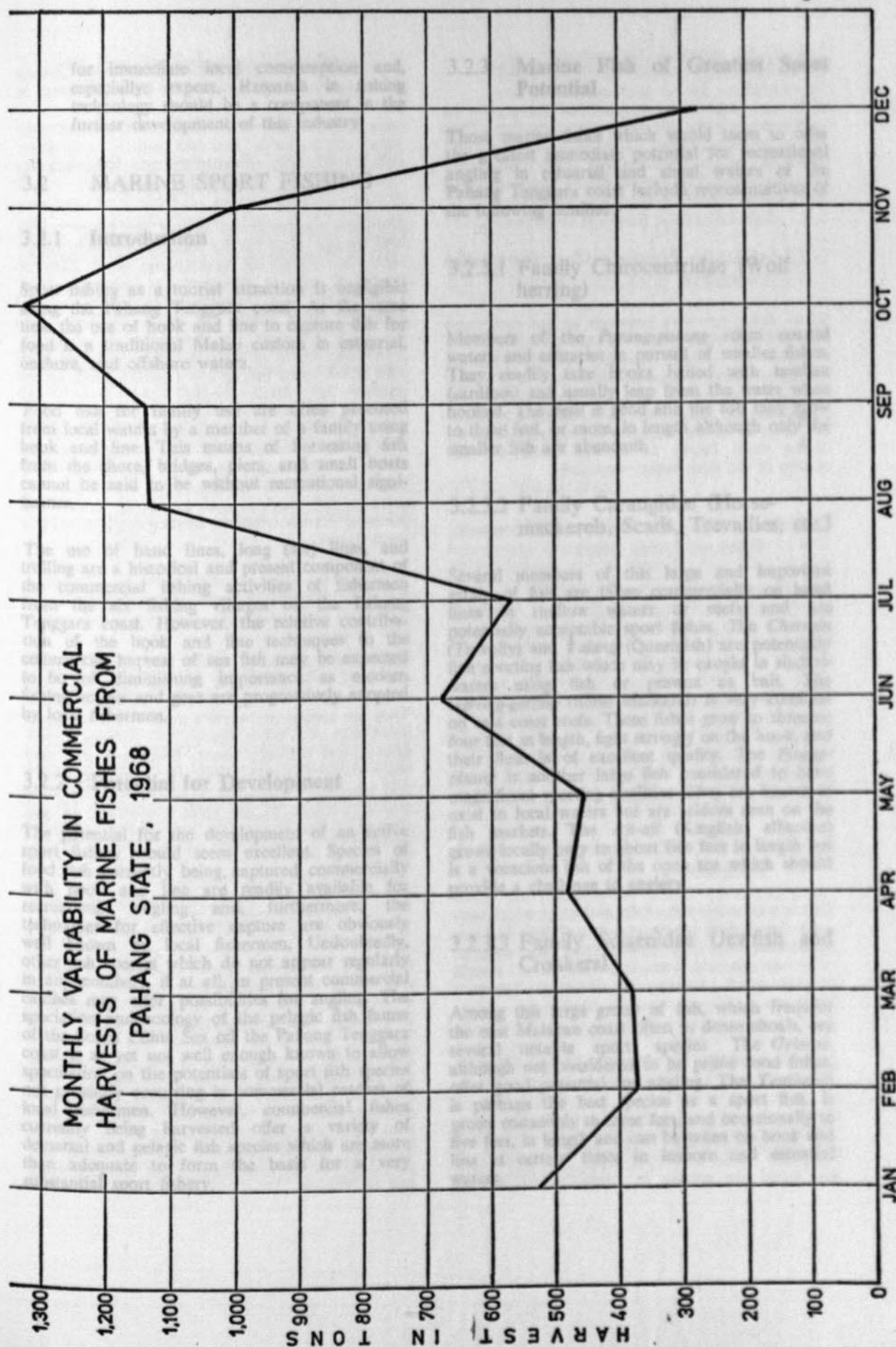
- (a) Exploration of the valuable fishery resources of the Yangtze coast based at existing fishing vessels based at existing ports (resulting in no economic benefits to P. Yangtze).

- (b) Exploration of the valuable fishery resources of the Yangtze coast based at existing fishing vessels based at existing ports (resulting in no economic benefits to P. Yangtze).
- (c) That exploration be undertaken to encourage the expansion of existing relative abundance of existing resources presently or currently available for exploitation along the P. Yangtze coast, and that local fishermen be encouraged to utilize available human potential in view of the economic potential.

(d) Creation of a modern fishing port on P. Yangtze coast to provide accommodation and services for offshore and offshore fishing vessels to be developed for the storage, processing, and distribution of fish products.

Region and fish in a dimension of local catch.

Fig. 3.1



for immediate local consumption and, especially, export. Research in fishing technology should be a component in the further development of this industry.

3.2 MARINE SPORT FISHING

3.2.1 Introduction

Sport fishing as a tourist attraction is negligible along the Pahang Tenggara coast. At the same time the use of hook and line to capture fish for food is a traditional Malay custom in estuarial, onshore, and offshore waters.

Food fish for family use are often procured from local waters by a member of a family using hook and line. This means of harvesting fish from the shore, bridges, piers, and small boats cannot be said to be without recreational significance.

The use of hand lines, long (set) lines, and trolling are a historical and present component of the commercial fishing activities of fishermen from the six fishing villages on the Pahang Tenggara coast. However, the relative contribution of the hook and line techniques to the commercial harvest of sea fish may be expected to be of diminishing importance as modern fishing vessels and gear are progressively adopted by local fishermen.

3.2.2 Potential for Development

The potential for the development of an active sport fishery would seem excellent. Species of food fish currently being captured commercially with hook and line are readily available for recreational angling and, furthermore, the techniques for effective capture are obviously well known by local fishermen. Undoubtedly, other fish species which do not appear regularly in any numbers, if at all, in present commercial catches may offer possibilities for angling. The speciation and ecology of the pelagic fish fauna of the South China Sea off the Pahang Tenggara coast is as yet not well enough known to allow speculation on the potentials of sport fish species not presently occurring in commercial catches of local fishermen. However, commercial fishes currently being harvested offer a variety of demersal and pelagic fish species which are more than adequate to form the basis for a very substantial sport fishery.

3.2.3 Marine Fish of Greatest Sport Potential

Those marine fishes which would seem to offer the greatest immediate potential for recreational angling in estuarial and shoal waters of the Pahang Tenggara coast include representatives of the following families:

3.2.3.1 Family Chirocentridae (Wolf herring)

Members of the *Parang-parang* roam coastal waters and estuaries in pursuit of smaller fishes. They readily take hooks baited with tamban (sardines) and usually leap from the water when hooked. The flesh is good and the fish may grow to three feet, or more, in length although only the smaller fish are abundant.

3.2.3.2 Family Carangidae (Horse-mackerels, Scads, Trevallies, etc.)

Several members of this large and important group of fish are taken commercially on hand lines in shallow waters or reefs and are potentially acceptable sport fishes. The *Chermin* (Trevally) and *Talang* (Queenfish) are potentially fine sporting fish which may be caught in shallow waters using fish or prawns as bait. The *Gerong-gerong* (horse mackerel) is very common on east coast reefs. These fishes grow to three or four feet in length, fight strongly on the hook, and their flesh is of excellent quality. The *Pisang-pisang* is another large fish considered to have magnificent sporting qualities. They are known to exist in local waters but are seldom seen on the fish markets. The *Aji-aji* (Kingfish, albacore) grows locally only to about two feet in length but is a voracious fish of the open sea which should provide a challenge to anglers.

3.2.3.3 Family Sciaenidae (Jewfish and Croakers)

Among this large group of fish, which frequent the east Malayan coast often in dense shoals, are several notable sport species. The *Gelama*, although not considered to be prime food fishes, offer good potential for angling. The *Temberah* is perhaps the best species as a sport fish. It grows commonly to three feet, and occasionally to five feet, in length and can be taken on hook and line at certain times in inshore and estuarial waters.

3.2.3.4 Family Lutianidae (Snappers)

This very important group of food fishes offer an excellent potential for recreational angling. They are taken readily on hand lines in deep-water and holes and shallower shoal areas. The *Merah* grow to about four feet in length but even small fish provide excellent sport was captured.

3.2.3.5 Family Nemipteridae (Threadfin breams)

These fishes are very common on the east coast but not the west coast of Malaysia and are, therefore, a unique member of the Pahang Tenggara marine fauna. They are small but beautiful fish which can be easily caught in abundance on hook and line. Fishing for *Kerisi* is said to have been a favourite sport of the ladies of the royal family of Pahang. However, the quality of the flesh varies seasonally.

3.2.3.6 Family Serranidae (Groupers, Rock cod, Sea bass)

The potential for recreational angling by members of this group of high quality food fishes is excellent. The *Kerapu* range from estuaries to deep waters but are usually found in the vicinity of rock or coral reefs. Their brilliant colouration when alive should be particularly attractive to anglers in addition to their vulnerability to hook and line especially when they congregate at breeding time. While most of the *Kerapu* captured commercially are comparatively small, several species grow to 500-1,000 pounds and are known locally as *Pertang*.

3.2.3.7 Family Rachycentridae (Black Kingfish)

This is a common fish of the east coast which may reach five feet in length and fish of four feet are not uncommon. The *Aruan tasek* has a reputation as an excellent sport fish and should provide good angling for Pahang Tenggara fishermen.

3.2.3.8 Family Plectorhynchidae (Sweetlips)

Members of this group of moderate sized fishes are widely distributed from shallow waters to reefs and banks in deeper water. Probably only the *Kachi* are present in adequate numbers to

provide a major sport fishery although *Kakap batu* may possibly be of sport fishing interest in estuarial waters.

3.2.3.9 Family Scombridae (Mackerels, Tunas, Albacores, Bonitos)

Although comparatively few of the many Scombrid species occur on the Pahang Tenggara coast, both the *Kembong* (mackerels) and *Tongkol* (mackerel tuna or albacore) are important food fishes with real potential for sport fishing. Although these fishes are small, reaching only 15 inches in length, the *Kembong* are abundant seasonally, move in large schools, and can provide active sport fishing for a prized food. Large numbers of small *tongkol* or "tunas" are available seasonally and may be caught in quantity by trolling from a small boat. They fight hard until boated. Because of the numbers of fish which can be caught in rapid succession, their fighting and food quality, and the chance of catching fish to four feet in length, makes the potential for an excellent development of such a sport fishery.

3.2.3.10 Family Scomberomoridae (Spanish Mackerels)

Similar in appearance to the tunas, the *Tenggiri* are large swift predators of the open seas and coastal waters of the Pahang Tenggara coast. They are among the world's most renowned game fishes and are taken readily by trolling appropriate lures behind a boat. Individual fish may reach six feet in length and 100 pounds in weight and represent a challenge to the most experienced angler. Because of the local availability of this species, it has exceptional potential in the development of a recreational fishery.

3.2.3.11 Family Histiophoridae (Sailfish, Marlin, Spearfishes)

Although uncommon in the east coast commercial fishery and although they represent a group of fish about which little is known locally, there is evidence that several species of *Layaran* (at least two sailfish, one spearfish, and one marlin) may not be as uncommon in the Malaysia area of the South China Sea as once thought. This group of fish offers prime angling on a world standard and would be expected to attract fishermen from all parts of the world to the Pahang Tenggara Region. However, the speciation and abundance of *Layaran* locally still requires study and verification.

3.2.3.12 Family Sphyraenidae (Barra-cudas and Sea Pike)

The *Kachang-kachang* are among the most savage inhabitants of the sea and, consequently, offer excellent potential as a sport fish. The Malay names the fish according to size: *Kachang-kachang*—to 2 feet in length; *Tenak*—medium size; and *Tenok*—largest size to 12 feet in length. These fish travel in schools and provide continuous angling once the formation is located.

3.2.3.13 Family Mugilidae (Grey Mullet)

This is a common fish of the Pahang Tenggara coast occurring in shallow coastal waters and estuaries. Although not easily taken by angling, they give excellent sport when hooked on light tackle. Although only 12 to 15 inches in length, the *Belanak* are a potentially useful sport fish for onshore anglers.

3.2.4 Summary of Major Potential Sport Fishes

A variety and abundance of fishes are available for sport fishing along the South China Sea coast of the Pahang Tenggara Region. The methodology for capturing most species is already well established because of the traditional use of hook and line by Malays in harvesting food fishes for personal and commercial use.

Those species offering the greatest immediate potential for seasonal or continuous *estuarial and onshore* sport fishing include the Chermin (*trevalies*), Gelama and Temberah (croakers), and Talang (Queenfish), and Belanak (grey mullets). Prime fishes of *reefs* include Merah (snappers) and Gerong-gerong (horse mackerels). Major choice fishes of *open waters* include the Kembong (mackerels), Tongkol (mackerel tunas), Kachang-kachang (barracudas), and Tenggiri (Spanish mackerels). Although representatives of world-renowned sport fishes are known to occur in Malaysian waters, the potential of their value as a sport fish is not yet determined.

3.2.5 Recommendations

- (1) That publicity be given to the availability of excellent sport fishing along the Pahang Tenggara coast.
- (2) In order that sport fishing should become a component of local tourism, local fishermen should be encouraged to consider the

sport fisherman as a source of income. Development of a sport fishing industry would be dependant on the availability of modern boats equipped with the amenities expected by tourists. In other parts of the world, commercial fishermen have been subsidized in the construction of *dual purpose* boats which serve primarily for commercial fishing but are appropriate for catering to the sport fishing fraternity.

3.3 FRESHWATER FISHERIES

3.3.1 Indigenous Freshwater Fishes

The natural inland waters of the Pahang Tenggara support a fish fauna of no less than 150 species, exclusive of those marine species which move into estuarial and tidal waters.

3.3.2 Food Fish

The true freshwater fish fauna can be divided into four general categories. There are a variety of over 30 *food fishes* which range in size from a few inches to three or four feet in length (Table 7.2, Appendix B of this Report). These species are a major source of protein for the Aborigines and other people living inland and the exploitation may be expected to increase as human settlement of the inland Pahang Tenggara becomes a reality and creates an increased local market for fresh fish. Neither the extent of the freshwater food fish resource nor present harvest levels are known. Future development of this resource, therefore, will require biological investigation and management both of which are required to ensure optimum yields and perpetuation of the fishery.

3.3.3 Sports Fish

There are presently at least 15 potential freshwater sport fish included among the larger food fishes which can be taken by hook and line. Among these, the Sebarau (*Hampala macrolepida*), the Kelasa (*Scleropages formosus*), the Temoleh (Probar bus), the Belinda (*Notopterus chitala*), the Keli (*Clarius batrachus*), and the Toman (*Channa micropeltes*) are perhaps the most spectacular sport fishes. At present there is negligible biological information pertinent to the management of these species. Two are known to be endangered, but the others would seem to range from common to abundant. Biological study leading to effective management of the major sport fishes is imperative while exploitation is still comparatively low.

3.3.4 Aquarium Fish

A third group of fish are known as the *aquarium fishes*, so called because of their beauty and ability to live under confinement. There are about 50 species of these among the Pahang Tenggara species of which about 12 kinds are of particular importance because of their restricted occurrence and consequent high commercial value. There is a major export business of aquarium fishes, estimated at \$2,000,000 annually. Most of these species are known to originate in Johor and Pahang States, but no information is available on the extent of harvest, although Tasek Bera is known to be one of the major sources of supply. The indiscriminate exploitation of these aquarium fishes, coupled with unfavourable environmental changes resulting from land development, may be expected to deplete, or exterminate, a number of the prime species unless stringent controls are implemented.

3.3.5 Forage Fish

The fourth group of fish include numerous species of *forage fishes*, either small species or the abundant young of larger species. The group are "primary converters" which transform raw nutrients or vegetation into fish flesh which can be eaten by omnivorous and carnivorous food and sport fishes. An abundance of *forage species* are highly essential if the production of most large food fish and nearly all sport fish is to be sustained or increased.

3.4 MANAGEMENT OF NATURAL FRESHWATER FISHING

3.4.1 Inventory Needed

An *inventory of the freshwater fisheries* of the Pahang Tenggara (and the eastern part of the Malay Peninsula) is imperative. The first phase of the study should include an analysis of species distribution and their relative abundance, with special emphasis on the habitat requirements of at least of the principle species. The second phase, based on a knowledge of the ecological requirements of indigenous fishes, will require the *biological management* of the aquatic environment and the species themselves (including possibly fish culture).

3.4.2 Pollution

The lack of application of conservation principles in mining, timbering, and land clearing operations has already greatly altered the aquatic environment to the detriment of indigenous fish species. Primary pollutants are water turbidity and siltation of the micro-habitat of the streams. The reproduction of most fishes is now limited to the clearer waters of streams in undeveloped areas. The reduction of favourable aquatic habitat may be expected to eliminate key freshwater fish from major rivers, and even their headwaters, if present land use practices are not modified to include a greater respect for the aquatic environment. The extent of range limitations on native fishes caused by past and present land use practices is unknown.

3.4.3 Recommendations

Therefore, it is recommended that

- (1) An inventory coupled with biological studies be undertaken immediately on freshwater fishes of the Pahang Tenggara to form the basis for a management plan which will prevent the decline or extinction of valuable food, sport, and aquarium fishes, and to allow for optimum harvest and utilization of such fishes on a sustained yield basis. The application of techniques in habitat maintenance and improvement, as well as the value of fish culture, as tools in maintaining or increasing the harvest of freshwater fishes should be investigated simultaneously.
- (2) An assessment of present land and water use practices within the Pahang Tenggara be undertaken immediately in order
 - (a) to assess the causes, location, and extent of present environmental pollution relative to the future welfare and survival of important fishes, and
 - (b) to establish environmental standards and the necessary regulatory controls over commercial interests profiting from the exploitation of timber and mineral resources and over those undertaking land development.

It is essential that these steps be taken before the aquatic environment and water quality deteriorates to the point of irreversibility not only for fisheries but for all human uses to which fresh water will be required in the future.

3.5 POTENTIAL FOR ARTIFICIAL POND FISHERIES IN PAHANG TENGGARA

3.5.1 Freshwater Pond Potential

The potential for the pond culture of freshwater food fish within the Pahang Tenggara is limited only by the available market. Principal biological problems are the seasonal excess of water during the monsoons and the generally low pH (high acidity) of surface waters throughout much of the region. As both problems can be overcome by proper engineering and pond management, and because techniques for tropical fish culture have become well-established for a number of native and exotic species, decisions on the future of pond fish production become an economic rather than a biological consideration.

A variety of freshwater pond fish are available for pond culture. Some species require more sophisticated management than others although, if fry are obtained for stocking ponds from either private or government hatcheries, the more difficult and sometimes tricky problem of artificial breeding is overcome.

3.5.2 Pond Breeding Stock Available

At present, five Government hatcheries in Malaysia provide fry of some ten species for distribution to fish ponds although major production is currently limited to Lampan Jawa, Lee Koh, and the Tilapia hybrid.

The following species were distributed as fry to ponds in Pahang State in 1969 but very few, if any reached ponds in the Pahang Tenggara:

Table 3.5—Hatchery Fish Distributed in Pahang State in 1969

Common Name	Scientific Name	Fry Distribution	
		Malaysia	Pahang State
Lampan Jawa	<i>Puntius javanicus</i>	2,215,196	81,670
Lee Koh	<i>Cyprinus carpio</i>	543,978	31,304
Tilapia hybrid	<i>T. zillii</i> vs <i>mossambique</i> ...	85,627	26,843
Peen Yee	<i>Hypophthalmichthys</i> spp ...	340	150

Fish pond owners in Malaysia must presently purchase their stocks of "Chinese carps" fry from private commercial fish hatcheries. The principle species reared for the table are the grass carp (Ikan Makan Rumpot, *Ctenopharyngodon idellus*), the silver carp (Ikan Perak, *Hypophthalmichthys molitrix* and the big head carp (Kepala Besar, *Aristichthys nobilis*).

potential danger to pond-reared fish may be added to the list of potential sport fish. Numerous other species of indigenous fishes would seem to lend themselves to production in ponds.

3.5.3 Exotic Breeding Stock Versus Indigenous Varieties

To date, there has been a pronounced reliance on exotic fishes for pond production. Inadequate attention has been given to indigenous Malaysian fishes which would be expected to be particularly well adapted climatically to local situations. Among those potential native species which have been used to a limited extent, or not at all, in fish pond culture are the Mata Merah and Bantak (*Osteochilus melanoplewia* and *vittatus*). Sebarau (*Tor tambroides*), Megalan (*Puntius bulu*), Boeng (*Cyclocheilichthys apogon*), and Ikan Patong (*Pristolepis fasciatus*). Two native predaceous species, the Aruan (*Ophiocephalus straitus*) and climbing perch (*Anabas testudineus*), while a

Species may be reared singly or mixed with other species. While single species production may be desirable to meet a specific market, the production of several species simultaneously may make better use of the pond productivity, especially if plankton, bottom, and surface feeding species are represented. Most species of food fish may be reared in combination with rice padi but special techniques are required. In view of the engineering and biological expertise required for pond construction and management, these details are excluded from this report.

3.5.4 Brackish Water Fish Culture

The east coast of the Pahang Tenggara is favourably suited for brackish water fish culture in coastal swamps and along estuarine areas of the major rivers. Techniques for culturing estuarine fish have been developed successfully elsewhere but not attempted on the east coast of Malaysia.

As the Pahang Tenggara coast has very limited mangrove, ponds must be constructed to draw in brackish or salt water as required. Among local marine fish which would seem to be the most suitable for brackish water pond culture are the grey mullets (Ikan Kemura or Belanak). Other species reared with success elsewhere are the Bulan Bulan (*Megalops cyprinoides*), the Sumpit-Sumpit (*Toxotes jaculator*) and the milkfish (Belanak Sembawa, Chanos-chanos). Experimental work would be required before the production of these species for the market can be recommended for the Pahang Tenggara. Also, there may be other indigenous species equally, or better, suited for pond culture under local conditions if production is warranted by market demand.

3.5.5 Justification for Fish Pond Development in Pahang Tenggara

The pond production of food fish has been considered seriously in the Pahang Tenggara as it offers real potential as a cheap source of local protein and a rewarding commercial operation¹.

The present dependence of the population of the eastern side of the Malay Peninsula on marine, and to a lesser extent, freshwater river fish carries with it an inherent danger of over-exploitation of natural fish stocks which, at this time, may seem to be limitless. However, pressure on the fisheries of the South China Sea may be expected to increase spectacularly within the next few years and there is no guarantee that fisheries harvests beyond the 12 miles limit will reach the Malaysian market. Further extensive "off-shore" fishing may seriously deteriorate "on-shore" fisheries and impose economic hardship on local traditional fisheries as it has in other parts of the world. Freshwater river fishes provide a very limited food resource and the future of present freshwater food fishes is already in jeopardy because of the rapid deterioration of aquatic environment resulting from present policies of resources use and land development.

At present in Pahang State there are 733 inland fish ponds with an area of 588.72 acres. Of these, 19 ponds are in disused mining pools and have an area of 210.93 acres; the remaining 714 ponds thus have an average size of about $\frac{1}{2}$ an acre and this is characteristic of such ponds, the largest of which would not exceed 1 acre. In Pahang, the location of the market and the extent to which marine fish are, or are not, available are crucial to the success of inland fishing operations. In Pahang, inland fishing is thus concentrated in the

north-west part of the State, settlements along the Sungei Pahang use riverine fish, and inland fishing operations in areas closer to the coast are very few, and are concerned with specialty fish for hotels and restaurants.

Consumers' tastes for different types of fish are understood not to be a limiting factor. In general, people from coastal areas are used to, and prefer, marine fish whereas those in inland areas accept either marine or inland fish. Price and availability appear to be at least equally as important as tastes in determining the pattern of consumption by type of fish.

While at the present time, natural marine and freshwater fishes would seem adequate to meet local proteins requirements of urban and rural people, it is unlikely that the situation can continue indefinitely with the projected growth of human population, the deterioration of the aquatic environment through physical and chemical pollution, the disappearance of significant of east coast marine fisheries as noted above.

Viewing the projected picture of protein demand and supply, the potential offered by fish pond production becomes significant and is included in longer term considerations of the Pahang Tenggara. The Orang Asli are especially dependent upon freshwater fish and might well be the first to benefit by the installation of ponds.

3.5.6 Pond Fish Culture Variety of Operations

Pond fish culture can be visualized at three levels of operation: Firstly, as a *peasant farming operation* where one or more small ponds, in conjunction with padi or other small agricultural operation, would provide a continuous sum of protein for a family and perhaps some income from sale on the local market; Secondly, a *communal farming operation* where an area of lowland is devoted to a group of ponds laid out in a pattern to provide an integrated fish farming operation with a central distribution agency. The objective of this scale of fish production would be to meet the needs of local markets by providing a continuous supply of desired species. The extent of export would depend on the production of surplus fish beyond the requirements of local markets; Thirdly, the *large private commercial operation* geared to meet the Malaysian market but with potentials for the export of high quality and attractively packaged products.

¹ Working Paper No. 48 "The Potential for Inland Fishing in Pahang Tenggara".

A prime altitude of fish farming at the peasant or commercial level is the ability to utilize *low-lying waste land* not suitable for agriculture (except padi), settlement, or other purposes. These areas with no serious competitive uses can be *highly productive sources of protein*.

As to yield and incomes, a 1 acre pond could yield 15 piculs per acre per year, but an average of 10 piculs is more likely. Information on market prices indicates that 80c per kati is a typical price for Tilapia, \$1.20 for Lampan Jawa, and \$1.40 for Lee Koh. Taking the average price, conservatively, to be \$1 per kati, the annual gross return from a 1 acre pond would be \$1,000.

Once a pond has been constructed, fertilized, and stocked with fry, the job is one of maintaining it in good condition and of adding fertilizers and grass cuttings for a year or so until the fish are of a size to be caught; such work takes something like 1 hour per day. Catching will normally extend over a 1-2 month period, but the time and duration of catch will be adjusted by the farmer to get the best market conditions, e.g., to avoid a glut of marine fish, to supply fish for a feast day, etc. After the catch, the pond is restocked with fresh fry from the breeding stations.

Further, bunds around fish ponds can be planted with vegetables and fruit trees to provide additional cash crops. The fertility of fish ponds is provided by natural nutrients, animal wastes, and supplemental artificial fertilizers. Much of these nutrients can be subsequently reclaimed from the pond muds and used for fertilizing garden soils. Further, the aquatic vegetation of the ponds can be fed to domestic animals. Because of the general availability of water and the presence of numerous suitable sites, pond fish production can be integrated profitably into the land development of the Pahang Tenggara.

The large scale private commercial fish farm operation requires a higher degree of sophistication to become a sound financial venture.

3.5.7 Conclusions

3.5.7.1

The main population centres in Pahang Tenggara, as now envisaged, will be close to the Kuala Rompin-Bukit Ibam road. With the expanded marine fishing activity from Kuala Rompin, it appears probable that the fish requirements of the people in those centres will, on the whole, be satisfied by marine fish sold in organized town markets.

However, the seasonal interruption to marine fishing during the north-east monsoon suggests the possibility of inland fishing operations adjacent to these population centres and arranged so that their fish are maturing at the required time. (Up to now the seasonal interruption to east coast fishing from Kuantan, for instance, has resulted in the hauling of fish from the west coast and in higher prices and lowered consumption). Taking per capita consumption at 55 katis per year, assuming a 50% penetration by freshwater fish for 2 months in the year, and allowing a yield of 10 piculs per acre pond, some 4½ acres would be required to supply 1,000 people in these towns with fish during the monsoon. Were the population of these major towns to grow eventually to 100,000 people, say, the acreage requirement would be 450 acres.

In addition, as the main Pahang Tenggara population centres increase in size and numbers, there is likely to develop commercial freshwater fishing to supply better quality fish fresh to restaurants and hotels in these centres, along lines already evident near the major towns in the west coast states. This is another reason why freshwater fishing is likely to develop near to population centres.

3.5.7.2

In areas of Pahang Tenggara that are further west or more rural, and in which sale of iced marine fish is impracticable or expensive, there will be the opportunity for inland fishing to be established on a profitable basis to meet local requirements for fish. Five 1 acre ponds, fished in rotation, would supply the fish requirements of about 100 people per year if their consumption was entirely of freshwater fish.

As the region develops, its road network is expanded, and its population increases in density, marine fish will be able to penetrate into market areas it could not reach before, and some inland fishing operations will be displaced. However, this will not occur for some time and there appears to be adequate justification for starting inland fish operations as the region is settled.

3.5.7.3

The programmes of the Fisheries Division for encouraging inland fishing should be made fully available in Pahang Tenggara. Selected settlers could receive training at Bukit Tinggi. Increased numbers of fisheries assistants should be trained and posted to the region to aid in setting up fish ponds as the area is settled and developed.

3.5.7.4

Inland fishing in rural areas or adjacent to urban areas is more likely to take place in smaller ponds, scattered in suitable locations, than in large ponds in any one area. Hence, it is not necessary to reserve large blocks of land for fishing purposes.

At the same time, care should be taken to identify suitable pieces of land and to bring in at an early date the Fisheries Division and perhaps D.I.D. for advice and assistance. It is considered that this can best be done through awareness in all settlement schemes of the important role for inland fishing, and this requires a promotion programme for inland fishing among individuals and organizations coming into the region. In addition, these agencies should be asked to explore at an early date the potential for inland fishing of the mining pools near Bukit Ibam.

3.5.7.5

In view of the scattered location of fish ponds, their small size, and the importance of individual effort to a successful operation, it is considered that the role of government should be in an advisory and assistance capacity, rather than in direct operation of fish ponds. The existing assistance measures appear adequate so long as their provision in Pahang Tenggara is planned in advance and they are thoroughly implemented. Additionally, special efforts might be made, in co-operation with the Agricultural Bank, to set up commercial-type operations on a larger scale than has been usual so far, particularly to supply inland fish to the markets in the urban centres of Pahang Tenggara.

3.5.7.6

The above general policies will be suitable as long as the off-shore monitoring programme of marine fish continues to indicate a plentiful supply. Should there be indications of depletion in marine fish, however, it would be necessary to reassess the policy for inland fishing with a view to placing it on a larger scale basis.

3.6 INVERTEBRATE FOOD PRODUCTION (CRUSTACEANS AND MOLLUSCS)

3.6.1 Species

There are a number of species of molluscs and crustaceans resident in Malaysian marine, estuarial, and freshwaters. Although no comprehensive survey has yet been undertaken on the

speciation of east coast invertebrates or their distribution or abundance, it may be assumed that most species common in South-east Asian waters occur within the Pahang Tenggara. Species are not stated in commercial fishing returns but the harvests are grouped only under Udang (crawfish, shrimp, prawn, lobster), Ketam (crab), and the molluscs under Sotong, Kerang, and Siput.

3.6.2 Pahang State Harvests

Total harvests of invertebrates from Pahang State in 1969 was 4,333 piculs of crustaceans and 2,048 piculs of molluscs, making up only 0.7 and 0.4 per cent, respectively of the total catches for Malaysia. The present contribution of the east coast fisheries to the invertebrate food market is, therefore, insignificant. The harvest of Udang from Kuala Nenas and Rompin within the Pahang Tenggara totalled 1,016 piculs, or about 25 per cent of the total for the State.

3.6.3 Potential

Potentials for increased utilization of the food invertebrates within the Pahang Tenggara would seem excellent. Limitations in gear and modern technology and inadequate knowledge of the biology of the various species, and a lack of product promotion would seem to be the major factors suppressing the more full exploitation of this valuable resource.

Until such time as more specific scientific information is available on the indigenous invertebrate fauna of the east coast and tributary freshwaters, it is impossible to speculate with any accuracy on the exploitability of the fishery. In view of the use of invertebrates as food by all major ethnic groups in Malaysia, and the potentials for export, the matter warrants serious biological and economic investigation.

Present harvests of marine prawns in Pahang Tenggara would seem to be a mixture of two species of banana prawns and two species of tiger prawns. These are penaeid species which spend their juvenile stages in brackish water. The artificially enriching (fertilizing) estuarial lagoons to increase production is a possibility, as is the idea of impounding the young in estuarial ponds where they would be held to market size. Both of these techniques require scientific study before being advocated for the Pahang Tenggara coast. Other species of invertebrates, including very

likely the Belachan Shrimp, offer possibilities for increasing local production if fishing grounds can be identified.

There would seem to be potential for the increased harvest of caridean prawns which inhabit brackish and freshwaters of the Pahang Tenggara. The only one of this group currently marketed locally is the Udang Galah which is the largest local species. This species (*Macrobrachium rosenbergii*) occurs in fresh and brackish waters in lowland areas and is especially abundant in the lower reaches of rivers which are influenced by tides. It will live in mining pools, irrigation canals, and even padi-fields. Experimental work at Penang and Singapore has indicated the possibility of artificial culture in ponds. However, because of peculiarities in its life history, artificial breeding and the rearing of young has proved difficult.

3.6.4 Artificial Culture

Regarding the possibility for the artificial culture of the Udang Galah, it is recommended that fishermen be encouraged to harvest the natural production from rivers and lowlands. Should mining pools or ponds become available, the artificial culture should first be tried by

transferring young prawns from the lower rivers into these new waters. While there is undoubtedly a market demand for this high quality product and potentials for the development of a strictly artificial prawn culture industry should be investigated for the Pahang Tenggara, it is unlikely that private capital will be available for developmental work until such time as a Government operated pilot hatchery proved the economic feasibility of the artificial culture and rearing of Udang Galah.

3.6.5 Investigation Required

The potential of other species of indigenous freshwater caridean prawns as a source of food and profit should be investigated. Work by Johnson at the University of Singapore suggests that a comparatively small species *Cryphiops* (*Macrobrachium*) *lanchesteri* is perhaps the best suited of local species because of its abundance and wide distribution in low-calcium waters including streams, ditches, mining pools, rice fields, etc. It is a herbivore (unlike Udang Galah) and, therefore, would supplement pond fish production. Local and public acceptance of this and other small freshwater prawns is, of course, a prerequisite to the development of an industry which would seem biologically very feasible.

4.1 THE TASK BERRY NATURE RESERVE PARK

Task Berry is one of two major natural bodies of freshwater on the Malay Peninsula, the other being Tasik Chini and Indragiri, and is situated within a biological community which is unique within Malaysia and which duplicated nowhere else in the world. Located at the southern base of the Titiwangsa Range, Task Berry is a large, shallow, irregularly shaped lake, about 10 km long and 5 km wide, with a total area of about 50 km². The lake is surrounded by a dense, low-lying forest, and is fed by a number of small streams. The water is clear and the temperature is about 25°C. The lake is a very important source of water for the local population, and is also a popular place for recreation. The Task Berry Nature Reserve Park was established in 1972, and covers an area of about 100 km². The park is managed by the Forest Department, and is open to the public for recreation. The park is a very important source of water for the local population, and is also a popular place for recreation. The Task Berry Nature Reserve Park was established in 1972, and covers an area of about 100 km². The park is managed by the Forest Department, and is open to the public for recreation.

4.0 RECOMMENDATIONS FOR THE ESTABLISHMENT OF PERMANENT RESERVES

Specific proposals for recreation and conservation should be related to the general context of environmental control and conservation practice developed for Pahang Tenggara. Allocating land for various uses is the basis of national and regional planning, thus delineating areas for recreation and conservation should be focused at optimizing the contribution of these in the national and regional land use plan.

The objective of maintaining an overall *balanced* ecology is elementary to agricultural and forestry development. "Natural biological controls and resistance to pest and disease reveal a containing dependence of agriculture on wildlife resources Integrated methods may prevent (The development of the pests') resistance to pesticides".¹

A second objective is to serve the purposes of *scientific enquiry*. "There are known, and also presumably as yet unknown, natural resources of significance in medicine and pure science, which can only be saved by the preservation of as wide a range as possible of species of living things in their natural habitats and biological communities."²

In addition to achieving water and soil conservation and wildlife preservation for their own reasons, "National parks and Nature Reserve, should be developed to provide for the growing requirements of an increasingly urban population to have some wilderness areas for *recreation*, relaxation and enjoyment therefore, additional benefits can be generated through tourism, work and revenue for local people, recreation for youth, and sometimes meat by hunting and fishing, and finally to assist in education and nation building."³

4.1 THE TASEK BERA NATURE RESERVE PARK

Tasek Bera is one of two major natural bodies of freshwater on the Malay Peninsula, the other being Tasek Chini and, therefore, supports a biological community which is unique within Malaysia and likely duplicated nowhere else in the world. Because of the scientific value of the

Tasek Bera and the potentials which it offers for educational and recreational activities, it is essential that this remarkable environment be preserved for the benefit of future generations.

4.1.1 Origin

The configuration of the Tasek and its deposits of silt indicate that it is the remnant of an ancient lake obliterated by ecological aging and major changes in the water catchment.

Although speculative, there is strong evidence that Tasek Bera was once fed by the present headwaters and riverine swamps of the Sungei Palong which in earlier times flowed northward through Tasek Bera into the Sungei Bera, in which case the Tasek would have been served by a much greater volume of water than at present. It is believed that the Sungei Palong cutback its headwaters through erosion to capture the former extensive headwaters of the Sungei Bera and, thus, divert the major water source of Tasek Bera to the south and isolate the Tasek from its water supply. The present southern catchment area of Tasek Bera is still ill-defined and it is probable that there are some marshes from which the drainage is both north to the Tasek Bera and south to the Sungei Palong. The characteristics of the rivers and marshes surrounding the Tasek indicate a very complex drainage history.

It would seem, therefore, that Tasek Bera is but the remnant of an ancient lake cut off from its major water source and now reaching an advanced stage of ecological aging. This thesis is supported by the present geophysical configuration, the extensive peat deposits, and the general limnological biological features of the Tasek.

4.1.2 Physiography

Tasek Bera appears today as a drowned valley covered largely with swamp forest and interspersed with open water areas and enclosed pools inter-connected by an intricate network of narrow channels and small rivers. The many channels are kept open by strong currents flowing typically in a northerly direction and are generally deep. These channels coalesce at the northern end of the Tasek to form the main and navigable Sungei Bera flowing northward to the Pahang River. The irregular "spurlike" peripheral outline of the Tasek is the result of original inundation of numerous headwater valleys.

Tasek Bera creates a wet area of approximately 40 sq miles. It stretches for approximately 17 miles in a north-south direction and varies in

¹ Dr P. R. Wycherley, "Conservation in Malaysia" UNESCO/NS/3357/66, Chap. 7, p. 158.

² Wycherley, Op. Cit. p. 159.

³ Ibid.

width from about 0.5 to three miles. The gradient of the Tasek is low and it is only the strong currents in the channels which prevent the more-or-less total obliteration of open water by vegetation. The vegetative cover gives a deceptive picture of the extent of Tasek Bera, especially if viewed from the air. The extensive swamp forest and marsh vegetation gives the impression of *Terra firma* but, in fact, are rooted on peat, formed a few feet below the water surface.

The height of land surrounding the Tasek provides a pleasant visual landscape.

4.1.3 Settlement

At present, several hundred Semai aborigines are living in the area within and surrounding Tasek Bera and a number continue to live and procure their food in traditional ways. Others have modified their way of life and have become permanent residents in Fort Iskandar, a former defense outpost built over a decade ago, serviced by a dirt road from the southwest. This settlement has become the gateway to Tasek Bera, although a network of logging roads now more-or-less surround the Tasek and several trails reach to, or near, the shoreline on the south and west.

As a result of centuries of aboriginal settlement throughout the watershed and recent logging operations particularly to the west and south, much of the forest peripheral to the Tasek has been modified greatly but remains almost entirely under forest and lallang cover. Logging operations, especially road construction, have altered local drainage patterns and increased siltation in tributaries to the west. However, there is no evidence that past or present land use patterns have altered appreciably the natural environment of the Tasek itself. Future land use and special provisions for this group of Orang Asli have been made in sections 3.14.20; 3.14.21; and 3.14.22 of the supporting report "Sociology and Migration in Pahang Tenggara".

4.1.4 Limnology

Tasek Bera represents a unique Southeast Asian aquatic environment.

Tasek Bera has been chosen as a research area within the current International Biological Programme (IBP) undertaken jointly by the University of Malaya and the Japanese Government in order to study primary productivity of tropical freshwater streams and swamps and the related bioecosystem. The detailed (IBP) Study, to be concluded in 1972, will provide new and

fundamental information on the nutrient budget and, as well, shed light on the evolution and ecological aging of tropical freshwaters. No adequate limnological description of Tasek Bera is possible at this time.

4.1.5 Flora

The Tasek Bera watershed includes a wide variety of floral types ranging from primitive algal species to higher plants and trees. The Tasek is known to support about 250 species of algae, many of which are endemic and new to science (Soepadmo, personal communication). Identified within the higher forms of vegetation are five species of submerged, three species of floating, and 13 species of rooted aquatic plants. One of these species, *Scirpus confervoides*, is a new record for all of Asia and was previously known only from Florida, Cuba, Guyana, Ceylon, and Madagascar. Terrestrial plants in the forest edge around the lake include at least 21 species of shrubs or trees, 6 species of woody climbers, and five species of ferns. Some 24 species, large trees, have been identified from the inland forest of the Tasek Bera watershed (Table 7.2, Appendix).

Because of the diversity of habitat within the proposed boundary of the Tasek Bera Nature Reserve, the flora of tropical swamp, grassland, and forest are represented. The swamp vegetation consists predominantly of *rasau* mixed with various reeds, lilies and submerged plants, especially the bladderwort. The swamp forest occurs on islands of deep peat overlying a luxuriant growth of ferns, pandans, sedges and sphagnum mosses. On higher land, the cover is of palm and various dipterocarps interspaced with lallang resulting from a shifting Aboriginal agriculture.

4.1.6 Fauna

The Tasek Bera watershed includes an abundance of species representative of the fauna of Malaysia.

The fish fauna of the Tasek contains many rare and unique forms which range in size from small minnows to large food and sport fishes. The provisional checklist of fishes is comprised of 129 species representing some 22 families. Cyprinids are the predominant group containing both brilliantly coloured aquarium species and excellent food and sport fishes. Among the fishes of particular scientific interest, the Ikan Kelasa (*Scleropages formosus*) and Ikan Temoleh (*Probarbus jullieni*) are on the endangered list of world fishes. The former species occurs naturally

only in restricted southeast watersheds of the Malay Peninsula and is the only known freshwater Malaysian fish to be present also in Australia and New Guinea, the latter species in several waters of Thailand, Cambodia, Laos, Vietnam, and Malaya. Both of these large species are still abundant in Tasek Bera and persist in the Pahang River but becoming rare elsewhere. Ikan Kelasa, aside from its food and angling qualities, is known scientifically as a "living fossil".

The limnology of the waters of southern Malaya, of which Tasek Bera is one of the few undisturbed environments, are (like a somewhat similar area in the Amazon Valley) especially suited for the production of potential and common aquarium fish species. Tasek Bera, therefore, is becoming a unique reservoir for some 50 kinds of these fishes which are of interest to scientists and naturalists. Because of the economic value of aquarium fishes, those of Tasek Bera are believed to have been heavily exploited commercially as part of the reported annual \$2,000,000 export value of aquarium fishes through Singapore. Over 20 of the aquarium—like fishes of Tasek Bera are considered special.

Of the fish fauna of Tasek Bera, over two dozen of the food species grow to sufficient size and have the necessary fighting qualities to be classified as prime sport fishes. Some species may reach over 20 pounds in weight. Undoubtedly, the Tasek Bera serves as a breeding ground and reservoir of major food and sport fishes which, aside from providing a local fishery, serve to stock not only the Sungai Bera but most probably the Pahang River system.

Virtually all of the amphibians and reptiles of Malaysian tropical swamps are present in Tasek Bera, including the gharial crocodile (*Tomistoma schlegelii*). Most of these species are suffering depredation as their habitats are destroyed by the ingress of civilization.

The avi-fauna of the Tasek Bera region is abundant with over 200 of the recorded 575 species of Malayan birds being represented by at least 16 orders and 47 families. In addition to providing a natural reservoir for indigenous avi-fauna which can be studied by the scientist and enjoyed by the naturalist, the area produced numerous game birds preferred by hunters. The value of the diverse marsh, grassland and forest habitats of Tasek Bera as a "gene pool" for the avi-fauna of the eastern Malay Peninsula and beyond will become increasingly significant as the economic development of jungle proceeds in the Pahang Tenggara.

Although forest exploitation for timber peripheral to Tasek Bera has greatly modified the natural habitat of the higher vertebrates, most of the native mammals still survive in the area. Any larger animals of the forest canopy locally disturbed by logging operations, such as the gibbon, may be expected to return within a few years. Among the large mammals of Malaysia, the seladang (*Bos gaurus*) and elephant (*Elephas maximus*) are still known to be present in the Tasek Bera area. Elephants are occasionally sighted and a herd of 8-10 seladang are known to range to the south of the Tasek. Tasek Bera is expected to offer sanctuary to these large mammals as their native range is progressively reduced by settlement. The tapir (*Tapirus indicus*) is still reported for the area while tiger (*Panthera tigris*), wild pig (*Babi hutan*), Rusa (*Cervus unicolor*), and other species of the jungle and peripheral agricultural and settlement lands are relatively abundant.

4.1.7 Justification for Establishment as a Nature Reserve

The abundance of the indigenous biota, representing most of the plant and animal species of the eastern Malay Peninsula, is, in itself, ample justification for the preservation of Tasek Bera in perpetuity. With the inevitable progress of civilization which will continue to destroy the natural floral and faunal communities of Malaysia, the sanctuary provided for plants and animals within the Tasek will become more and more significant in the preservation of a living national heritage, a legacy about which future generations may be proud. Because of the unique limnological and biological features of Tasek Bera, scientific and naturalist interests in the indigenous fauna and flora extend far beyond the borders of Malaysia and, if made available for research and nature study, the Preserve may be expected to attract scientists and tourists from all over the world.

While the preservation of Scientific values must be of prime concern in planning the future of the Tasek Bera Nature Preserve, the opportunity for optimum public use for education and recreation, compatible with the preservation of natural flora, fauna, and landscape, must be given high priority in the development of a management plan.

It is difficult to distinguish between education and recreation and, in fact, perhaps they should not be divorced in the development concepts of Tasek Bera. By maintaining the Tasek primarily as a primitive wilderness, use of the area will appeal principally to Malaysians and tourists

wishing experience in a jungle environment with the opportunity to view and photograph unusual vegetation, rare and beautiful birds and fishes: and with the hope of observing rare animals like crocodiles, elephants or more common animals of swamp and lowland forest.

Although it has been stated that the primary objective for establishing Tasek Bera as a Nature Preserve is to provide a reservoir, or "gene pool" of native biota in order to preserve indigenous species from extinction, it must be emphasized that *conservation means wise use of available resources*, on the perpetual yield basis. There is no reason, therefore, that exploitable resources within the Tasek should not be utilized provided that no natural aquatic or terrestrial environment are altered, nor species survival or welfare threatened. There should be no objection to the *selective harvest of timber from peripheral forests* under the supervision of a *professional conservationist* and, in fact, forest management may be expected to be a necessary tool for future wildlife management. Similarly, the *controlled exploitation* of local food and sport fish by Aborigines and sport fishermen, or the removal of *brood stock of aquarium species* for culture elsewhere, would seem to be reasonable uses for the fisheries resources of the Tasek.

Since the area surrounding Tasek Bera is swampy and seasonal variations occur, it is difficult to determine where the nature Reserve should stop. The underlying principal in this delineation is to avoid any possible disruption to the Lake itself. Consequently, the reserve area should include both Tasek Bera and Tasek Dampar and their immediate watersheds, encompassing 75,000 acres as shown in Fig. 4.1. Surrounding this should be a controlled development zone where cultivation would be permissible, but perhaps where the use of certain pesticides and chemicals would be prohibited.

4.1.8 Exploitation for Tourism

The intriguing natural jungle environment and the abundance of indigenous wildlife would seem to offer a potential for the development of tourism based on the aesthetic and biotic features of Tasek Bera. Likely tourists activities would include appreciation of natural scenery, the viewing and photographing of native plants, fish, and animals, visitation to undisturbed jungle and Aborigine settlements, wilderness camping, and recreational angling. Hunting should be permitted only beyond the confines of the reserve. Power boats should not be allowed in the area.

Access to the Tasek Bera Nature Reserve must be restricted to one, and at the most three points of entry. Existing access is from the south west to Fort Iskandar. This should remain as the main access point. Future access should be sited to avoid disruption to the lake. Proposed major roads to Pahang Tenggara skirt the area and no access is proposed from the south or east to avoid interference. With construction of the East West road north of the Tasek, a further access point would be possible to Bukit Buhu which has been suggested as a suitable site for a future forestry and administration headquarters.

An educational and nature interpretation centre, including laboratory and accommodation for visiting scientists and naturalists, should be constructed at a central location. All building and associated development must be restricted to the west side of the Tasek while the east side of the Tasek must remain in an undeveloped primitive state except for Aborigine occupation.

The development of an educational-recreational programme with supporting facilities at Tasek Bera would seem to offer potential employment for local Aborigines in a type of work for which they are superbly qualified. As a long-term objective, the Aborigine population should be encouraged to settle in permanent agricultural holdings but take advantage, where possible, of employment possibilities within the Tasek Bera complex.

4.2 TASEK CHINI NATURE RESERVE PARK

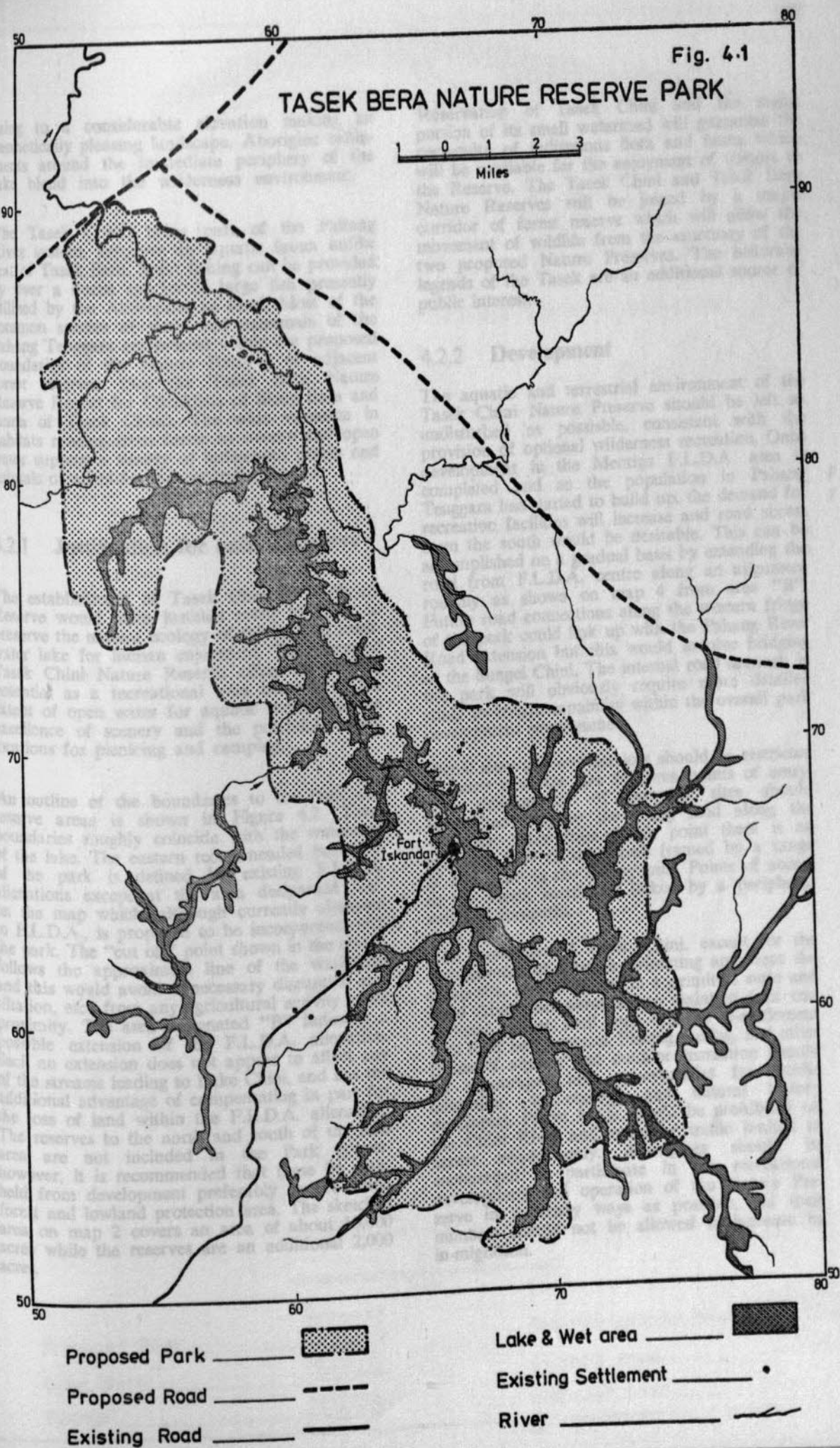
Tasek Chini is the other of the two natural bodies of freshwater in Malaysia which can be described as lake environments. Located to the South of the Pahang River about 1 mile due South from Kertam, the Tasek can be reached by road or water.

Travel by water requires the use of a small boat to ascend the shallow and narrow Chini River over a distance of about two miles from the Pahang River. Access by land is accomplished via the Pekan—Kg. Melayu road along the South bank of the Pahang River with the final few miles on timber and mining roads which extend nearly to the east and south shores of the Tasek.

Tasek Chini contains open water much clearer than Tasek Bera, except during flood period, and is suitable for motorless boating, fishing and swimming. Considerable marsh habitat also exists. The lake is surrounded by primary forest

Fig. 4.1
TASEK BERA NATURE RESERVE PARK

1 0 1 2 3
Miles



rising to a considerable elevation making an aesthetically pleasing landscape. Aborigine settlements around the immediate periphery of the lake blend into the wilderness environment.

The Tasek Chini, being part of the Pahang River system, supports an aquatic fauna unlike that of Tasek Bera. Sport fishing can be provided by over a dozen species of large fish presently utilized by the Aborigines as food. Most of the common species of birds and mammals of the Pahang Tenggara are present within the proposed boundaries of the Nature Reserve or adjacent forest reserves. (See the Tasek Bera Nature Reserve Report for Checklists of likely flora and fauna of Tasek Chini). The wide variation in habitats ranging from forest to swamp and open water support a variety of indigenous plants and animals of scientific and naturalist interest.

4.2.1 Justification for nature Reserve

The establishment of Tasek Chini as a Nature Reserve would seem justified solely in order to preserve the natural ecology of this natural freshwater lake for human enjoyment. The proposed Tasek Chini Nature Reserve offers an exciting potential as a recreational area because of the extent of open water for aquatic recreation, the excellence of scenery and the potentially good locations for picnicing and camping.

An outline of the boundaries to the park and reserve areas is shown in Figure 4.2. These boundaries roughly coincide with the watershed of the lake. The eastern recommended boundary of the park is defined by existing F.L.D.A. alienations except at the area designated "A" on the map which, although currently alienated to F.L.D.A., is proposed to be incorporated into the park. The "cut off" point shown in the sketch follows the approximate line of the watershed and this would avoid unnecessary disruption and siltation, etc., from any agricultural activity in its proximity. The area designated "B" indicates a possible extension of the F.L.D.A. alienation. Such an extension does not appear to affect any of the streams leading to Lake Chini, and has the additional advantage of compensating in part for the loss of land within the F.L.D.A. alienation. The reserves to the north and south of the lake area are not included in the Park proper, however, it is recommended that these be withheld from development preferably as protection forest and lowland protection area. The sketched area on map 2 covers an area of about 10,000 acres while the reserves are an additional 2,000 acres.

Reservation of Tasek Chini and the major portion of its small watershed will guarantee the perpetuity of indigenous flora and fauna which will be available for the enjoyment of visitors to the Reserve. The Tasek Chini and Tasek Bera Nature Reserves will be joined by a major corridor of forest reserve which will allow the movement of wildlife from the sanctuary of the two proposed Nature Preserves. The historical legends of the Tasek are an additional source of public interest.

4.2.2 Development

The aquatic and terrestrial environment of the Tasek Chini Nature Preserve should be left as undisturbed as possible, consistent with the provision of optional wilderness recreation. Once development in the Mentiga F.L.D.A. area is completed and as the population in Pahang Tenggara has started to build up, the demand for recreation facilities will increase and road access from the south would be desirable. This can be accomplished on a gradual basis by extending the road from F.L.D.A. centre along an alignment roughly as shown on map 4 from area "B". Future road connections along the western fringe of the park could link up with the Pahang River Road extension but this would involve bridging of the Sungei Chini. The internal road network in the park will obviously require more detailed study to ensure capability within the overall park development programme.

Picnic sites and any services should be restricted to areas near the two or three points of entry. The development of camping sites should be limited only to the rising land along the northeast shore from which point there is an excellent view of the Tasek framed by a range of high land in the background. Points of access to the Tasek should be linked by a peripheral series of footpaths.

The remainder of Tasek Chini, except for the development of a beach swimming area near the camp site, should be left in a primitive state and local Aborigines permitted to maintain their traditional culture until such time as re-settlement is in their best interests. Fishing, sailing, and other forms of aquatic and outdoor recreation should be encouraged and opportunities for public education in ecology and natural history developed. Power boats should be prohibited on the Chini River and vehicular traffic limited to access roads only. Aborigines should be encouraged to participate in the recreational development and operation of the Nature Preserve in as many ways as possible, but their numbers should not be allowed to increase by in-migration.

Proposed Park

Open Water

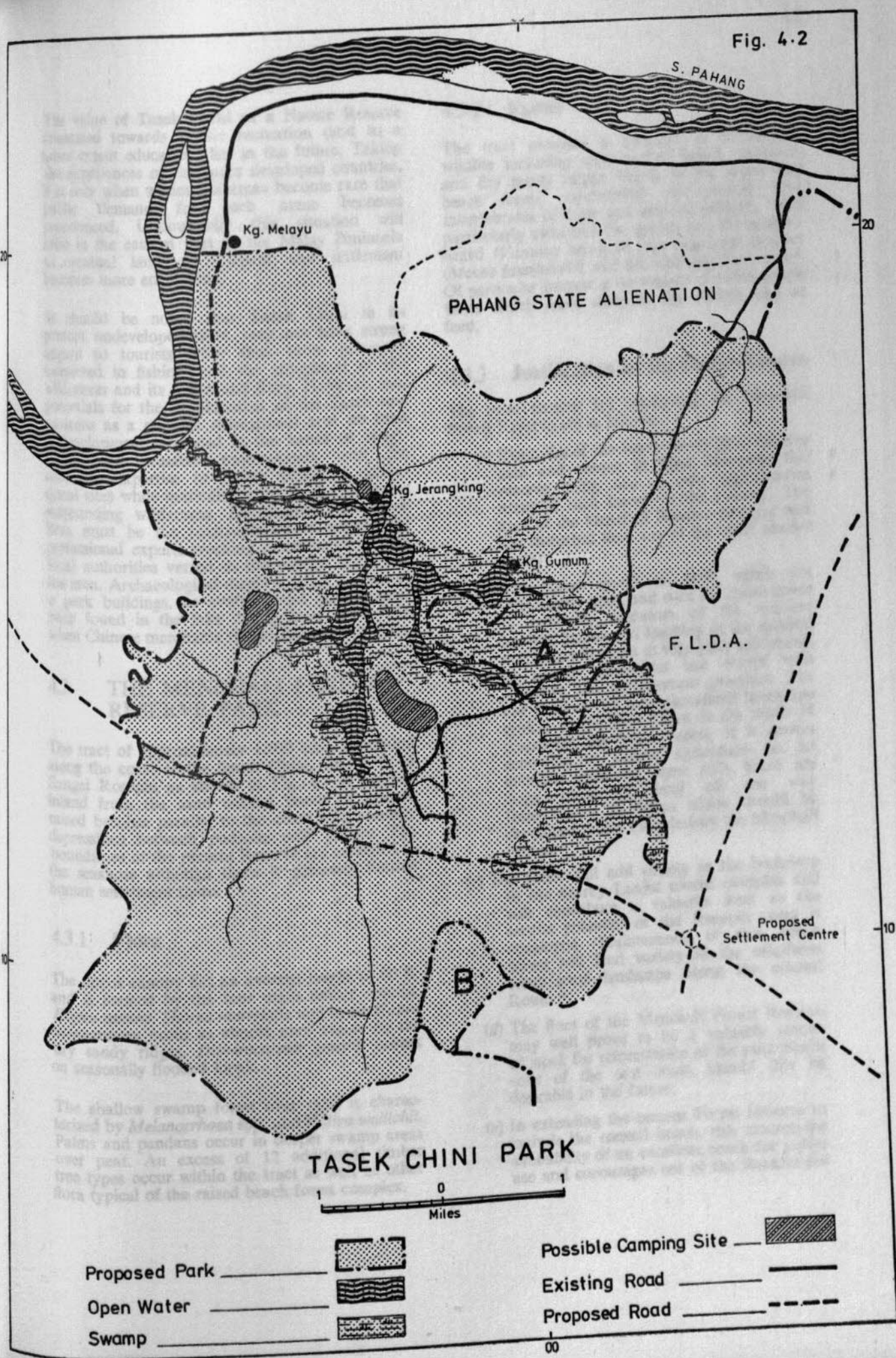
Swamp

Possible Camping Site

Existing Road

Proposed Road

Fig. 4.2



The value of Tasek Chini as a Nature Reserve orientated towards public recreation (and to a lesser extent education) lies in the future. Taking the experiences of the more developed countries, it is only when wilderness areas become rare that public demand for such areas becomes pronounced. Undoubtedly this situation will arise in the eastern part of the Malay Peninsula as eventual land development and settlement becomes more enveloping.

It should be noted that Tasek Chini in its present undeveloped state, may not have strong appeal to tourists other than those primarily interested in fishing and the enjoyment of the wilderness and its fauna and flora. However, real potentials for the development of the Tasek and environs as a popular recreational area do exist if development is placed in the hands of imaginative and creative professionals with the necessary expertise to create attractive recreational sites while maintaining the aesthetics of the surrounding wilderness. Development of Tasek Bera must be the responsibility of appropriate professional experts working in cooperation with local authorities versed in the natural history of the area. Archaeological displays could be part of a park buildings, as artifacts and pottery have been found in the lake dating from 1500 A.D. when Chinese merchants visited Pahang to buy tin.

4.3 THE MENCHALI FOREST RESERVE PARK

The tract of approximately 1,500 acres is located along the coast of the South China Sea north of Sungei Rompin as shown in Fig. 4.4 It extends inland from the sand coastal beach to include raised beaches parallel to the coast with swampy depressions between podsollic soils profile. The boundaries of the present Reserve are extended to the seashore although there is presently limited human settlement there.

4.3.1 Flora

The upper canopy has an average height of 50 ft. and is formed by the four main timber species. *Hopea nutans*, *Shorea materialis* and some *Hopea mengarawan* occur as almost pure stands on the dry sandy ridges. *Dipterocarpus gracilis* occurs on seasonally flooded lopak.

The shallow swamp forest over sand is characterized by *Melanorrhoea* spp. and *Vatica wallichii*. Palms and pandans occur in deeper swamp areas over peat. An excess of 12 additional timber tree types occur within the tract as well as other flora typical of the raised beach forest complex.

4.3.2 Fauna

The tract provides a diversity of habitat for wildlife including wave-washed beach, wetlands, and dry sandy ridges. Fauna of the beach and beach forest communities are present with invertebrates of shore and wetland habitats, being particularly attractive for species like the monitor lizard (*Varanus salvator*), the macaque monkey (*Macaca fascicularis*), and the wild pig (*Sus scrofa*). Of particular interest is the variety of native jungle birds which move daily to the coastal area to feed.

4.3.3 Justification for the Forest Reserve

The main reasons for conserving the Menchali Forest Reserve are as follows:

- (a) Examples of the beach forest have become rare and unique in West Malaysia, this reserve being one of only four known areas of such forests in the country. The area of the Menchali Reserve is larger and less disturbed than any of the other similar areas.
- (b) The forest grows on soils which are intrinsically poor, and once the forest cover is removed, oxidation of the nutrient holding humus and leaching of the mineral nutrients will result in very poor soil unable to sustain continuous use except with intensive soil management practices. The low productivity scrub/grassland landscape typical of the East Coast is the result of destroying the beach forest. If it proves economic to sustain agriculture on an intensive basis on these soils, there are large tracts of land all the way from Endau to Pekan which should be developed rather than destroy the Menchali Forest.
- (c) The forest will add variety in the backdrop to the nearby Lanjut tourist complex and will contribute a valuable item as the tourist potential of the Rompin coast is developed. Maintenance of this beach forest will lend variety to the otherwise scrub/grass landscape along the coastal Route 5.
- (d) The flora of the Menchali Forest Reserve may well prove to be a valuable source of stock for reforestation of the poor beach soils of the east coast, should this be desirable in the future.
- (e) In extending the present Forest Reserve to include the coastal beach, this assures the availability of an excellent beach for public use and encourages use of the Reserve for

educational and recreational purposes without undue interference with natural geographic or ecological features.

- (f) In summary, the proposal to maintain and extend the boundary of the Menchali Forest Reserve, allows the tract to serve the dual role of forest preserve and wildlife sanctuary while providing aesthetic and landscape qualities for public recreation.

4.4 COASTAL ZONE FOR TOURISM

The quality of the East Coast beaches are legend. There are very few stretches which are not suitable for swimming, fishing, boating, diving and other water activities. Initial utilization of the coastal area of Pahang Tenggara should be focused on the most suitable sites for recreation. Areas not developed now should be protected for future public oriented development. (See Fig. 4.4).

The coastal zone refers to the area between the road and the shore from Pekan town to Sungei Endau. Within this boundary, some 40,000 acres, lies all of the suitable beaches and some existing forest reserves. Most of this is Federally held land, except perhaps where existing settlements occur.

It is suggested that specific areas of the peat forest to the west of the road be included as part of a special protection area pending the outcome of investigations into harvesting of swamp forests. Large portions of these forests, however, will not be utilized for either forestry or agriculture and protective restrictions are designed to reduce the possibility of needless damage to wildlife habitats.

4.4.1 Development

4.4.1.1 Lanjut-Rompin

It is anticipated that aside from existing fishing villages, the major activities along the coast would be associated with tourism and recreation. The main development should occur at Lanjut. Here, hotels, clubs, bars, restaurants, golf courses, swimming pools, boat launches, and water sports equipment rental facilities should be encouraged. Information kiosks and guides should be available to encourage day trips to Pulau Tioman or to the Endau-Rompin National Park. This development should keep pace with local and International tourist demands expanding south of Kuala Rompin when it is warranted.

4.4.1.2 Tourist Parks Proposed

Other tourist attractions along the coast are suggested as eight small parks distributed at approximately 10 mile intervals. These small parks will draw the tourist up or down the coast, thus enlivening what is now a dull uninteresting trip. These parks are illustrated in Fig. 4.4. Each park could represent a small industry commencing with a petrol station permit and a beach or park permit. The tourist facility could, at commencement, be very modest, but must have a full-time operator. Each park represents at least two initial small business enterprises (bumiputra) for a total of 16 ventures. At a later date when the tourist trade merits the increase, much more elaborate accommodations can be developed along the coast.

Lanjut is the most well sited point on the coast for initial intensive tourist and recreation development. It is an existing settlement with some facilities and a labour force to serve them. It is at the intersection of the coast road and the Rompin rail line which is scheduled for conversion to a road. In addition to this it has a runway and adequate docking facilities for it to function as a drop off point for activities on Pulau Tioman and other coastal islands. This complex has been written up in considerable detail in Project Study Paper No. 4¹ and is already the site of Government initiative through the acquisition of the recreational facilities of the Rompin Iron Mining Co. by the State of Pahang.

4.5 ENDAU-ROMPIN NATIONAL PARK

The proposed National Park is an area of approximately 85,000 acres in Pahang State to be adjoined by land in Johor State of a similar area. This region consists of high hill country located in the upper catchments of the Sg. Keratong, Sg. Pontian, Sg. Anak Endau, Sg. Kinchin and Sg. Kemayan in Pahang and the Sg. Endau, Sg. Selai and Sg. Segamat in Johor. The part of the National Park in Pahang will cover an area comprising the mountain range of G. Besar (3,398 ft. a.s.l.) to G. Ulu Kempayan (2,803 ft. a.s.l.) and the series of sandstone escarpments towards the north, stretching from Bt. Lawai to Bt. Peter. It is proposed that similar terrain in the adjacent part of Johor State should be incorporated within the Park. Indeed, in 1971 the Prime Minister called for joint meetings of the two States of Johor and Pahang to consider this matter.

¹ Study Paper No. 4 "Lanjut-Rompin: A Preliminary Assessment of Recreational Potential".

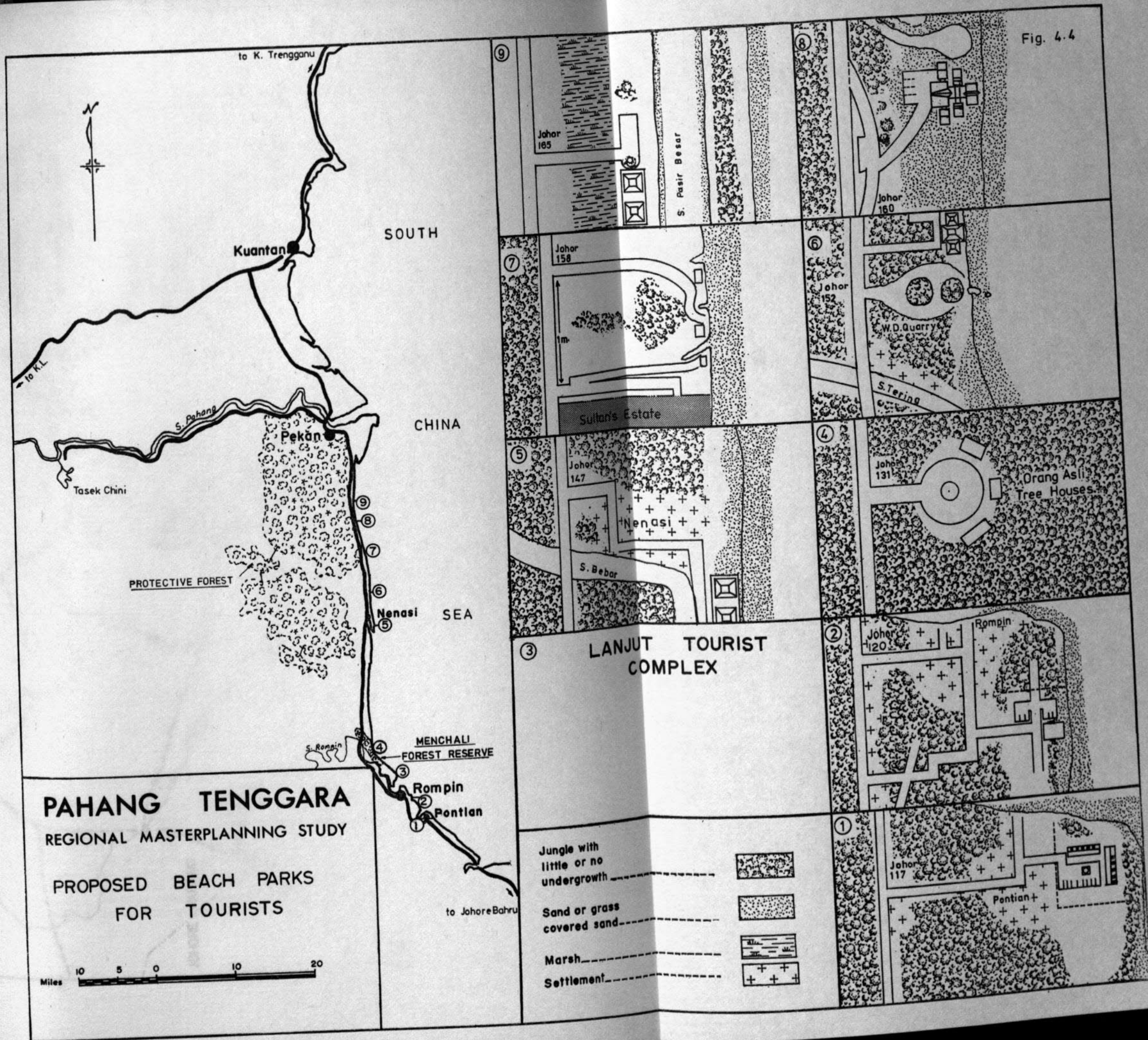
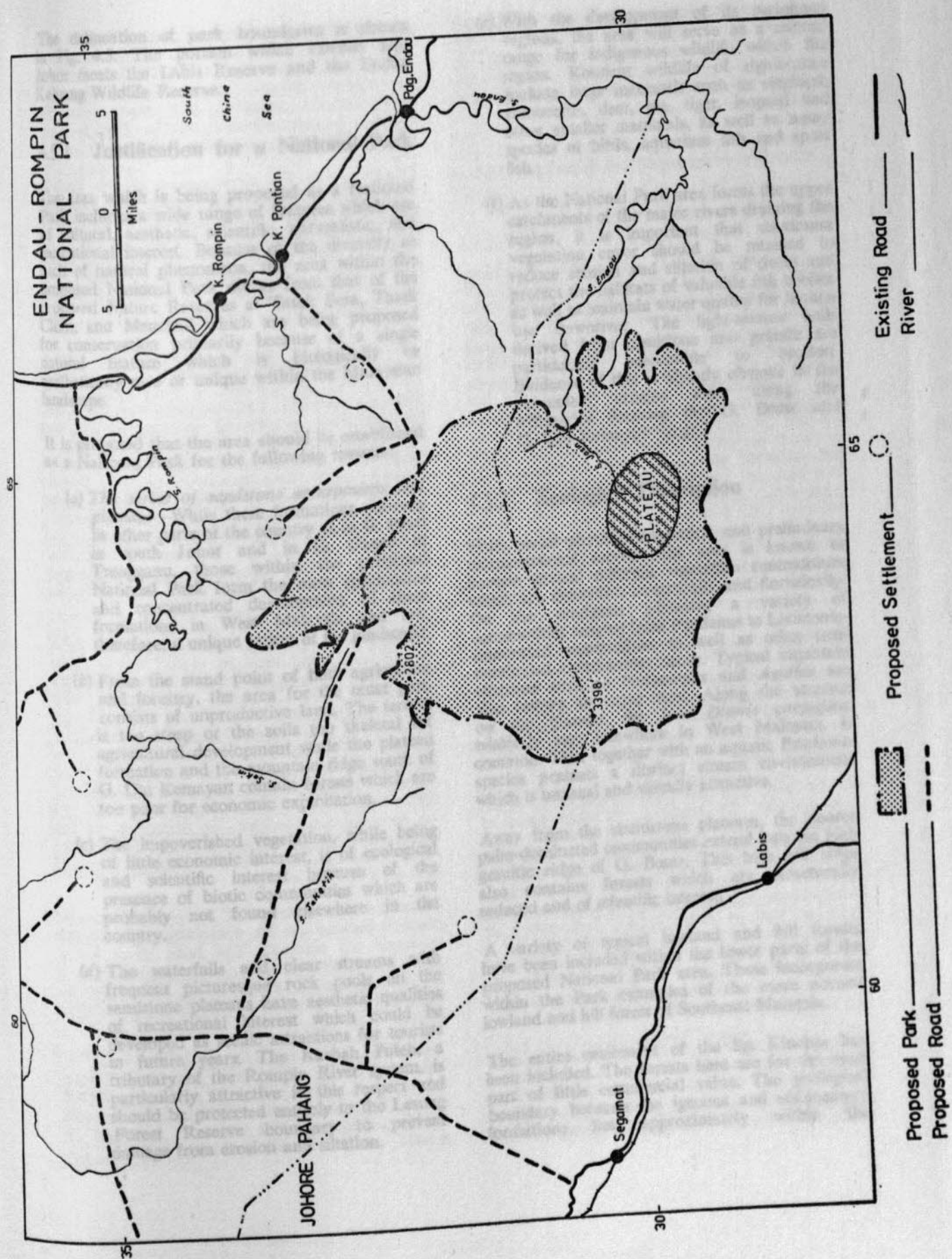


Fig. 4.5



The delineation of park boundaries is shown in Fig. 4.5. The portion which extends into Johor meets the Labis Reserve and the Endau Keluang Wildlife Reserve.

4.5.1 Justification for a National Park

The area which is being proposed as a National Park includes a wide range of features which are of cultural, aesthetic, scientific, naturalistic, and recreational interest. Because of the diversity as such of natural phenomena, the area within the proposed National Park differs from that of the proposed Nature Reserves at Tasek Bera, Tasek Chini, and Menchali which are being proposed for conservation primarily because of a single natural feature which is biologically or aesthetically rare or unique within the Malaysian landscape.

It is proposed that the area should be established as a National Park for the following reasons:

- (a) *The series of sandstone escarpments and plateaus*—While these formations out-crop in other parts of the country as in G. Panti in south Johor and in G. Gagau in Trengganu, those within the proposed National Park form the most spectacular and concentrated development of these formations in West Malaysia and are, therefore, a unique aspect of the landscape.
- (b) From the stand point of both agriculture and forestry, the area for the most part, consists of unproductive land. The terrain is too steep or the soils too skeletal for agricultural development while the plateau formation and the mountain ridge south of G. Ulu Kemayan contain forests which are too poor for economic exploitation.
- (c) The impoverished vegetation, while being of little economic interest, is of ecological and scientific interest because of the presence of biotic communities which are probably not found elsewhere in the country.
- (d) The waterfalls and clear streams with frequent picturesque rock pools on the sandstone plateaus have aesthetic qualities of recreational interest which could be developed as scenic attractions for tourists in future years. The Kachah Puteh, a tributary of the Rompin River system, is particularly attractive in this respect and should be protected entirely to the Lesong Forest Reserve boundary to prevent damage from erosion and siltation.

- (e) With the development of its peripheral regions, the area will serve as a natural range for indigenous wildlife within the region. Resident wildlife of significance include large mammals such as elephant, rhinoceros, deer, pig, tiger, leopard and other smaller mammals, as well as many species of birds, aquarium fish and sport fish.

- (f) As the National Park area forms the upper catchments of the major rivers draining the region, it is important that maximum vegetation cover should be retained to reduce erosion and siltation of rivers and protect the habitats of valuable fish species as well as maintain water quality for human use downriver. The light-texture soils derived from sandstone and granite are particularly susceptible to erosion. Evidence of this is already obvious in the permanent erosion scars along the tributaries draining the G. Besar and G. Ulu Kemayan range.

4.5.2 Ecological Description

From aerial photo-interpretation and preliminary reconnaissance surveys, the area is known to contain several different vegetation communities which are distinctive structurally and floristically. On the sandstone plateaus, a variety of communities ranging from Pandanus to Livistonia-dominated communities as well as other tree-dominated communities occur. Typical mountain elements such as *Podocarpus* and *Agathis* are also known to occur here. Along the streams on the plateau, the fern *Diptris conjugata*, relatively rare elsewhere in West Malaysia, is common. This, together with an aquatic *Pandanus* species presents a distinct stream environment which is unusual and visually attractive.

Away from the sandstone plateaus, the poorer palm-dominated communities extend into the high granitic ridge of G. Besar. This high hill ridge also contains forests which are structurally reduced and of scientific interest.

A variety of typical lowland and hill forests have been included within the lower parts of the proposed National Park area. These incorporate within the Park examples of the more normal lowland and hill forest of Southeast Malaysia.

The entire catchment of the Sg. Kinchin has been included. The forests here are for the most part of little commercial value. The geological boundary between the igneous and sedimentary formations lies approximately within the

Sg. Kinchin Catchment. Also, the westerly limit of Kapur forests appears to be located in the catchment. This limit also appears to coincide with the spectacular palm, *Johannesteysmania altifrons*, with boat-shaped leaves up to 12 feet in length.

4.5.3 Development and Management

4.5.3.1 Flora and Fauna

The proposed National Park, while containing features of general cultural and recreational interest because of the unique landscape, and scientific value because of the distinctive vegetation communities, is probably by itself too small to be expected to preserve those large mammals threatened with extinction. However, it is fortunate that peripherally the land is too steep for agricultural development. These areas of steep land contain productive forest which should be managed, preserving or enhancing the environment for preferred species of birds and mammals. The National Park will then be set within this more extensive area which includes both wildlife Preserve and Forest Reserve area. The latter being subject to exploitation management, but with due attention being paid to the conservation of wildlife, including the restricted or non-use of toxic arboricides and the establishment of appropriate hunting and fishing regulations.

The larger Reserve with an estimated minimum area of 500,000 acres (including the Johor component) will then form a significant wildlife reserve to act as a gene pool for indigenous wildlife and provide ample opportunities for scientific research, nature study, and general outdoor recreation.

At the same time the Forest Department should also consider the retention of small areas of productive timber stands, picturesque floral communities, and groves of mature and over mature trees for demonstration and scientific purposes. Other tracts should be preserved within the National Park to illustrate the major Forest types as well as virgin jungle. Preservation of these various ecological communities in a relatively undeveloped state will not only hold the areas for scientific study but will greatly increase the educational and aesthetic values of the National Park.

A most favourable attribute of the proposed Endau-Rompin National Park is its geographical location within a major land development and managed forest area. The presence of peripheral roads will make the Park accessible from all sides

yet the anticipated fringe of Forest Reserve will isolate the wilderness areas and buffer the environmental influence of civilization. Further, the major highway links with Singapore and Kuala Lumpur, as well as new communities, will increase the attractiveness of the Park for day use as well as longer vacation periods.

Potentials for the development of the Endau-Rompin National Park offer an exciting opportunity to establish a national heritage which will fulfill a multiplicity of purposes extending from the preservation of natural flora and fauna to a variety of scientific and recreational uses. The diversity of Spectacular scenery cannot be over-emphasized.

4.5.3.2 Tourism/Recreation

The management concept proposed for this National Park is one of optimum public use consistent, of course, with the preservation of wilderness areas, the protection of endangered animals, and the demonstration of unique ecological communities. If this objective is to be realized, the development and ultimate management of the National Park will require the integrated efforts of foresters, biologists, naturalists, hydrologists, and other competent specialists in areas of renewable resources development.

Responsibility for the creation of the preliminary park plan must be placed in the hands of a specialist in that field, but working in close cooperation with scientists and others with pertinent expertise including these with a knowledge of the local geography and natural history of the area. Because of the extent of the area, the diversity in topography and scenery, and the variety of ecological communities, it is anticipated that virtually all types of outdoor activities can be accommodated within, or peripheral to, the Park boundary. To suggest a mode for development would be unwarranted without an intensive field study of the location.

From the tourist viewpoint the most spectacular physical features are the waterfalls, cataracts and mountain top plateaux. The Jasin River has a series of rapids and cataracts beginning from a 200 foot waterfall, at the base of a plateau, running to the junction of the Jasin and Endau Rivers.

There are two large plateaux, one each in Johor and Pahang. The one in Johor has volcanic origins and covers an area of more than 10,000 acres. The Pahang plateau is remarkably flat and smaller at about 1,000 acres. It is based on granite—and the elevation is about 1,600 ft. The

temperature of these highland areas is moderate enough to suggest hill station development with golf links and other resort activities. The variety of terrain and plant species suggests potential for hiking and slope climbing. There are a number of minor plateaux located in the Lesong Forest Reserve which, as well, may prove to be suitable for development.

Rhinoceros, tiger, bearded pig, wild boar, miniature deer and elephant are among the abundance of wildlife known to exist in the area. Some of these are very rare, consequently, their habituation in the park would protect them and present the opportunity for the general public to observe them at feeding stations and observation posts.

A great number of animals are not approaching extinction at all. It is common practice in many wildlife sanctuaries to regulate the numbers of certain species and this presents the opportunity for seasonal selective hunting for a variety of game. In this respect the type of hunting suggested is a safari type with guides and the supervision of a Park official. "Open Season" hunting is not recommended due to the expected high level of other users. Fishing potential is believed to exist in all of the rivers and streams in the area.

The Endau-Rompin National Park should have a very broad public appeal not unlike that of Yellowstone National Park in the United States which annually attracts visitors from all over the world. The pattern of development would be expected to parallel that of United States and Canadian National Parks with similar integrated and interrelated conservation, scientific, and recreational objectives. In addition to providing a permanent monument to the national heritage of Malaysia, the proposed park would be expected to become a major attraction for both Malaysians and tourists from overseas. Conceivably, the National Park could become a local centre for a tourist complex allied to the extensive and excellent marine beaches of the east coast of Pahang Tenggara.

4.5.3.3 Access

At present, access is possible only from the south and the east along forestry roads. The principal southern access route originates at Kahang along the Kulong-Mersing road, crosses the Sungei Kahang, proceeds up the Sungei Endau valley to the vicinity of Kampong Chegar Rambutan at the junction of the Endau and Jasin Rivers. The eastern route is from the coastal road near Kuala Pontian crossing the Sungei Anak Endau and proceeding to a point near the base of Gunong Keriong.

The proposed road from the North South highway through the Sungei Sekin Valley would bisect the area and provide access at a number of secondary points. This would be the shortest route from the western populated areas, and would link with the access to the park from the south and the east where the park has more variety of terrain and more interesting features than the west and is the most convenient for Johor and Singapore residents.

4.5.3.4 Park Administration and Services

It is suggested that an authority be established to administer the park. Some of its function may include:

- A — Wildlife Research.
 - Ecological Studies.
 - Maintenance of Feeding Stations.
- B — Development of Observation Points.
 - Delineation of Hiking Trails.
 - Development of a Park Museum and Orientation Centre.
 - Initiation of Nature Observation Programmes.
 - Tourist Information Service.
 - Provision for Signs.
 - Promotion and Advertising.
- C — Control of Hunting and Fishing.
 - Control of Logging.
 - Control of Mining Activity.
 - Control of Entry Points.
 - Refuse collection and Litter Control.
- D — Planning Responsibility for:
 - Road Location and Phasing.
 - Tourist Accommodation Siting.
 - Parking.

4.5.3.5 Phasing

The following steps are necessary for implementation of the park programme:

- (1) Survey and delineation of Park Boundaries and adjoining reserve.
- (2) Draft act and legislation on the purpose, use and control of the park.
- (3) Develop access and control points to the park.
- (4) Initiate a wildlife survey and park service.
- (5) Promotion and tabulation of the increase or change in usage of the park.

5.0 A COMPREHENSIVE ENVIRONMENTAL APPROACH TO DEVELOPMENT

Accompanying the growing concern about environmental matters has been the recognition that environmental considerations should be incorporated into the comprehensive development process¹.

Although this concern emerged from the environmental problems encountered by the industrially advanced countries (these problems being largely the outcome of high level but unbalanced development), it is also being recognized and expressed as an important issue for developing countries, thus:

It would be incorrect for the developing countries to concentrate on the task of development and to neglect the environment in the belief that there would be time later after the development has been achieved. It was not "development" and "environment", but "development and environment safeguarding" together . . . (there is) need for environmental consciousness at all stages of planning².

Two broad categories of environmental problems have been distinguished:

- problems arising from inadequacy of development, excessive population growth and poor social and economic conditions.
- problems arising in the process of development as negative side-effects, such as pollution and soil erosion.

These categories of problem are related to the master-planning work of the study for Pahang Tenggara as a part of the Malaysian economy and society. Attention is given to the more positive approach on enhancement of certain natural features in the Pahang Tenggara area that can contribute materially to a good environment. Both the issues and the kinds of policy measures that are being found most significant for developing as well as developed countries are cited.

and finally the recommendations made are brought together and more general recommendations are developed from them.

It may be worthwhile, at this point, to mention two factors which underlie the approach adopted here.

Firstly, it is recognised that development means change and this, in turn, means alteration in prior conditions. There is need, therefore, to identify limited areas worthy of preservation for purposes of scientific studies of natural biological communities which may be unique to the region. But the larger areas to be developed will require appropriate policies and programmes to produce and maintain a decent environment for the people who will live there. It is essential that this be done from the start because it becomes very difficult and costly to correct bad situations once they have been created.

Secondly, Pahang Tenggara being largely unoccupied provides a unique opportunity for introducing changes in settlement, land management and environmental practices that are desirable for Malaysia as a whole. The region can thus be something of a prototype for the introduction of new policies and programmes in other areas of the country, where it might well be more difficult to institute because of population density and existence of established operations and practices.

5.1 PROBLEMS ARISING FROM INADEQUACY OF DEVELOPMENT

The report of the panel of experts on Development and Environment commented thus¹:

The major environmental problems of developing countries are . . . predominantly problems that reflect the poverty and very lack of development of their societies. They are problems, in other words, of both rural and urban poverty. In both the towns and in the countryside, not merely the "quality of life" but life itself is endangered by poor water, housing, sanitation and nutrition, by sickness and disease and by natural disasters. These are problems, no less than those of industrial pollution, that clamour for attention in the context of the concern with human environment. They are problems which affect the greater mass of mankind.

¹ *Development and Environment*, Report by a Panel of Experts to the Secretary General of the United Nations Conference on the Human Environment, Founmex (Switzerland), June 1971.

² Statement by the Executive Secretary, *Seminar on Development and Environment*, Economic Commission for Asia and the Far East, Bangkok, August 1971, E/CN. 11/999, page 5.

¹ *Development and Environment*, Report by a Panel of Experts, op. cit. p. 1.

Malaysia is, of course, in a fortunate position compared to many other developing countries in that its level of per capita income is comparatively high, its social and public services are relatively well developed, and it has not experienced the effects of uncontrolled urbanization and metropolitan development to the same extent as other countries.

Having said this, however, problems remain: the Second Malaysia Plan outlines the strategies, priorities and programmes that are being adopted to overcome these problems and to achieve the objectives and goals of the New Economic Policy.

Within this general policy position, the Project has attempted to draw up the masterplan for the Pahang Tenggara region so as to achieve, within the region, national standards for economic and social development so that the region will contribute to realization of national objectives and goals. Full details of the components of the masterplan and of their contribution in these regards are to be found in other study reports and will not be repeated here. They do include, however, measures directed toward the establishment of per capita incomes in the region at levels at least equal to the prospective national averages over the next 20 years; creation of a diversity of job opportunities that will allow the use of different skills and will contribute to the enrichment and development of people; the setting up of an educational and training system appropriate to the region's needs and prospects; the interdependent development of urban and rural areas so that there will be no sharp discontinuities in incomes and opportunities between town and country people, the provision of housing, water, sanitation and health services at standards comparable to, or in advance of, those currently being followed or contemplated; and recommendations regarding flood control measures and siting of physical facilities so as to minimize damage and interruption from floods. One particular aspect of the study's recommendations does, however, require discussion here, since it appears to be at variance with the concern being generally expressed: this is the matter of urbanization.

Many countries, both developed and developing, are plagued by the unplanned, unchecked, sprawling growth of urban and metropolitan areas. These result in overcrowding, slums and squatter settlements, pollution of water systems and the atmosphere by the disposal of human waste and industrial effluents, and a heightened sensitivity to outbreak of endemic diseases associated with such conditions. Here, again, Malaysia is no exception, although its problems

may be of lesser degree in terms of scale if not with respect to the importance and extensiveness of the remedial measures needed.

In view of these difficulties and the likelihood of intensification of them, there has been something of a reaction against "urbanization" and an expressed desire to move people and industries out of urban centres and to disperse economic activity over wider geographical areas.

With this background, it may appear retrograde that the study is recommending a substantial degree of urbanization in Pahang Tenggara and, indeed, is proposing urbanization as an essential component of sound development. There are good reasons for this position however.

In part, the view of urbanization depends on the direction of approach: since Malaysia is a predominantly rural country with problems of rural poverty and lack of services, urbanization is more attractive than for a country which already has several multi-million cities and is very much aware of the attendant problems. It should be noted as well that the sizes of the urban centres being recommended for Pahang Tenggara are not large in comparison with those elsewhere that are causing most concern.

Moreover, it is considered—and extensive supporting evidence has been developed—that a certain degree of urbanization is mandatory for changes in occupational structure for the transformation of the economy and society of Malaysia that is a basic goal of the New Economic Policy.

And finally the cause of the problems associated with urbanization may have been attributed improperly to urbanization as such, whereas the failure lies in faulty urban institutions that result in poor services. A solution is not to be found solely through dispersal into rural areas; there is no guarantee that rural institutions in a rural setting will be less prone to failure, and the prospect of substantial population growth, despite population control programmes, indicates pressure on the absorptive capacity of rural areas which, in any case, already have problems of their own.

What is required is the provision of a good environment and living conditions both in urban and rural areas. The Project believes that this can be achieved, and its recommendations have been designed to help bring it about and to overcome problems arising from inadequacy of development.

Once again, the need for early action is stressed. The World Bank, in a report quoted in the *Straits Times* of 3rd December, 1971, states that the inadequate provision of water and sewerage facilities for urban communities in most developing countries can seriously hamper their economic growth, and lack of adequate facilities results in much higher costs for alternatives, increased medical costs, and reduced productivity. Although these comments related to water and sewerage only, it is considered that institution of proper land management and pollution control practices are equally necessary if permanent degradation of the country and its natural resources is to be avoided.

5.2 PROBLEMS ARISING IN THE PROCESS OF DEVELOPMENT

As was mentioned in the introduction, the general environmental approach being adopted for Pahang Tenggara recognizes, and accepts, that development of any kind unavoidably will alter the environment and the eco-system in the region. In light of this, it seeks to preserve existing natural conditions in certain limited areas and to introduce sound land management and environmental practices in the larger areas to be developed.

It could, of course, be argued that the best approach, from an environmental point of view, would be not to develop Pahang Tenggara at all, but to leave it largely untouched, i.e., to establish ecological considerations as being of primary importance. Remote though this consideration might appear to be for Malaysia; preservation of environments in a natural state is an option that many other countries would now like to have and that Malaysia itself might espouse if its rate of industrialization and population concentration were to be extremely rapid. However, the pace of these developments expected in Malaysia does not justify retaining such a large area outside alternative uses.

The ECAFE Seminar Report distinguished two types of negative side-effects from development: those which derive from development policies that do not give adequate attention to them but which are clearly avoidable through proper planning in advance; and those which are inherent in the development process but whose effect can be mitigated by adequate environmental planning, management and control. The following discussion relates to the provision that has been made for the two kinds of side-effects in the planning for Pahang Tenggara.

5.2.1 Human Settlement

Pahang Tenggara being virtually an empty area, there is the unique opportunity to create human settlements in both urban and rural areas which meet aesthetic, social and environmental criteria at costs no more than those currently being incurred in Malaysia.

Inevitably, settlement of substantial numbers of people in the region, together with the network of supporting infrastructure, will have substantial effects on the environment. At first glance it might appear that a more dispersed population would pose less concentrated environmental dangers than a more consolidated one, in that there would be a lesser impact in any one place and hence a better capacity for the environment to diminish the effect. However, the spreading of people over a wider area and the establishment of a more dispersed infrastructure creates wider zones of interference and raises the possibility that the effects of lesser damage in more places may be greater than that of more concentrated and more easily controllable settlements. It is sometimes argued that dispersal of people makes it easier to handle disposal of their wastes, but a contrary view is that concentration results in more effective and cheaper disposal.

Although there continue to be differences of opinion in these matters, it would appear that, on balance, urbanization (besides being advocated on developmental and social grounds as was mentioned earlier) can also advance as environmentally preferable. Moreover, detailed investigations reported in another Project paper have shown that the costs of providing a full range of infrastructure and services are less for single urban centres than for a number of rural settlements. This allows provision of the same standards at less cost or of higher standards at the same cost.

Two examples of higher service standards that have environmental implications are water supply and sewerage. As is described in detail under Water Resources, it is contemplated that piped water be supplied into every house in the region and that all houses be provided with septic tanks with tile drains or rockpits. These will be improvements both to the environment and to health. At a later stage it may be found worthwhile in the larger and more densely populated towns in the region to install complete sewerage systems and treatment plants, as part of the general need to upgrade sanitation standards in Malaysia.

5.2.2 Land and Water Management

A number of injurious practices can adversely affect the land and water resources of Pahang Tenggara, with both immediate and longer term consequences. These are discussed briefly below, and more extensive treatment of both land and water management can be found in other Project reports. Also, a publication by Wycherley¹ provides detailed information on many aspects of these matters.

5.2.2.1 Erosion

Removal of forest cover and cultivation on sloping land without adequate soil conservation measures can cause erosion, which will be of serious proportions on steeply sloping land, and can lead to eventual destruction of the soil base.

To counteract the dangers from this, land clearing operations are being arranged on two bases: the clearing only of land that is suitable, from a slope as well as an agronomic aspect, for agriculture; and sustained yield forestry operations on land permanently suited to forestry, including land of greater slopes. Agriculture will be restricted to land with slopes less than 20°, and it is recommended that rubber only be planted on land between 12° and 20°. Terracing is recommended wherever required to prevent erosion.

In general, planting of cover crops and the following of sound soil protection policies is being recommended for all agriculture within the region. Shallow soils are more subject to erosion than deeper soils and, therefore, require more careful management. Five points are particularly important for good land management practices:

- Land should be cleared when the probability of heavy rain is low
- Slash cover should be left on the surface whenever possible
- Fast growing cover crops should be established as soon as possible
- Proper fertilizers should be used to maintain crop growth and to upgrade the soil base
- Planting and cultivation should be done as much as possible following the natural contours of the land.

Erosion in higher catchment areas and off river banks because of improper forest and vegetative clearing contributes to downstream siltation of riverbeds, e.g. along the S. Pahang, and has intensified the damages from large scale flooding arising from heavy rainfall.

5.2.2.2 Fertilizers, Pesticides, etc.

A large number of chemical compounds are applied to the soil to develop crop growth and the soil base, to destroy weeds and, in some cases, trees, and to insects and other predators. It is important that usage and choice of such products be governed by environmental, as well as agronomic and economic, considerations.

Fertilizers when properly chosen and applied, are not polluters since they are absorbed into the soil and utilized by plants in the process of growth.

Chemical sprays such as insecticides, herbicides and fungicides, which are applied either to plants or directly to the soil surface are different, however. While they are widely recognized as essential requirements for achieving consistently high yields of good quality crops, they may and do cause pollution if not carefully selected and applied according to specifications. The harmful effects result from the fact that the chemicals are either not readily bio-degradable or are slow in dissolution. They tend to become progressively concentrated in the food chain at sufficiently high levels to be potentially dangerous to humans, animals and birds. The problem is compounded by the rapidly growing number of new and increasingly selective products becoming available for use without a corresponding increase in understanding among potential users of how to employ them properly.

Arboricides are not being recommended in the intensive forest management system being proposed by the study.

It is important that water catchment areas be identified and protected by suitable measures. In particular, the use of contaminants in the headwaters and the interior of conservation areas should be controlled and monitored.

In Pahang Tenggara it is recommended that several monitoring stations for study of the movement of contaminants be established, likely by MARDI and/or those responsible for the conservation areas. Their early establishment would allow full assessment of the effects of

¹ *Conservation in Malaysia*, International Union for Conservation of Nature and Natural Resources, 1969.

development on the environment, and would aid the taking of preventive measures at less cost and more effectively than remedial measures after substantial pollution had occurred.

5.2.2.3 Water Resources

The term water resources is used to refer to the relative availability of water in a condition suitable for a variety of purposes including human use, for industrial processes, for fisheries, for tourism and for recreation.

Reference has already been made to improvements being suggested for disposal of human wastes and will be made shortly regarding industrial operations; the desirability of preventing or minimizing water contamination from pesticides, etc. has also been referred to.

In general, the attempt should be made to avoid serious contamination of water resources and to maintain them in a condition where treatment processes need not be overly sophisticated or costly. This requires a variety of measures to regulate and safeguard against pollution which have been outlined in detail in a separate paper on water resources. The principal policy aspects of these measures are discussed later in this paper.

5.2.2.4 Mining

Large scale mining can have deleterious effects on the environment. Open-cast holes and slag heaps of the kind typical in tin and iron ore mining in Malaysia are unsightly and mar the countryside. The associated removal of vegetative cover contributes materially to erosion. Disused and abandoned mining pools that are breeding places for mosquitoes are a danger to public health.

In Pahang Tenggara, mining operations are now comparatively small since the iron ore operation at Bukit Ibam ceased. Prospective future mining operations should be conducted bearing environmental effects in mind; specifically, operations should be required to bear the costs of restoring vegetative cover for slag piles and to instal low-contaminant treatment processes that have been developed.

5.2.3 Industrialization

A succinct statement of the factors causing pollution by industry and of the results is to be found in the ECAFE Report already mentioned¹.

The general picture is that industries were set up mostly with a view to take the best economic advantage of urban locations, where infrastructure facilities existed, with little or no concern for environmental considerations. The developing countries in the region have become so preoccupied with the need for economic growth that the actual purpose of development is often forgotten; in their struggle to create new capacities some lose sight of the wider meaning of development, which is the creation of new qualities of life. Most of the governmental agencies concerned are without legislative power to enforce measures to maintain proper standards for discharge of industrial effluents and trade wastes. Some of the Governments have adopted industrial zoning which has made the problems of waste effluent much easier and more economic to deal with. However, these estates are still facing pollution problems owing to lack of funds for suitable disposal facilities.

Most industries are discharging their effluents and wastes directly into streams and rivers. A few industries have installed waste-treatment plants but they are reported not to be fully in use for lack of legal enforcement or of strong public protest. Since many of the industries are of small or medium scale their financial resources are limited and they are unable to instal anti-pollution equipment or plants. They need financial and technical aid from their Governments and banking systems. Their immediate concern has been to remain competitive. Unless there is adequate pressure to force them to incur additional expenditure on anti-pollution equipment they are unlikely to make the requisite changes, unless again these should suddenly become an economic proposition. In some cases, a new technology has developed or a market is found for new products which can be made by further processing the wastes.

Industrial activities, including primary and secondary resource processing, are foreseen to be an integral part of the development of Pahang Tenggara so that employment, income and social

¹ Human Environment in the ECAFE Region, *ibid.*, pp. 18-19.

development objectives can be met. In the light of the foregoing statement and the fact that legislation is minimal in Malaysia for pollution control in general and by industry in particular, it is evident that measures for control of pollution in the region can be a prototype for general measures for the country as a whole. These matters are discussed further later in this report and specific recommendations have been made in a separate paper on water resources.

In any event however, substantial environmental problems will arise from industrial activities in the region. The effluent from oil palm processing is believed to have comparatively little effect but the run-off from rubber processing can affect, depending on the process, drinking and irrigation water to various extents. Tapioca and sago production may cause some pollution and a distasteful smell. Canning operations for fruits and vegetables produce large quantities of refuse for disposal and thus increase the biological oxygen demand on river waters. The refuse from wood products processing, if not fully used, can also be harmful. Detailed investigations are needed into the effects for water—and air—pollution of these processing operations since it is clear that they could create major deleterious effects unless advance provision is made for lessening these.

Other, non-resource based, industrial activities in urban centres will also have environmental effects although it may be noted that recommended improvements in operations, e.g. the establishment of a single modern slaughterhouse for the beef production units and other animals, would be beneficial.

Evidently then, there is need for early formulation of policy and measures for pollution regulation and control in Pahang Tenggara as a component of national policies and programmes, if development of the region is not to be improper from an environmental aspect, with major impairment of the resources and usefulness of the area. The need for early formulation of such policy and measures cannot be overstressed.

5.3 NATURAL FEATURES IN PAHANG TENGGARA

Thus far the emphasis has been, unhappily, on the problems that arise from lack of development or from the development process itself. In this section the opportunity arises to present more positive aspects deriving from the enhancement of certain natural features in Pahang Tenggara which will benefit both people and wildlife.

There is no question but that a severe disturbance to indigenous wildlife will arise from the development of the region. The clearing of large areas of forest and conversion of the land to agriculture will be a deprivation of living space for animals; the settlement of substantial numbers of people in the area will create further possibilities for the harassment, and perhaps eventual extinction, of individual species or of wildlife as a whole. Moreover, if experience in other settlements in Malaysia is any guide, this process can be expected to be accelerated by the behaviour of the animals themselves: lacking adequate space and sometimes preferring cultivated rather than wild food, they have intruded into settlements and thus invited their own destruction.

With these considerations in mind, and with a desire to provide a good natural environment for the human inhabitants of the region, recommendations have been made, directed toward the preservation of indigenous flora and fauna, jungle wilderness, and scenic landscape in particular parts of Pahang Tenggara as a living national heritage to be studied and enjoyed by future generations of Malaysians and visitors to the country.

Certain specific criteria for development of these resources emerge from the general environmental approach being adopted and from the general principle that conservation means the wise use of resources on a perpetual yield basis, as follows:

- development should provide for educational and scientific, as well as recreational, purposes
- developments should be of different kinds that complement each other, rather than being similar and competitive
- developments should have regard not only to the local natural environment, but also to the local economy and society: it is desirable that none of these be wantonly destroyed
- developments should be of local, regional and international interest, and attract people from all of these origins
- developments should be planned and implemented within an integrated, multi-disciplinary framework of people and ideas, and should be managed by groups with similar, broad competence.

5.3.1 General

It is considered that a programme containing these five elements would be satisfactory for the people and wildlife in the region and would make a significant environmental contribution to Malaysia as a whole. Not the least part of this would be growing public awareness regarding environmental matters, which should be fostered also by an information programme that will educate people about the contribution they can make as citizens with pride in their country.

The development of the National Park and of Tasek Bera are of national significance and could be proceeded with at an early date, using the expertise of a variety of disciplines and organizations in the country. It is most important for success that the design and conduct of these developments in particular be undertaken within a wide framework of multi-disciplinary ideas and experience.

5.4 ISSUES AND POLICY MEASURES

The problems arising from environmental pollution, and the technical and economic factors underlying them, have been known for a long time. However, in the same way as widespread interest in the environment has developed only lately, so also analysis of the causes and effects of pollution in a manner suited to public policy formulation and action has been quite recent.

Comparatively little effort has been devoted to environmental problems in either an investigative or analytical sense. Fortunately, recent experiences in the United States and the United Kingdom, and the imminence of the 1972 United Nations Conference on the Human Environment, have stimulated much long-needed research. In general, however, it may be said that action at national government levels to translate this new knowledge into specific environmental programmes continues mostly to be both little and late. Both in Malaysia as a whole and Pahang Tenggara in particular, there is need for early action.

The following paragraphs deal with some important issues to be considered in framing policy in both developing and developed countries, and the kinds of counter-measures being considered.

5.4.1 The Economic Cause of Environmental Deterioration

The underlying economic reason for environmental problems is a shortcoming in the ability of economic systems to take account of environmental costs.

A recent U.S. Report comments thus¹:

... When full production costs are included in the prices of final products, the market allocates resources efficiently. If, however, all costs are not included—for example, the costs to society of environmental degradation—then the resulting prices of the products are too low. When products are underpriced, consumption of them is higher than it would be if all costs were included. Consequently, compared with other products, too many resources are devoted to their production. To the extent that the costs of preventing undesirable environmental impacts are not reflected in the price of goods and services, the market fails to allocate resources efficiently, and too much waste is produced.

The common property resources—air and water—do not fully enter into the market exchange. They are progressively degraded because they are used as free “dumps” for consumption and production residuals. But such dumping, in fact, exacts positive social costs. It comes at a high price to society—in degraded air and water, impaired health, loss of fish and wildlife, loss of recreational opportunities and aesthetic values, and added costs of treatment necessary for downstream water users. Yet these social costs are not to be found in the credit and debit ledgers of dischargers.

Excessive pollution and degradation of the environment are thereby encouraged. Indeed, little else should seriously be expected. Environmental problems stem largely from this fundamental failure of the economic system to take account of environmental cost

¹ *Environmental Quality*, the Second Annual Report of the Council on Environmental Quality, August 1971, p. 102.

A Report from the United Kingdom expressed the matter thus¹:

The economic reason why society may not strike the right balance between economic output and the quality of the environment is that the costs of many kinds of pollution are borne not by the polluters, but by somebody else. As a result these "external" costs will not, in general, be taken fully into account by firms, individuals or other bodies who cause pollution. The other side of the coin is that those who spend money on reducing pollution may not always be the people who gain from the resulting improvement in the environment. This applies both to "tangible" pollution, such as the poisoning of fish in polluted waters, and to "intangible" pollution, such as unpleasant smells or ugly landscapes.

This characteristic of pollution has three main consequences:

- (a) Output of goods and services which give rise to pollution tends to be pushed beyond the socially optimum point. Also, expenditure to reduce pollution will often be inadequate
- (b) There is generally not enough incentive to reduce the amount of pollution per unit of output of the goods and services responsible, so that not enough resources and effort are devoted to this objective
- (c) Insofar as pollution costs are not borne by those who cause pollution or by the purchasers of their products, but by those who happen to be the victims of the pollution, some of the total welfare resulting from the economic activity of the community is being redistributed away from the victims of pollution in favour of other groups in the community

5.4.2 The Burden of Pollution Cost

While pollution control or reduction does cause increased costs for society as a whole at any given level of national output, in the sense that the transfer of real resources to pollution removes the resources from alternative use, there are counter-vailing benefits. Firms and departments engaged in pollution control will generate employment and

incomes in these new lines of activity, water and air will be cleaner and more readily useable, and health treatment and other costs will be relatively less. However, as noted, the costs and benefits will be experienced to a large extent by different groups of people.

The question of who bears the costs of pollution is germane not only on grounds of equity as between individuals or groups but also in terms of the relative efficiency of the countermeasures that might be adopted; how should the monetary costs of keeping a good environment be apportioned throughout the economic system so as to bear fairly between individuals and groups and be most efficient in improving the allocation of resources? The answer on economic grounds is to be found by placing the burden of cost on the products, firms or agencies creating the pollution. As the U.S. Report earlier mentioned, said:

A primary issue is whether the costs of pollution control will be borne by the goods whose production pollutes or whether they will be paid for from general tax revenues. In the United States, the primary responsibility for preserving and cleaning up the environment rests with those who degrade it, and prices of products reflect environmental cleanup costs. Not only is this policy fair and consistent with our system of assigning costs, but it leads to lower total pollution costs as consumers shift purchases toward goods that make fewer demands on the environment.

The U.K. Report commented similarly (page 6):

Alternative legal or institutional arrangements could be made to ensure that the costs of pollution . . . did enter into the calculations of the polluters like any other production costs. These costs would then play their full part in determining how far society should go in reducing pollution, and would no doubt lead to less pollution, other things being equal.

While the effect on different products, industries and firms will depend on the market conditions for both sale of products and purchase of supplies (e.g. on degree of monopoly, product substitution, and demand inelasticity) it is evident that attribution of costs directly to pollutant sources is the better method of shifting the allocation of resources in the desired direction.

Malaysia has not yet encountered these policy issues to the same extent as more advanced (and more polluted) countries, but it is desirable that

¹ Royal Commission on Environmental Pollution. First Report, February 1971, p. 4.

it formulates its position in advance of experiencing the worst effects from degradation of the environment.

This will produce a better country for people to live in and enjoy, and will be less costly than trying to correct bad situations later.

5.4.3 Costs and Benefits

Decisions on attaining and maintaining different levels of environmental quality need to take into account the benefits to be attained and the costs to be incurred. Measurement of costs and benefits in a meaningful way is a difficult thing to do at any time; in matters of the environment it is, paradoxically, somewhat less difficult for countries in which substantial degradation has already occurred than for countries of regions where the environment is relatively unspoilt. But the requirement to try to visualize what costs might be if extensive pollution were to occur is the more fortunate situation, and should be used as a basis for formulating policy measures and programmes.

At the same time, the environment cannot be put in a class by itself, with priority over all other social and economic goals and objectives. The U.K. Report already mentioned has some pertinent comments (page 6):

The social benefits of cleaner air and water, less noise and a more pleasant landscape, have to be put into perspective with other claims on resources, such as housing, health and education, or private consumption and investment. Nobody would suggest that the allocation of resources amongst these uses should be based on an "all-or-nothing" approach. For example, it would hardly be suggested that health has some absolute priority over all other social needs. Ideally, we might all like to have pure water and complete freedom from noise and dirty air; but in practice we might tolerate some shortcomings in the environment in the interests of having, say, better schools, or better health or cultural facilities than we now enjoy. So long as resources are limited, choices have to be made between alternative ways of using them. There is no social merit in making exaggerated claims for one particular form of expenditure to the detriment of others which, to many people, may be more important.

The Report also makes the point that the choice to be made is not only between pollution in the aggregate and all other uses of resources; it is also between different kinds of pollution.

"What is needed is a careful prediction of the long-term ecological effects of various kinds of pollution, together with a sober analysis of their short-term impact. But there is no time to be lost in trying to determine priorities, since improvement in the environment take a long time to achieve. Furthermore, the choice does not depend simply on which forms of pollution appear to be the most "undesirable", since the relative costs enter into choices between different forms of pollution abatement.

The U.S. Report quoted earlier makes similar points and enlarges on the matters of cost variation (pages 118-121):

Costs of curbing the amount of discharged wastes vary at different levels of abatement.

Attaining low levels of control is relatively inexpensive but becomes more costly as higher levels of abatement are attained.

Besides the overall issue of comparative benefits and costs of attaining different levels of quality, there are possibilities to achieve the same benefits at greatly differing costs, depending on how standards are attained. A number of analyses indicate wide variations in costs of achieving a given quality level. For example . . . it is much cheaper to reduce air pollution the most where it costs the least than to try to cut it proportionately at every source . . . it costs less to achieve the same results by avoiding uniform treatment and using a least-cost solution instead. (A particular) study indicates that a dissolved oxygen level of at least 3 parts per million would cost about twice as much with uniform treatment as at a least-cost solution. The latter would demand large waste load reductions from firms with low abatement costs and smaller reductions from firms with higher costs.

5.4.4 Strategies for Achieving Environmental Goals

These matters of varying methods and costs of obtaining levels of environmental quality are important also for the choice of strategies for achieving environmental goals.

Thus, the U.S. Report, in a detailed discussion of different strategies (pages 134-144), observes that while environmental standards that call for uniform or proportionate reductions by all dischargers might appear equitable they may also be inefficient and expensive, and bear unequally

on newer and older plants and on their sales and profits. The same pollution control results could be achieved at far less cost if those with low costs treat to high levels and vice versa. This would require, however, detailed knowledge of costs of reduction for each source—which is impracticable—and would in turn introduce grounds of inequity since operators of plants with high abatement costs would escape responsibility.

Quite apart from these questions, however, standards do have several merits:

the principles are simple and straightforward and build upon an existing legal structure.

Though explicit information on benefits and costs leaves much to be desired, standard-setting does provide mechanisms for collective decisions of their value in determining desired levels of environmental quality.

... unlike some subsidy measures, they do not discourage firms from using a variety of alternative abatement measures. ... by choosing the best mix of process changes, improved management, and treatment to meet the standards.

Total reliance on regulatory authority does, however, raise problems. Some have been noted above; additionally they arise in the initial establishment of the standard and then in the proof of violation, and these responsibilities can delay enforcement—sometimes for several years or even a decade or more.

The levying of charges against dumping of waste materials into the environment is a useful complementary method to standards:

Charge levels could be set to stimulate each discharger toward positive and effective action to cut pollution. Manufacturers would have an incentive to change production processes, improve internal plant management of wastes, and rely more heavily on recycling and recovery to reduce waste discharge. They would be encouraged to seek out and use new technologies rather than debating their technical feasibility

As the costs of pollution control are incorporated into the market structure, producers and consumers of high pollution goods would carry their share of the burden. And as prices of goods reflect the relative costs of pollution abatement, consumers would, to some extent, shift to goods that embody lower environmental costs.

By placing the cost responsibility on the polluters, charge systems are equitable. The operator of a plant where reductions are possible only at high costs is not forced to make large reductions. But neither does he continue to pollute without bearing the burden of the charge and thereby win a competitive advantage over those who undertake control and incur the costs. By placing an equal charge on all dischargers, the charge system provides an equitable basis for achieving greater efficiency in meeting environmental standards.

As a result, the U.S. Report recommends a combination of regulation and charges. It does not endorse financial aids, like special capital cost allowances, grants and loans, as appropriate long-term measures. Their individual characteristics differ but, in general, such financial aids create a bias toward capital spending for pollution control (whereas preferred ways can be through process changes, improved plant management, and reuse and recycling of materials) and, since the costs of these aids are not fully reflected in product prices, they do little to shift consumption patterns and thence the allocation of resources.

It would seem that both standards and charges would be appropriate for Malaysia as a whole, but that properly established and enforced standards would be adequate in Pahang Tenggara where pollution can be curbed right from the start.

5.4.5 International Effects

With the growing international concern for the environment, the actions of individual countries regarding environmental control within their own borders have implications for their international trade position and that of other nations.

As the U.S. Report states (pages 131-133), the balance of advantage will depend on several factors:

- the extent to which nations allow the costs of pollution controls to be reflected in product prices, as distinct from being subsidized from general tax revenues.
- even if there were international agreement that product prices absorb environmental control costs, countries will experience different levels of cost depending on product mix, absolute levels of production, climatological and topographic factors.

- environmental control standards will not be the same in each nation.
- nations may use product standards as disguised non-tariff barriers, setting standards that are more easily met by their own producers or applying them in a discriminatory way.

This shifting in balance is a continuing process, as the Report mentions (page 133):

Whatever competitive advantages foreign products enjoy in the near term will shift as all nations begin to upgrade environmental quality. All of the industrialized nations are actively engaged in environmental protection programmes of some sort. However, the United States is generally conceded to be considerably ahead—both in the degree of control and the quality of control technology. In the future, as other countries begin to make large investments in pollution control facilities, the U.S. position in world trade markets should improve. Moreover, its technological lead should establish the United States as an exporter of pollution control devices and engineering competence.

The ECAFE Seminar Report also gave detailed attention to the international implications of environmental controls, mentioning specifically the possibility of "neo-protectionism" and the effects on the transfer of technology of higher-cost, non-pollutive, plant and equipment being supplied by advanced countries to less developed countries (although this might be beneficial in the long run). On the other hand, the pattern of international investment might be affected, particularly if developing countries with a higher margin of environmental safety could participate in certain industrial fields which would become more costly for the developed countries because of the higher cost of environment protection in these countries.

Besides touching on a number of other important issues, the Seminar Report commented in general thus (page 20):

Developing countries had to be prepared to deal with the possible impact on them of the measures being taken by industrialized countries in dealing with their own environmental problems. They would have to be well informed and organized, both to minimize the difficulties and to benefit from the opportunities which might arise from such measures.

5.4.6 Specific Considerations

The ECAFE Seminar on Development and Environment arrived at a number of considerations and recommendations on the basis of its assessment of environmental issues with respect to the countries in South-east Asia. Since these are comprehensive statements, they are reproduced in full (page 17-19):

In concrete terms, environmental concern, while pursuing development, should mean a number of things, e.g.:

- (1) Study proposals submitted for approval of authorities should be required to include, as far as possible, an assessment of the environmental impact of the project. The licensing or approving authority should take an over-all view of the joint impact environment of a number of projects and activities. Costs of after thought ecological and environmental palliatives were often much higher than the additional cost of providing for environmental corrective action at the outset.
- (2) So far as possible, alternative investment projects relating to the production of a product or a complex of products should not only specify the technological differences between the alternatives but also the differences, if any, in their effect on the environment.
- (3) Efforts should be made to foresee the demand for products which were likely to give rise to environmental degradation by their use or by their production, if no intervention were made. In such cases, investment licensing, direct controls or fiscal measures (including subsidies and taxes, and effluent charges) should be used to prevent the demand arising and supply responding if the product were not considered essential, or favouring technologies which were less pollutive.
- (4) By adequate physical planning, taking the spatial and locational aspects into account, much could be done and more economically by way of providing the minimum necessary infrastructure for urban development and avoiding serious deterioration of the quality of the environment.
- (5) The ecological approach can help in designing a more satisfactory strategy for rational use of natural resources. Planning in such matters should clearly recognize

the limits to exploitation as well as the opportunities for development. In particular, it should seek to identify ecologically fragile areas and, in general, set out guidelines for intelligent use of land, marine and other resources.

(6) Regional and local planning should be strengthened and competence created to undertake over-all planning and environmental management and control.

(7) In view of the general scarcity of resources, on every issue of choice involving resource allocation an answer would depend on careful weighing of costs and benefits. No satisfactory answer could be given unless both costs and benefits were analysed and compared. Hence, there was a need for greatly improving the data base and research for planning and analysis in the environmental field. A good deal of attention should therefore be given to quantification it was suggested that each country should take urgent steps to establish appropriate machinery for environmental planning, management and control, working in close association with the machinery of planning for economic and social development.

Such machinery, with adequate resources at its command, could be entrusted with the task of (a) conducting environmental surveys and appraisal of existing policies and legislation for environmental control, (b) working out environmental standards by way of (i) "goals" of development (e.g. nutrition) to be achieved and (ii) limits (e.g. pollutants) not to be exceeded, (c) developing indicators of environmental

situation, (d) making quantitative evaluation of the impact of the environment of different kinds of activities and evaluation of alternatives from the environmental angle, (e) interpreting development policies in terms of environmental factors, (f) undertaking studies directed to relating environmental concerns with planning methods, analyses and procedures, (g) making recommendations for strengthening environmental work in terms of well-conceived priorities and in regard to the most appropriate authorities and institutions for environmental control, (h) stimulating and assisting research into all aspects of environmental control, (i) advising on the adequacy of training arrangements for personnel required for environmental work, (j) publishing works on environmental problems, (k) offering any other device desired by the Government on environmental matters.

Few, if any, countries in the world have achieved such a standard of performance in the field of environmental assessment and control. Nevertheless, these are the kinds of steps which are required, are being recommended and are being adopted. It is desirable that Malaysia, in its own domestic and international interests and for both economic and social reasons, proceed similarly, after investigation of which actions are most appropriate for its circumstances.

The environmental considerations in the development of Pahang Tenggara can thus be a prototype for the formulation of national policy. The foregoing description of considerations and action recommended in the region are intended to assist in the formulation of policy and to provide a basis for action within the region.

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7.0 APPENDIX

7.1 PARK ADMINISTRATION

7.1.1 GENERAL

Extract from the National Parks and Wildlife Conservation Act, 1964.

1.1.1.1

The National Parks and Wildlife Conservation Act, 1964, provides for the establishment of National Parks and Wildlife Reserves.

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The National Parks and Wildlife Conservation Act, 1964, provides for the establishment of National Parks and Wildlife Reserves.

7.2 Weekly programmes of trips, talks, etc. Mountain climbing.

8. Hunting prohibited. Fishing allowed. Renting of boats and horses. Pets allowed only on leash.

9. Accommodation; Private purchase.

— hotels

— grouped shelters or cabins, fully equipped

— tent camping; sanitary facilities, wash bowls and showers, rubbish receptacles

— isolated cabins with sanitary facilities

10. First aid posts located near but outside of park

11. First aid posts

7.2 TASEK BERA FLORA

7.2.1 Aquatic Plants

(a) Submerged	<i>Blasia schimperiana</i>
	<i>Ceratophyllum demersum</i>
	<i>Hydrilla verticillata</i>
	<i>Potamogeton nodosus</i>
	<i>Utricularia</i>
(b) Floating	<i>Najas</i>
	<i>Utricularia</i>
	<i>Utricularia</i>
(c) Rooted	<i>Archamia</i>
	<i>Dendrobium</i>
	<i>Eleocharis</i>
	<i>Eleocharis</i>
	<i>Eleocharis</i>
	<i>Eleocharis</i>
	<i>Eleocharis</i>
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	<i>Eleocharis</i>
	<i>Eleocharis</i>
	<i>Eleocharis</i>

Preliminary Checklist of Higher Plant Community in Tasek Bera and Vicinity. (Data provided by Dr E. Soepadmo, University of Malaya)

7.0 APPENDIX

7.1 PARK ADMINISTRATION JURISDICTIONS AND SERVICES

Extracts from: The National Parks of the United States, Louis A. Bolin, Knopf, 1962.

1. The Park Service:

Function ...	Conservation of landscape, natural and historic objects, and wildlife.
Duties ...	Lays out and builds roads and trails and sets up camping zones.
Contracted out ...	Hotels, inns, cabins, shelters, public transportation.
Charges ...	Small charges for park entry and for guide services.
Interpretative Services	Lectures, talks, advice to public.

- Road signs before reaching, at and inside. Rural look and clarity.
- Roads inside of excellent standard and built for volume traffic. Leaflets and look-out tables, numbered features.
- Camping areas (with water and sanitation); hotels and wood shelters; restaurants, canteens, cafeterias; shops for clothing, foodstuffs, other supplies; souvenirs and curios; postcards.
- Residences for park supervisor, rangers, Park museum with books, libraries; maps; scale models; complete local flower collections; trail maps; fauna specimens fossils; geological models; dioramas; climatic records; auto biological data on primitive peoples.
- Lookout parking areas, trails to vantage points; sanitary facilities; drinking fountains.

- Weekly programmes of trips, talks, etc. Mountain climbing.

- Hunting prohibited, Fishing allowed. Renting of boats and horses. Pets allowed only on leash.

- Accommodation; Private enterprise.

- hotels
- grouped shelters or cabins, fully equipped
- tent camping; sanitary facilities, wash-bowls and showers, rubbish receptacles
- isolated cabins with sanitary facilities
- motels located near but outside of park.

- Fire precautions

7.2 TASEK BERA FLORA

7.2.1 Aquatic Plants¹

- | | | |
|---------------|-----|---|
| (a) Submerged | ... | <i>Blyxa echinosperma</i>
<i>Cryptocoryne griffithii</i>
<i>Hydrilla verticillata</i>
<i>Potamogeton malaianus</i>
<i>Scirpus confervoides</i> |
| (b) Floating | ... | <i>Nymphoides indica</i>
<i>Utricularia aurea</i> (yellow flowered)
<i>Utricularia flexuosus</i> (pink flowered) |
| (c) Rooted | ... | <i>Archytaea vahlII</i>
<i>Dendrobium aloifolium</i>
<i>Elaeocarpus sp.</i>
<i>Eleocharis ochrostachys</i>
<i>Eriocaulon sexangulare</i>
<i>Flagellaria indica</i>
<i>Gynotroches axillaris</i>
<i>Lepironia articulata</i>
<i>Ludwigia stipitata</i>
<i>Lycopodium cernuum</i>
<i>Nepenthes gracilis</i>
<i>Pandanus helicopus</i>
<i>Scirpus mucronatus</i> |

¹ Preliminary Checklist of Higher Plants Occurring in Tasek Bera and Vicinity. (Data provided by Dr E. Soepadmo, University of Malaya).

7.2.2 Terrestrial Plants in Forest Edge of Tasek¹

Trees or Shrubs	Woody Climbers
<i>Artocarpus scortechninii</i>	<i>Agelaia trinervis</i>
<i>Baeckia frutescens</i>	<i>Bauhinia</i> sp.
<i>Castanopsis javanica</i>	<i>Cnetis palala</i>
<i>Eugenia</i> spp. (5 species)	<i>Entada</i> sp.
<i>Fagraea fragrans</i>	<i>Gretum latifolium</i>
<i>Garcinia nigrolineata</i>	<i>G. genmonoides</i>
<i>Gardenia singaporeana</i>	
<i>Ixonanthes reticulata</i>	
<i>Ixora</i> spp.	
<i>Koompassia malaccensis</i>	
<i>Lithocarpus elegans</i>	Ferns and Allies
<i>L. wallichianus</i>	
<i>Ormosia parvifolia</i>	<i>Bolbitis</i> sp.
<i>Pittosporum</i> sp.	<i>Lycopodium cernuum</i>
<i>Rhodamnia cinerea</i>	<i>Lygodium</i> spp.
<i>Sindora intermedia</i>	<i>Taenitis</i> sp.
<i>Tristania sumatrana</i>	<i>Tectaria</i> sp.

7.2.3 Terrestrial Plants in Inland Forest of Tasek Bera¹

<i>Baccaurea parviflora</i>	<i>Elatiospermum tapos</i>
<i>Barringtonia spicata</i>	<i>Fibraurea chloroleuca</i>
<i>Canarium littorale</i>	(woody climber)
<i>C. patentinervium</i>	<i>Grewia latifolia</i>
<i>Castanopsis inermis</i>	<i>Girroniera parvifolia</i>
<i>C. javanica</i>	<i>G. subaequalis</i>
<i>C. rhamnifolia</i>	<i>Gynotroches axillaris</i>
<i>C. schefferiana</i>	<i>Payena</i> sp.
<i>Clerodendron corymbosum</i>	<i>Parinarium corymbosum</i>
<i>Cratoxylon arborescens</i>	<i>Nauclea</i> sp.
<i>Dillenia reticulata</i>	<i>Rinorea</i> sp.
<i>Dipterocarpus costulatus</i>	<i>Shorea leprosula</i>
<i>Dysoxylum cauliflorum</i>	

7.3 TASEK BERA FAUNA

7.3.1 Fishes²

Dasyatidae

Dasyatis Uarnak (Forsk.).

¹ Preliminary Checklist of Higher Plants Occurring in Tasek Bera and Vicinity. (Data provided by Dr E. Soepadmo, University of Malaya).

² Preliminary Checklist of the Fishes of Tasek Bera and Pahang River. (Data provided by Dr E. Alfred, Singapore National Museum).

Akysidae

Acrochordonichtys Ischnosoma Blkr.

Acrochordonichtys Melanogaster (Blkr.)

Acrochordonichthys Rugosus (Bleeker).

Anabantidae

Anabas Testudineus (Bloch).

³ *Belontia Hasselti* (c.v.).

Betta Pugnax (Cantor).

³ *Helostoma Temmicneki* c.v.

² *Osphronemus Goramy* Lac.

³ *Trichogaster Trichopterus* (Pall).

Trichopsis Vittatus (Cuvier).

Bagaridae

² *Bagarius Bagarius* (h.b.).

Glyptothorax Majus.

Glyptothorax Playpogon (c.v.).

Glyptothorax Playpogonoides (Blkr).

Bagridae

Leiocassis Baramensis Reg.

Leiocassis Micropogon (Blkr).

Mystus Cavasius (Hamilton).

M. Nigriceps.

¹ *Mystus Nemurus* (c.v.)

Mystus Planiceps (c.v.)

Mystus Wycki (Blkr)

Belonidae

Xenentodon Canciloides (Blkr)

Clariidae

Clarias Batrachus (L.)

Clarias Meladerma Blkr

Clarias Nieuhoi c.v.

Clarias Teysmanni Blkr

Cobitidae

Vaillantella Flavofasciata

Cyprinidae

Acrossocheilus Deauratus (c. & v.)

A. Hexagonolepis

¹ *Amblyrhynchichthys Truncatus* (Bellker)

¹ *Balantiocheilus Melanopterus* (Blkr)

Barbichthys Laevis (c.v.)

Barbus Pahangensis

Barbus Soroides

¹ *Barilius Guttatus* Day

¹ *Barynotus Microlepis* (Blkr)

¹ Large food and sport species.

² Large food and sport species.

³ Aquarium species of special significance.

- 2 *Cyclocheilichthys Apogon* (c.v.)
- 2 *Cyclocheilichthys Armatus* (c.v.)
- Cyclocheilichthys Heteronema* (Blkr)
- Cyclocheilichthys Repasson* (Blkr)
- Dangila Cuvieri Valenciennes*
- Dangila Fasciata* (Bleeker)
- Dangila Lineata Sauvage*
- 1 *Hampala Macrolepidota* (c.v.)
- Labiobarbus Cuvieri* (c.v.)
- Labiobarbus Fasciatus* (Blkr)
- Labiobarbus Lestiva* (Heckel)
- Labiobarbus Ocellatus* (Heck)
- Labiobarbus* sp.
- Leptobarbus Hoeveni* (Blkr)
- Lissochilus Deuratus* (Valenciennes)
- Lissochilus Normani* Smith
- Lissochilus Tweediei* Herre & Myers
- Lobocheilus Cornutus* Smith
- Lobocheilus Quadrilineatus* (Fowler)
- Luciosoma Bleekeri* (Steindachner)
- Luciosoma Setigerum* (c.v.)
- Luciosoma Trinema* (Blkr)
- 1 *Morulius Chrysophekadion* (Blkr)
- Mystacoleucus Marginatus* (c.v.)
- Osteochilus Brachynotopterus* (Blkr)
- 1 *Osteochilus* sp.
- 2 *Osteochilus Hasselti* (c.v.)
- Osteochilus Kahanjanensis* (Blkr)
- 1 *Osteochilus Melanopleura* (Blkr)
- Osteochilus Microcephalus* (Valenci Ennes)
- Osteochilus Vittatus* (c.v.)
- Osteochilus* sp.
- 3 *Probarbus Jullieni* Sauvage
- Puntius Binotatus* (c.v.)
- 1 *Puntius Bulu* (Blkr)
- Puntius Daruphani Tweediei*
- 2 *Puntius Eugrammus* (Silas)
- 2 *Puntius Fasciatus* (Blkr)
- Puntius Halei* (Duncker)
- 2 *Puntius Lateristriga* (c.v.)
- 2 *Puntius Partipentazona* (Fowler)
- 1 *Puntius Schwanefeldi* (Blkr)
- 1 *Rasbora Bankanensis* (Bleeker)
- 2 *Rasbora Cephalotaenia* (Bleeker)
- Rasbora Dorisocellata* Duncker
- Rasbora Elegans* Volz
- 2 *Rasbora Heteromorpha* Duncker

- 1 Large food and sport species.
- 2 Aquarium species of special significance.
- 3 Endangered Specie.

- Rasbora Leteristriata* (Bleeker)
- Rasbora Myersi* Brilltan
- 2 *Rasbora Pauciperforata* w. & de b.
- Rasbora Retrocorsalis* Smith
- Rasbora Sumatrana* (Bleeker)
- 2 *Rasbora Taeniata* Ahl
- 2 *Rasbora Trilineata* Steindachner
- 1 *Tor Douronensis* (c. & v.)
- Tor Tamba* (c.v.)
- Tor Tambroides* (Blkr)

Eleotridae

- Eleotris Insulindica* (Bleeker)
- Ophiocara Porocephala* (c.v.)
- Oxyeleotris Marmoratus* (Blkr)

Gobiidae

- Acentrogobius Balteata* (Herre)
- Glossogobius Biocellatus* (Valenciennes)
- Glossogobius Celebius* (Valenciennes)
- Glossogobius Giurus* (h.b.)
- Periophthalmus Argentilineatus* c.v.

Gobiidae

- Stigmatogobius Isognathus* Bleeker

Homalopteridae

- Homaloptera Leonardi* Hora
- Homaloptera Nigra* Alfred
- Homaloptera Ocellata* v.d. Hoeven
- Homaloptera Orthogoniata* Vaillant
- Homaloptera Zollingeri* Blkr

Luciocephalidae

- Luciocephalus Pulcher* (Gray)

Mastacembelidae

- Macrogathus Aculeatus* (Bl.)
- Mastacembelus* sp.

Mastacembelidae

- 2 *Mastacembelus Maculatus* c.v.

Nandidae

- 2 *Nandus Nebulosus* Blkr
- 2 *Pristolepis (catopra) Fasciatus* (Blkr)

Nototeridae

- 1 *Notopeterus Chitala* (h.b.)
- 1 *Notopterus Notopterus* (pallas)

Ophiocephalidae

- Channa Lucius*
- Channa* sp.

- 1 Large food and sport species.
- 2 Aquarium species of special significance.

Channa Maruloides

Channa Melanoptera

Channa Micropeltes

Ophiocephalidae

Channa Striata

Ophicephalus Gachua

Osteoglossidae

¹ *Scleropages Formosus* (Mull. & Schl.)

¹ Large food and sport species.

Pangasidae

Lalates Hexanema (Blkr)

¹ *Pangasius Ponderosus* Herre & Myers

Synbranchidae

Fluta Alba (Zuiew)

Tetrodontidae

Chonerhinus Modestus (Blkr)

² *Tetraodon Leiurus* Bleeker

² *Tetraodon Palembangensis* Bleeker

¹ Large food and sport species.

² Aquarium species of special significance.

7.3.2 Birds¹

Order Ciconiformes (herons) ...	...	...	...	one family, 6 species
Order Anseriformes (ducks) ...	...	...	...	one family, 1 species
Order Falconiformes (hawks and eagles) ...	...	...	...	three families, 8 species
Order Galliformes (pheasants and partridges) ...	...	...	...	one family, 5 species
Order Gruiformes (bustard quails) ...	...	...	...	one family, 11 species
Order Charadriiformes (painted snipe) ...	...	...	...	three families, 8 species
Order Columbiformes (pigeons and doves) ...	...	...	...	one family, 5 species
Order Psittaciformes (parrots) ...	...	...	...	one family, 2 species
Order Cuculiformes (cuckoos) ...	...	...	...	one family, 15 species
Order Strigiformes (owls) ...	...	...	...	two families, 5 species
Order Caprimulgiformes ...	...	...	...	two families, 3 species
Order Apodiformes (Swifts) ...	...	...	...	two families, 8 species
Order Trogoniformes (trogons) ...	...	...	...	one family, 3 species
Order Coraciiformes (Kingfisher) ...	...	...	...	four families, 19 species
Order Paciformes (barbets, woodpeckers) ...	...	...	...	three families, 13 species
Order Passeriformes ...	...	...	...	twenty families, 66 species

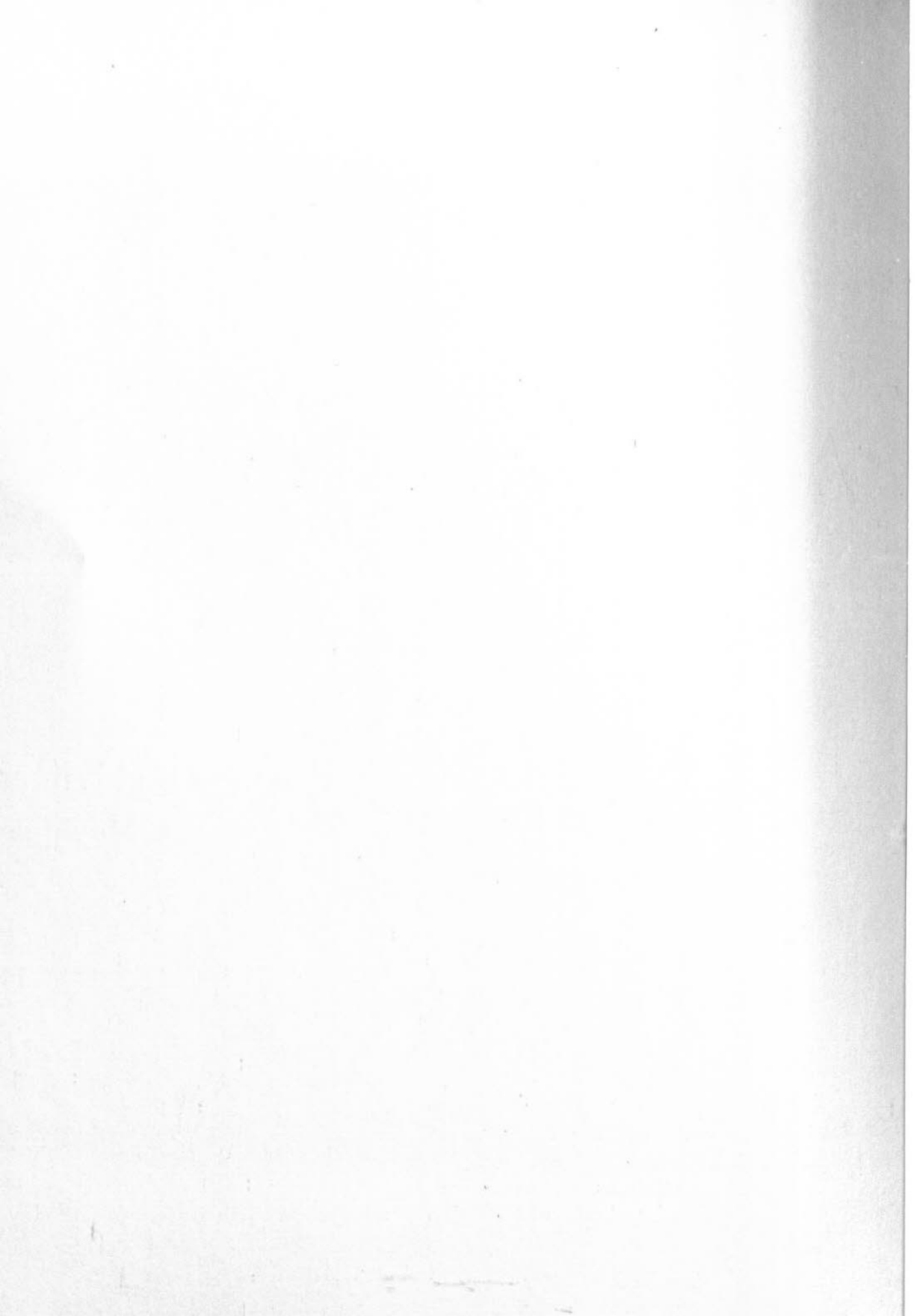
¹ Preliminary Checklist of Orders of Birds Typical of the Tasek Bera (extracted from list of Lord Medway, Unpublished).

7.4 INVESTMENT AND PRODUCTION COST DATA FOR A HALF-ACRE FISH POND

	Total Outlay	Annual Cost
	\$	\$
<i>Investment</i>		
Water Control System	275	14
Pond Construction:		
Equipment and Materials	43	2
Labour	600	30
	<u>918</u>	<u>46</u>

Operating Costs

	\$
Labour (\$3 per man day)	18
Fertilizer Application	36
Bund Maintenance	12
Harvesting	25
Fertilizer—150 lb.	15
Lime—5 cwt.	1
Polythene Bags for Fertilizer	3
Nets	<u>110</u>



HUNTING TECHNICAL SERVICES

PAHANG TENGGARA REGIONAL MASTERPLANNING STUDY

**Geology and Mineral Resources
in Pahang Tenggara**

Geology and Mineral Resources in Pahang Tenggara

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1.0 INTRODUCTION

1.1 TERMS OF REFERENCE

The terms of reference for the geological study of Pahang Tenggara are as follows:

"Study the mining potential to determine the areas likely to contain workable deposits of exploitable minerals where further prospecting should be carried out. This information is necessary to ensure that mining development possibilities are fully considered in the master-plan and that, at a local level, the phasing of agricultural and forest development activities should not conflict with possible mining developments. The study will involve analysis of all available geological, mineral prospecting, and mining data for the region and the consultants will be expected to work closely with the staff of the Geological Survey and Department of Mines. Recommendations for carrying out prospecting work in the future, particularly in respect of minerals other than tin, will be required".

2.0 TOPOGRAPHY AND DRAINAGE

2.1 GENERAL DESCRIPTION

Almost the entire eastern one third of the area is underlain by Quaternary alluvium with a few small hills rising above the swamp. A hilly area in the form of an inverted U occupies the north-west and north-central region. These hills are a reflection of the underlying geology with the legs of the U being composed of resistant conglomerate, quartzite and sandstone, and the interior lowland by softer shales and mudstone. Another hilly area in the southeast again reflects the presence of sandstone and volcanic rocks that are more resistant to weathering than the granites to the west.

The drainage pattern is also a reflection of the underlying geology. In the northwest Sg. Jeram and its tributaries drain the area underlain by the soft shales and related rocks of the Tembeling Group. Sg. Pukin, Jekatih and Keratong and their tributaries are almost entirely confined to the central area of granite. Sg. Anak Endau and Sikin, which follow linear valleys, have their positions controlled by northwest-southeast faults. The western portion of the area west of the Tembeling Group drains northward into Sg. Pahang. The entire area is low lying and, except for the area of volcanic andesite on Sg. Pahang, is underlain by the soft and deeply weathered rocks of the Gemas Group.

3.1.2 Jeram-Gemas Group

Overlying the rocks of the Pahang Group are formations of a thick section of Tertiary or Quaternary origin. These formations are composed of shales, sandstones, and conglomerates. The shales are generally soft and weather to a fine-grained material. The sandstones are more resistant and weather to a coarser-grained material. The conglomerates are composed of rounded pebbles of sandstone and quartzite in a matrix of sand and silt. These formations are generally found in the low-lying areas of the region and are underlain by the rocks of the Pahang Group.

The Jeram-Gemas Group is a Tertiary or Quaternary formation that covers a large area of the region. It is composed of shales, sandstones, and conglomerates. The shales are generally soft and weather to a fine-grained material. The sandstones are more resistant and weather to a coarser-grained material. The conglomerates are composed of rounded pebbles of sandstone and quartzite in a matrix of sand and silt. These formations are generally found in the low-lying areas of the region and are underlain by the rocks of the Pahang Group.

3.0 GENERAL GEOLOGY

3.1 STRATIGRAPHY—GENERAL STATEMENT

Pahang Tenggara is divided into six separate areas for reconnaissance mapping by the staff geologists of the Geological Survey of Malaysia. Work on the mapping program commenced late in 1967 and is just now being completed so that the information is very recent. With six groups mapping in different areas, confusion arose concerning the correlation and naming of the various rock units. The present geological map (Fig. 3.1) is the first attempt to bring all of the information together and to name and correlate the units so as to produce a stratigraphic section applicable to the whole area. This is done by sub-dividing the stratigraphic column into five informal "groups" representing the various litho-logical and structural units and assigning a tentative geologic age to them as well as to the igneous flows and intrusives.

3.1.1 Mersing Group

The oldest rocks in the area are an interbedded sequence of metamorphosed sedimentary and volcanic rocks. The sedimentary units are now conglomerates, quartzites and phyllites, the volcanic members indurated tuffs and agglomerates and crystal tuffs which locally have been designated as "quartz porphyry". This is particularly true in the vicinity of the iron deposits around Bukit Ibam. It is generally accepted that these "quartz porphyries" are thermally metamorphosed phases of the crystal tuffs in the vicinity of dioritic intrusives of that area and that they are not intrusive as had formerly been believed to be the case. In general, the rocks of the group have been severely folded.

3.1.2 Jasin—Gayong Group

Overlying the rocks of the Mersing Group unconformably are a thick series of ignimbritic or welded tuffs and their agglomeratic equivalents and crystal tuffs. While being definitely younger than the Mersing Group they are still older than the Triassic granite which is intrusive into them and they are hence designated here as either late Permian or early Triassic.

3.1.3 Granite

The main batholithic intrusive in the area extends in a north-northwesterly direction from the south central part of the area at Gunong Besar to Bukit

Chermingat some 20 miles south of Sungai Pahang. The granite continues southward into Johor. Elsewhere in the area smaller stocks of granite are intrusive into the older rocks and there are possibly some covered by the coastal alluvium. Generally, the rock is a biotite granite but in the southern two thirds of the main batholith there seems to be a greater content of amphiboles.¹ (This is also indicated on the aeromagnetic map as a series of west-northwesterly trending minor anomalies). Age determinations of this granite made further to the south indicate it to be lower Triassic.

3.1.4 Gemas Group

This group apparently is younger than, and overlies, the granite and occupies the entire western portion of the area west of the batholith. It has been tentatively subdivided into three parts. No relative ages for the separate divisions has been attempted but, in general, the arenaceous facies occupies the eastern portion adjacent to the granite followed to the west by the tuffaceous rocks and sill further west by the predominantly shaly series of rocks. While all of the arenaceous rocks adjacent to the granite in the area eastward and southeastward of Bukit Kerisek have been included in this group, it is possible that some of them may be more properly included in the younger Tembeling Group. There are no stocks of granite intrusive into the Gemas Group similar to those cutting the rocks of the Mersing Group to the east and no thermally metamorphosed facies or metamorphic minerals have been noted in the rocks of the Gemas Group near their contact with the granite. Fossils collected from the argillaceous facies of the group in the extreme western portion of the area indicate a middle Triassic age. The rocks are moderately folded with north-northwest-trending fold axes.

3.1.5 Andesite

In the extreme northwest corner of the area adjacent to Sg. Pahang is an area of andesite flows. There is no evidence of their age within the study area but similar rocks north of Sg. Pahang are thought to be Triassic. They are very well reflected in the aeromagnetic map by a group of minor anomalies.

¹ The aeromagnetic survey map is kept by the Geological Survey of Malaysia Headquarters, Scrivenor Road, Ipoh.

3.1.6 Tembeling Group

This group of conglomerates, sandstones, shales, siltstones and mudstones overly the beds of the Gemas Group with what is thought to be an unconformity because of the less severe folding and a somewhat more westerly trend of the fold axes in the Tembeling rocks. It would appear from the structure that the argillaceous portion of the group is younger than the arenaceous and occupies the central portion of a syncline. These rocks are faulted to the east against the older Mersing Group along a northerly-trending fault zone.

3.1.7 Younger Intrusives

Syenite, diorite and granodiorite stocks intrude both the Gemas and Tembeling Groups. They form two more or less northerly-trending zones one in the southwest and the other in the north-central part of the area. The rocks of both the Mersing and Gemas Groups have been thermally metamorphosed to hornfels type rocks by these intrusives. No metamorphosed rocks have been found in the vicinity of Bukit Chermingat at the north end of the granite batholith but here outcrops are scarce. These rocks usually are indicated by relatively strong isolated anomalies on the magnetic map.

3.1.8 Gagau Group

These rocks represent the youngest consolidated sedimentaries in the study area. They comprise conglomerates and sandstones with minor shale interbeds and rest unconformably on the rocks of the Mersing and Jasin Gayong Groups. They are not in contact with either the Gemas or Tembeling Group in the study area but they are considered to be younger than the latter because of their relatively flat-lying attitude wherever they occur.

3.1.9 Segamat Basalt

These Tertiary flows extend southward from Bukit Kerisek midway along the southwestern boundary of the study area along the same north-south trending zone of the younger intrusives. They form a strongly anomalous magnetic zone. Similar basalt in the Kuantan area has been dated at around a million years old and has been assigned to the Tertiary.

3.1.10 Alluvium

A broad zone of coastal alluvial swamp occupies a large area inland from the coast. This band is 25 miles wide at Sungei Pahang narrowing to about 10 miles at the southeast corner of the area. Sands, silts, muds and organic matter make up this jungle covered area. Occasional small hills pierce upward through the alluvium which averages more than 50 feet in thickness. It extends inland along the major river valleys such as along Sg. Rompin and Anak Endau where it gives way to river alluvium. This is also present along Sg. Bera southward from the northwest corner of the area and around Tasek Bera and Tasek Dampar. It also occupies the valleys of Sg. Keratong, Aur and Rompin.

3.2 STRUCTURE

3.2.1 Folding

The rocks of the Gemas, Jasin-Gayong and Mersing Groups have all been folded with the axial trend of the folds parallel to the axis of the granite batholith which is the predominant structural direction of the Malay Peninsula. The three groups, however, differ in the intensity of the folding to which they have been subjected. The Mersing and Jasin-Gayong Groups are very closely folded, often isoclinally, or overturned. The Gemas Group, while strongly folded, does not exhibit the same intensity of folding. Nor are the rocks as severely metamorphosed. Both of these facts are used to evaluate the relative ages in addition to the fossil evidence found in the Gemas Group. The Tembeling rocks have been bent into a series of broad open folds much less severe than the folding in the Gemas. Moreover, the general trend in this area would appear to be somewhat more westerly although this does not appear to be the case further to the north. The Gagau rocks are essentially unfolded.

3.2.2 Faulting

Three main directions of faulting are present in the area. These are northwest, northeast and north. The age of the faulting is not known but it is thought that several periods of movement have occurred certainly along the north and the northwest fault directions.

The only mineralization in the area other than tin appears to be related to the northerly faults and the younger intrusives zones with the exception of the Sungei Sawah and Pontian lateritic iron occurrences.

4.0 ECONOMIC GEOLOGY

4.1 GENERAL STATEMENT

Records on prospecting and mining are incomplete but it is evident that such operations have been going on in many parts of the area since the early 1900's. By the end of 1970, approximately 10% of the total area of Pahang Tenggara had been prospected in varying degrees chiefly for alluvial tin, iron and ferro-manganese (Fig. 4.1a). In addition, several of the magnetic anomalies indicated by the aeromagnetic survey were investigated by the Geological Survey. These investigations were to determine the cause of the anomaly and, if possible, to relate it to iron deposits. In several cases, it was found that the anomaly was caused by small stocks of the younger intrusives and, having determined the apparent cause of the anomaly no further work was done. This is unfortunate because it would appear that minerals other than iron could be related to these intrusives. The results of all prospecting and mining activities in the area are available from the archives of the Geological Survey and the Department of Mines.

Only four ore minerals have been mined in the study area (see Fig. 4.1b). These are, in order of economic importance, iron, tin, manganese and barite. The iron (with the exception of the Sg. Sawah and Pontian deposits), manganese and barite appear to be genetically related to the younger intrusives and the northerly faulting. The tin is all alluvial but it is considered that the primary source is, as it is in the rest of West Malaysia, the Triassic granite. Available records from the office of the Department of Mines in Kuantan show the following production of the various ores:

Iron—

Rompin Mining 1962-1970	...	17,210,158 tons
Tasek Chini 1965-1968	...	572,915 "
Pontian 1961-1964	...	369,436 "
		18,152,509 "

Tin—

Bukit Payong Area 1965-1970	10,135 piculs
Lesong Forest Reserve Area 1965-1970	...
	6,756 "
	16,891 "

Manganese

This is included with the Tasek Chini iron production and totalled about 174,000 tons in the form of ferro-manganese.

Barite

There are no official records of barite being mined but it is known that about 200 tons have been shipped.

Tables 4.1a and 4.1b show the annual production of tin and iron ores from mines located in the study area.

4.2 DESCRIPTION OF KNOWN MINERAL OCCURRENCES

4.2.1 Iron Deposits (see Fig. 4.2)

4.2.1.1 The Ulu Rompin Iron Deposits

Production of these deposits ceased in October, 1970, because of a lack of marketable ore. The primary ore in the main deposit at Bukit Ibam is one of 35% grade magnetite with some hematite, chalcopyrite and pyrite. This primary ore body had been enriched by weathering to a deposit, nearer the surface which graded better than 60% iron. The primary ore is thought to be related in origin to a granodiorite stock which is present near the footwall of the ore body. Contact metamorphism, replacement and hydrothermal origins have been postulated for this ore but, in fact, it is probably a combination of the several types. The major significant facts as far as this study is concerned is its spatial relationship to the younger intrusives and the northerly faulting together with the presence of chalcopyrite in the primary ore and zinc in assay results. While several bodies were mined the major production was from the open cut at Bukit Ibam. The primary ore from which the other deposits were derived is not known, but presumably it also would be found to be related to the younger intrusives. These intrusives are quite evident on the aeromagnetic map but could be detailed more accurately by ground magnetic surveys.

4.2.1.2 Iron-Manganese Deposits at Tasek Chini

These are detrital ores of hematite and pyrolusite. The primary source of the minerals has not been ascertained, but here again magnetic anomalies are evident in this area indicating either a magnetite body or a younger intrusive containing magnetite.

Fig. 4.1a

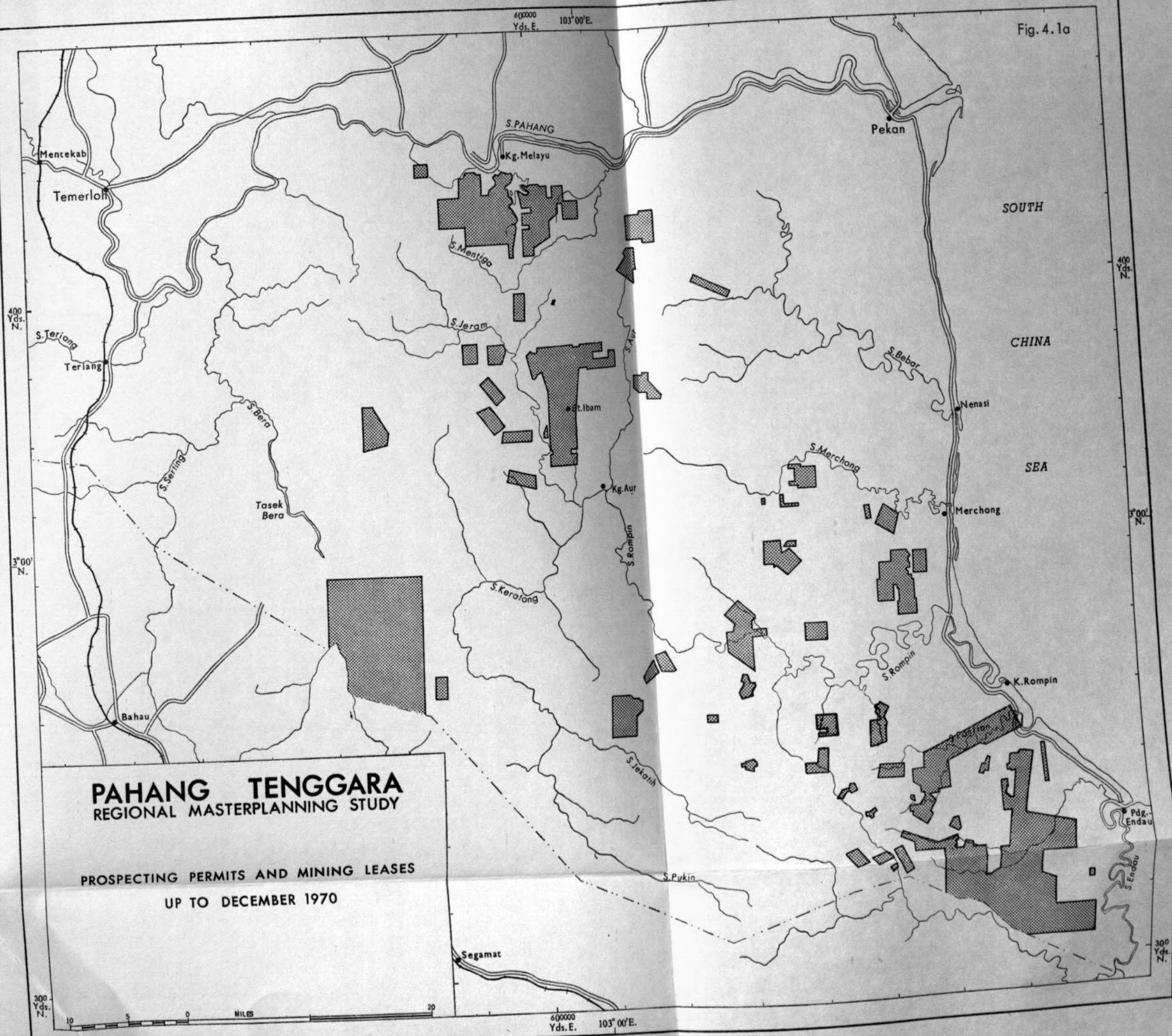
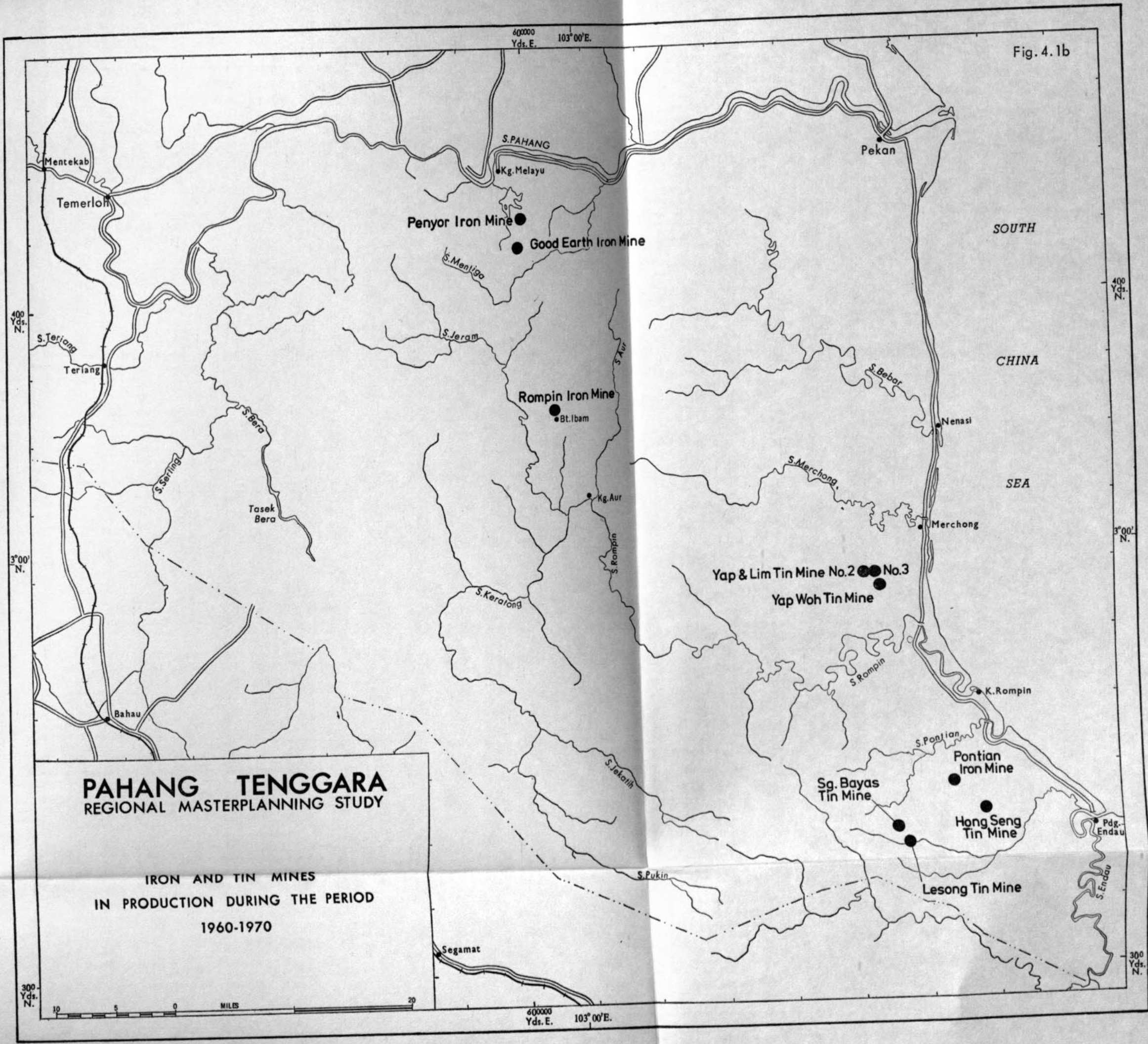


Fig. 4.1b



PAHANG TENGGARA REGIONAL MASTERPLANNING STUDY

IRON AND TIN MINES
IN PRODUCTION DURING THE PERIOD
1960-1970

Fig. 4.2.

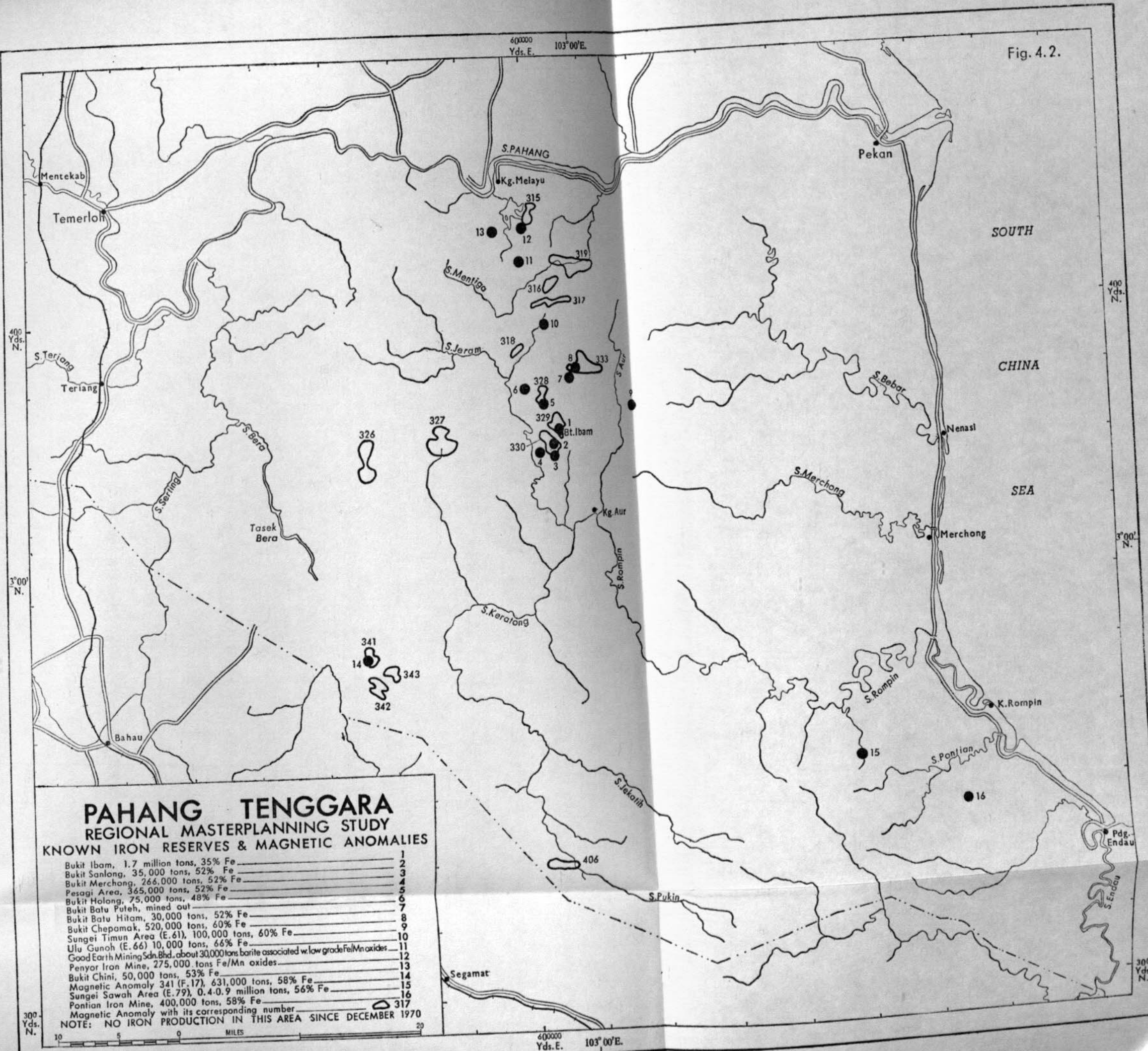


Table 4.1a—Annual Production of Iron Ore from Individual Mines Covering the Period 1961 - 1970
Expressed in Thousands of Long Tons of Shippable Ore

Name of Mine	1961 (Started April) 120	1962 119	1963 94	1964 37	1965 (Closed July)	1966	1967	1968	1969	1970
Pontian Iron Mine	120	119	94	37						
Rompin Iron Mine		(Started June) 662	1,823	2,051	2,029	2,155	2,041	2,225	2,419	1,766
Good Earth Iron Mine					(Started June) 106	152	96	45		
Hong Hing Mining Sdn. Bhd. (Ferro-manganese)								24		
Penyor Iron Mine (Ferro-manga- nese)									(Started June) 63	87
Yearly Total	120	781	1,917	2,088	2,135	2,307	2,137	2,294	2,482	1,853
GRAND TOTAL FOR 1961 - 1970										18,114 long tons

Table 4.1b—Annual Production of Tin Ore from Individual Mines Covering the Period 1965 - 1970
Expressed as Piculs of Shippable Cassiterite Concentrates

Name of Mine	1965	1966	1967	1968	1969	1970
Area—Lesong Forest Reserve						
Lesong Tin Mine Ltd	..	(Started Oct.) 318	841	1,098	772	699
			(Started Oct.) 136	509	(Stopped March) 100	
Hong Seng Mining Ltd	..				(Started Feb.) 690	851
Sg. Bayas Tin Mine Ltd	..					
Area—Bt. Payong						
Yap & Lim Tin Mine No. 2	..	(Started April) 1,311	1,586	1,064	871	820
			(Started Nov.) 12			
Yap & Lim Tin Mine No. 3	..					
Yik Woh Mining Ltd	..			970	1,453	1,800
						(Started Aug.) 248
Yearly Total	..	318	2,575	3,641	3,836	4,418
GRAND TOTAL FOR 1965 - 1970	..					16,831 piculs

4.2.1.3 Iron Deposits Near S. Pontian

These are lateritic deposits and are in no way similar to those previously described. They have probably resulted from the weathering of an iron rich volcanic rock. Laterites are very common over the entire area but only locally do they attain sufficient size and contain enough iron to be commercially exploitable.

4.2.2 Tin Deposits

4.2.2.1 Bukit Payong

Yap and Lim Mining Co. have had gravel pump mines working in this area since 1966 in which time they had produced, up to the end of 1970, 9,847 piculs of cassiterite. These deposits occur in the coastal alluvium which surrounds Bukit Payong. They are obviously derived from a source related to a muscovite granite which is found in two of the mines. Cassiterite has been noted in pegmatite boulders in one of the excavations by Geological Survey geologists. They also found quartz-tourmaline vein cutting the older Mersing Group sedimentary rocks which are intruded by the granite.

Recently, a narrow (1"-6") quartz-tourmaline vein containing cassiterite has been found cutting the altered tuffs in one of the mine excavations. This shallow-dipping vein is being traced by an adit and diamond drilling to ascertain its relationship to the nearby granite. This is the only such vein that has been found south of the Pahang Consolidated Lode mine a few miles northwest of Kuantan at Sungei Lembing.

4.2.2.2 Lesong Forest Reserve

Three alluvial operations are being carried out in this area, one in the recent alluvium along Sungei Anak Endau and the other two in the alluvium on tributaries of Sungei Pontian. Since their opening in 1965 they have yielded 6,786 piculs of cassiterite. The source of the cassiterite in both cases is probably a nearby granite stock.

4.2.3 Barite Deposits

These occur in the vicinity of the secondary ferro-manganese deposits south of Tasek Chini on Bukit Bottle. Not too much is known concerning the deposits since the office of the Department of Mines in Kuantan has no record of any barite being mined. It is known, however, that the barite occurs as blebs and lenses in tuffaceous schists and phyllites of the Mersing Group. The relationship between the ferro-manganese and the barite is not clear nor is the true quality of the barite known. Should the barite contain iron its value would be greatly diminished. No real estimate of reserves of the barite has been made but a figure of 30,000 tons has been suggested. Nor has any suggestion been made concerning the origin of the deposits except that they appear to be fissure fillings. There are no magnetic anomalies in the vicinity of Bukit Bottle so that a relationship of the deposits to one of the younger intrusives is doubtful although one small outcrop on the northern flank of the hill has been described as granite in a prospecting report.

Two small outcrops of barite were recorded one and four miles south of Bukit Sembilan, Ulu Rompin. They are associated with limonite and neither occurrence is likely to be of any economic value.

5.0 MINERAL POTENTIAL

5.1 GENERAL STATEMENT

The mining industry of Pahang Tenggara has been, in the past, completely dominated by the iron mining operation centred around Bukit Ibam. In fact, this was the only major mining operation in the area but, by iron mining standards, was still a small producer. This fact is brought out when it is realized that the bigger iron producers of the world mine more in one year than the 17 million tons that the Bukit Ibam deposits produced in their mining life of 8 years, and they normally try to maintain reserves for 20 years. But for Pahang Tenggara it was considered, and properly so, a major mine because of its position in the economy as a revenue producer for the area and as an employer of a considerable amount of labour.

Prospecting in the area has always been by normal surface methods, that is, the deposits were located because they were exposed at the surface of the ground where they could be sampled by trenching and, occasionally, shallow drilling. All the mineral deposits in the area were discovered in this fashion, tin being usually discovered by dulang washing and subsequent banka drilling. The barite and manganese were discovered during the exploitation of the surface hematite deposits south of Tasek Chini. But probably this method of exploration will no longer produce results since about all the obvious deposits have been discovered. New modern techniques will have to be brought into use if any new mineral deposits are to be located. The first stage in this respect is, of course, an intimate study of the geology of the region, with particular attention being paid to the geological relationships of the known ore bodies and their mineralogical composition, in an attempt to arrive at some idea as to their origin. If it can be shown that certain mineral deposits have a unique relationship to their geological environment, then it is obvious that a similar environment elsewhere should be investigated in the search for additional deposits. Surface exploration can no longer be relied on to investigate thoroughly any particular area and geophysical and geochemical techniques must be utilized. This fact was recognized by the Geological Survey Department in the mid 1950's when they undertook an aeromagnetic survey of a large part of Malaya including Pahang Tenggara. They also recognized the need for geochemical surveys and these are now routine in geological mapping programmes.

Many minerals are commonly associated in their genesis with intrusive igneous rocks and, therefore, the geological mapping of such rocks

is of prime importance. Aeromagnetic surveys can assist in this investigation as is shown by the delineation of the younger intrusives on the aeromagnetic map. The iron, manganese and indications of copper and zinc are associated with such rocks. The tin deposits of Malaya are related in origin to the intrusive granitic rocks and the alluvial deposits of tin and associated minerals are commonly found near the intrusive contact of the granite and the older rocks. The intrusive rocks in the study area are obviously the key to the discovery of new deposits. They have been delineated and are shown on the geological map (Fig. 3.1).

The mineral potential of the study area is not great but the favourable and possible mineral zones are outlined in the mineral potential map (Fig. 5.1a). These zones have been selected on the basis of the presence of known deposits, the geological structure, the presence of intrusive rocks, the presence of magnetic anomalies and the presence of tin and heavy mineral concentrates.

The potential mineral deposits in the area may be divided into two classes—tin and minerals other than tin. On the mineral potential map (Fig. 5.1a), those areas lying to the east of a north-south line bisecting the area are potentially tin zones, those to the west have potential for other minerals. While they have all been included on the total mineral potential map, those areas specifically related to tin deposits have been shown separately (Fig. 5.1b). These latter areas would be prospected by the time-honoured methods that have always been used in Malaysia because it is likely that any tin deposits discovered, certainly the first deposits, would be of the alluvial type.

The areas selected in the western half of the study area are related to the known and suspected areas of younger intrusives and the presence of known and suspected north-south fault zones. One such zone extends northward from Ulu Rompin to Sg. Pahang. This zone also continues northward beyond the river and any integrated exploration program would in all probability, include this northern extension since it is in this extension that boulders containing galena are known to occur. This zone within the study area comprises 160 square miles and another 100 square miles extends northward across Sg. Pahang. In the zone within the study area there is a possibility of conflict with an agricultural scheme on Sg. Mentiga and, as a matter of urgency, this area should be prospected before a definite commitment is made.

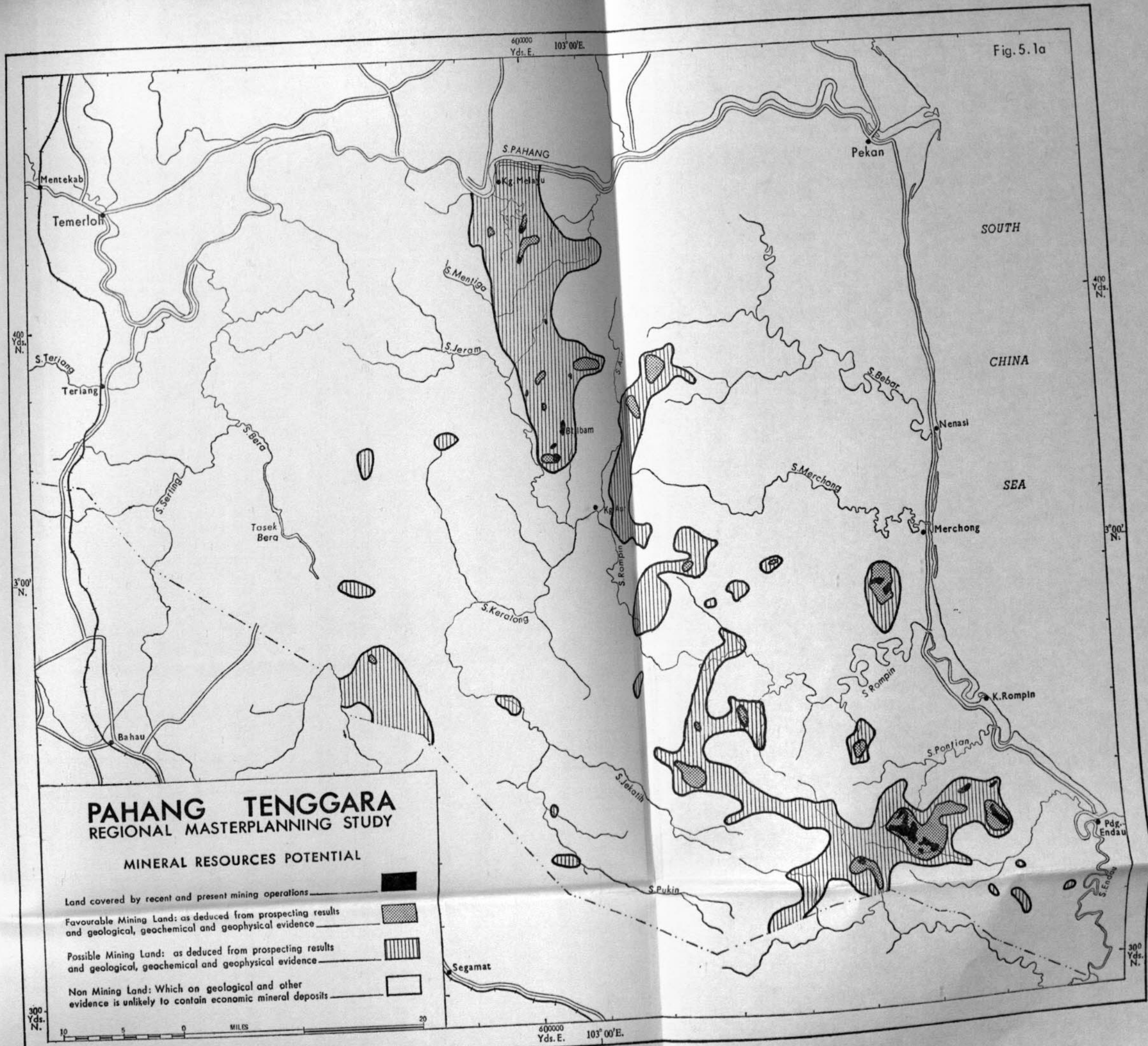
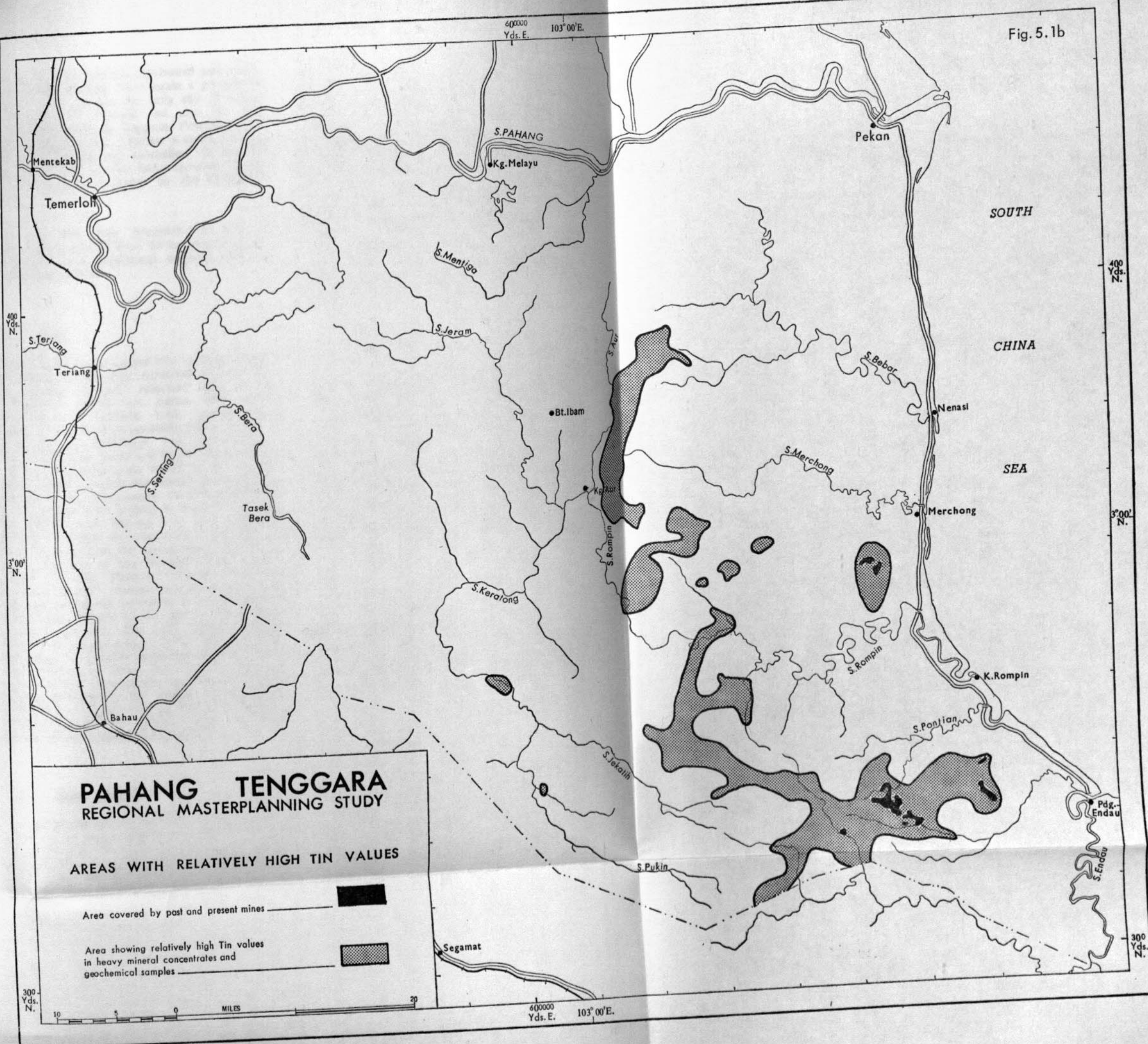


Fig. 5.1b



The second zone extends northward and southward from Bt. Kerisek. Here again a prospecting program would include not only the 35 square miles around Bt. Kerisek but also the zone extending southward to Segamat. Possible northward extensions of this zone are a small anomaly near Tasek Dampar and anomalies 326 and 327 (see Fig. 4.2). At the two latter locations diorite intrusives have been found by the Geological Survey.

The areas that have potential for minerals other than tin would have to be prospected by geochemical and geophysical methods followed by deep core drilling.

5.1.1 Iron

Figure 4.2 shows the known iron occurrences and the reserves as presently estimated together with the magnetic anomaly numbers cited in the aeromagnetic reports (see Agocs, 1960, 1965). Locations 1-14 include both primary and secondary iron deposits probably related in origin to the younger intrusives. The probability of finding more high grade iron in this area is small and the exploration costs would be out of proportion to the probable expectancy since such exploration would, of necessity, involve geophysical surveys followed by drilling. It must be assumed that the Rompin Mining Co. did everything possible to extend their reserves to prolong the life of the operation, but as has been pointed out in the "Report of the Working Party in the closure of the Rompin Mining Company Sendirian Berhad", enough reserves of sufficiently high grade could not be found. It is very unlikely that another deposit of the size of Bukit Ibam occurs in the area. The study agrees with the Director of the Geological Survey who stated in that report "It is believed that the remaining iron-oxide reserves at Bukit Ibam and surrounding areas are not economically exploitable". Small operations involving the mining of the richer deposits of secondary ore may be practical but it is not expected that further large scale iron mining will be possible in the area.

5.1.2 Base Metals

It is significant that north of Sg. Pahang along the strike of the north-south fault zone, occurrences of galena in boulders are known but their primary source has never been identified. In the primary ore and the gangue mineral assemblage at Bukit Ibam chalcopyrite, pyrite, sphalerite and

galena are known to occur. These are in the contact metamorphic and replacement zones related to the granodiorite intrusive. While none of the minerals occur in sufficient quantity to be exploitable, their very presence suggests that the areas around other related intrusives should be investigated for these minerals. This would involve first a semi-detailed geochemical survey of the areas known to contain the younger intrusives. These are the areas extending from Bukit Ibam northward to Sg. Pahang and around Bukit Chermingat, Godam and Kerisek. Should the geochemical investigations indicate the presence of any of these minerals, then electromagnetic surveys should be undertaken to locate sites for test drilling. The geochemical investigation of these areas should take precedence in an exploration program.

5.1.3 Tin

Both lode and alluvial tin deposits are associated with the contact between the Triassic granites and the older rocks. In the study area such contacts occur only in the eastern half of the region since the western half is underlain by younger sedimentaries and therefore no tin deposits of either type can be expected from these younger rocks. The areas outlined on the tin potential map (Fig. 5.1b), were indicated by the heavy mineral concentrates and geochemical investigations made during the course of the geological mapping of the area. The usual tin exploration techniques would be used in exploring these areas.

5.1.4 Manganese

Pyrolusite is known to occur only in association with the secondary iron ores and in particular those in the vicinity of Tasek Chini. There is no prospect of major ferro-manganese deposits being located in the area.

5.1.5 Barite

The Barite at Tasek Chini is aerially associated with the iron deposits of the region but the genetic relationship has not been established. It is generally thought that the barite occupies fissure fillings but not enough geological work has been done on the deposit. It would be logical to explore the surrounding area for similar bodies but it is not considered that large deposits will be found in the area.

5.1.6 Bauxite

Only minor occurrences of bauxite were found in Pahang Tenggara and these are not of commercial grade. It is generally accepted that the conditions of weathering were such that laterite formed rather than bauxite and that commercially exploitable deposits of this mineral cannot be expected to be found.

5.1.7 Tungsten and Titanium

Minerals of these metals are generally associated with tin deposits but no especially significant concentration has been found in the tin mines of the area or in geochemical studies and heavy mineral concentrate sampling. Any production would be as a by-product of tin mining.

5.1.8 Radioactive Minerals

No minerals of this group have been noted in the area and no especially significant indications of such minerals were noted as a result of the radioactivity survey made in conjunction with the aeromagnetic survey.

5.1.9 Limestone

The only occurrences of limestone in the study area are at the open cast iron mine of Bukit Batu Puteh north of Bukit Ibam and in the open cast at Bukit Ibam itself. No analyses of these limestone are available. The Bukit Ibam occurrence is at the bottom of the open cast and is not exploitable but that at Bukit Batu Puteh may be able to be quarried on a small scale. Limestone requirements for the area could be supplied from any of three locations outside the study area all of which are capable of producing almost unlimited supplies of almost pure CaCO_3 .

These are located as follows:

- (a) the limestone hills 15 miles northwest of Kuantan where Bt. Sagu is located.
- (b) at Gunong Senyum just east of Sg. Pahang 20 miles north of Temerloh in the Jengka Triangle, or
- (c) at Bt. Chinta Manis 12 miles southeast of Bentong.

5.1.10 Glass Sand

No deposits of sand pure enough to be considered for the glass industry have been noted in geological surveys. The only ones of interest are the present beaches and raised beaches near the coast but these, being marine sand, contain a considerable amount of impurities notably sea shells. It is possible that some of the raised beaches might contain sections pure enough to be considered but it is very doubtful.

5.1.11 Laterite

Lateritization is very widespread in the area and laterites are commonly used for surfacing roads in the interior.

5.1.12 Construction Materials

Stone aggregate could be quarried from any of the suitably located occurrences of the ignimbritic tuff. In fact, one quarry is presently being operated by the J.K.R. in a small hill outcrop of such tuffs at Tanjong Batu 20 miles south of Pekan.

A quarry was opened and a small stock of good quality crushed granite stone has been left at Bukit Ridan. This quarry was developed for ballast of the Rompin Iron Mine railway. In the eastern half of the study area a large supply of rock material suitable for building and construction purposes exists in the hilly regions of outcropping granites, quartzites and ignimbrites but their availability can only be realized when development reaches these parts.

6.0 RECOMMENDATIONS

The mineral potential for the area is not great but there are certain areas that warrant investigation because it is reasonable to suppose from our present state of knowledge, that it is in these areas alone that any significant mineral deposits might be expected to be found. It would seem to be advisable, therefore, to make these available for prospecting at the earliest possible time in order that their merits may be either proven or disproven. If the latter should prove to be the case then the land can be put to immediate use other than mining. It should be pointed out also that, even though mineral deposits (other than tin) of exploitable size are found, it is almost certain that they would be mined by underground methods and hence, unlike placer mining, the surface of only a comparatively small area would be affected by the operation. It is suggested, therefore, that attention should be given to the immediate investigation of the north-south zone extending from Ulu Rompin to Sg. Pahang giving particular attention to the areas around the stocks of intermediate intrusives and the magnetic highs as indicated in Fig. 4.2. Secondly, the magnetic anomalies at Bt. Chermingat, Bt. Godam and Bt. Kerisek should be examined again together with anomalies numbered 319 and 416. The initial prospecting method should be geochemical with particular attention being given to the base metals. Extreme care will have to be taken in the northern zone because of the danger of contamination from earlier mining activities in the area. A consulting geochemist with tropical experience should be in charge of the work.

Detailed magnetic surveys should also be made on the ground. If, as a result of these initial investigations, favourable results are obtained, a

detailed programme of electromagnetic surveys should be undertaken. This would be followed, if warranted, by deep exploratory core drilling. The same general technique would apply to all areas. In order that the most experienced private organizations in this field might be induced to undertake such work, consideration should be given to modifying the prospecting laws to permit free entry into the region without the necessity of acquiring prospecting permits. These should be required only after the electromagnetic phase of the exploration and prior to drilling and after favourable results have been obtained. But certain protection would still have to be given to ensure the prospecting permit and subsequent mining certificate be issued only to those conducting the initial surveys.

The existing permit system requires a deposit of \$5 per acre for the first 1,000 acres and \$2 per acre on the remainder of any permit area granted. Should an area of 200 square miles be selected as a suitable area for an integrated program of prospecting the required deposit would be \$259,000. Such a sum cannot be considered as an incentive to a search for metals other than tin. Additional geological and mineralogical information could also be obtained by requiring existing mines to submit regular reports on their findings in this regard.

Subsequent to the writing of the Consultant's geological report, the Malaysian Geological Department has conducted further exploratory work for base metal potentials and for industrial clays. In that this work is continuing, their findings are not dealt with here.

7.0 WORKING PARTY FOR MINERAL RESOURCES

A working party (consisting of the Federal Director of Lands and Mines, Economic Planning Unit representatives, Director of the Geological Survey Department, and of the State of Pahang, the Legal Advisor, General Manager of the State Development Corporation, Senior Inspector of Mines and the Coordinator of Pahang Tenggara Study, together with the Consultants) was appointed by the Steering Committee to report on the issues in mining. Their findings are as follows:

7.1 ISSUES

- (a) The study has identified areas of significant mineral potential for which there is a need to obtain land mineral clearances.
- (b) Prospecting should be carried out over areas identified as potential alluvial tin deposits.
- (c) Prospecting should be carried out over areas identified as potential base metal deposits for which highly capitalized and scientific prospecting procedures are required.

7.2 RECOMMENDATIONS

7.2.1 Mineral Clearances over Areas Identified as having Insignificant Mineral Potential

It is agreed that the mineral potential map (Fig. 5.1a) produced by the Consultants is the best portrayal of the information available, but that inasmuch as the Pahang Tenggara development area had not been widely opened up by roads, or other means of access, that there were other potentials possible. Therefore, prospecting should not be prohibited in unidentified areas as long as these areas were not immediately required for development.

It is agreed that in subsequent project development periods the Mines Department is prepared to give mining clearance two years in advance of the requirement for development, based on the agriculture and other schedulings.

7.2.2 Areas Identified as having Alluvial Tin Deposits

The areas identified for alluvial tin are divided into two different categories:

- (a) Open caste or hydraulic sluicing possibilities defined as relatively small blocks of 2,000 acres each capable of being operated by the small local miner.
- (b) Areas which are suitable to be mined by dredges are of 8,000 to 10,000 acres in extent. The number of these areas might be added to if a mining company were to propose the consolidation of two or more of the smaller 2,000 acre blocks.

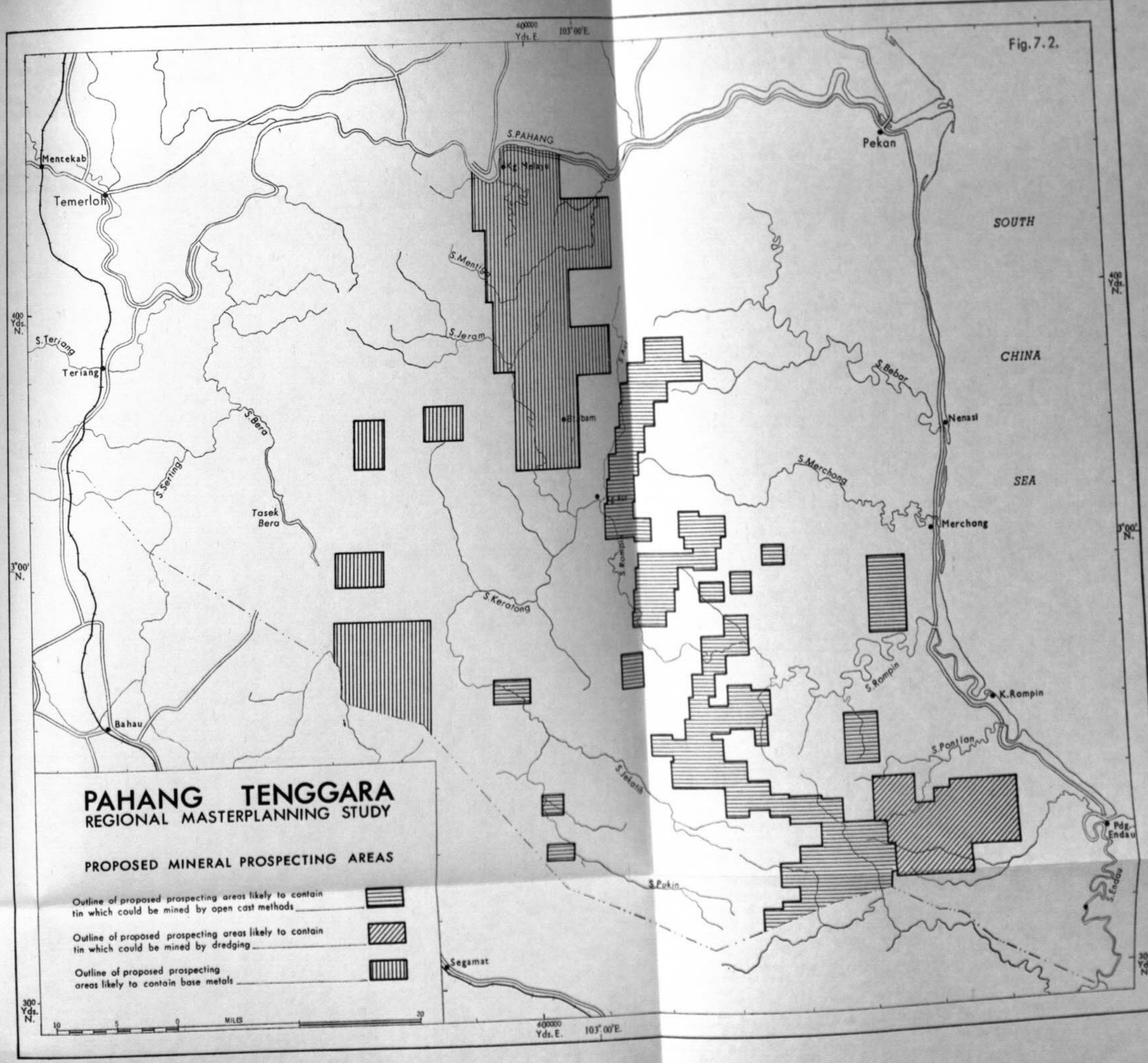
The prospecting and mining of these blocks must be undertaken by local or foreign companies which are capable of dredging. Suitable arrangements could be made for ventures or for joint ventures with statutory bodies. Three such areas are envisaged and a fourth area is a possibility as a consolidation of 2,000 acre blocks.

It was considered that the existing legal requirements for the prospecting of these dredging areas would be prohibitive; and that therefore prospecting should be carried out under some form of agreement with the Pahang Tenggara Development Authority.

7.2.3 Areas Identified as having Base Metal Potential

This area as defined in the map (Fig. 7.2) covers 220,000 acres, which for prospecting and development purposes is recommended to be divided into two parts available for venture contracts. These ventures would of necessity be highly capitalized and must be explored by sophisticated methods far advanced from those generally in use in Malaysia at the present time. In order to provide incentives to attract suitable venture companies it is considered necessary that comprehensive agreements be entered into to afford them long term guarantees for prospecting, development and mining operation and marketing. It is anticipated that such agreements would best serve the mining company and the Government if they were undertaken in the form of joint ventures with the Pahang Tenggara Development Authority. To this end the advisory working party

Fig. 7.2.



drew up a draft contract agreement which might be used as a basis for negotiation between the Pahang Tenggara Development Authority and the appropriate mining company.

It is further proposed that the Pahang Tenggara Development Authority should not wait to be approached by mining companies interested in development, but that the Authority should select

suitable responsible corporations and approach them with respect to making contracts for exploration and development of the mining resources for dredging and base metals. Only through intervention of the Authority can the mineral exploration for dredged tin and base metals be promoted, as under the existing mining assessments there is no incentive for private enterprises to invest in such ventures.

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M. Cooper

**The Government of Malaysia
The State of Pahang**

PAHANG TENGGARA

Regional Masterplanning Study

**Climate and Water
Resources**

**Foundation of Canada Engineering Corp. Ltd.
van Ginkel Associates Ltd.
S.G. Gardiner Engineering Services Ltd.
Charnell International Consultants Ltd.**

HUNTING TECHNICAL SERVICES

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Although most of the rainfall occurs during the West and West Monsoon, heavy rainfalls may also be experienced at other times of the year. Microclimates are created by the irregular topography of the country and the sequence of monsoons may vary from place to place. The yearly maximum of rainfall can occur during either the West Mon or East West Monsoon depending on the location. The yearly maximum rainfall may occur in any one of several months. Furthermore a third rainfall has sometimes occurred during a transitional period and a second peak during the following or preceding monsoon. The rainfall during prolonged periods often has an intensity of many times the average monthly rainfall causing the rivers to overflow their banks and to inundate vast areas of adjacent land.

10) The location of the source of supplies of water for potable, industrial, irrigation and hydroelectric purposes where suitable for such use of water are proposed.

11) An assessment of the requirements for industrial and domestic water supplies with a projection of needs over the coming fifty years.

12) The preparation of an overall policy and plan for the development of water supplies, taking into account the development of agriculture and industrial requirements, including the location of water intake to the source and associated works.

1.0 INTRODUCTION

The peninsula comprising West Malaysia is situated near the equator between Latitude $1^{\circ} 15'N$ and $6^{\circ} 45'N$ and Longitude $99^{\circ}E$ and $104^{\circ} 20'E$ the South China Sea on the eastern shore and the Straits of Malacca on the West.

The country has an elongated shape, lacks a wide alluvial plain and consists, for the most part of highlands composed of ancient granitic rocks. The highland backbone parallels the western side of the peninsula dropping sharply to the Straits of Malacca and more gradually eastwards. The major possibilities for hydroelectric-power development consequently, are located on the west side, particularly in the north of the peninsula. The main lowlands of the country are located in the eastern side of the peninsula. In contrast to the west coast, extensive sandbanks have formed along the east coast where the spring tidal range is up to ten feet.

The climate of West Malaysia is equatorial with fairly uniform temperature and rainfall prevailing throughout the year. Annual climatic changes result from the seasonal variations in direction and velocity of the trade winds, which divide the year into four seasons:

- (a) the North East Monsoon prevailing from November or early December to March;
- (b) the transitional period of 5-7 weeks roughly falling in the month of April in the south and May in the north;
- (c) the South West Monsoon lasting from June to September;
- (d) the second transitional period during October or early November.

Although most of the rainfall occurs during the East and West Monsoons, heavy rainfalls may also be experienced at other times of the year. Micro-climates are created by the irregular topography of the country and the sequence of rainfall can vary from place to place. The yearly maximum of rainfall can occur during either the North East or South West Monsoon depending on the location. The yearly minimum rainfall may occur in any one of several months. Furthermore a peak rainfall has sometimes occurred during a transitional period and a second peak during the following or preceding monsoon. The rainfall during prolonged storms often has an intensity of many times the average monthly rainfall, causing the rivers to overflow their banks and to inundate vast areas of adjacent land.

The Pahang Tenggara Region (hereinafter referred to as the "Region") is located at the southern tip of the State of Pahang on the east side of the Malay Peninsula. The Region comprises about 4,000 square miles or 29% of the total land area of the State of Pahang and includes all of the area south of the S. Pahang. It borders the South China Sea on the east and the states of Johore and Negeri Sembilan on the south and west. Only a few people live in the interior of the Region most of which is covered by virgin jungle. Most of the area is inaccessible to vehicles except by means of privately constructed logging roads. The largest river in the Region is the S. Rompin, the catchment of which, together with its tributaries, (the S. Keratong, Jeram and Aur) covers almost half of the Region. The sources of these rivers are in the central and southern mountainous areas with elevations of up to 1,800' above Mean Sea Level. These mountainous areas cover approximately one third of the Region. The remaining two thirds of the Region is flat or undulating between zero and 300' above M.S.L. Most of the area along the river banks and the sea coast consists of marshland.

1.1 TERMS OF REFERENCE

The study of the water resources includes:

- (a) A review of available rainfall and hydrological data.
- (b) A study of the possible changes in the discharge of rivers arising from the proposed development, including urban and industrial discharges, and where such changes are significant, recommend soil, river and water conservancy measures to prevent or reduce the incidence of flooding, silting and pollution in the lower reaches.
- (c) The location of the source of supplies of water for potable, industrial, irrigation and hydroelectric purposes where schemes for such use of water are proposed.
- (d) An assessment of the requirement for industrial and potable water supplies with a projection of needs over the ensuing thirty years.
- (e) The preparation of an economically realistic plan for the development of water supplies, phased according to the development of settlements and industrial requirement, including the location of access roads to the source and treatment works.

- (f) An economic assessment of the feasibility, following consultations with the N.E.B., of a hydroelectric development in the Sungei Jeram.

1.2 SUMMARY

Projections of climatic conditions within the Region are for the most part, based on data recorded outside of and along the periphery of the Region. These data show pronounced differences in rainfall pattern along each of the three sides of the Region. It thus appears that essentially different climatic patterns exist in three parts of the Region, namely, the South Eastern part, North-Central part and the Western part, with a transitional area from one pattern to the other along the dividing lines as indicated on Figure 1. The average annual rainfall in the south east corner is about 130 inches, reducing to about 110 inches in the north east corner and less than 90 inches in the west. The wind is strongest and most frequent along the coast where the temperatures also show the smallest diurnal and annual variations.

Because of the scarcity of river runoff data most of the observations pertaining to river behaviour are, of necessity, only theoretical, based on the behaviour of other similar streams whose behaviour has been documented for long periods of time. Rivers in the Region were inspected during dry and wet seasons, at which time some incidental current measurements were made. However, it must be stressed that because factual river flow and rainfall data in the catchments are not presently available, the conclusions and the recommendations contained herein must be regarded as very preliminary and subject to considerable change.

The yields of rivers within the Region under present natural conditions were calculated with reference to known river discharges elsewhere in West Malaysia. The changed yields of the rivers resulting from development of the Region are expected to be marginal, provided soil conservation measures are implemented concurrently with that development. The most significant change following development is expected to be in the dry weather flow, which would be reduced from the present calculated value of 0.45 cusec to 0.27 cusec. per sq. mi. of watershed. Water samples taken from rivers in the Central and South-Eastern part of the Region, analysed by the Government Department of Chemistry, were found to be of

excellent quality. However, conductivity tests, made in the rivers of the Western part of the Region, indicate a degree of deterioration already taking place, probably resulting from the developments within the catchment of these rivers. It is to be expected that all rivers in the Region would be contaminated after development unless the disposal of water from households and industry is rigidly controlled.

Specific flood control measures can be developed only after the levels, cross sections and discharges of rivers in the Region have been determined. A first step towards permanent flood amelioration would be the clearing of streams, although the consequences on river discharge cannot be determined quantitatively without more topographic and hydrologic data. Furthermore it is not possible at present to determine the value of the benefits likely to be derived from the capital expenditures. Consequently it is suggested that, for the first ten years of development, the low lying areas which are subject to regular inundation should not be developed. In the intervening period it will be possible and necessary to collect the data required to assess the costs of and benefits likely to result from various possible remedial measures.

The synthetic river discharge data which have been compiled for the S. Jeram indicate that hydroelectric power could be developed at a site near Bulut Nipis. This possibility is all the more attractive because any electricity produced in the southern and eastern part of the peninsula could reduce the amount which would otherwise have to be transmitted from the north or west of Malaysia. However there is some question as to whether a suitable dam site could be found near Bulut Nipis. This question can only be answered by means of a geological site investigation.

Sewage Collection systems and treatment plants will not be needed in the settlements until they reach a population of 25,000. Except in the case of the two main Regional centres this will happen only towards the end of the planning period. Initially households would be provided with individual septic tanks. The expected life of the septic tanks would be about twenty years, after which other facilities would be needed.

Should the capacity of existing government agencies be over-extended by the program of development in Pahang Tenggara, then it may

be necessary to establish a "Water Resources Branch" and a "Civil and Mechanical Works Branch" within the Development Authority to manage the water resources of the Region. The former would be responsible for identifying and controlling the quality of water resources, as well as the issuance of water rights to various users whereas the latter would be responsible for construction of all water control facilities as well as other infrastructure facilities required in the Region.

1.3 RECOMMENDATIONS

It is recommended that the installation of 14 rainfall recorders and 17 water level recorders as indicated on Figure 19 and listed in Table 20 be undertaken by the D.I.D. without delay. A minimum of 10 years of records are required to design and estimate the cost of any major water resources development. Each year that the installation of these recorders is delayed will result in a similar delay in the construction of urgently needed projects.

2.0 ANALYSIS

2.1 INTRODUCTION

Climatological and hydrological studies are aimed at determining the intensity and distribution of precipitation and other related natural phenomena with respect to place and time. The information thus obtained, coupled with information on soils, terrain, etc. is required to determine what crops could be grown in various locations. It is necessary also to locate sources of water for domestic and industrial use, and to determine if water conservation or flood control measures will have to be implemented. Finally, this information is required to determine whether some or all of the Region's electrical requirements could be supplied by development of hydroelectric power within the Region.

Regrettably, for various reasons, but primarily because of the difficulty of access into most parts of the Region very little climatological and river runoff data have been collected within the Region. Furthermore, the severe flooding which occurred in many parts of the Region in January 1971 destroyed most of the stream gauging stations along the S. Pahang. Most of the information pertaining to the extent of inundation had therefore to be obtained from personal examination of high watermarks, etc. The urgent need for such data as a basis for future planning has already been drawn to the attention of the Government and it is expected that steps will soon be taken to rectify this deficiency.

2.2 METHODOLOGY

In the absence of recorded observations for this Region it has been necessary, for the purposes of this study, to transpose data obtained from hydrological stations located along the periphery as well as in adjacent states, notably Johor and Negeri Sembilan. Similarly, the assessment of discharges in the Region are largely based on records from streams draining similar catchments elsewhere in West Malaysia.

The procedures employed in this analysis are described in greater detail in the following paragraphs. It should be noted, however, that although these calculations provide what is considered to be a reasonably good indication of climate and hydrologic conditions in Pahang Tenggara, they cannot be used as a basis for

any final management decision wherein these considerations could be critical. This note of caution applies particularly to the design of any facilities intended to ameliorate the damaging effects of flooding or to generate electrical power. Such decisions can and must be based only on factual data collected within the Region over a period of at least ten years.

2.3 SOURCE OF DATA

A review of available climatological data in and adjacent to the Pahang Tenggara Region was based primarily on data received from the Drainage and Irrigation Department, the Meteorological Service and other government agencies. Except for ten D.I.D. operated stations along the east coast and twelve along the Sungai Pahang, one privately operated rainfall station at the former Bukit Ibam Mine and one evaporimeter station at Paya Supayang, the Region is devoid of hydrological stations (Figure 1). The data on which the following review is based were thus for the most part collected at stations located along the periphery of the Pahang Tenggara Region. All these meteorological and hydrological stations from which data were received are listed in Table 1. Daily rainfall records are obtained by standard 8-inch rain gauges while the rain-recording stations are equipped with either Casella or George Kent automatic rainfall recorders. Most of the daily rainfall stations within the Region were installed in 1960. The short period of observation coupled with the scarcity of recording stations precludes accurate predictions of rainfall intensity and duration.

The evaporimeter stations use the United States Class A land pans. It was found that the records were misleading on days of rainfall with more than 3 inches. For rainfall in excess of this quantity the water in the pan rises over the brim and flows away without a possibility of measurement.

Stick gauges were installed along S. Pahang several years ago, but none exist along the Rompin or other rivers in the Region. Moreover, these are read only at specified times so a continuous record is not available. However, at Temerloh, discharge calculations have been made, based on current measurements and measured cross sections of the river at the site of three of the stick gauges. The stations for which records are available are listed in Table 1.

3.0 CLIMATE

3.1 WIND

Surface winds over the Region are generally light throughout the year. The yearly average windspeed along the coast is 8 m.p.h. At Kuala Pahang, at the north east corner of the Region, the average windspeed is 8.3 m.p.h. At Mersing the average windspeed is 7.7 m.p.h. Average windspeed is only 1.5 m.p.h. at Temerloh.

Wind roses for Kuala Pahang, Mersing and Temerloh are shown in Fig. 1. These show the percentages of the year during which surface winds occur within certain ranges of direction and speed. Although westerly and south-westerly winds are most prevalent along the coast, their velocity is light. The northeasterly winds are the strongest.

Table 2 summarizes the percentage frequency of winds by month for 3 stations. The wind regime is pronounced along the coast, but becomes less distinct at Temerloh, where calm weather prevails during 45 per cent of the year.

Table 3 lists the occurrences of gusts at three stations. Along the coast gusts of over 30 m.p.h. occur most frequently in December, with an average return of once in 4 days in Kuala Pahang and an average of once in 3 days in Mersing. At Temerloh gusts of over 40 m.p.h. are rare.

3.2 RAINFALL

A number of mean annual and monthly rainfall maps of West Malaysia has been developed by the Malaysian Meteorological Service, Singapore Meteorological Services, Dale (1959) and the Drainage and Irrigation Department. Although the corresponding maps depict a similar general rainfall pattern, there are variations in the locations of isohyets drawn. This is mainly due to the different periods of record used in compiling these maps. The isohyets shown in Fig. 1 correspond to the map developed by the Singapore Meteorological Service (1965) since these data cover the most recent 10-year period available.

The mean annual rainfall in the Region as shown on Fig. 1 varies between 130 inches on the coast to 80 inches along the western inland border. The rainfall generally follows a linear pattern parallel and perpendicular to the east coastline except at mountainous areas where the isohyets tend to converge. Heaviest rainfalls occur along the coast.

The review and assessment of mean monthly rainfall in the Region are based on records of the following stations: Pahang Tua (8202), Nenasi Dispensari (8265), D.I.D. Endau (7270), Kg. Tenang, Segamat (7008), Glendale Estate (5096), Kuala Bera Forest Checking Station (8086), Kampong Salong (8096) and Bukit Ibam (private gauge).

Along the coast the most intensive rainfall occurs during the months of December and January whereas June to August are relatively dry months (Fig. 2). The rainfall during the North East Monsoon experienced in the central part of the Region is less than at the Coast. (See Kampong Salong and Bukit Ibam stations' records). There the greatest depth of rainfall occurs during October-December instead of during December-January as along the coast. A secondary maximum of rainfall is also recorded at these locations during March-May. Inland along the western border the rainfall distribution becomes more uniform, with two slight peaks. The maximum of these peaks occurs during the transitional periods and the other during the South West Monsoon or at the end of the North East Monsoon.

Table 4 lists the average number of raindays with more than 0.01" of rainfall recorded at Kuala Pahang and Temerloh. The highest number of rain days occur during the North East Monsoon season whereas the months of June-August generally have a lower number of days. February and June are the months with the least rain days. Maximum and minimum probable rainfalls have been computed, using the annual series and Gumbel probability method. The duration-frequency curves for maximum depths of rainfall recorded lasting 1, 2, 3, 5, 7, 10, 15 and 30 days and minimum rainfall lasting 5, 10, 15, 45, 60 and 90 days have been compiled. The results are shown in Figure 3 (a) to (h) incl.

The rainfall patterns along each of the three sides of the Region show marked differences. In order to arrive at a probable rainfall for the Region it has been assumed that the three different patterns would extend into the Region from each side for some distance and that they would be separated by transitional areas. The Region has therefore been divided in three areas on the basis of their topographic configuration as shown in Fig. 1. It is assumed that the transition from one pattern to the other would occur along these dividing lines over a variable width. The rainfall stations along the periphery of the Region have accordingly been listed in three groups in Table 5.

The 10, 20, 80 and 90 per cent confidence limits are calculated by means of the station-year method rather than the frequency of occurrence, which could imply too high an order of reliability. The calculated confidence limits are listed in Table 6 and are shown in Figure 4 (a, b, c). The 80 and 90 per cent confidence limits have been reduced to arrive at "Effective Rainfall".¹

It can be seen that February is a dry month in all parts of the Region. However, the records of rainfall for February over the years show, in particular for the South Eastern part, a great variation in total depth, with more light than heavy rainfall. This could be explained by the fact that, when the monsoon starts and ends early, February is dry whereas, if the monsoon is delayed, the month of February experiences heavy rainfall.

3.3 TEMPERATURE

Within the Region only one auxilliary meteorological station, at Pekan, has recorded temperatures. The annual mean temperatures are generally below 79°F, with the exception of a small area around Pekan where the mean temperature is 80.4°F. Variations over the year in mean monthly temperatures are between 2.0°F and 3.5°F, with slightly less variation along the coast. Mersing records are believed to be fairly typical for the Southern coastal conditions, Pekan for the Northern coastal conditions and Temerloh for the temperatures in the inland area.

April-June are the warmest months (average of 81.5°F in Pekan, 79.3°F and Mersing and 79.7°F in Temerloh) while in November-February generally lower temperatures are recorded, coinciding with the dry and the wet periods during the South West and North East Monsoons. (See Fig. 5).

The annual mean diurnal temperature variations are usually smaller at the coast than at the inland stations. During the year the diurnal variations are much higher than the variation in mean monthly temperature. At Mersing the diurnal variation is 13.2°F, at Temerloh the variation is 16.8°F. The maximum diurnal variation usually occurs in September and the minimum diurnal variation in December/January, when the average temperatures are also the lowest.

¹ The actual rainfall (R) is reduced by $0.015 R^2$ to account for losses which are not available for plant growth.

3.4 RELATIVE HUMIDITY

The humidity within the Region has been inferred from recorded observations made in Kuantan, Mersing and Temerloh. The relative humidity is uniformly high throughout the year. The mean relative humidity recorded along the coast is slightly higher than in the interior (Fig. 6). The diurnal relative humidity varies inversely with the temperature. During the day the humidity fluctuates between 55 and 75 per cent and during the night it rises to above 95 percent when dew forms. The inland station at Temerloh shows the more extreme conditions. The higher diurnal variations of relative humidity are recorded during the dry months (June-September).

3.5 SUNSHINE

The average number of bright sunshine hours per year varies between 2100 and 2300, tending to increase from North to South along the coast.

Fig. 7 illustrate the average number of hours of bright sunshine per day at Kuantan, Mersing and Temerloh. The months with most sunshine during the year are March and April, being the last month of the North East Monsoon and the transitional period. The season with least sunshine is the North East Monsoon in November and December; Temerloh, an inland station, recorded a higher number of bright sunshine hours in November-January than the stations at the coast, where the effect of the North East Monsoon and the rainfall are greatest.

3.6 SOLAR RADIATION

The only actinograph for recording the incidence of solar radiation in West Malaysia is located at the Meteorological Service Headquarters in Petaling Jaya. This instrument was installed in 1969 and is still in an experimental stage; the short period of record does not warrant the use of these data as a basis for conclusions. The Singapore Meteorological Service has a Casella bimetallic actinograph installed since January 1961 at the Paya Lebar Station. The northern most point of the Region is less than 200 miles away from this station. The bright sunshine distribution at Mersing and Kallang Airport has a similar pattern as observed in the Singapore Station (Fig. 8). Therefore the incoming solar radiation of the Region has been inferred from the Singapore records.

Fig. 8 shows the mean monthly solar radiation (1961-1967) at Paya Lebar as well as the mean monthly bright sunshine hours at Mersing and Singapore. The values are expressed in cal/cm². The mean annual total incoming radiation is 147,750 cal/cm².

3.7 EVAPORATION

Evaporimeters have been installed and evaporation recorded at five stations along the periphery of the Region. The data from Paya Supayang (7 years) and Temerloh (4 years) were selected to represent respectively, the coastal and inland areas. Adjustments to these records were made to reduce the effect of rainfall collected by the pans. The evaporation pans installed in these two stations are the United States Weather Bureau Class "A" Land Pans. The pan is 4 feet in diameter and 10" deep, and is raised 6" above the ground on a wooden platform. The pan is painted black, unlike the unpainted galvanized iron pan used in other parts of the world.

A pan coefficient of 0.7 is normally used for converting the observed values to the open water-surface evaporation likely to be experienced at lakes and reservoirs. For the painted black pan a pan coefficient of 0.66 is used by the D.I.D. Research office ¹. The mean annual open water-surface evaporation at Paya Supayang is tabulated

at 49 inches (pan coefficient of 0.66). The mean monthly figures vary between 3.7 and 4.5 inches.

The lowest evaporation rates are recorded during November-February (Table 7). The mean annual open water-surface evaporation at Temerloh is 44 inches. The monthly evaporation is fairly evenly distributed throughout the year. The lower evaporation rate at the inland station may be due to a combination of convection and wind speed. Convection is strong over land, especially during the hottest hours of the day when most of the evaporation takes place and is almost absent over the coast during that time; wind speed is higher near the coast than over inland areas.

3.8 CLOUD COVER

Cloud cover observations are made at the Kuantan Airport by the Meteorological Service. The mean monthly cloud cover measured in oktas at 07.30, 13.30 and 19.30 hours local time is shown in Fig. 9. The period February-April has less cloud cover, whilst during October-January more cloud is recorded. A greater daily variation in cloud cover is recorded during January-April, while for the rest of the year the daily variation is insignificant.

The observations at Kuantan should be applied only to areas near the coast which are similarly influenced by the sea.

¹ Drainage and Irrigation Department (1967). D.I.D. Research Station Memo No. 128. Results from Evaporation pan observations in West Malaysia.

4.0 SURFACE WATER PRESENT CONDITION

4.1 MONTHLY RIVER RUNOFF

4.1.1 Major Rivers

The major rivers in the Region are the S. Bera, the S. Mentiga, the S. Rompin and its tributaries, the S. Jeram, the S. Jakatih and the S. Pukin. The location of these streams is indicated in Fig. 1.

4.1.2 Runoff-Formula

When it was found that the application of existing formulae to catchments in West Malaysia did not give satisfactory results, a relation between annual runoff, annual and mean-annual rainfall was worked out to arrive at more reliable results. After the annual runoff was thus calculated, the monthly runoff values were compiled by the method of Thornthwaite and Matter¹. In trial calculations for four catchments the calculated values of runoff showed good conformity with the actually recorded discharges. The assumed distribution of rainfall was arrived at as indicated in Section 3.2.

4.1.3 Catchments used to Develop Annual Runoff Formula

Amongst the 52 catchments in West Malaysia for which runoff and rainfall records are maintained on a regular basis, three catchments were selected with climatic, topographic and ground cover characteristics roughly similar to those prevailing in the Region. These base catchments are: S. Sedim (No. 2416)², S. Kinta (No. 3463) and S. Segamat (No. 7414). There is no evidence of gains or losses in runoff by groundwater flow in these catchments. A short description of the salient features of these catchments is given below:

(a) S. Sedim (No. 2416)

Place of runoff measurement: Bridge Merbau Pulas, elevation 47' M.S.L.

Catchment area: 170 sq. mi.

About 45 per cent of the area is steep, rising to heights of 6,000 ft. The highlands above 250 feet are covered by virgin jungle, the undulating hills are covered by rubber plantations and the lowlands are swamps. The soils in the mountainous region are of granitic origin whereas the soils of the lower hills are sandy loams.

Period of observations: 1947 to 1962.

Mean annual rainfall: 110.3 inches.

Recording stations at S. Raja Estate (No. 1079)¹, Bagan Serai Estate (No. 1081) and Bt. Karanam Estate (No. 1078).

Mean annual runoff: 57.5 inches.

(b) S. Kinta (No. 3463)

Place of runoff measurement: Bridge Tanjong Rambutan, elevation 226' M.S.L.

Catchment area: 95 sq. mi.

About 97 per cent is steep, rising to heights of 7,000 feet, with undulating hills near the gauging station. The mountainous area is covered by virgin jungle, the hills are under rubber; the soils are severely weathered granite, sands and clays.

Period of observations: 1947 to 1962.

Mean annual rainfall: 103.6 inches.

Recording stations at Ipoh Hospital (No. 3116), Tanjong Rambutan Mental Hospital (No. 3115), Kinta Water Supply (No. 3214) and Strathisla Estate (No. 3112).

Mean annual runoff: 50.7 inches.

(c) S. Segamat (No. 7414)

Place of runoff measurement: Bridge at Segamat, elevation 42' M.S.L.

Catchment area: 254 sq. mi.

About 70 per cent is hilly to mountainous rising to heights of 3,000 feet; and the remainder is undulating with swamps. The mountainous part is under virgin jungle, the hills are under rubber and some padi is cultivated in the lowlands. The soils are granitic sands and clays, about 80 per cent of which contain sandy loams. Some water is tapped for irrigation.

¹ Thornthwaite C. W. and Matter J. R. (1957). Instructions and Tables for computed Potential Evapotranspiration and the Water Balance. Drexel Institute of Technology Publ. in Climatology Vd. 10 No. 3 (1941-1960).

² The numbers refer to the D.I.D. numbers in: Hydrological Data, Stream Flow Records (1941-1960).

¹ The numbers refer to the D.I.D. station numbers: Hydrological Data, Rainfall Records (1959-1965).

Period of observations: 1951 to 1960

Mean annual rainfall: 79.9 inches.

Recording stations at Segamat Estate (No. 7011), Segamat Filter House (No. 7212), Chuan Moh San Estate (No. 7010) and Kg. Tenang (No. 7008).

Mean annual runoff: 54.9 inches.

4.1.4 Runoff-Rainfall Relationship

The relationship between annual runoff and rainfall was found to be expressed by the formula: (see section 4.1.2).

$$RUa = 0.4214 \frac{Ra^2}{Rma} \quad 3/2 \text{ in which}$$

RUa is the total runoff for the year over the catchment in inches.

Ra is the total rainfall for the year on the catchment in inches.

Rma is the mean annual rainfall for the catchment in inches.

4.1.5 Evapo-transpiration

The annual evapo-transpiration losses attributable to vegetation in the catchment is obtained by deducting the calculated annual runoff from the annual rainfall. Furthermore, the evapo-transpiration in a catchment is a function of the total annual rainfall as well as the mean annual rainfall. When comparing the evapo-transpiration values in two catchments which in a certain year have the same quantity of rainfall, the catchment with the higher mean annual rainfall will show a higher value of evapo-transpiration. Annual evapo-transpiration losses are found to range from 40"-50", corresponding to annual rainfalls of 75"-120".

4.1.6 Test of the Runoff-Formula

To test the reliability of the formula the monthly discharges in the S. Besut at Jerleh (No. 9411) were computed for the period January 1956-December 1968. The catchment has a forest cover of 80 per cent and has topography and soils about similar to those in the three base catchments, with a mean annual rainfall of 137.7 inches. The annual runoff for each year was computed and the monthly runoff was computed by the method of Thornthwaite and Matter. The results are shown in Figures 10 (a) and (b). The calculated monthly values of runoff show very little deviation from actually measured values of river flow.

4.1.7 Computation of 20-year and 5-year Low Flows in S. Rompin

The S. Rompin catchment was subdivided into the following sub-catchments:

S. Keratong Catchment (621 sq. mi.)

S. Jeram Catchment (246 sq. mi.)

S. Aur Catchment (112 sq. mi.)

Remaining section S. Rompin (256 sq. mi.)

Continuous monthly rainfall records were compiled for the various sub-catchments of the River, by means of the station-year method. The monthly values were used to compute the monthly discharges of S. Rompin at Kg. Sawak (1240 sq. mi.) as outlined before. The stations were grouped as shown in Tables 8a & 8b.

The 95 and the 80 per cent confidence limits of monthly discharges in acre ft. are listed in Table 8 and shown in cusec per sq. mi. in Figure 11 (a and b).

Monthly discharges in other streams in the Region, in acre ft., are listed in Table 9 (a and b) and they are shown in Figure 12 in cusec. per sq. mi.

The period of relatively lower discharge varies from July to September depending on the location of the subcatchments in relation as to the direction of winds. Higher discharges occur in November to January.

4.2 HIGH RUNOFF

4.2.1 Data Available

Daily observations of river levels have been recorded only for the S. Pahang since 1960 at the stations listed in Table 1. Since 1964 river discharges have been measured at regular intervals in the S. Pahang at Temerloh. A full stage rating curve for this cross section has been established by the Drainage and Irrigation Research Station.

4.2.2 Flood Frequency in the S. Pahang

The available runoff records for the S. Pahang at Temerloh and other stations cover too short a period to permit accurate forecasts to be made of the frequency of return of various river discharge and, in particular, of extreme flood discharges.

Records of rainfall in the S. Pahang catchment have been kept since 1950 at about 70 stations. The approximate frequency of rainfall curves in the catchment have been used to assess the return periods of floods in the river.

The highest rainfalls in the catchment in terms of intensity and duration are during October/March. Their values were extracted from the records. Monthly evapo-transpiration values in each of the sub-catchments were calculated as indicated in Section 4.1.5. The daily evapo-transpiration was taken as the total evapo-transpiration for the month divided by the number of days in the month. The daily runoff was taken as the actual rainfall reduced by the daily evapo-transpiration. In a final tabulation for the discharge at Temerloh the distance of the sub-catchment from Temerloh was taken into account.

Using annual series and Gumbel probability methods, the frequency curves were compiled for probable runoff volumes returning once in 2, 5, 10 and 20 years with a duration of 1, 2, 3, 5, 7, 10, 15, 20 and 25 days. From these curves the once in 50 year returning volumes were projected. The results are shown in Fig. 13.

4.2.3 January 1971 Flood in S. Pahang

Exceptionally heavy rains fell over practically all of West Malaysia from December 26, 1970 till January 5, 1971. In Pahang Tenggara Region the rivers also rose to extremely high levels. River water overtopped the banks at many places, inundating low-lying areas to depths of up to 12 ft.

Rainfall data for the period at the Kuantan Airport Station reveal that during the eleven days' storm a total depth of 60.1 inches had fallen, or an average of 5.46 inches per day. The average daily rainfall over the entire catchment during the 21 days of river flood was 1.05 inches depth or a total flood volume of 9.5 million acre ft.

Prior to the 1971 rainstorm the highest rainfall on record in Kuantan occurred during December 1926 and January 1927. The total depth in 23 days of storm was 116.06 inches or an average intensity of 5.05 inches per day. Although the intensity of rainfall had been lower than during the recent storm, the rivers during that period rose to higher levels than in 1971, due to the

higher total depth of rainfall, or a different distribution of the daily rainfall, resulting in a different flood hydrograph.

After the river levels had receded measurement of the high water marks along the river was carried out (See Table 10). At Temerloh during the 1971 floods the river reached a maximum level of 126' M.S.L. For this site a rating curve had been established with a maximum measured discharge of 200,000 cusec at a level of 110.2' M.S.L. After projecting this curve, the peak discharge at level 126' M.S.L. was assessed at 480,000 cusec.

With reference to the frequency curves for floods in the S. Pahang (Fig. 13) it appears that the 1970/71 peak discharge corresponded to a probable return of once in 30 years, and that the flood volume had a probable return of once in 35 years.

4.2.4 Maximum Probable Floods and Hydrographs—S. Pahang and S. Rompin

Hydrographs for the S. Pahang at Lubok Paku and the S. Rompin at Kg. Sawak have been compiled in a manner as described in the publication "Hydrology Guide For Use in Watershed Planning".¹ The results are shown in Figs. 14 and 15. It was found that at Lubok Paku the maximum probable flood discharge would be in the order of 1,500,000 cusec. and at Kg. Sawak 225,000 cusec.

4.3 QUALITY OF WATER

4.3.1 Chemical Analysis

One hundred samples of river water were collected by the Consultants the first half of 1971. They were taken from midstream about one foot below the water surface. The sampling sites are indicated on Fig. 1. All samples were chemically analysed in the Laboratory of the Department of Chemistry at Petaling Jaya.

¹ Hydrology Guide for Use in Watershed Planning. National Engineering Handbook Section 4, Hydrology, Supplement A, U.S. Department of Agriculture, Soil Conservation Service.

Ninety four samples were analysed for chloride, boron, sodium and total suspended solids, and six samples were more fully analysed. The results of the analyses are listed in Tables 11 and 12.

Based on the Standard of the California State Water Resources Board the quality of water is excellent to good, Class I. The water is amenable to simple treatment to produce potable water.

4.3.2 Salt Water Penetration

Salt water penetrates into the streams at times of low discharge and concurrent high tides in the sea. Brackish water with a conductivity of about 2,000 micromhos and a chloride content of 480 p.p.m. has been found in the rivers draining the Region about 10 miles inland (5 miles in a straight line).

4.4 GROUNDWATER

On the east side of Tasek Chini, a few wells spring at an elevation of about +70' M.S.L. Water boiling up about one mile east of Tasek Chini is clear though slightly brownish in colour. The conductivity of the water varies between 23.7 and 27.6 micro-mhos. The yield fluctuates with the local rainfall, indicating a shallow aquifer close to the surface. Two more wells were found along the banks of the S. Mentiga with the help of people familiar with the jungle. The yield of these wells is very small and the water has a strong sulphuric smell.

There is at present no further indication, in the Region, of an aquifer with sufficient capacity to serve as a watersupply. It would be possible however to draw water from dug wells, not deeper than about 20 feet, as is being done in smaller communities on an individual basis. Strictly speaking this water is not groundwater as it originates from rainfall on the immediate surroundings of the well.

5.0 RIVER REGIME AFTER DEVELOPMENT

5.1 PROPOSED DEVELOPMENTS IN RIVER CATCHMENTS

In order to avoid serious disruptions to existing natural balances, the clearing of jungle in parts of a catchment, and subsequent development of these areas, will have to be carried out together with the necessary conservation measures. After development, a new balance between rainfall, sediment transport, high flows and dry weather flows will be achieved. This new balance should not, however, differ significantly from the existing situation provided conservation measures, described in Section 5.1.1 are implemented.

5.1.1 Conservation Measures

It is recommended that the following conservation measures be implemented concurrent with any development in the Region.

- (a) Terracing or benching to prevent excessive erosion of the top soil.
- (b) Construction of dropstructures in drains to reduce the gradient of the drainage channel, thereby reducing the velocity of water and subsequent scouring.
- (c) The larger streams and their tributaries should be cleared of fallen trees and other debris to increase water velocities in the river, thereby increasing their capacity to keep sediments moving.
- (d) A band about 100-200 yards wide along the banks of the rivers should be left uncleared to prevent or retard the entry of roots, trunks or branches from the cleared areas, into the streams.
- (e) Discharges from settlements and industry should be treated in accordance with acceptable limits of pollutants.

5.1.2 Expected Influence on Future Runoff

A detailed account of the expected changes in river discharge is given in Chapter 7.

The dry weather flows in the rivers would decrease resulting from a reduction in retention capacity of the original forest floor to include only storage in the soil. The volume of dry

weather flow as well as the river level during that period would be reduced. If the entire catchment area were cleared, the retention in the catchment would be reduced to about one-third of the original capacity. A comparison between the estimated present dry weather flows and the expected future dry weather flows is shown in Table 9 (a and b) for Sungei Jeram, Bera, Mentiga, Jekatih, Pukin, Keratong, Aur and Anak Endau, assuming that 50 per cent of each catchment would be developed.

5.2 POSSIBLE DETERIORATION OF WATER QUALITY

5.2.1 Causes of Contamination

The quantity of water available in the Region would be adversely affected by uncontrolled development. While the runoff conditions could eventually be improved, the water quality in the streams could deteriorate sufficiently to render it unsuitable for all purposes.

Municipal, industrial and agricultural wastes are the main causes of contamination. Controlled discharge of effluents from these sources is therefore imperative at all times.

5.2.2 Standards for Disposal of Wastes

Contamination of water can be kept within acceptable limits provided concentration of pollutants in the effluent discharged into the surface water is controlled in proportion to the total riverflows as listed in Table 8. Strict adherence to these requirements by each developer, town and industry, would obviate the cause of excessive pollution and maintain the quality of water within acceptable limits. Table 13 lists presently accepted standards for pollutants contained in industrial and municipal effluents.

The urgent need to enforce permissible standards for effluents is demonstrated by the values of conductivity found in the water of the S. Seriting and its tributaries. Settlement of rural population and agriculture has started in the catchment of the S. Seriting. Although still on a small scale, a marked increase in the conductivity of the water in the stream was found. The maximum values measured ranged between 77 and 87 micro-mhos. It is not known what the original conductivity was, but there is no reason

to assume that it would have been different from that in the S. Jerangkai, a tributary of the S. Seriting not yet developed, or in any other stream in the Region which is presently unsettled. There the highest values were found to vary between 25 and 35 micro-mhos. The same applies also to the S. Teriang, where the electrical conductivity was found to be as high as 59 micro-mhos.

5.2.3 Effluents from Towns

Contamination of streams by effluents from settlements which are too small to warrant a sewage treatment plant, can be kept under control if the disposal of raw household wastes into the streams is kept to a minimum. Since pipe-borne water would be supplied for domestic use, the need for wells would be eliminated, as would also the accompanying dangers of contamination of well water.

Until such time as the population of a settlement is large enough to warrant a sewage collection system and treatment plant, all houses should be provided with a septic tank. These tanks would collect only household waste, i.e. not rainwater. The overflows from the tanks should

discharge in a pit or tile drain in the garden rather than in the street drains. A municipally operated sanitary service could empty the septic tanks on a regular basis. The sludge collected could be used for natural fertilizer or be disposed of after centralized treatment.

If and when a sewage system is installed, the connection with the house waste pipe would bypass the septic tank and convey the effluent directly into the city sewer.

5.2.4 Drainage from Agriculture

Deterioration of water quality by agriculture would be more difficult to contain within acceptable limits. Contamination by agricultural chemicals would be slow but would likely be more widespread. Drainage from the fields would carry with it in solution constituents of fertilizers and pesticides. The use of harmful and lethal elements in the manufacture of at least some of these chemicals cannot yet be avoided. Complete prohibition of the use of pesticides would reduce crop yields and farmer's incomes. Until such time that pesticides can be produced without objectionable constituents, some pollution by agriculture will be unavoidable.

6.0 MUNICIPAL AND INDUSTRIAL WATER

6.1 GENERAL

6.1.1 Supply of Water

Pipe borne water for residential, institutional and industrial use should be delivered to new as well as existing communities in the Region. The system envisaged herein would consist of two parts:

Firstly: The delivery system comprising collection, purification and conveyance of water to a central storage reservoir near each settlement.

Secondly: The distribution system comprising the conveyance of water from the central storage to the various consumers.

6.1.2 Unit Water Demand

The daily *per capita* consumption of water is estimated as follows:

Domestic water	...	...	6.5 cu. ft.
Offices, public places, stores, etc.	...	...	0.5 cu. ft.
Industry	...	...	1.7 cu. ft.
Losses of water	...	...	1.3 cu. ft.
Total daily consumption per capita	...	...	10.0 cu. ft.

6.1.3 Quality of River Water

Water samples taken from various streams in the interior of the Region show a uniform good to excellent quality, amenable to simple treatment for use as potable water. Samples taken from streams along the western border (S. Serling catchment) show some deterioration in quality and the water samples taken in coastal streams on the east side of the Region show salt water penetration extending more than ten miles inland. A review of the results of the chemical analysis of the water samples is given in Section 4.3.2. The results are listed in Tables 11 and 12. Water sampling sites are indicated on Fig. 1. While at present river water requires only filtering and chlorination it may in future be necessary to employ more sophisticated purification processes to keep pace with increasing contamination of river water.

6.1.4 Selection of Catchments for Watersupply

Chapter 4 contains assessments of available dry weather flows for rivers in the Region. Theoretically, for each catchment the dry weather flow of 0.27 cusec per sq. mi. would apply to all catchments regardless of their size. The reduced runoff during dry weather is not so much attributable to a reduction in the intensity of rainfall as to a reduction in the extent and frequency. Moreover, during dry weather a rain-storm is more likely to bypass a small catchment than a large one. Thus the dry weather flow will at times be reduced to zero in small catchments.

The catchments which have been selected as sources of watersupply are: S. Rompin, S. Mentiga, S. Gayong, S. Teroh, S. Kepasing, S. Batu and S. Cherong. Amongst these only the S. Rompin has a catchment area of over 1,000 sq. mi. and can be considered as having a definite minimum dry weather flow sufficient to provide a reliable run-of-the-river source for an assured watersupply. The other catchments would provide an assured watersupply only by means of a regulating reservoir, the capacity of which would need to be in the order of a two to three months water demand. The grouping of the towns to be served by the respective sources is shown in Fig. 16. The towns are listed in Table 14 together with their ultimate population and water demand.

6.1.5 Delivery and Water Distribution System

The complete system would consist of a network of pipes, laid along the highways and roads. In some parts of the system the water would flow by gravity. However, in most areas pumps would be required to lift the water from lower to higher elevations. Storage of water would be incorporated in the system.

6.1.6 Power for Watersupply

It is anticipated that electric power would be available to all communities either through transmission from a national grid or by generation in the town itself. It is assumed that most pumps would be electrically operated. In very remote locations it may be necessary to use diesel operated pumps or else temporary power plants. Such plants would serve until electrification of the Region is integrated. The switchover from one source of power to the other would then not cause any interruption and would not require costly changes in equipment.

6.1.7 Capacity of System

The capacity of mainlines and major equipment should be adequate to supply at least some of the foreseeable future requirements. However, the phasing and capacity of these installations should be examined in each case to arrive at optimum solutions. All installations should have a certain degree of flexibility for the delivery of water. For instance, the quantity delivered can be adjusted to the demand by operating the installation for longer or shorter period. Normally the daily operating time would be 20 hours; thus providing a reserve capacity of 20 percent. This reserve capacity would be available to delay the installation of additional equipment required to cope with increasing demands. Similarly reduced demands would be supplied by corresponding reductions in operating times.

6.1.8 Storage Facilities

Each town would have a central storage tank or reservoir to which the water for use in the town would be delivered. This would supply various satellite tanks throughout the town. The central storage would preferably be constructed on top of a hill near the town. Its capacity would be equal to half the daily demand. In case the central storage would also function as storage for a booster station to serve towns further on, its capacity would be increased by 10 percent of the additional daily demand.

6.1.9 Diversion of River Water

The S. Rompin scheme would have an intake tower constructed in the river. The other six smaller systems would have a reservoir to store a three months water supply to be used during the dry season.

For the small catchments an earth dam would be built in the stream valley with a partly gated concrete spillway and an intake culvert gated on

the upstream side. No provisions for sedimentation would be needed in the purification area. Sediments carried by river water would be deposited in the reservoir. They would be flushed out by opening the gates in the spillway during high river discharge.

6.1.10 Purification Plants, Powerhouse and Staff Quarters

The purification plant would be located close to the source. The watersupply management office, stores, laboratory and power-house would also be located in the plant area. Housing for the staff would be located adjacent to the purification plant. In the initial stages the plant would be built for about 30 percent of the ultimate capacity. Enough space would be reserved for expansion and eventual addition of other processes in the same area.

6.1.11 Summary of Estimated Cost

Costs have been estimated for those schemes which in 1990, would serve a total population of 291,230 located in 30 towns, settlement of which would be undertaken before 1980. The cost of schemes required to service the remaining proposed towns, settlement of which would not be undertaken till after 1980, has not been estimated.

Information pertaining to elevations and locations has been obtained from existing topographic maps, published to a scale of one inch to one mile. The cost for the distribution system has been assumed at \$100 per capita. The actual cost for a particular scheme will, of course, vary depending on topography and other relevant factors.

The costs of the construction, operation and maintenance are summarised below from Tables 17 and 19.

Expenditure in \$1 million				
	Delivery	Distribution	Total Construction	O & M
Till 1975	13.0	11.4	24.4	5.3
1975-1980	6.8	10.4	17.2	28.3
1980-1985	3.2	8.9	12.2	36.4
1985-1990	0.5	5.5	6.0	46.3
TOTAL	23.5	36.2	59.8	116.3

Cost of operation and maintenance includes costs of material, labour, depreciation and repayment of capital in 30 years at an interest rate of 6 percent.

6.1.12 Revenue

At the prevailing rates in West Malaysia there would be an annual deficit in the operation of the watersupply of about 20 per cent.

6.2 SCHEMES FOR DELIVERY

6.2.1 S. Rompin

The catchment area of the river upstream of the proposed intake is 1,100 sq. miles. The estimated 20-year low monthly river flow is 32,000 acre ft. or 524 cusec. The anticipated withdrawal in 1990 would be 20.8 cusec. Low water in the river is estimated at +25 M.S.L., corresponding to a discharge of about 1,000 cusec. The main features of the scheme are listed in Table 15a. The schematic layout of the purification plant is shown in Figure 17.

6.2.2 S. Mentiga

At the site of the storage dam the river has a catchment area of 52 sq. mi. The 20-year annual low yield is estimated at 28,000 acre ft. or a regulated minimum flow of 38.6 cusec. The expected withdrawal for the water-supply in 1990 would be 2.72 cusec. The main features of the scheme are listed in Table 15b.

6.2.3 S. Gayong

At the site of the dam the river has a catchment area of 8.5 sq. mi., the 20-year low annual yield is estimated at 6,700 acre ft. or a regulated runoff of 9.3 cusec. The expected demand for the scheme would be 1.48 cusec. It is proposed to supply town 23 and 9 from this source. The construction cost of this scheme would be high compared to the other proposed schemes. The mainline along the highway as an alternative, connecting the two with the town 10, is long and would not serve communities along its course until after 1980. A saving in construction cost may be possible if, after a close observation of the salt water penetration into the S. Rompin, it would become evident that town 23 could be supplied with good quality water from the S. Rompin.

The construction of the earth dam in the S. Gayong could be delayed until after 1980. The initial demands, not exceeding 0.40 cusec., could be extracted from the river through a crib. The main features of the scheme are listed in Table 15c.

6.2.4 S. Kepasing

At the site of the dam the catchment area of the river is 14.4 sq. mi. The estimated 20-year low annual yield is 11,400 acre ft. or a regulated flow of 15.7 cusec. The expected ultimate withdrawal is 5.20 cusec. The main features of this scheme are listed in Table 15d.

6.2.5 S. Teroh

At the damsite the catchment area of the stream is 5.6 sq. mi. The estimated 20-year low annual yield after development is 3,210 acre ft. or 4.4 cusec. The daily demand for water in 1990 is estimated at 5.04 cusec. The main features of the scheme are listed in Table 15e.

6.2.6 S. Cherong

At the damsite the catchment area of the stream is 5.3 sq. mi.; the 20-year low annual yield is 2,510 acre ft. or cusec. The expected daily consumption in 1990 would be 3.98 cusec. The initial demand of 0.38 cusec can be withdrawn from the stream through a crib. An earth dam would be constructed after 1975. The main features of the scheme are listed in Table 15f.

6.2.7 S. Batu

At the damsite the stream catchment has an area of 8.4 sq. mi. The 20-year low annual yield is estimated at 4,440 acre ft. or 6.1 cusec. The daily demand by the supply system in 1990 would be 3.41 cusec. The earth dam would be constructed during the initial period. The main features of the scheme are listed in Table 15g.

6.3 CONSTRUCTION COSTS OF DELIVERY SYSTEMS

6.3.1 Tangible Costs

The cost of those items which can be assessed quantitatively reasonably well on the basis of published topographic maps are listed in Tables 15a—15g. The cost of these items was determined

simply by multiplying the requirements by their respective unit costs shown in Section 6.3. These costs include supply and installation of the various items.

6.3.2 Investigations and Design

The cost of investigation, design, and construction supervision is taken at 8 percent of the tangible costs.

6.3.3 Non-tangible Costs

The cost of all other items is included in a contingency item of 15 percent to the above tangible costs.

6.3.4 Unit Costs

- (a) Access Roads are assumed to cost \$50,000 per mile.
- (b) Intakes and earth dams are accounted for as lump sum items.
- (c) The cost of purification plants is estimated to be \$75,000 per cusec of capacity when grit removal and sedimentation is required and at \$18,000 per cusec when only filtering and chlorination is required.
- (d) Pipe lines.

6" @	\$ 30,000	per mile.
8" @	\$ 40,000	"
10" @	\$ 59,000	"
12" @	\$ 72,000	"
14" @	\$ 90,000	"
16" @	\$107,000	"
- (e) Structures for pump stations are estimated to cost \$60/sq. ft.
- (f) The cost of pumps, motors & wiring vary with the operating head as well as installed capacity, as follows; \$250 per kW for 250' head and \$390 for 100' head.
- (g) The cost of Storage Tanks are governed by the capacity of the network, and are estimated at \$75,000 per cusec.
- (h) Distribution Networks are taken at \$100 per capita.

6.3.5 Power House at Damsite

The cost of power house equipment estimated at \$300 per installed kW and the cost of the structure at \$60 per sq. ft. The costs of the power houses are not included in the total of the estimate. Repayment of the installation is

accounted for in the costs of electricity needed for the operation and maintenance of the schemes.

6.3.6 Cost of Watersupply

The separate costs of each scheme are listed in Tables 16a to 16g. A summary of these costs is given in Table 17. The average construction cost is \$171 per capita.

6.4 COST OF OPERATION AND MAINTENANCE OF DELIVERY SCHEMES

6.4.1 Direct Cost

- (a) Electricity is taken at \$0.025 per kWh, which includes the cost of operating, maintaining, amortizing and depreciating the power plant.
- (b) Labour costs are taken (per shift) as follows:

Plant Capacity	Cost Per Year
0-1 cusec	\$ 7,200
1-2 cusec	9,000
2 cusec and over ...	12,000

The cost of labour for booster stations is taken at \$2,400 per year per shift.

- (c) Chemicals are taken at \$11,800 per cusec per year.
- (d) Maintenance of equipment is taken at 2 percent per year of capital cost. Maintenance of other facilities is estimated at 0.1 percent per year of capital cost.

6.4.2 Cost of Capital

- (a) Depreciation of mechanical equipment is taken at 1/15 of capital cost per year.
- (b) Depreciation of all other items is taken at 1/30 of capital cost per year.
- (c) Repayment of capital cost is taken at repayment over 30 years with a rate of interest of 6 percent.

6.4.3 Annual Cost

The annual costs of operating and maintaining the various schemes are listed in Tables 18a to 18g; a summary of these costs is shown in Table 19. The total cost of 1000 gallons is thus found to be \$1.19.

7.0 DRAINAGE, EROSION, SEDIMENTATION, INUNDATION AND FLOOD PROTECTION

7.1 INSIDE NATURAL FORESTS

7.1.1 Soil Erosion

The trees, underbush and layer of decayed vegetation on the ground all help to protect the soil surface from the impact of the falling raindrops. On bare, slightly sloping terrain the energy of the falling rain tends to loosen the surface particles and then carry them away with the surface flow.

7.1.2 Formation of Drainage Channels

During heavy rainfall only a part of the rain penetrates the soil. The remainder which stays above the surface flows to the nearest depression. The flow of this water is retarded by exposed roots, trunks, fallen trees and brush. However, continuing its course downstream it gathers more volume and generates more speed. At a certain point the flow has attained sufficient energy to scour a channel in the forest floor. The flow of water from thereon is more or less confined.

7.1.3 Marshes

During the wet season upstream of this point, and in particular in wide and flat valleys, the depression is continuously covered by a sheet of water. The entire depression has the appearance of a marsh and even in the dry season many pools of standing water remain notwithstanding the fact that the elevation of the depression above the nearby stream is adequate to drain the pools by gravity.

7.1.4 Sediments

During most of the year the rivers contain relatively small amounts of sediments. The sediments found in the rivers are usually the result of bank erosion rather than erosion of soil within the catchment. During flood discharge the rivers scour the concave banks as well as other obstacles to flow such as trees standing on the bank which may be undermined and fall into the river.

7.1.5 Obstructions in the Rivers

Obstructions in the rivers such as fallen trees, rocks and other obstacles cause the river levels to rise more during floods than if the water could

flow unimpeded. When the banks near these obstacles are low the rivers flow over their banks and inundate the adjacent lowlands.

7.1.6 Inundations and Sand Bars

Inundations may be the result of temporary obstacles, such as a fallen tree, which in the course of time would sink deeper into the riverbed, or they may be of a permanent nature such as rocks in the riverbed or banks, or bridge piers.

When a river overflows its banks, the remaining discharge is reduced. The total volume of bed load carried by the full discharge upstream of this section cannot be carried further by the continuing flow. The excess in bed load is left behind in the form of sandbars, which raise the riverbed and further reduce the effective height of the riverbanks. This situation is evident in the lower reaches of the S. Keratong and S. Pahang.

7.1.7 Natural Balance in River Regime

The profile and cross sections at any place in a river course are in balance with the discharges, flood pattern and sediment transport. Any development which changes one of these factors, will initiate changes in the other factors as well, resulting eventually in a new balance conforming to the changed conditions. The interrelationship between cause and effect is too complex to express by means of mathematical formulae. Only after extended study of a particular stream is it possible to predict the nature and to a lesser extent the magnitude of changes in regime likely to result from certain courses of action. Such a study frequently involves the use of moveable bed models, the construction and operation of which are both expensive and time consuming. However, some useful general predictions can be made by experts in this field.

7.2 CLEARING OF FOREST AND SUBSEQUENT AGRICULTURE

7.2.1 Erosion

Some types of agriculture, such as tree cultivation, do not represent a drastic change from the original forest stand. The soil surface is still protected to some degree from the energy of falling rain. However, the annual cultivation and the perennial cultivation, when not yet mature, entirely expose the soil surface. To alleviate the danger of

erosion it is necessary to terrace exposed slopes. In practice it will probably not be practicable to level all of the area to prevent erosion. Exposed slopes can be protected to some extent by perennial creepers. Such protection should be provided as soon as possible after forest clearing operations when exposed surfaces are most vulnerable to erosion.

7.2.2 River Flow

After a prolonged rainfall the river discharge reaches its peak sooner than after a prolonged dryspell, the rate depending on the shape of the catchment and direction of the rainstorm. For a regularly recurring medium intensity rainstorm the resultant additional rise in water level will probably be in the order of only a few inches. The total stream flow volume is increased as a result of reduced evapo-transpiration losses following clearing of the original forest cover. The duration of high water will remain about the same. The dry weather flow which represents the run-off of water retained on the surface of the forest floor, together with the quantity arriving in the streams after percolation through the soil would be reduced to only the quantity percolated through the soil.

The very heavy rainstorms returning once in 50 or more years are extensive. They cover large parts of/or the entire catchment and last for longer periods. Sometime after the onset of rain the forest floor becomes saturated after which any additional rain drains over the surface. The retention capacity of the forest floor is small in comparison to the intensity and volume of a heavy rainfall. The peak discharge, the total volume and the duration of heavy floods after development will remain essentially the same as before development.

7.2.3 Sediment

Erosion of top soil in the catchment will not be significantly increased provided some basic precautions are observed. The total increase in sediments in the river and sandbar forming would not cause more frequent or more serious inundations than before.

7.2.4 River Regime

When no river training is undertaken, the original balance after clearing would be marginally changed. Depths of water, areas inundated and depth of inundations, their return period and all other phenomena connected with river run-off would remain practically unchanged.

7.3 INUNDATIONS IN DEVELOPED LANDS

7.3.1 Drainage Requirements

Capital outlays for drainage are limited to the amounts which can be justified within the framework of total expenditure for all development within the Region. In new developments where income per acre is still at a low level, complete prevention of inundations appears to be unwarranted. Inundations for short periods, of low frequency and causing no serious damage to property, would be acceptable. During the initial stages of development expenditures for pumped drainage would not appear justifiable. In planning the layout of cities and towns the costly buildings, shopping centres and industry would be located on higher ground, so that even if the lower areas of the town would at times be inundated, these buildings would not be adversely affected.

7.3.2 Drainage of Marshes

Initially only gravity drainage should be provided in marshes. Such drainage would then be confined to marshes located in higher parts of a catchment. These areas usually dry up after the land is cleared and after drains have been excavated. Culverts will have to be constructed wherever a road crosses a drainage course so as to avoid the creation of artificial marshes.

7.3.3 Low Lying Areas Along River Banks

The incidence and extent of inundation would be reduced by lowering the river levels. In general this would be practicable only where high water is caused by temporary obstacles in the river bed. Then removal of these obstacles in an overall programme of river clearing could be the only requirement. Dyking and drainage in the initial stages would be too costly.

7.3.4 Improvement of Discharge Capacity of Rivers

Permanent improvements in the discharge capacity and lowering the water levels of rivers in the Region cannot be achieved by changing the elevations of the river beds. An exception to this is localized improvements which can be effected by removal of obstacles, or by shortening the course of the river. However, the size of suspended particles, the quantity of the solids in suspension,

the volume of run-off, the elevation of the upper catchment, and the length of the river, all contribute to determine the lowest elevation in a cross section in relation to its distance from the sea. If a section of a river is dredged below this elevation, the dredged hole will soon be filled and maintenance of the deeper channel would require a continuous dredging operation.

Removal of obstructions would increase the overall velocity of water, improve the river discharge and its capacity to move material. This operation would in due course result in a lowering of the river bed. Due to lower water levels, less water would overflow the banks to inundate adjacent lands. The resultant peak discharges would be increased, thereby enabling the river to move material more effectively, thus further lowering the river bed.

7.4 CLEARING OF THE S. ROMPIN

7.4.1 Purpose

The run-off in the S. Rompin accounts for nearly half of the Region's total surface area. Therefore, improvement in the discharge of this river would benefit about half of the Region's development. Clearing of the river bed would be the first step to the complete amelioration, a process which would take a few decades. The river then would also provide easy and cheap water transport for the shipment of some of the goods produced in the Region.

7.4.2 Section to be cleared

The stretch to be improved in the first instance would begin about 10 miles downstream from the confluence of the S. Rompin and the S. Aur at Kg. Aur, and extend into the tributaries of S. Aur and S. Jeram for 10 miles, and into the S. Keratong for 30 miles, upstream of Kg. Aur.

7.4.3 Nature of Work and Equipment

Clearing of the stream would consist of removing from the river bed all trees, trunks, roots together with all trees projecting over the banks of the river. The debris should be removed at least 100 yards away from the bank. Trees which are nearly covered by sediments may be too difficult to remove in which case a hole would have to be dredged around the tree so that it would sink permanently, below bed elevation. The mixture of dredged sand, branches, roots etc. would be deposited on land.

The equipment needed would consist of a 12-inch cutter dredge, one pontoon equipped with a 10-ton derrick, one pontoon for water transport, two small tugs, two bulldozers, a number of chainsaws, two row boats, small tools and cable. The rate of progress in clearing operations can only be guessed at since it would depend almost entirely on the number of obstacles to be removed. The work would have to be carried out during medium and low river discharge, which would be mainly in the dry season, April to October. The work would start near the mouth of the river and proceed upstream.

7.4.4 Survey

Survey of the river would extend from the estuary to past the highest settlement. Prior to commencing clearing operations an inspection of the river and an assessment of the clearing work to be done would be made. Two permanent water level recorders would be installed, one at Kg. Aur and the second nearer to the coast where the tides do not yet affect the river levels. In addition to these recorders, about 60 temporary stick gauges would be installed on the left bank of the river. The elevation of the two recorders and the stick gauges would have to be established with respect to Mean Sea Level. The distance between the stick gauges measured along the bank, would vary but would average about one mile. The survey of the riverbed would be done in sections between the stick gauges. The depths of water would be measured with an echo sounder, mounted on a small boat, which would traverse from one cross section to the next in straight lines. While the survey in a section is in progress, the level at the bordering stick gauges would be read hourly. Thereafter the stick gauges would not be needed. The parts of the river bed where the water is too shallow, together with a stretch about 100 yards wide along the banks would be levelled by instruments from the bank. The survey of the river would constitute the basis for subsequent river improvement studies.

7.4.5 Assessment of Cost

It is assumed that the project would take two years with 300 working days per year and a 12-hour workday for the equipment.

Cost of survey and mapping ...	\$ 450,000
Cost of clearing ...	2,000,000

The cost of these operations would amount to about \$4.00 per development acre.

7.5 FLOODS IN S. PAHANG

7.5.1 Data

The incidence of high water in the S. Pahang has been reviewed in Chapter 4 Sections 4.2.2, 4.2.3 and 4.2.4.

7.5.2 Area Inundated by S. Pahang

The approximate extent of inundation south of the S. Pahang during the 1970/71 flood is shown on Fig. 18. The area is estimated at 400 sq. mi. Near the river banks the level of inundation would correspond to that in the river. Further away the level would be reduced depending on the duration of high water in the river and the speed with which the water would flow and spread over the land. Superimposed on these elevations would be the depth of inundation caused by local rainfall and river run-off. An average rainfall of 5 feet occurred during the ten-day period, which could not be discharged due to high water in the S. Pahang. This resulted in total depths of inundation of up to 12 feet at some places.

7.5.3 Inundation at Pekan

Inundation of Pekan during the December '70 and January '71 flood was the result of two coincident phenomena. High river discharge coincided with high spring tides in the sea. The river discharge was therefore severely restricted and at times the flow in the river was reversed over a considerable distance from the mouth. Starting upstream of Paloh Hinai water flowed over the banks and contributed to the inundation in and around Pekan. Although the recent inundation at Pekan was severe, some of the older residents in Pekan recall that in 1926 flood levels there were 3 feet higher.

7.5.4 Sandbars in the River Mouth

The flow in the S. Pahang carried with it a considerable quantity of bed load which, starting from Paloh Hinai, was deposited on the river bed by the water flowing over its banks. After the water levels receded, extensive formations of sandbars were visible in the river mouth. It is probable that these sandbars would be reduced during successive floods provided that they occur at more favourable times with respect to tides.

7.5.5 Flood Protection

Flood protection could be provided either by retention of flood waters in the upper catchment or by construction of levees along the river bank. Which of these solutions would produce the most benefits at the lowest cost cannot be established at present.

Inundation by river discharge in the S. Pahang corresponding to that experienced during the recent flood has occurred three times in the last 40 years. Such frequent recurrences cannot be tolerated in a developed area. Any protection which may be provided should at least provide safeguards against floods of a magnitude equal to that recently experienced. There is however, no factual information available to determine whether such a safeguard would be adequate or economically justifiable.

7.5.6 Investigation of S. Pahang and its Catchment

The basis for amelioration along the S. Pahang would be a study of the behaviour of the S. Pahang as well as present and future conditions in its catchment. As a start it will be necessary to install automatic water level recorders in the major tributaries of the river (Fig. 19 and Table 20). A continuous 10-year record of levels and discharges would permit correlation between existing rainfall records and river discharge and would provide a basis for a reliable frequency prediction. The study of the catchment would also include a survey of possible storage reservoirs in the tributaries, their effectiveness with regard to flood protection, and their additional potentials, such as for hydro-electric power, irrigation and municipal watersupply.

Following completion of the 10-year observation period it would be possible to determine the degree of protection to be provided, the method to be used, and the cost of such protection. The benefits to be derived from construction of amelioration works on the S. Pahang benefit not only Pahang Tenggara but also much of the remainder of Pahang.

7.5.7 Flood Protection of Pekan

In view of the fact that Pekan is Pahang's royal town, the need for providing protection against flooding is considered to be particularly urgent.

It appears that the only relief which would be provided in a reasonably short time would be to build a dyke and ditch around the town. Following this the area enclosed by the dyke could be raised progressively to an elevation of +19' M.S.L. with river-dredged sand. The cost and benefits of such a program would however, require land surveys, property surveys and cost-estimates to be made to determine the value of the proposal.

7.6 CONSTRUCTION OF DRAINAGE NETWORKS

7.6.1 Standards for Capacity of Drainage Networks

For larger towns and cities, (i.e. those with a population of 25,000 or more) it is considered adequate to provide drainage facilities that would handle a two-day-rainfall returning once in five years. Smaller towns and villages would have lesser design requirement. Thus it is suggested that for settlements of 5,000 and less the drainage system be designed to discharge the maximum rainfall expected to occur each year. The same requirement would apply to lands cultivated with annual crops. Lands under perennial crops would require drainage facilities capable of handling the maximum two-day-rainfall expected twice a year. Drainage network design criteria are listed in Table 21.

7.6.2 Agricultural Drainage

Drainage facilities for cultivated land would have to be designed to suit the topography of the site. Field drains would consist of open ditches radiating towards nearby depressions. Drains should be approximately two feet deep with a bottom width of one foot and spaced about 150 feet apart, the exact spacing depending on the crop to be grown as well as the soil characteristics. Excavated soil would be spread over the adjacent fields. The drains would discharge into a collector ditch excavated in the depression, which in turn would discharge into a natural stream. The gradient of the ditch bottom should not exceed one foot per 1,000 feet. Where the topography would require a steeper gradient, drop structures would be required in the drains to prevent scouring.

7.6.3 Drainage in Urban Areas

In urban areas drains would be constructed along the roads, the gradient corresponding to that of the roads. They would likely be semi-circular pre-cast concrete pipe. The road drains would discharge into a natural stream via a collector ditch. The capacity of these natural streams would probably need to be enlarged to carry the additional run-off.

Contamination of streams by the discharge of town wastes could be controlled by not permitting the drains to collect waste water from households. Septic tanks would have to be provided and the effluent therefrom be disposed of in rock pits in householders' gardens.

8.0 DEVELOPMENT OF HYDROELECTRIC POWER IN THE S. JERAM

8.1 GENERAL

8.1.1 Location

The hills on both sides of the S. Jeram come close to the river at Bulut Nipis and form a canyon one and a half miles long. The canyon is about 100 feet wide at the bottom with side slopes of approximately 40° from the horizontal. The elevation of the river bed within the canyon drops from approximately +72' M.S.L. at the entrance to about +55' M.S.L. at the exit. The tops of the bordering hills are more than +250 feet above M.S.L. Rocks are exposed in the hills and provided the geology of the canyon is favourable the possibility of this being a good dam site is suggested. The general location is indicated in Figure 20.

8.1.2 Catchment

(a) The catchment (area 186 square miles) is pear-shaped with its major axis oriented in the north-west, south-east direction. It has a maximum length of about 21 miles and a breadth of 10 miles as shown in Figure 20

(b) The land adjacent to the stream is flat. Further away it becomes undulating, and then hilly. The watershed in the south reaches elevations of +1,200' M.S.L.; in the west and north it reaches elevations of +1,800' M.S.L. and in the east it reaches +500' M.S.L. A low saddle slightly above +150' M.S.L. separates the S. Jeram from the S. Mentiga.

(c) Small areas along the river are occupied by shifting cultivation, whereas the remainder of the catchment is under virgin jungle. No permanent settlement exists within the catchment.

(d) The surface soils at lower elevations are clays and clay-loams to sandy-loams of various grades. Higher up occasional granitic rock outcrops are found.

(e) The catchment is exposed to winds from the east and is somewhat sheltered from south-westerly winds.

(f) No climatic or streamflow data is presently available. In the absence of recorded data it has been necessary to synthesize data as described in Chapters 3 and 4. The relevant data for the S. Jeram storage are shown below:

Assessed Annual Yields in the S. Jeram
at Bulut Nipis
(Acre feet per annum)

	Low Discharge	High Discharge
Average	452,400	
Once in 5 years	290,000	560,000
Once in 10 years	210,000	670,000
Once in 20 years	150,000	830,000

The monthly dry-weather flows are listed in Table 9.

(g) Silt and sediment transport appears to be normal and the river bed at Bulut Nipis appears to be stable.

8.1.3 Use of Reservoir

The prime use of the storage would be for generation of hydroelectric power to be fed into the West Malaysia Power Grid operated by the National Electricity Board. Further possibilities for its use are fish culture and recreation, and a limited degree of flood amelioration.

8.2 DAM, RESERVOIR AND POWER HOUSE

8.2.1 Type of Dam

A mass concrete gravity dam appears to be best suited to this site. The foundation of the dam would be on rock, which would probably require grouting.

8.2.2 Location of Dam and Power House

As indicated in Section 8.1.1 the elevation of the river bed drops approximately 17 ft. within the length of the canyon. Advantage could be taken of this drop by constructing a dam at the entrance and a power house at the exit of the canyon. A penstock of two 6-ft. diameter pipes, 1.5 miles long or alternatively an open canal about 1.5

miles, or a tunnel and a short penstock would be required to convey the water to the power house. The practicability of this arrangement is however, difficult to assess on the basis of presently available site information. It has been assumed that a good foundation could be found in the canyon, where the river bed is somewhat below +60' M.S.L. The power house would be incorporated in the dam. The location and a possible general arrangement are shown in Figure 21.

8.2.3 Description of Dam

The dam would have a horizontal curvature with a radius of 500 feet. The length of the crest would be 530 feet at elevation +150' MSL. The spillway would consist of two parts, each 215 feet long, located at either end of the dam crest, and separated by a centre section 100 ft. long. The power house would be located within this centre section. A 25-foot wide bridge over the spillway section resting on piers 20 feet apart, would provide access to the power house as well as connecting both abutments. The foundation of the dam in the river bed would be at elevation +50' MSL rising to +125' MSL in the sides of the canyon. The upstream face would be vertical and the downstream face would slope with an angle of 65° from the horizontal.

8.2.4 Description of Spillway

Each spillway would consist of approximately 100 feet of open spillway with a crest elevation of +130' MSL and 115 feet of gated spillway containing five openings each 20 feet wide, with a sill elevation of +120' MSL. The gates would be lifted only when extremely high floods would threaten to overtop the dam. During normal operations they would remain closed. The lifting gear for these gates would be moveable on rails, located on either side of the dam crest. The upstream face of the spillway would be vertical and sloping 70° on the downstream side. The design flood for the spillway has been assumed at a maximum daily inflow of 3,000 cusec. and a total volume of 770,000 acre feet in 16 days. With this flood the maximum reservoir level would be +148' MSL when all gates are opened.

8.2.5 Data of Reservoir

The area-capacity curve of the reservoir is shown in Figure 22. The average annual yield, dry-weather flow and 50-year low annual yield have been estimated. The method used in estimating these yields is described in Section S. 4.1.1. to 4.1.7.

On this basis the reservoir would have the following characteristics:

Catchment area	...	...	186 sq. mi.
Assumed maximum spillway design flood:			
Maximum inflow	...	...	36,000 cusec
Flood volume	...	...	770,000 acre ft.
Duration	...	...	16 days
Assessed average annual yield	...	...	452 400 acre ft.
Capacity at full storage (+130' MSL)	...	...	431,350 acre ft.
Capacity at dead storage (+90' MSL)	...	...	15,970 acre ft.
Net storage capacity	...	...	415,380 acre ft.
Maximum high water level (design flood)	...	...	+148' MSL
River level below the dam tailwater)	...	...	+ 60' MSL

8.2.6 Potential of Hydroelectric Power

The average annual yield of the catchment is estimated at 452,400 acre feet. In a multi-annual storage as would be provided in the reservoir, this quantity would be withdrawn, as an average over a long period of time. From this quantity about 50,000 acre feet would be lost annually by evaporation and only 402,400 acre feet would be available for power generation.

The level in the reservoir during 80 percent of the years would remain above +122' MSL and during these years it would drop theoretically during one month to +122' MSL. The average available static head would be 128 feet—60 feet = 68 feet. The average annual generation of power would be about 22.5 million kWh. at an assumed efficiency of 0.8.

8.2.7 Power House

The power house would be 30 feet×70 feet and would accommodate two generating units. The following would be the preliminary characteristic of each generator unit:

Energy output	...	...	11.25 million kWh.
Installed power with 0.8 load factor	...	...	2,150 hp
Average static head	...	...	68 feet
Type turbine	...	...	Propeller ¹
Turbine speed	...	...	about 485 r.p.m.
Diameter at throat of runner	...	...	about 4 feet
Intake tube diameter	...	...	6 feet
Tailwater	...	...	+ 60' MSL
Centre line of distributor	...	...	+ 55' MSL

¹ Dr Francis type turbine.

8.3 ESTIMATE OF COSTS

8.3.1 Clearing of Jungle

About 2,500 acres of jungle in the construction site and along the shores of the reservoir would have to be cleared. Clearing costs are estimated at \$200 per acre. If it becomes necessary to clear reservoir site for recreational or other purposes, the additional cost thereof should be borne by those expected to benefit therefrom. This item is accounted for although the value of timber in the reservoir area could offset the cost of clearing.

8.3.2 Excavation

It is estimated that a total of 15,000 cu. yards of rock and earth would have to be removed. The average cost of excavating is assumed at \$6.50 per cu. yard.

8.3.3 Grouting

It is expected that some grouting would be required at the dam site. In the absence of any specific information a lump sum of \$10,000 is included in the estimate to cover this item.

8.3.4 Concrete

It is estimated that 65,000 cu. yards of concrete would be required to construct the spillway and dam. About 3 percent of this would require reinforcement and the remaining 97 percent would be mass concrete. Sand and stone required for aggregate would be readily available at the site. The cost of concrete is estimated at \$40 per cu. yard.

8.3.5 Gates

About 2,000 square feet of gates would be installed. The cost of the gates including the moveable lifting gear is estimated at \$55 per square feet.

8.3.6 Intake, Conduits, Power House and Equipment

The cost of plant and equipment is estimated at \$450 per kW of installed capacity of 3,200 kW.

8.3.7 Transmission

The power house at S. Jeram would be connected to the West Malaysia Power Grid. It is assumed that for this purpose 4 miles of line would be required. The cost is assumed at \$80,000 per mile.

8.3.8 Contingencies

A number of smaller items would increase the cost of power by an estimated 25 percent. This amount has been added to the major capital cost items identified above as a contingency.

8.3.9 Operating and Maintenance

Fixed charges are estimated at:

	Percentage of Estimated Capital Cost
Interest on capital outlay	5.5
Taxes and insurance ...	0.5
Depreciation ...	0.7
Total ...	6.7

The annual operating and maintenance cost of the plant is estimated at \$5.50 per installed kW.

8.3.10 Summary of Costs

Capital cost:

Clearing ...	\$ 500,000
Excavation ...	97,500
Grouting ...	10,000
Concrete ...	2,600,000
Gates ...	110,000
Intake, Conduits, Power	
House and equipment ...	1,440,000
Transmission line ...	320,000
Total ...	5,077,500
Contingencies ...	1,272,500
Estimated capital cost ...	\$6,350,000

Annual costs:

Fixed charges $(0.067 \times 6,350,000)$	= \$425,450
Operation and maintenance $(5.50 \times 3,200)$...	= 17,600
Estimated Total Annual Costs	\$443,050

8.3.11 Cost of Energy

The cost of energy would be $\frac{443,050}{22,500,000}$
= \$0.0197 per kWh.

8.4 OTHER USES OF THE RESERVOIR

8.4.1 Multi-purpose Reservoir

The possibility of creating a multi-purpose reservoir on the S. Jeram should be investigated together with any further studies related to power generation. The lake would offer excellent recreational possibilities and it would make a natural body for fish culture.

At operational level, the reservoir would have an area of 20,200 acres. The lake would be surrounded by hills reaching heights of about 1,500 feet above water level. The scenery would be attractive and it would appear to be an ideal location for all water-oriented sports.

About 25 percent of the lake would be shallower than 10 feet and a further 25 percent shallower than 20 feet. At its deepest point the lake would be 60 feet deep.

8.4.2 Forest in the Reservoir

At present the entire bottom area is covered with a high stand of virgin forest. Raising the water level would kill the trees, but it would take a long time before the trees would have withered away and before the water surface would be safe for boating, unless the entire reservoir area were cleared of trees before flooding.

Furthermore, if the trees were left in the lake they would gradually decay, resulting in depletion of the available oxygen in the water to below the level required for fish to survive.

8.4.3 Costs

If the reservoir were to be constructed as a multi-purpose facility some slight additional cost would be incurred in the dam but the major cost would result from the additional clearing required within the reservoir.

The total cost of this additional clearing would amount to approximately \$3.4 million or about \$85 each per acre of water surface for recreation and fishing respectively if one half of the additional costs were assigned to each beneficiary.

8.5 POSSIBILITY FOR EXPANSION OF GENERATING CAPACITY

8.5.1 Mentiga Reservoir

Adjoining the Jeram Catchment to the north is the Mentiga Catchment, shown on Figure 20. The watershed separating both catchments has a low saddle slightly over elevation +150' MSL. Two reservoirs could be built for one power house at S. Jeram.

The following would be required to create a continuous reservoir system

- (1) Closure of the Mentiga valley with an 85-foot high earth dam and 250-foot long spillway at a location 7 miles upstream from Kg. Geliau. The closure would create a reservoir with a capacity of 200,000 acre feet.

The average annual yield of the Mentiga Catchment would amount to about 109,800 acre feet and would become available as additional yield for the Jeram power house.

- (2) A connection between the two reservoirs, a tunnel or open cut, either gated or open would provide the possibility of increasing the yield available to the Jeram power house. It would also preserve a part of the flood water from the Jeram Catchment which would otherwise be spilled and lost over the Jeram dam. The additional quantity of water available for generation of power would amount to about 200,000 acre feet and would represent an additional energy output of 11.2 million kWh annually.

- (3) The estimated cost of closing the S. Mentiga would be:

Earth dam	\$2,243,000
Spillway	156,000
Connection between reservoirs	539,000
	\$2,938,000
Contingencies	734,500
Total	\$3,672,500

The cost of the additional energy would be about \$0.022. The combined reservoirs would probably produce energy at a cost of around \$0.02 per kWh.

8.6 CONCLUSION

The above preliminary assessment of the potential of a reservoir in the S. Jeram (eventually in combination with a reservoir in the S. Mentiga) leads to the conclusion that the possibility exists for a useful and worthwhile investment.

However, although a hydroelectric project may be buildable in the Jeram Valley, it is not felt that the study of its feasibility should be pressed at this time. It would appear that the reservoir area is presently more valuable for forestry. Moreover the hydro project would be a relatively small one compared to the possibilities in the head waters of the Pahang River, where a larger dam would supply not only power, but with their considerably larger reservoirs would help to alleviate flooding in the Pahang River. It is proposed that the consideration of a hydroelectric project be left in abeyance for ten years at which time it might be reappraised as an alternative to use of the land for agriculture.

9.1 CENTRALIZED TREATMENT

9.1.1 Sewer Systems
Sewer systems are connected to collect liquid household and industrial wastes and to carry them to a centralized treatment plant before being discharged into a river. In a developing country the first stage of a sewerage system consists of a few thousand houses in the suburbs. It may be a simple gravity system or a pump-out station.

9.2 SWS

9.2.1 Centralized Sewerage System
A centralized sewerage system is one in which the effluent from the treatment plant is discharged into a river or sea.

(a) Domestic Sewerage

(b) Industrial Sewerage

(c) Stormwater

(d) Chemical Effluent

(e) Agricultural Effluent

(f) Municipal Solid Waste
(g) Sewage Sludge

9.0 DISPOSAL OF HOUSEHOLD AND INDUSTRIAL WASTE

9.1 TOXIC NATURE OF EFFLUENTS

As has been indicated in Sections 5.2.1 to 5.2.4 inclusive the contamination of river water resulting from uncontrolled disposal of wastes would lead to increasing toxicity of surface water. This water would in extreme cases no longer be able to support plant or animal life and it would be useless for most other purposes. The list of potential contaminants is large and as varied as the processes which would be located within the Region and could therefore contribute to progressive deterioration of the water supply. Thus, the only effective way of preventing this deplorable state of affairs is to require treatment of all effluents which may, directly or indirectly, find their way into a water course. The treatment processes should be such as to reduce the concentration of all toxic elements to acceptable maximum limits. Standards for these limits have been listed in Table 13.

9.2 CENTRALIZED TREATMENT OF EFFLUENTS

9.2.1 Sewer Systems

Sewer systems are constructed to collect liquid household and industrial wastes, and to carry these to a centralized treatment plant before being discharged into a river. In a developing region the cost of such a system would constitute a heavy financial burden on the residents. It may

thus be necessary to postpone installation of a central sewer system until the towns are more heavily populated.

9.2.2 Household Wastes

During the initial stages of development it is suggested that each household be supplied with a septic tank to biologically treat its waste, which would then be disposed of in a tile drain or buried rock pit.

9.2.3 Industrial Wastes

Harmful industrial wastes would have to be diluted to specified concentrations before disposal. Initially each industry would be required to treat its own wastes prior to disposal.

9.2.4 Costs of Waste Disposal

Septic tanks would be constructed together with the houses and other buildings they would serve, thus capital outlays would at all times be deferred as long as possible. However, a sewer system would have to be constructed to a capacity in excess of initial requirements. Thus at least part of the investment would be unproductive for many years.

It is estimated that standardized septic tanks and rockpits could be provided at a cost of \$100 per capita, including installation.

10.0 ORGANIZATION

10.1 WORK TO BE DONE

The following sections summarize the work which has to be done to implement the various projects described herein.

10.1.1 Water Resources

Daily records must be kept of streamflow and water quality. Daily streamflows would be recorded by automatic waterlevel recorders, the corresponding discharges daily would be determined by reference to the rating curve. Water quality would be checked by means of appropriate regular sampling of river water which would be subjected to chemical analysis. This work would be carried out for all major streams in the Region which may at some future date be considered as a source of water for industrial, domestic, agricultural purposes, or for generation of power.

10.1.2 Civil And Mechanical Works

The publicly financed construction associated with implementation of the proposed Regional Master Plan, including watersupply facilities and river improvement works, would constitute a heavy work load requiring much care and attention to planning, design, road construction, etc. In order to complete all of these facilities on time particular attention will have to be paid to co-ordinating the use of all available resources, including men, equipment and materials.

10.1.3 Agencies

The works as outlined above should be assigned to existing agencies in the Federal and State Governments. This would include responsibility for water resources as well as other civil and mechanical works. It is recognized that most existing government agencies are already overloaded with prior commitments and it may therefore become necessary to assign the work directly to the Pahang Tenggara Development Authority, but this should be avoided if at all possible. The following is a brief description of the organization which would be required to handle all of the new construction in Pahang Tenggara if the work had to be assigned to a separate "group" whether part of an existing agency, the Authority or other body.

10.2 WATER RESOURCES

The staff to be responsible for the Water Resources would need to be designated as soon as possible after inception of the Pahang Tenggara Development Authority. Their main responsibilities would be to control the granting of water rights as well as to control the quality of water within the Region.

10.2.1 Duties

In addition to the above jurisdictional responsibilities it is necessary to:

- (a) List all streams in the Region having a potential of being used in the proposed development.
- (b) Install water level recorders or stick gauges as may be required to compile statistical data required for future water-use studies.
- (c) Keep daily record of the flow in the streams.
- (d) Check the quality of water at regular intervals and keep record thereof.
- (e) Install rainfall gauges and recorders in the catchments of the streams and maintain a daily record thereof.
- (f) Assess the useful quantity of water in these streams.
- (g) Review applications for withdrawal of water.
- (h) Set standards for discharge of effluent by applicants (industry and communities) based on prevailing physical conditions in the streams.

10.2.2 Staff

It is anticipated that the following staff would be needed to carry out these functions:

- (a) Director, Chief Hydrologist.
- (b) Senior Hydrologists.
- (c) Hydrologists.
- (d) Chemical Engineer,
- (e) Assistant Chemical Engineer.
- (f) Accountants, Administrative Staff,
Draughtsmen.

10.3 CIVIL AND MECHANICAL WORKS

The staff to be responsible for the Civil and Mechanical Works program would also need to be designated immediately after inception of the Pahang Tenggara Development Authority. They would be responsible for the planning, design and construction of all civil and mechanical works constructed within the Region with public funds.

10.3.1 Divisions

The staff would be formed into several divisions, each responsible for Watersupply, Road and Bridge construction, Electricity Supply to communities not supplied by NEB, Forestry, Drainage and, at a later date, Sewerage.

10.3.2 Duties

This would be a technical program and the duties of the staff would be to:

- (a) Investigate, survey and report on proposed Projects.

- (b) Prepare the Design, Specifications and Terms of Contract for Projects.

- (c) Call for tenders and select the successful bidder.

- (d) Enter into contracts with successful bidders.

- (e) Receive the works on completion.

- (f) Retain Consultants when required to supplement the staff capabilities.

10.3.3 Staff

A Director should be appointed who would be a Senior Engineer with broad experience in the public utility field. He would be supported by two or three Deputy Directors each of whom would also be a Chief Engineer of one of the several disciplines represented by the operating divisions. Each of the divisions would be headed by an Assistant Chief Engineer. Each division would also include supporting staff consisting of senior engineers, engineers, draughtsmen, surveyors and administrative personnel.

10.3.3 Agencies

The work as outlined above should be assigned to existing agencies in the Federal and State Governments. This would include responsibility for water resources as well as other civil and mechanical works. It is recognized that most existing government agencies are already overburdened with prior commitments and it may therefore become necessary to assign the work directly to the Pahang Tenggara Development Authority, but this should be avoided if at all possible. The following is a brief description of the organization which would be required to handle all of the new construction in Pahang Tenggara if the work had to be assigned to a separate "group" whether part of an existing agency, the Authority or other body.

11.0 RECOMMENDATIONS

11.1 WORK PROJECTED DURING SECOND MALAYSIA PLAN

11.1.1 Installation of Rainfall Recorders

Fourteen rainfall recorders need to be installed at locations indicated on Fig. 19 and listed in Table 20B. This would be the first step toward completing the network of rainfall stations, the remainder of which would be installed at a later date following construction of roads to the presently inaccessible locations. The cost of the initial installation is estimated at \$27,000 and the cost of operation and maintenance at \$2,000 per month.

11.1.2 Installation of River Level Recorders

Seventeen water level recorders need to be installed as indicated on Fig. 19 and listed in Table 20A. Additional recorders should be installed as and when access roads are built into various parts of the Region. The cost of the initial installation is estimated at \$700,000, including the cost of constructing approximately 35 miles of access roads and surveys required to establish bench marks at the various sites. Operating and maintenance costs are estimated to total \$3,500 per month.

11.1.3 Geological Investigation for Hydro-Power

If it is decided to investigate the feasibility of developing the hydro-electric power potential of the S. Jeram it would be necessary firstly to confirm the existence of an acceptable dam site. This would involve topographic surveys as well as a geological investigation of the canyon near Bulut Nipis. The geological investigation would involve drilling aimed at locating and describing any faults which may exist. Only after this investigation has been finished and it has been concluded that no insurmountable foundation problems exist in the canyon, would it be expedient to proceed with detailed topography. It is estimated that the geological investigation above would cost \$450,000, including the preparation of an engineering report.

11.1.4 Survey and Mapping of S. Rompin

Any study of possible improvements of the S. Rompin pertaining to drainage, flood protection and water transport would necessitate preparation of hydrographic maps of the river to a point about 30 miles upstream of Kg. Aur. Such maps should be drawn to a scale of 1:10,000 and should show 5 ft. contours as well as other hydrographic features. The cost of the survey and mapping is estimated at \$850,000.

11.1.5 First Improvement of S. Rompin

A general clearing of the S. Rompin including removal of obstacles to the riverflow over a distance of about 110 miles is estimated at \$2,000,000, or about \$4.00 per developed acre in the catchment.

11.1.6 Survey, Design and Construction of Watersupplies

Seven watersupply schemes would be constructed of which the largest would be the S. Rompin watersupply. The cost is estimated at \$22,600,000 and the annual operation and maintenance cost at \$5,200,000.

11.1.7 Flood Protection for Pekan

A survey of Pekan and surrounding settlements comprising a total area of 14 sq. mi. should be carried out. A topographic map at 1:1,000 scale showing 2-ft. contours, should be prepared including in particular a survey along the alignment of the proposed dyke. Soil samples would have to be taken and analysed to determine their suitability as dyke fill. Following completion of this survey and soils investigation it would be possible to proceed with design of the dyke and drainage works, as well as detailed study of raising parts of the site with river-run sand.

11.2. WORK PROJECTED DURING THE THIRD MALAYSIA PLAN

11.2.1 Climates and Water Resources

At the end of the Third Malaysia Plan, about eight years of continuous records would be available to establish the validity of the projections made herein pertaining to climate and river

run-off within the Region. This would have to be followed by a review of all preliminary recommendations which have been made on the basis of presently available data.

11.2.2 Investigations for Protection against S. Pahang Floods

Possible sites for storage of flood water within the catchment of the S. Pahang should be examined in conjunction with other possible uses of the reservoirs. The study of flood protection would determine the costs of various schemes as well as the value of benefits to be obtained.

11.2.3 Improvement S. Rompin

A study of the S. Rompin should be made with recommendations and cost estimates for measures required to improve the river discharge, to reduce the area subject to regularly returning inundations and to facilitate the water transport.

11.2.4 Watersupply

Watersupply schemes would have to be expanded to provide for continued growth of Regional settlements. Some new schemes would also be undertaken.

Table 1—Existing Hydrological and Meteorological Stations

	Station	Location	Grid Reference	Date of Installation	Remarks
WITHIN PAHANG TENGGAH REGION		<i>Rainfall Stations:</i>			
	3	Pekan Hospital	WM 699380 ..	January 1898 ..	Closed
	8086	Kg. Bera Forest Checking Station ..	WA 513100 ..	May 1948 ..	
	8097	Kg. Mentiga Estate	WB 130176 ..	July 1960 ..	
	8101	Kg. Temai Hilir	WM 520440 ..	October 1948 ..	
	8161	Batu 9 Jalan Nenasi	WM 730260 ..	January 1961 ..	
	8168	Kampung Bebar	WR 739838 ..	April 1960 ..	
	8180	Kg. Sabak	WG 605489 ..	November 1960 ..	
	8181	Rompin Rest House	WG 681398 ..	April 1960 ..	
	8183	Paya Sepayang	WG 653305 ..	May 1964 ..	Recorder 1-12-67
WITHIN PAHANG BUT OUTSIDE OF REGION	8265	Nenasi Dispensari	ER 747962 ..	December 1947 ..	
		Bukit Iban Mining	WG 050840 ..	January 1960 ..	Private Gauge
		<i>Rainfall Stations:</i>			
	8018	J.K.R., Gambang	WB 224482 ..	January 1925 ..	
	8020	Bukit Setongkol, Kuantan	WB 422561 ..	January 1933 ..	
	8021	18th mile Kg. Bharu	WB 446511 ..	December 1961 ..	
	8082	Tebing Tinggi Lebak	WA 388103 ..	December 1961 ..	
	8083	Ladang Karman	WA 368040 ..	December 1947 ..	
	8084	Kemasul Estate, Mengkarak	WF 348989 ..	January 1948 ..	
	8085	Kg. Batu Che Mek	WA 482025 ..	January 1961 ..	
	8087	J.K.R., Kampong Awah	WA 524233 ..	June 1950 ..	
	8088	Kg. Chenor Estate	WA 578213 ..	January 1961 ..	
	8092	J.K.R., Lubok Paku	WA 811233 ..	January 1925 ..	
	8093	J.K.R., Sg. Kertam	WM 056598 ..	January 1925 ..	April 1967
	8094	J.K.R., Maran	WA 803330 ..	January 1912 ..	
	8095	Kg. New Zealand	WA 892389 ..	January 1966 ..	
	8096	Kg. Salong	WB 000216 ..	July 1960 ..	
	8098	J.K.R., Lepar	WB 001465 ..	May 1932 ..	
	8099	Kg. Pulau Rumpit	WB 251229 ..	November, 1960 ..	
	8100	Tavy Estate	WB 228424 ..	January 1962 ..	
	8103	Kuala Pahang Customs	WM 775437 ..	January 1932 ..	
	8104	Kg. Baru Penor	WM 656532 ..	January 1962 ..	
	8151	Kemayan Estate	WF 319821 ..	July 1950 ..	
	8152	Mengkauang	WF 345928 ..	January 1962 ..	
	8202	Pahang Tua	WM 647468 ..	January 1946 ..	Recorder 31-12-61
	8222	Padang Lallang, Kuantan	WB 490608 ..	1968 ..	Recorder 31-1-67
	8281	J.P.T., Temerloh	WA 383160 ..	January 1924 ..	Recorder 31-3-60
IN JOHORE		<i>Rainfall Stations:</i>			
	7004	Paya Lang Estate, Segamat	WF 827134 ..	January 1929 ..	
	7008	Kg. Tenang, Segamat	WM 145994 ..	July 1948 ..	
	7010	Chuang Moh San Estate, Segamat	WL 990987 ..	March 1951 ..	
	7011	Segamat Estate	WF 939012 ..	January 1935 ..	
	7013	Ladang Getah Labis Bahru, Segamat	WF 930937 ..	April 1952 ..	
	7158	Paloh Estate, Paloh	WM 324663 ..	June 1942 ..	
	7162	94th Mile Kahang, Kluang	WM 746680 ..	June 1937 ..	
	7163	Kahang Headworks, Kluang	WM 807696 ..	November 1949 ..	
	7168	Labong Dam, Endau	WG 894128 ..	November 1947 ..	
	7169	Endau Agriculture Station	WG 847156 ..	October 1948 ..	
	7181	Sek. Kebangsaan, Ayer Tawar	WG 886187 ..	January 1952 ..	
	7183	Tenglu Waterworks, Mersing	WN 052025 ..	August 1949 ..	
	7184	Agriculture Station, Tenglu	WN 075987 ..	September 1946 ..	
	7185	Mersing Meteo. Station	WN 093957 ..	January 1932 ..	
	7209	Melville Estate, Labis	WM 100884 ..	January 1935 ..	Recorder 28-2-67
	7212	Segamat Filter House	WM 855044 ..	April 1942 ..	Recorder 12-1-66
	7270	D.I.D. Store, Endau	MG 838206 ..	January, 1947 ..	Recorder 31-1-60

Table 1—Existing Hydrological and Meteorological Stations—(cont.)

Station	Location	Grid Reference	Date of Installation	Remarks
<i>Rainfall Stations:</i>				
5018	Pertang Estate	Q 316759 ..	October 1913	
5020	Simpang Durian Estate	Q 272914 ..	January 1939	
5021	Kg. Sungai Buloh	Q 312937 ..	August 1947	
5084	Kg. Kubang	Q 721356 ..	July 1957	
5091	Kg. Ulu Serting	Q 389660 ..	January 1959	
5093	Bahau Estate	Q 548560 ..	November 1926	
5094	Kelpin Estate	Q 631524 ..	June 1935	
5095	Sg. Sabaling Estate	Q 508725 ..	September 1926	
5098	Sg. Lui Halt	Q 433893 ..	September 1959	
5220	Simpanan Durian Triang Illir	Q 280891 ..	November 1964 ..	Recorder
5283	New Rompin Estate	Q 619448 ..	January 1924 ..	Recorder 30-11-64
<i>Evaporimeter Stations:</i>				
7370	D.I.D. Store, Endau	WG 838206 ..	June 1962 ..	Class A
8302	Pahang Tua Pumphouse	WB 513310 ..	December 1962 ..	Class A
8322	Padang Lallang, Kuantan	WB 412608 ..	June 1962 ..	Class A
8372	Paya Kangsar, Pumphouse	WA 391717 ..	January 1932 ..	Class A
8381	D.I.D. Store, Temerloh	WL 380167 ..	December 1962 ..	Class A
<i>Stick Gauges:</i>				
32	Sg. Pahang di-Chenor	WF 590220		
35	Sg. Pahang di-Belimbing*	WA 948178		
36	Sg. Pahang di-Paloh Hinai*	WB 215216		
37	Sg. Pahang di-Lubok Paku	WA 810234		
38	Sg. Pahang di-Temai	WB 385278		
39	Sg. Pahang di-Sekor	WB 468267		
40	Sg. Pahang di-Pahang Tua	WB 509298		
<i>Stream Gauging Stations:</i>				
8511	Sg. Pahang and Temerloh	WA 385167 ..	January 1963	Recorder Sept. 1968
8521	Sg. Bentong at K. Marong Road	VE 764250 ..	September 1965	
7571	Sg. Lenggur	WM 977728 ..	1946 ..	Recorder Nov. 1961
5431	Sg. Triang, Juntai	Q 266883 ..	1947	
5432	Sg. Triang, Kg. Chenor	Q 115733 ..	1947	
<i>Meteorological Stations:</i>				
	Kuantan Aerodrome	—	1946	
	Mersing	—	1929	
	Temerloh	—	1929	
	Kuala Pahang	—	1929-1940	

*Flood Warning Stations.

Table 2—Prevailing Wind Direction

A. Station: *Kuala Pahang*

Month	N	NE	E	SE	S	SW	W	NW	Calm
January	35.2	45.1	3.5	0.2	2.3	0.4	4.3	8.9	0.1
February	26.5	49.3	8.4	0.3	1.6	0.5	4.9	8.2	0.3
March	17.0	36.8	16.0	2.6	1.9	2.0	12.5	10.6	0.6
April	8.9	19.1	18.2	6.1	4.4	8.0	25.1	8.8	1.4
May	2.4	4.3	9.7	13.8	13.6	17.0	32.4	4.8	2.0
June	0.9	1.4	5.5	16.8	16.7	22.3	30.7	3.2	2.5
July	0.7	0.8	2.4	15.2	24.8	26.0	26.5	2.2	1.4
August	0.6	0.6	2.4	14.5	24.1	23.2	31.5	2.4	0.7
September	1.0	0.7	3.7	14.0	18.5	22.9	33.9	3.8	1.5
October	6.3	8.5	8.9	7.7	9.2	14.4	32.8	9.6	2.6
November	14.6	17.5	9.4	4.7	4.5	7.4	27.0	13.5	1.4
December	29.5	32.8	5.6	0.8	2.1	1.6	11.6	15.5	0.5

B. Station: *Mersing*

Month	N	NE	E	SE	S	SW	W	NW	Calm
January	46.4	25.8	1.6	0.2	0.3	1.1	6.1	15.5	3.0
February	40.8	27.7	2.3	0.4	0.6	2.7	8.6	9.7	7.1
March	25.0	25.3	5.7	1.5	2.6	10.8	18.3	7.3	3.5
April	10.2	16.1	9.1	2.6	4.8	21.7	26.9	4.8	3.8
May	2.7	6.5	10.3	5.7	11.2	34.9	23.5	2.0	3.2
June	0.8	2.9	9.6	7.7	14.8	38.8	21.0	1.2	3.2
July	0.4	1.4	7.3	9.3	21.8	40.2	16.5	0.8	2.3
August	0.4	1.3	7.2	9.6	19.6	39.7	19.3	0.6	2.3
September	0.7	2.1	8.8	7.6	16.4	38.3	21.2	1.0	3.9
October	3.8	7.1	6.4	4.1	8.3	32.8	30.8	3.3	3.4
November	14.5	10.0	3.8	1.2	3.9	18.2	31.2	13.2	4.0
December	35.8	17.5	2.0	0.6	1.3	4.4	15.4	20.7	2.3

Table 2—Prevailing Wind Direction—(cont.)

C. Station: *Temerloh*

Month	N	NE	E	SE	S	SW	W	NW	Calm
January	18.2	10.1	7.2	1.9	1.2	0.8	4.2	10.8	45.6
February	15.7	13.6	11.6	2.4	2.0	0.8	2.5	6.7	44.7
March	13.9	13.5	11.1	4.3	4.4	2.0	4.1	7.0	39.7
April	11.2	12.3	9.2	5.2	6.2	2.8	4.9	6.9	41.3
May	5.8	7.6	7.9	8.4	11.0	3.8	5.8	5.2	44.5
June	4.8	5.2	7.5	9.4	11.1	3.4	4.5	3.8	50.3
July	2.9	3.1	6.4	12.3	16.5	3.8	3.1	2.8	49.1
August	3.9	4.1	6.4	11.6	16.9	4.6	4.2	3.3	45.0
September	4.3	4.6	6.5	9.4	14.0	4.6	4.6	3.4	48.6
October	6.7	7.1	7.2	6.5	9.3	3.8	5.7	5.0	48.7
November	10.9	8.4	7.2	4.0	4.8	2.5	4.7	6.8	50.7
December	14.8	10.9	7.5	2.7	2.1	1.2	3.0	8.0	49.8

Source: Malaysian Meteorological Service Climatological Summaries Part 1—Wind.

Table 3—Gust Velocity and Frequency

	Station	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Gust > 30 m.p.h.	K. Pahang	7.6	2.3	2.1	1.7	2.2	2.8	4.1	4.1	4.2	4.1	2.2	4.7
	Mersing	11.8	3.3	2.8	1.6	3.1	3.3	5.0	3.6	4.6	3.3	2.9	7.0
	Temerloh	0.2	—	0.6	0.8	0.7	0.7	0.4	0.4	1.4	0.7	0.4	0.3
Gust > 40 m.p.h.	K. Pahang	0.6	0.1	0.3	0.1	0.1	0.7	0.5	1.1	0.7	0.3	0.3	0.8
	Mersing	1.7	0.2	0.2	0.2	0.7	0.6	1.0	0.4	1.2	0.4	0.4	1.4
	Temerloh	—	—	0.1	0.1	0.1	0.3	—	—	0.2	0.2	—	—

Source: Malaysian Meteorological Service.

Climatological Summaries Part I—Wind.

Table 4—Rainfall Frequency

Station	J	F	M	A	M	J	J	A	S	O	N	D	Total
Kuala Pahang (12 years) ..	20	12	16	16	15	12	12	11	14	20	21	21	190
Temerloh (17 years) ..	18	11	15	15	15	12	11	13	16	17	21	19	183

Source: Singapore Meteorological Service.

Climatological Summaries.

Part II—rainfall, 1965.

Table 5—Grouping of Stations with Similar Rainfall Patterns

South Eastern Part	North Central Part	Western Part
D.I.D. Endau (18 years) ¹	Bukit Ibam (10 years)	Kg. Tenang, Segamat
Kuala Pontian Custom Station (9 years)	Kampong Salong (10 years)	(16 years)
Endau Agricultural Stations (13 years)	J.K.R. Kertam (23 years)	Glendale Estate (24 years)
Lebong Dam Endau (17 years)	Gambang (23 years)	Paya Lang Estate (30 years)
Sekolah Kebangsaan, Ayer Tawar (14 years)	J.K.R. Lepar (21 years)	Kelpin Estate (23 years)
Paya Supayang (6 years)	—	—
Total 77 Station-years	Total 87 Station-years	Total 93 Station-years

¹ Figures in brackets denote the period of available records.

Table 6—Confidence Limits of Effective and Actual Rainfall

Month	EFFECTIVE RAINFALL (inches)*					ACTUAL RAINFALL (inches)				
	90% Confidence limit					20% Confidence limit				
	S.E. Part	N.C. Part	W. Part	S.E. Part	N.C. Part	S.E. Part	N.C. Part	W. Part	S.E. Part	N.C. Part
January	6.11	3.23	2.47	10.90	4.71	27.36	16.47	11.55	32.08	19.73
February	1.89	1.26	1.15	3.02	2.04	20.40	10.42	7.13	25.28	14.10
March	2.16	2.20	1.87	4.01	3.23	15.36	11.20	8.52	19.10	16.40
April	1.89	3.87	3.14	3.21	4.96	8.78	11.23	9.82	9.89	12.84
May	3.07	3.41	3.52	3.92	4.90	8.88	10.77	9.65	10.40	12.73
June	2.62	2.90	1.96	3.58	3.28	8.48	7.67	6.47	9.65	9.10
July	3.55	1.50	1.07	4.20	2.59	9.80	6.56	5.32	11.40	7.73
August	3.05	2.73	1.71	3.80	3.83	8.47	9.80	6.30	10.64	10.90
September	3.70	3.70	1.97	4.31	4.59	9.77	10.55	6.96	11.40	12.07
October	4.76	5.54	4.02	5.69	6.48	11.49	13.91	12.27	14.73	16.73
November	7.44	5.91	3.90	9.45	6.99	23.80	15.42	10.89	28.20	16.30
December	12.86	4.60	2.65	14.18	6.38	40.40	20.80	10.60	49.07	26.20
Total	53.10	40.85	29.43	70.27	53.98	192.99	144.80	105.48	231.84	174.83
										128.36

S.E.—South eastern part; N.C.—North central part; W—Western part.

* Effective Rainfall is the actual rainfall (R) reduced by 0.015R² (inches).

Table 7—Mean Open Water Surface Evaporation
(in inches per month and per year)

Station	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Paya Supayang (7 years) ..	3.77	3.87	4.48	4.32	4.24	4.06	4.09	4.28	4.16	4.08	3.95	3.72	49.02
Temerloh (4 years) ..	3.78	3.56	4.15	3.80	3.78	3.61	3.59	3.68	3.65	3.41	3.48	3.35	43.84

Source: Drainage and Irrigation Department (Kuantan).

Table 8—Composite Image of Evaporation and Vaporization

Table 8a—Estimated Twenty-Year Monthly Low Runoff in the S. Rompin¹
(Ninety-five Percent Confidence Limit)

Catchment	Keratong	Jeram	Aur	Remainder Rompin	Rompin
Area sq. mi.	621	246	112	261	1,240
Discharge	acre ft.	acre ft.	acre ft.	acre ft.	acre ft.
January	39,330	12,250	12,880	30,010	94,470
February	30,350	9,430	13,800	32,160	85,740
March	17,950	11,650	9,920	23,110	62,630
April	14,410	14,490	6,860	16,000	51,760
May	34,370	10,440	8,130	18,940	71,880
June	29,190	10,390	5,460	12,740	57,780
July	23,670	8,320	3,720	8,670	44,380
August	19,090	6,200	3,650	8,500	37,440
September	20,690	5,860	4,200	9,780	40,530
October	24,820	9,230	7,160	16,690	57,900
November	36,000	11,710	12,730	29,660	88,100
December	40,090	16,490	10,260	23,910	90,750

¹ R. Sompin at Kg. Sawak.

Table 8b—Estimated Five-Year Monthly Low Runoff in the S. Rompin
(Ninety Percent Confidence Limit)

Catchment	Keratong	Jeram	Aur	Remainder Rompin	Rompin
Area sq. mi.	621	246	112	261	1,240
Discharge	acre ft.	acre ft.	acre ft.	acre ft.	acre ft.
January	63,010	46,890	24,030	56,010	189,940
February	46,210	31,150	17,840	41,580	136,780
March	44,290	23,290	15,770	36,750	120,100
April	53,580	23,420	14,530	33,860	125,390
May	54,980	24,500	12,530	29,210	121,220
June	49,150	22,400	10,930	25,470	107,950
July	42,380	16,640	8,330	19,420	86,770
August	37,420	13,760	9,160	21,340	81,680
September	33,260	15,950	9,730	22,670	81,610
October	38,950	23,140	13,290	30,970	106,350
November	69,100	31,760	19,390	45,190	165,440
December	74,460	39,480	23,140	53,920	191,000

Table 9a—Estimated Present and Future Dry Weather Flows¹
(Acre-Feet per Month)

Catchment	S. Jeram		S. Bera		S. Mentiga		S. Jekatih	
Area sq. mile	186 ²		96 ³		50 ⁴		93 ⁵	
Mean annual yield ..	452,430		176,210		133,970		163,580	
Month	Present	Future	Present	Future	Present	Future	Present	Future
January	9,280	6,030	7,320	4,760	4,120	2,680	5,890	3,830
February	7,130	4,630	2,180	1,420	4,050	2,630	4,540	2,950
March	8,800	5,720	3,660	2,380	3,410	2,220	2,690	1,750
April	10,950	7,120	2,740	1,780	3,000	1,950	2,160	1,400
May	7,890	5,130	3,660	2,380	2,890	1,880	5,140	3,340
June	7,860	5,110	2,570	1,670	2,290	1,490	4,370	2,840
July	6,060	3,940	2,120	1,380	1,890	1,230	3,540	2,300
August	4,690	3,050	2,360	1,530	1,440	940	2,860	1,860
September	4,430	2,880	2,270	1,480	1,550	1,010	3,100	2,020
October	6,970	4,530	5,190	3,370	1,940	1,260	3,710	2,410
November	8,850	5,760	6,460	4,200	4,050	2,630	5,090	3,310
December	12,400	8,060	8,090	5,260	3,810	2,480	6,000	3,900

The minimum dry weather flow in the catchments at present is estimated at 0.41 cusec. per sq. mile of catchment. This quantity may be reduced in the future to 0.27 cusec. per sq. mile.

¹ It is assumed that 50 percent of the catchment will be developed in future.

² At Bulut Nipis.

³ At Bukit Kuin.

⁴ At 4 miles upstream of Kg. Geliau.

⁵ At 3 miles upstream from the confluence with S. Pukin.

Table 9b—Estimated Present and Future Dry Weather Flows¹
(Acre-Feet per Month)

Catchment	S. Pukin		S. Keratong		S. Aur		S. Anak Endau	
Area sq. mile	129 ²		621 ³		112 ⁴		26 ⁵	
Mean Annual yield ..	226,770		1,091,680		328,650		76,290	
Month	Present	Future	Present	Future	Present	Future	Present	Future
January	8,170	5,310	39,320	25,560	12,880	8,370	2,990	1,940
February	6,300	4,100	30,340	19,720	13,810	8,980	3,200	2,080
March	3,730	2,420	17,940	11,660	9,910	6,440	2,300	1,500
April	2,990	1,940	14,410	9,370	6,860	4,460	1,590	1,030
May	7,140	4,640	34,360	22,330	8,120	5,280	1,890	1,230
June	6,060	3,940	29,190	18,970	5,460	3,550	1,270	830
July	4,920	3,200	23,670	15,390	3,720	2,420	860	560
August	3,970	2,580	19,090	12,410	3,650	2,370	850	550
September	4,300	2,800	20,690	13,450	4,200	2,730	970	630
October	5,150	3,350	24,810	16,130	7,160	4,650	1,660	1,080
November	7,060	4,590	33,990	22,090	12,730	8,270	2,950	1,920
December	8,330	5,410	40,080	26,050	10,260	6,670	2,380	1,550

¹ It is assumed that 50 percent of the catchment will be developed in future.

² At 2 miles upstream from the confluence with Sungei Jekatih.

³ At the confluence with S. Jeram.

⁴ At the confluence with S. Rompin (Kg. Aur).

⁵ Near Bukit Selendang.

Table 10—Flood Levels Within the S. Pahang Catchment
(in Feet above Mean Sea Level, except as noted)

	1970/71	1967	1931	1926	Datum
Batu Malim, S. Lipis	387.8	—	—	—	
Benta, S. Lipis	267.0	247.9	261.0	285.8	
K. Medang, S. Jelai	21.5	12.0	30.0	50.0	Stage Level
Chegar Parah, S. Trantum	299.3	282.2	290.0	307.4	
Selbourne Estate, S. Jelai	248.0	—	—	—	
Kuala Lipis, S. Jelai	247.9	215.0	233.0	252.9	
K. Tahan, S. Tembeling	50.0	34.4	46.4	76.3	Stage Level
K. Tembeling, S. Pahang	203.0	181.6	199.5	222.1	
Jerantut Ferry	180.3	164.5	176.5	188.8	
K. Lengkong, S. Semantan	180.0	—	—	—	
Temerloh	125.8	109.5	122.4	137.9	
Chenor	96.0	—	—	—	
Belimbing	79.0	52.8	—	83.0	
Paloh Hinai	49.0	37.5	—	52.4	
Pekan	15.9	—	—	—	

Table 11—Water Sample Test Results
(Shown in maximum, average and minimum values)

Catchment	Conductivity m. mhos	Chloride p.p.m.	Boron p.p.m.	Sodium p.p.m.	Suspended solids p.p.m.
Pahang	52.80	3.00	0.10	6.60	360.00
	44.51	1.23	0.06	3.61	77.10
	34.77	1.00	< 0.05	1.80	5.00
Mentiga	32.53	2.00	0.09	2.20	25.00
	29.53	1.60	0.06	2.12	20.00
	27.28	1.00	< 0.05	1.90	10.00
Tasek Chini	27.60	3.00	0.09	2.00	45.00
	24.99	2.25	0.07	1.28	18.33
	23.73	1.00	< 0.05	0.80	5.00
Teriang	58.70	4.00	< 0.05	4.60	360.00
	49.06	2.60	< 0.05	3.88	241.25
	35.79	1.00	< 0.05	2.60	45.00
Tasek Bera	42.66	6.00	0.07	4.40	95.00
	28.76	2.33	0.05	2.64	37.50
	20.00	1.00	< 0.05	1.40	5.00
Serting	87.60	5.00	0.08	6.10	580.00
	53.28	2.00	0.05	4.41	79.09
	19.77	1.00	< 0.05	1.50	5.00
Keratong	33.27	3.00	0.09	7.20	25.00
	27.12	1.81	0.05	3.19	11.64
	19.00	1.00	< 0.05	2.00	3.00
Pukin and Jekatih	33.00	5.00	0.06	5.00	10.00
	30.74	3.00	0.05	3.70	6.66
	28.71	2.00	< 0.05	3.00	5.00
Anak Endau	20.13	2.60	< 0.05	3.60	515.00
	16.73	2.20	< 0.05	2.80	285.00
	14.96	2.00	< 0.05	2.20	55.00
Rompin	31.28	7.00	< 0.05	3.20	20.00
	29.62	3.50	< 0.05	3.10	16.66
	28.38	1.00	< 0.05	2.50	10.00
Pontian	2000.00	480.00	0.10	335.00	25.00
	—	162.33	0.07	113.43	15.00
	28.71	3.00	< 0.05	2.50	< 5.00

Table 12—Water Sample Detailed Test Results

No traces were found in any of the samples of the following: Sulphites, Selenium, Hexavalent Chromium, Arsenic, Lead, Sulphates and Carbonates

River	Bera	Keratong	Pukin	Jekatih	Rompin	Mentigi
Conductivity (micro-mhos)	30.0	27.0	29.4	33.0	29.8	30.6
pH	6.6	6.7	6.8	6.8	6.8	6.7
Chloride as Cl	2	2	1	2	1	1
Sodium as Na	3.2	3.4	3.7	3.7	3.7	3.4
Potassium as K	2.2	1.8	1.8	1.6	1.4	1.6
Fluoride as F	< 0.05	< 0.05	< 0.05	0.05	0.05	0.05
Iron as Fe	1.28	0.52	0.48	0.48	1.60	0.76
Total hardness as CaCO ₃	10	10	8	10	8	10
Total dissolved solids at 105-110° Centigrade ..	70	50	40	55	40	55
Calcium hardness as CaCO ₃	4	6	4	4	4	8
Magnesium hardness as CaCO ₃	6	4	4	6	4	2
Oxidised nitrogen as N	0.21	0.15	0.15	0.15	0.18	0.21
Suspended solids	65	25	10	5	10	25

* Results of tests conducted by the Chemistry Department, Petaling Jaya

Table 13—Industrial and Municipal Effluent Pollutant Limits

Pollutant	Limit
(a) A 5-Day 20°C B.O.D.	Not exceeding 20 p.p.m.
(b) Suspended solids	Not exceeding 30 p.p.m.
(c) A 4 hours' oxygen absorption figure from N/80 KMnO ₄ at 27°C . .	Not exceeding 20 p.p.m.
(d) A pH value	Within the range 5 to 9
(e) Soluble solids	Not exceeding 7,500 p.p.m.
(f) Total iron content	Not exceeding 3 p.p.m.
(g) A successful 5 days' 20°C Methylene blue stability test	
(h) Zinc, Chromate, Arsenic, Silver, Copper, Mercury, Cadmium, Barium, Selenium, Lead, Nickel, individually or in total	Not exceeding 0.5 p.p.m.
(i) Free Chlorine	Not exceeding 1.0 p.p.m.
(j) Sulphide as H ₂ S	Not exceeding 0.5 p.p.m.
(k) Formaldehyde	Not exceeding 1.0 p.p.m.
(l) Phenols	Not exceeding 0.5 p.p.m.
(m) Cyanide as CN	Not exceeding 0.1 p.p.m.
(n) Oils and Grease	Not exceeding 5.0 p.p.m. (or not visible)
(o) Temperature	Not exceeding 35° C
(p) Detergent	Not exceeding 2 p.p.m.
(q) Tar	Nil

The above p.p.m. figures apply when the minimum flow in the stream is equal to or greater than 8 times the rate of discharge of the effluent. If such dilution is not available the figures should be reduced accordingly.

Source: Public Works Department (Municipal Watersupply).

Table 14—Projected Population and Water Demand

S. Rompin Watersupply (Catchment 1.100 sq. miles)

Town			1975		1980	Population			1985		1990	24 Hour Demand in Cusec 1990
2	..	..	580	..	6,270	..	6,340	..	6,940	..	0.81	
4	..	..	—	..	2,130	..	2,270	..	3,890	..	0.45	
5	..	..	2,400	..	2,320	..	2,240	..	2,160	..	0.25	
6	..	..	1,070	..	2,910	..	5,740	..	5,180	..	0.67	
7	..	..	2,400	..	5,770	..	6,720	..	7,370	..	0.86	
8	..	..	1,750	..	7,800	..	6,830	..	9,210	..	1.35	
10	..	..	14,260	..	42,930	..	55,600	..	68,690	..	7.99	
12	..	..	—	..	60	..	1,580	..	2,510	..	0.29	
16	..	..	1,870	..	8,410	..	7,080	..	6,260	..	0.98	
17	..	..	15,160	..	14,470	..	13,470	..	13,930	..	1.68	
20	..	..	—	..	1,650	..	4,760	..	6,620	..	0.77	
21	..	..	930	..	2,510	..	2,010	..	2,280	..	0.29	
22	..	..	28,280	..	37,900	..	35,530	..	38,510	..	4.44	
TOTAL	..		68,700	..	135,130	..	150,170	..	173,550	..	20.83	

S. Mentiga Watersupply (Catchment 52 sq. miles)

1	12,080	24,800	22,430	22,660	2.96
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S. Gayong Watersupply (Catchment 8.5 sq. miles)

9	—	2,770	8,490	10,750	1.08
23	—	—	150	3,380	0.40
TOTAL	—	2,770	8,640	14,130	1.48

S. Kepasing Watersupply (Catchment 14.4 sq. miles)

3	2,850	12,640	15,010	16,470	1.89
13	7,380	12,650	11,710	12,100	1.40
14	4,750	5,920	4,900	4,670	0.54
15	1,830	10,300	11,910	11,830	1.37
TOTAL	16,810	41,510	43,530	45,470	5.20

S. Teroh Watersupply (Catchment 5.6 sq. miles)

24	—	650	10,530	16,940	1.93
26	—	18,800	19,010	18,550	2.14
27	—	—	630	8,440	0.97
TOTAL	—	19,450	40,170	43,930	5.04

Table 14—Projected Population and Water Demand—(cont.)

Town			1975		1980	Population		1985		1990		24 Hour Demand in Cusec 1990
<i>S. Cherong Watersupply (Catchment 5.3 sq. miles)</i>												
18	..	..	3,150	..	2,470	..	2,320	..	2,430	..	0.29	
19	..	..	—	..	7,450	..	9,110	..	10,780	..	1.29	
25	..	..	—	..	11,300	..	19,100	..	20,180	..	2.4	
TOTAL	..		<u>3,150</u>	..	<u>21,220</u>	..	<u>30,530</u>	..	<u>33,390</u>	..	<u>3.98</u>	

S. Batu Watersupply (Catchment 8.4 sq. miles)

31	..	..	14,200	..	19,040	..	20,280	..	19,490	..	2.25
32	..	..	7,680	..	11,460	..	10,140	..	10,010	..	1.16
TOTAL	..		<u>21,880</u>	..	<u>30,500</u>	..	<u>30,420</u>	..	<u>29,500</u>	..	<u>3.41</u>

Table 15f—Main Features of S. Cherong Water Supply

Towns	Elevation	Distance	1971/75	PIPE DIAMETER INCH		PUMP STATION kW		1986/90		1971/75		STORAGE TANKS CUSEC.		1986/90
				Malaysia Plans 1976/80	1981/85	Malaysia Plans 1976/80	1981/85	Malaysia Plans 1976/80	1981/85			Malaysia Plans 1976/80	1981/85	
18	250	—	—	—	—	—	—	—	—	0.26	—	—	—	—
Plant	160	1.8	10	—	—	—	—	—	—	—	—	—	—	—
	200	—	—	—	—	—	—	—	—	—	—	0.62	0.62	—
19	200	—	—	—	—	—	—	—	—	—	—	—	—	—
Plant	160	4.5	—	6	—	19	—	—	—	—	—	—	—	—
	270	—	—	—	—	—	—	—	—	—	—	1.20	1.40	—
25	270	—	—	—	—	—	—	—	—	—	—	—	—	—
Plant	160	4.5	—	12	—	40	—	—	—	—	—	—	—	—
	160	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 15g—Main Features of S. Batu Water Supply

Towns	Elevation	Distance	1971/75	PIPE DIAMETER INCH		PUMP STATION kW		1986/90		1971/75		STORAGE TANKS CUSEC.		1986/90
				Malaysia Plans 1976/80	1981/85	Malaysia Plans 1976/80	1981/85	Malaysia Plans 1976/80	1981/85			Malaysia Plans 1976/80	1981/85	
31	250	—	—	—	—	—	—	—	—	2.26	—	—	—	—
Plant	150	0.9	10	—	—	—	—	—	—	—	—	—	—	—
	150	—	—	—	—	—	—	—	—	—	—	—	—	—
32	250	2.7	8	—	—	14	—	—	—	—	—	—	—	—
	250	—	—	—	—	—	—	—	—	1.20	—	—	—	—

Table 16a—Capital Cost Estimate
S. Rompin Water Supply Delivery System

Item				Capital Expenditures during Successive Malaysia Plans (\$1,000)								
				1971/75		1976/80		1981/85		1986/90		Total
Investigation, Design	..	..	..	626	..	105	..	36	..	—	..	767
Access Roads	..	..	..	575	..	—	..	—	..	—	..	575
Intake	..	..	..	300	..	—	..	—	..	—	..	300
Purification Plant	..	..	..	383	..	—	..	192	..	—	..	575
Pipe line	..	..	..	3,848	..	1,188	..	838	..	385	..	6,259
Pump Stations	..	..	..	238	..	34	..	17	..	45	..	334
Storage	..	..	..	808	..	447	..	270	..	18	..	1,543
Sub-total	..			6,778	..	1,774	..	1,353	..	448	..	10,353
Contingencies 15%	..	..	..	1,017	..	266	..	203	..	67	..	1,553
TOTAL	..			7,795	..	2,040	..	1,556	..	515	..	11,906
Cost per Capita (population 1990)	..			—	..	—	..	—	..	—	..	72.25
Power house at damsite	..	..	..	141	..	53	..	—	..	53	..	246

Table 16b—Capital Cost Estimate
S. Mentiga Water Supply Delivery System

Item	Capital Expenditures during Successive Malaysia Plans (\$1,000)										Total
	1971/75	1976/80		1981/85		1986/90					
Investigation, Design	100									100	
Access Roads	50									50	
Intake	270									270	
Purification Plant	45									45	
Pipe line	45									45	
Pump Stations	50									50	
Storage	200									200	
Sub-total	760									760	
Contingencies 15%	109									109	
TOTAL	869									869	
Cost per Capita (population 1990)											
Power house at damsite	25									35	
										25	

Table 16c—Capital Cost Estimate
S. Gayong Water Supply Delivery System

Item	Capital Expenditures during Successive Malaysia Plans (\$1,000)				Total
	1971/75	1976/80	1981/85	1986/90	
Investigation, Design	—	114	—	—	114
Access Roads	—	91	—	—	91
Intake	—	50	157	—	207
Purification Plant	—	18	12	—	30
Pipe line	—	132	390	—	522
Pump Stations	—	30	—	—	30
Storage	—	64	62	—	126
Sub-total ..	—	899	621	—	1,120
Contingencies 15%	—	75	93	—	168
TOTAL ..	—	574	714	—	1,288
Cost per Capita (population 1990) ..	—	—	—	—	92
Power house at damsite	—	18	—	—	18

Table 16d—Capital Cost Estimate
S. Kepasing Water Supply Delivery System

Item	Capital Expenditures during Successive Malaysia Plans (\$1,000)				Total
	1971/75	1976/80	1981/85	1986/90	
Investigation, Design	232	—	—	—	232
Access Roads	125	—	—	—	125
Intake	136	500	—	—	636
Purification Plant	33	63	—	—	96
Pipe line	1,168	130	—	—	1,298
Pump Stations	39	40	—	—	79
Storage	1,751	235	—	—	410
Sub-total ..	1,908	968	—	—	2,876
Contingencies 15%	288	147	—	—	435
TOTAL ..	2,196	1,115	—	—	3,311
Cost per Capita (population 1990) ..	—	—	—	—	73
Power house at damsite	35	25	—	—	60

Table 16e—Capital Cost Estimate
S. Teroh Water Supply Delivery System

Item	Capital Expenditures during Successive Malaysia Plans (\$1,000)										Total	
	1971/75		1976/80		1981/85		1986/90					
Investigation, Design	..	..	..	214	..	—	..	—	..	—	..	214
Access Roads	..	..	..	—	..	25	..	—	..	—	..	25
Intake	..	..	..	—	..	306	..	300	..	—	..	606
Purification Plant	..	..	..	—	..	50	..	40	..	—	..	90
Pipe line	..	..	..	—	..	706	..	320	..	—	..	1,026
Pump Stations	..	..	..	—	..	40	..	15	..	—	..	55
Storage	..	..	..	—	..	354	..	40	..	—	..	394
Sub-total	..			214	..	1,481	..	715	..	—	..	2,410
Contingencies 15%	..	..	..	32	..	222	..	107	..	—	..	361
TOTAL	..			246	..	1,703	..	822	..	—	..	2,771
Cost per Capita (population 1990)	..			—	..	—	..	—	..	—	..	63
Power house at damsite	..	..	..	—	..	40	..	22	..	—	..	62

Table 16f—Capital Cost Estimate
S. Cherong Water Supply Delivery System

Item	Capital Expenditures during Successive Malaysia Plans (\$1,000)										Total	
	1971/75		1976/80		1981/85		1986/90					
Investigation, Design	..	..	..	188	..	—	..	—	..	—	..	188
Access Roads	..	..	..	0	..	0	..	—	..	—	..	0
Intake	..	..	..	60	..	490	..	—	..	—	..	550
Purification Plant	..	..	..	120	..	120	..	—	..	—	..	240
Pipe line	..	..	..	50	..	476	..	—	..	—	..	529
Pump Stations	..	..	..	16	..	16	..	—	..	—	..	32
Storage	..	..	..	40	..	120	..	128	..	—	..	288
Sub-total	..	..	..	474	..	1,225	..	128	..	—	..	1,827
Contingencies 15%	..	..	..	71	..	183	..	19	..	—	..	263
TOTAL	..	..	..	545	..	1,408	..	137	..	—	..	2,090
Cost per Capita (population 1990)	..	..	..	—	..	—	..	—	..	—	..	62
Power house at damsite	..	..	..	32	..	16	..	—	..	—	..	48

Table 16g—Capital Cost Estimate
S. Batu Water Supply Delivery System

Item	Capital Expenditures during Successive Malaysia Plans (\$1,000)					Total
	1971/75	1976/80	1981/85	1986/90		
Investigation, Design	102	—	—	—	..	102
Access Roads	25	—	—	—	..	25
Intake	550	—	—	—	..	550
Purification Plant	62	—	—	—	..	62
Pipe line	158	—	—	—	..	158
Pump Stations	23	—	—	—	..	23
Storage	255	—	—	—	..	255
						1,175
Sub-total ..	1,175	—	—	—	..	1,175
						175
Contingencies 15%	175	—	—	—	..	175
						1,350
TOTAL ..	1,350	—	—	—	..	1,350
Cost per Capita (population 1990) ..	—	—	—	—	..	46
Power house at damsite	20	—	—	—	..	14

Table 17—Capital Cost Estimate Summary Water Supply
For Towns to be Settled Before 1980

Delivery schemes to Towns	1990 Population	Construction Cost in \$1,000 during Malaysia Plan				Total	1990 Per Capita Cost (\$)
		1971/75	1976/80	1981/85	1986/90		
S. Rompin	173,550	7,795	2,040	1,556	515	11,906	72
S. Mentiga	22,660	869	—	—	—	869	35
S. Gayong	14,130	—	574	714	—	1,288	92
S. Kepasing	45,470	2,196	1,115	—	—	3,311	73
S. Teroh	43,930	246	1,703	822	—	2,771	63
S. Cherong	33,390	545	1,408	137	—	2,090	62
S. Batu	29,500	1,350	—	—	—	1,350	46
Delivery scheme Total	362,630	13,001	6,840	3,229	515	23,585	65
Distribution Assessment	—	11,417	10,398	8,949	5,499	36,263	100
Total Construction Cost	—	24,418	17,238	12,178	6,014	59,848	165

Table 18a—Operating and Maintenance Cost Estimate

S. Rompin Water Supply Delivery System

Item	Annual Costs (\$1,000)			
	1975	1980	1985	1990
Energy	64	126	140	162
Labour	83	105	121	127
Chemicals	148	187	195	226
Maintenance mechanical parts	3	4	5	6
Maintenance civil parts	6	8	10	12
Sub-total ..	304	430	471	533
Contingencies 15%	46	65	71	80
TOTAL ..	350	495	542	613
Depreciation, mechanical parts	8	16	17	22
Depreciation, civil parts	262	330	381	397
Repayment of Capital	566	718	828	865
TOTAL O & M ..	1,186	1,559	1,768	1,897
Quantity water delivered acre ft.	5,496	10,805	12,004	13,878
Cost per acre ft.	0.216	0.144	0.147	0.137

Table 18b—Operating and Maintenance Cost Estimate

S. Mentiga Water Supply Delivery System

Item	Annual Costs (\$1,000)			
	1975	1980	1985	1990
Energy	7	14	13	13
Labour	12	20	20	20
Chemicals	16	32	29	30
Maintenance mechanical parts	1	1	1	1
Maintenance civil parts	1	2	2	2
Sub-total ..	37	69	65	66
Contingencies 15%	6	10	10	10
TOTAL ..	43	79	75	76
Depreciation, mechanical parts	1	1	1	1
Depreciation, civil parts	29	29	29	29
Repayment of Capital	63	63	63	63
TOTAL O & M ..	136	172	168	169
Quantity water delivered acre ft.	1,012	2,076	1,890	1,898
Cost per acre ft.	0.134	0.083	0.089	0.089

Table 18c—Operating and Maintenance Cost Estimate

S. Gayong Water Supply Delivery System

Item	Annual Costs (\$1,000)			
	1975	1980	1985	1990
Energy	0 ..	2 ..	4 ..	7
Labour	0 ..	10 ..	22 ..	22
Chemicals	0 ..	4 ..	13 ..	19
Maintenance mechanical parts	0 ..	1 ..	1 ..	1
Maintenance civil parts	0 ..	2 ..	2 ..	2
Sub-total ..	0 ..	19 ..	42 ..	51
Contingencies 15%	0 ..	3 ..	6 ..	8
TOTAL ..	0 ..	22 ..	48 ..	59
Depreciation, mechanical parts	0 ..	— ..	2 ..	2
Depreciation, civil parts	0 ..	20 ..	43 ..	43
Repayment of Capital	— ..	43 ..	94 ..	94
TOTAL O & M ..	0 ..	85 ..	189 ..	198
Quantity water delivered acre ft.	0 ..	232 ..	723 ..	1,186
Cost per acre ft.	0 ..	0.376 ..	0.261 ..	0.167

Table 18d—Operating and Maintenance Cost Estimate

S. Kepasing Water Supply Delivery System

Item	Annual Costs (\$1,000)			
	1975	1980	1985	1990
Energy	14 ..	34 ..	36 ..	37
Labour	42 ..	63 ..	63 ..	63
Chemicals	23 ..	56 ..	60 ..	62
Maintenance mechanical parts	1 ..	2 ..	2 ..	2
Maintenance civil parts	— ..	— ..	— ..	—
Sub-total ..	80 ..	155 ..	161 ..	164
Contingencies 15%	12 ..	23 ..	24 ..	25
TOTAL ..	92 ..	178 ..	185 ..	189
Depreciation, mechanical parts	3 ..	5 ..	5 ..	5
Depreciation, civil parts	70 ..	106 ..	106 ..	106
Repayment of Capital	159 ..	241 ..	241 ..	241
TOTAL O & M ..	324 ..	530 ..	537 ..	541
Quantity water delivered acre ft.	1,409 ..	3,466 ..	3,657 ..	3,809
Cost per acre ft.	0.230 ..	0.153 ..	0.147 ..	0.142

Table 18e—Operating and Maintenance Cost Estimate

S. Teroh Water Supply Delivery System

Item	Annual Costs (\$1,000)			
	1975	1980	1985	1990
Energy	0	8	19	19
Labour	0	30	53	53
Chemicals	0	18	40	59
Maintenance mechanical parts	0	1	1	1
Maintenance civil parts	0	2	2	2
Sub-total ..	0	59	115	134
Contingencies 15%	0	9	17	20
TOTAL ..	0	68	132	154
Depreciation, mechanical parts	0	2	3	3
Depreciation, civil parts	0	63	91	91
Repayment of Capital	12	140	201	201
TOTAL O & M ..	12	273	427	449
Quantity water delivered acre ft.	0	1,617	2,499	3,675
Cost per acre ft.	—	0.169	0.179	0.122

Table 18f—Operating and Maintenance Cost Estimate

S. Cherong Water Supply Delivery System

Item	Annual Costs (\$1,000)			
	1975	1980	1985	1990
Energy	1	5	7	8
Labour	20	30	32	34
Chemicals	8	20	30	33
Maintenance mechanical parts	—	—	—	1
Maintenance civil parts	1	1	2	2
Sub-total ..	30	56	71	78
Contingencies 15%	5	8	11	12
TOTAL ..	35	64	82	90
Depreciation, mechanical parts	1	1	2	2
Depreciation, civil parts	15	68	68	68
Repayment of Capital	36	145	152	152
TOTAL O & M ..	87	278	304	312
Quantity water delivered acre ft.	290	1,800	2,600	2,882
Cost per acre ft.	0.30	0.154	0.117	0.108

Table 18g—Operating and Maintenance Cost Estimate

S. Batu Water Supply Delivery System

Item	Annual Costs (\$1,000)			
	1975	1980	1985	1990
Energy	7 ..	7 ..	8 ..	8
Labour	42 ..	42 ..	42 ..	42
Chemicals	30 ..	33 ..	35 ..	33
Maintenance mechanical parts	— ..	— ..	— ..	—
Maintenance civil parts	1 ..	1 ..	1 ..	1
Sub-total ..	83 ..	83 ..	83 ..	83
Contingencies 15%	12 ..	12 ..	13 ..	12
TOTAL ..	95 ..	95 ..	99 ..	96
Depreciation, mechanical parts	1 ..	1 ..	1 ..	1
Depreciation, civil parts	42 ..	42 ..	42 ..	42
Repayment of Capital	98 ..	98 ..	98 ..	98
TOTAL O & M ..	236 ..	236 ..	240 ..	237
Quantity water delivered acre ft.	1,900 ..	2,100 ..	2,200 ..	2,100
Cost per acre ft.	0.126 ..	0.112 ..	0.109 ..	0.113

Table 19—Operating and Maintenance Cost Estimate Summary Water Supply Delivery Systems for Towns to be Settled Before 1980

Delivery Scheme	Expenditures in \$1,000 at year				1990 Cost \$1,000 1. Gall.
	1975	1980	1985	1990	
S. Rompin	1,186 ..	1,559 ..	1,768 ..	1,897 ..	0.50
S. Mentiga	136 ..	172 ..	168 ..	169 ..	0.33
S. Gayong	— ..	85 ..	189 ..	198 ..	0.43
S. Kepasing	324 ..	530 ..	537 ..	541 ..	0.52
S. Teroh	— ..	273 ..	427 ..	449 ..	0.45
S. Cherong	87 ..	278 ..	304 ..	312 ..	0.40
S. Batu	236 ..	236 ..	240 ..	237 ..	0.41
Operating and Maintenance Delivery System Total ¹	1,969 ..	3,133 ..	3,633 ..	3,803 ..	0.47
Contribution O & M assumed Total ¹ ..	1,802 ..	4,440 ..	5,255 ..	5,847 ..	0.72
TOTAL ..	3,761 ..	7,573 ..	8,888 ..	9,650 ..	1.19

¹Including Capital Charges:

Depreciation Mechanical plant—6.7%

Depreciation civil works—3.3%

Repayment Capital 6% over—30 years

Table 20—Proposed Water Level and Rainfall Recording Stations

(A) Water Level Recorders

No.	River	Location
1	.. S. Kechau	.. Kg. Dusun
2	.. S. Tembeling	.. Kg. Sizama
3	.. S. Telom	.. Bkt. Betong
4	.. S. Tekai	.. Bkt. Bintangor
5	.. S. Cheka	.. Bkt. Tamar
6	.. S. Semantan	.. Kg. Buloh
7	.. S. Mentiga	.. Kg. Geliau
8	.. S. Bera	.. Kg. Kepajan
9	.. S. Bebar	.. Kg. Chang
10	.. S. Jeram	.. Bulut Nipis
11	.. S. Bera	.. Bt. Kuin
12	.. S. Serting	.. Pdg. Gudang
13	.. S. Merchong	.. Kg. Temiris
14	.. S. Rompin	.. Kg. Aur
15	.. S. Keratong	.. Kg. Lagau
16	.. S. Rompin	.. Kg. Semupok
17	.. S. Lepar	.. Kg. Paya Rambutan

(B) Rainfall Recorders

Letter	Location
A	.. Kg. Chechar
B	.. Kg. Geliau
C	.. Kg. Mebedang
D	.. Kg. Uchang
E	.. Bkt. Langu
F	.. Kg. Terubin
G	.. Bkt. Kuin
H	.. Kg. Aur
I	.. Kg. Semupok
J	.. Kg. Temiris
K	.. Kg. Tanam
L	.. Kg. Gambir
M	.. Confluence S. Katon, S. Pontian
N	.. Catchment S. Anak Endau

Table 21—Drainage Network Design Criteria

(Tabulated Figures are Inches of Rainfall Per Day as Basis for Design of Drainage Facilities)

Area to be drained	PART OF REGION		
	S. Eastern	N. Central	Western
Towns with population over 25,000.. .. .	6.3	5.0	4.1
Towns with population 5,000–25,000	3.0–6.3	2.0–5.0	1.5–4.1
Towns with population less than 5,000	3.0	2.0	1.5
Annual crops	3.0	2.0	1.5
Perennial Crops	1.5	1.2	0.9

FIGURES

APPENDIX B

Fig. 1

PAHANG TENGGARA REGIONAL MASTERPLANNING STUDY

5 0 5 10 15
MILES

CLIMATE & WATER RESOURCES

—LEGEND—

Hydrology
 Rainfall Station.....
 Stick Gauge.....
 Evaporimeter Station.....
 Stream Gauge.....
 Water Sampling Site.....

Rainfall
 Isohyet (inches).....-110-

Wind

calm 1-3 4-7 8-12 13-18 19-24 25-31 M.P.H.

Time 0 5 10 15 %

Source data
 Malaysian Meteorological Service
 Climatological Summaries
 Part I - Wind

Singapore Meteorological Service
 Climatological Summaries
 Part II - Rainfall 1965

Note
 For hydrology data in text see Table
 1-1 (rainfall stn., stick gauge, evapo-
 rimeter stn.) & 3-3-4 (water
 sampling site)

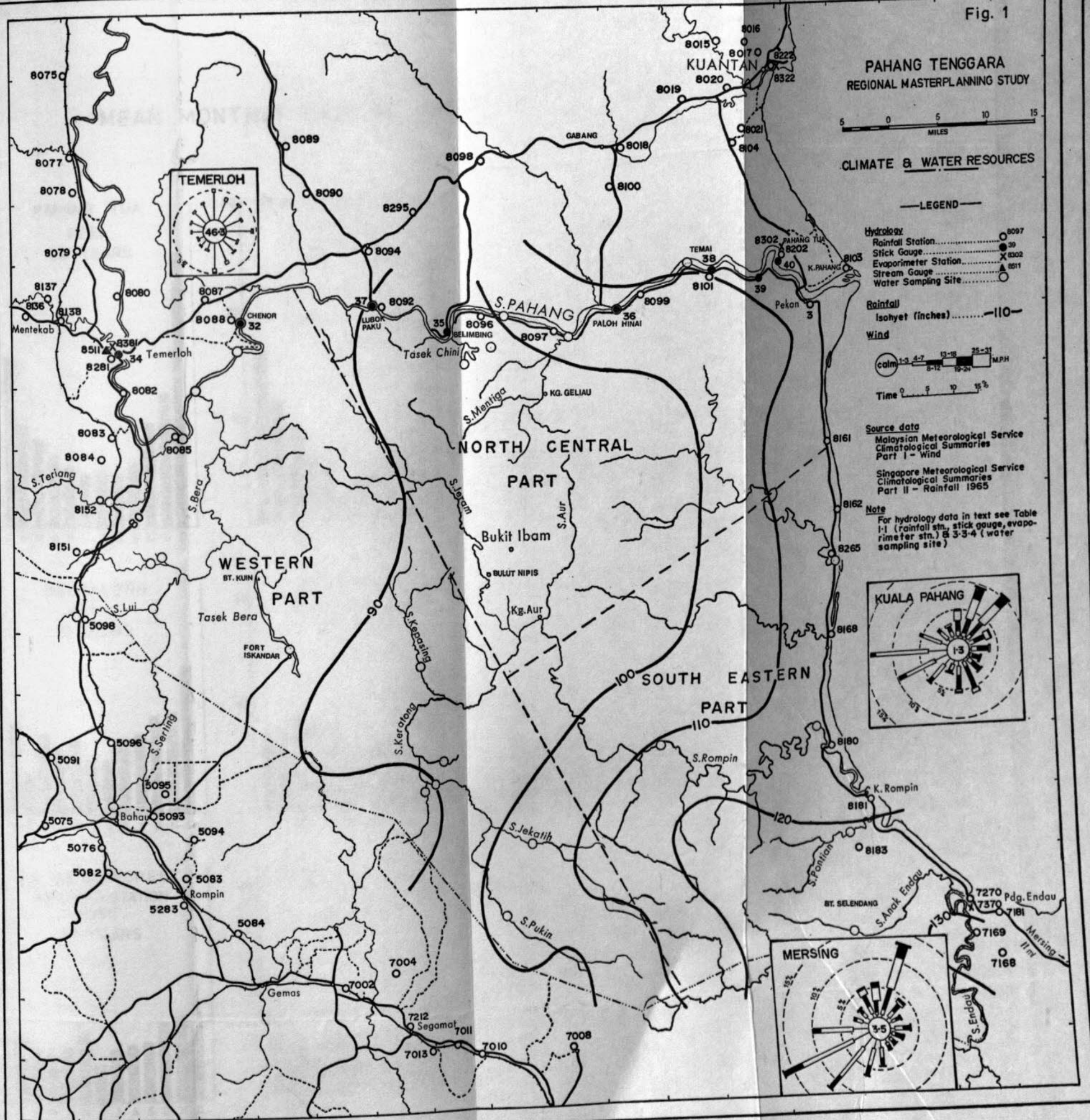
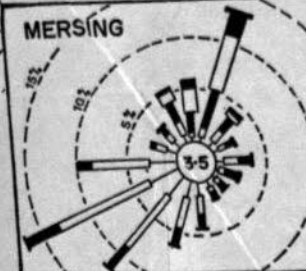
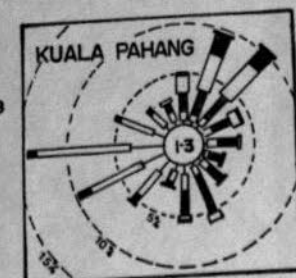
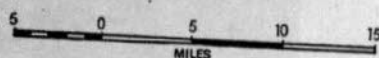


Fig. 1

PAHANG TENGGARA REGIONAL MASTERPLANNING STUDY

CLIMATE & WATER RESOURCES



—LEGEND—

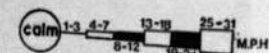
Hydrology

- Rainfall Station..... 8097
- Stick Gauge..... 39
- Evaporimeter Station..... 8302
- Stream Gauge..... 8611
- Water Sampling Site.....

Rainfall

Isohyet (inches).....110—

Wind



Time 0 5 10 15 %

Source data

Malaysian Meteorological Service
Climatological Summaries
Part I - Wind

Singapore Meteorological Service
Climatological Summaries
Part II - Rainfall 1965

Note

For hydrology data in text see Table
1-1 (rainfall stn., stick gauge, evapo-
rimeter stn.) & 3-3-4 (water
sampling site)

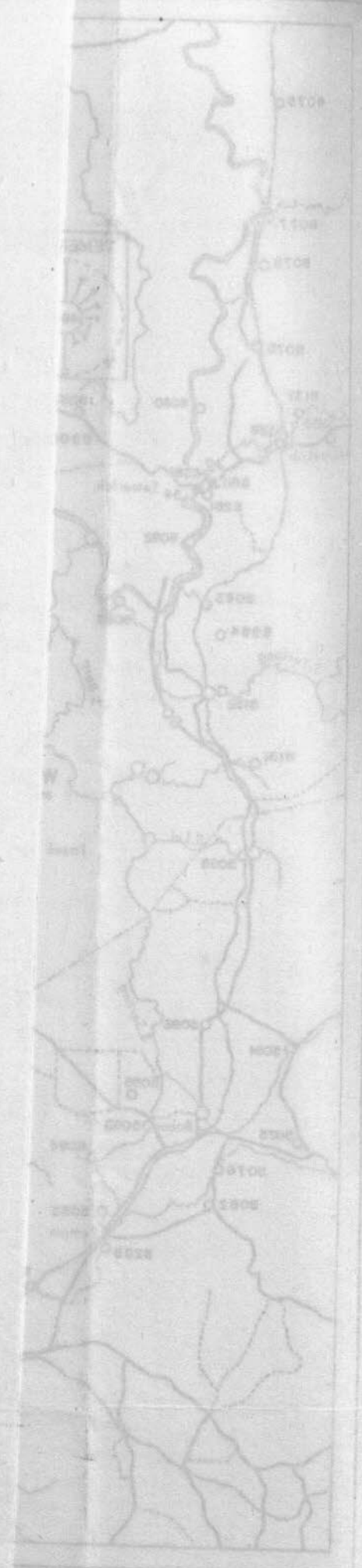
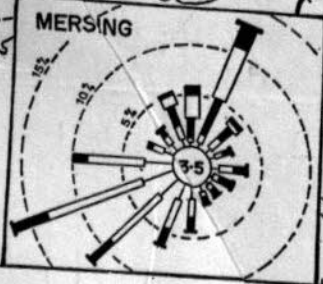
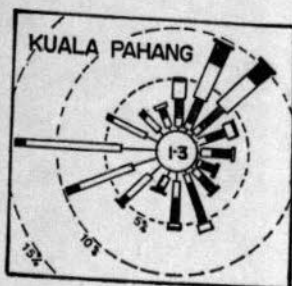


Fig. 2

MEAN MONTHLY RAINFALL DISTRIBUTION

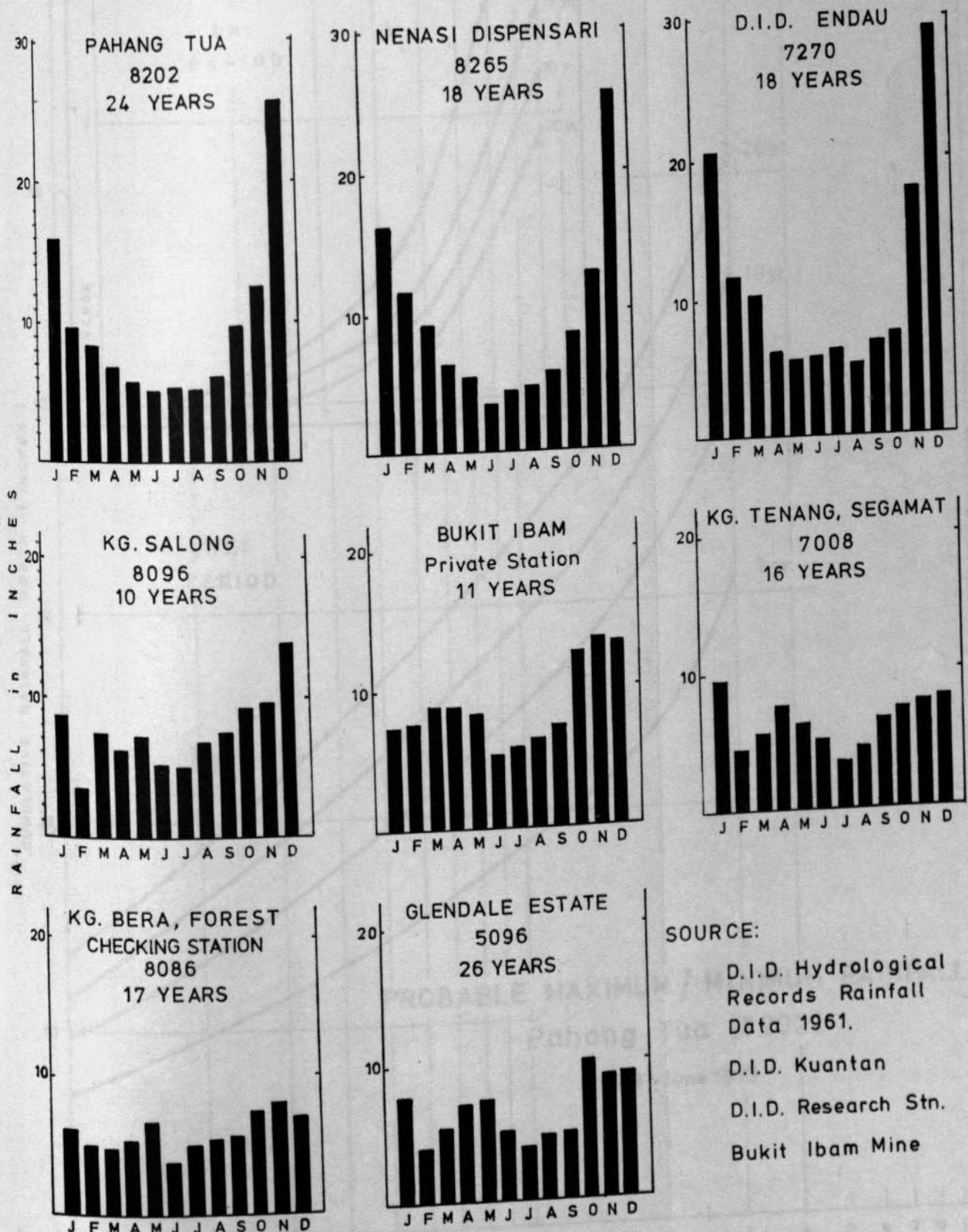


Fig. 3a

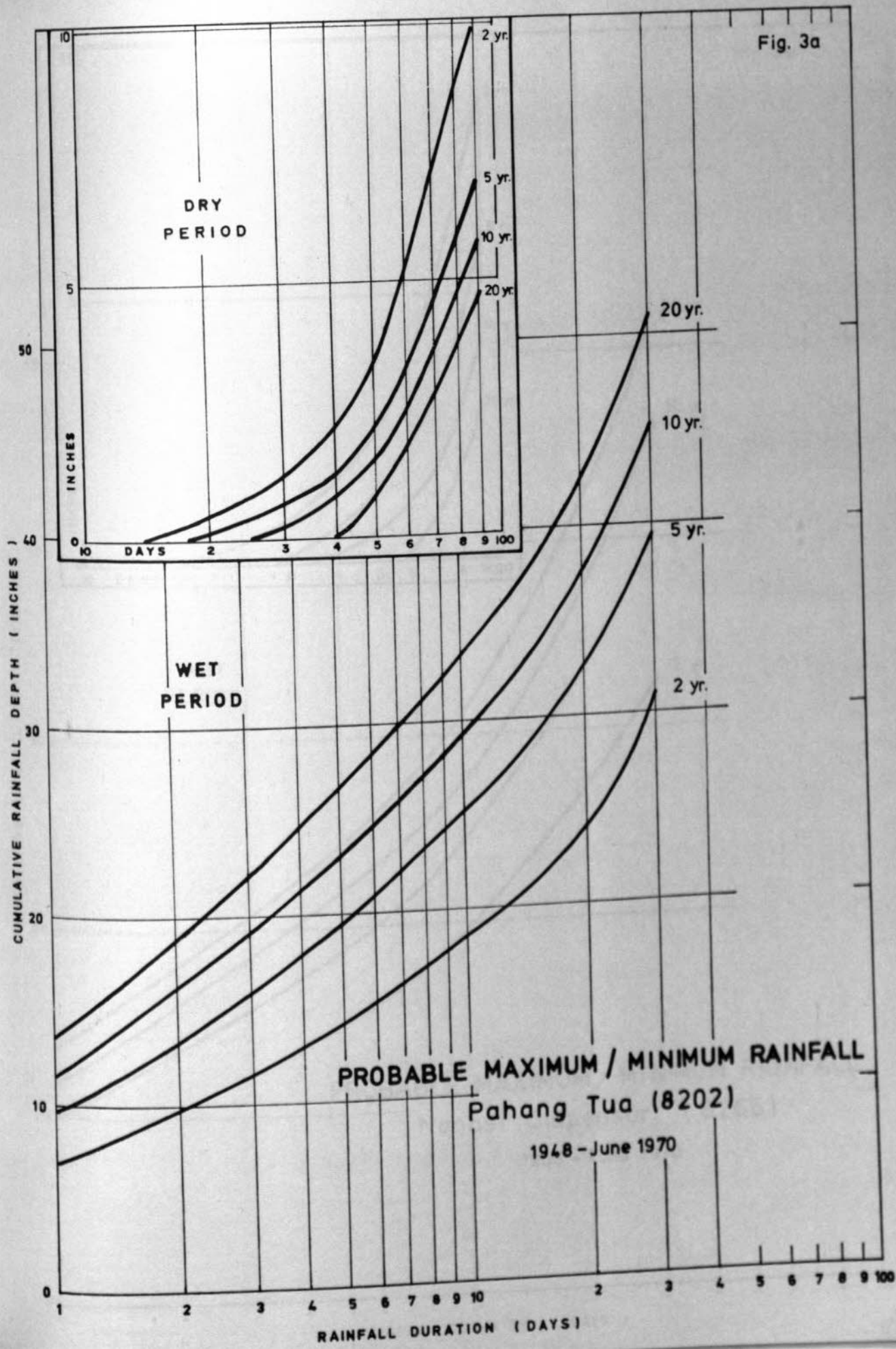


Fig. 3b

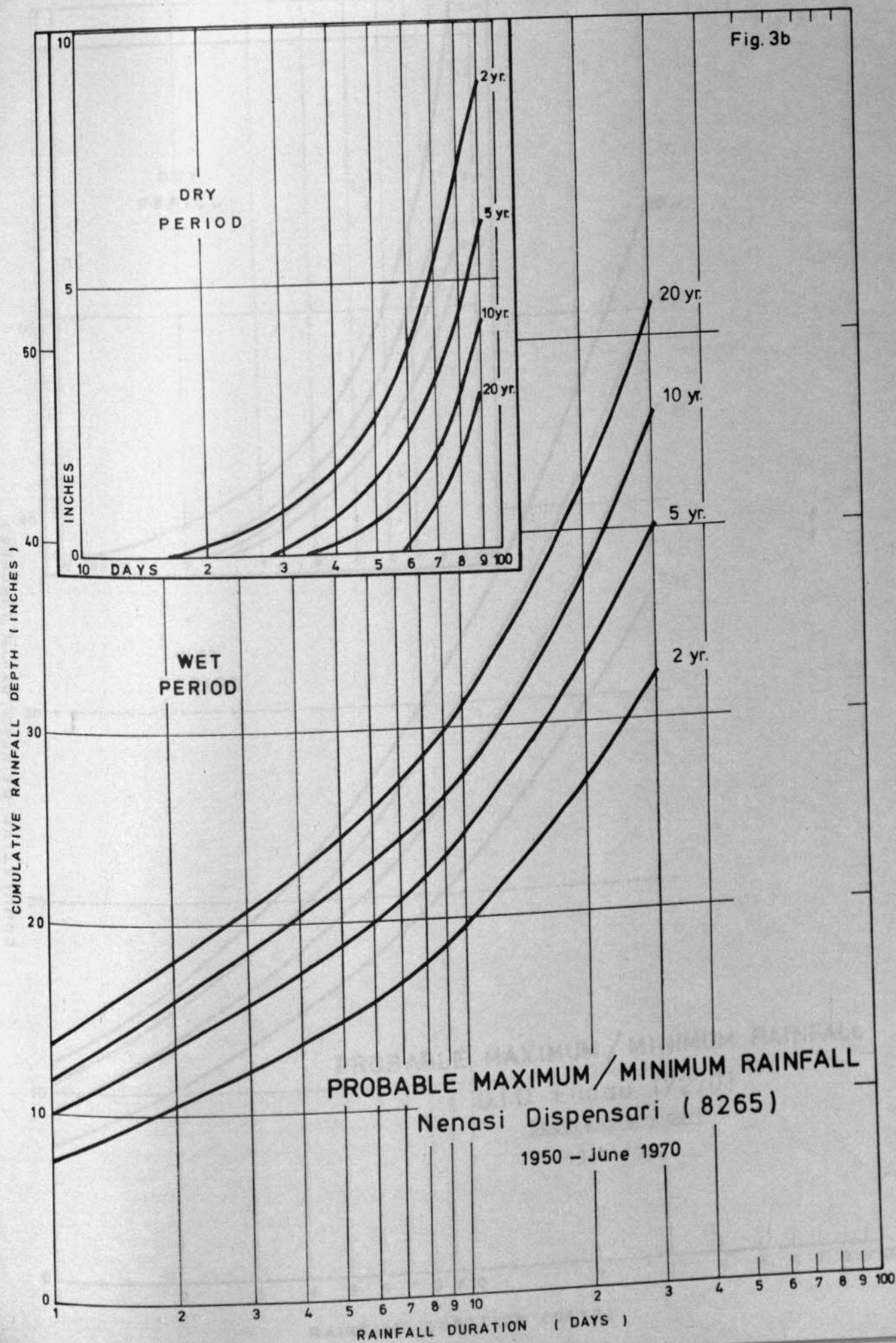


Fig. 3 c

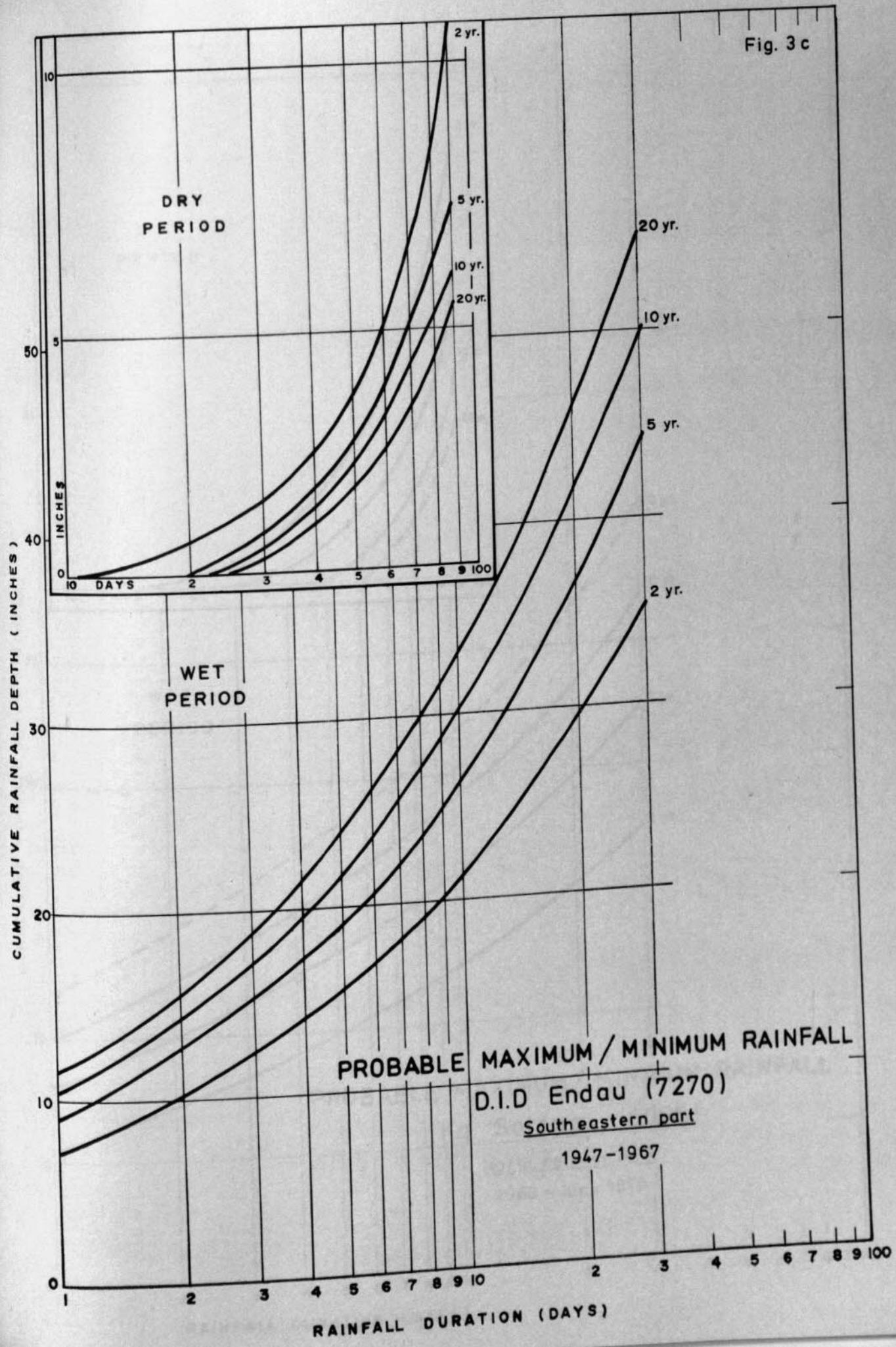


Fig. 3d

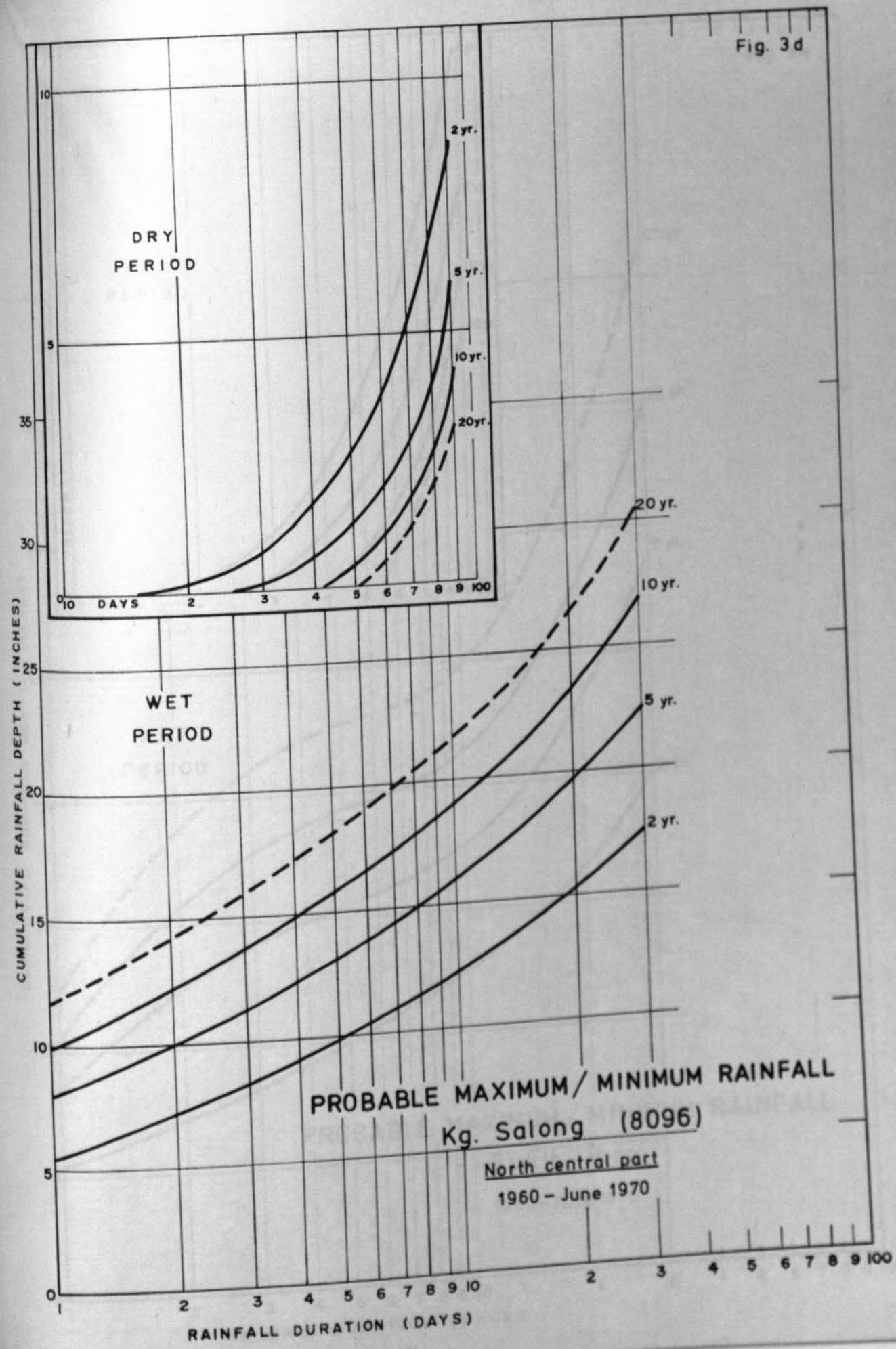


Fig. 3 e

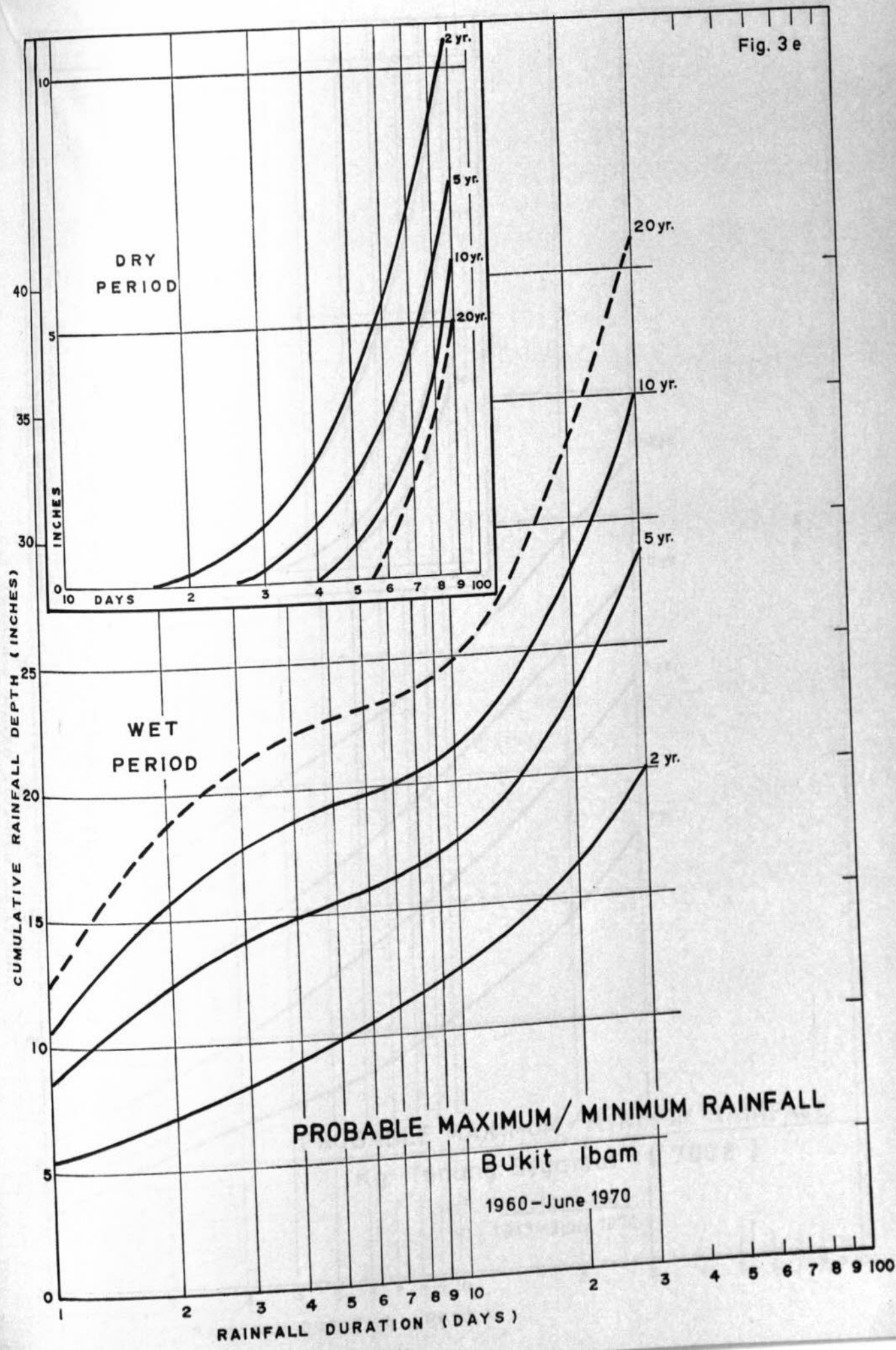


Fig. 3 f

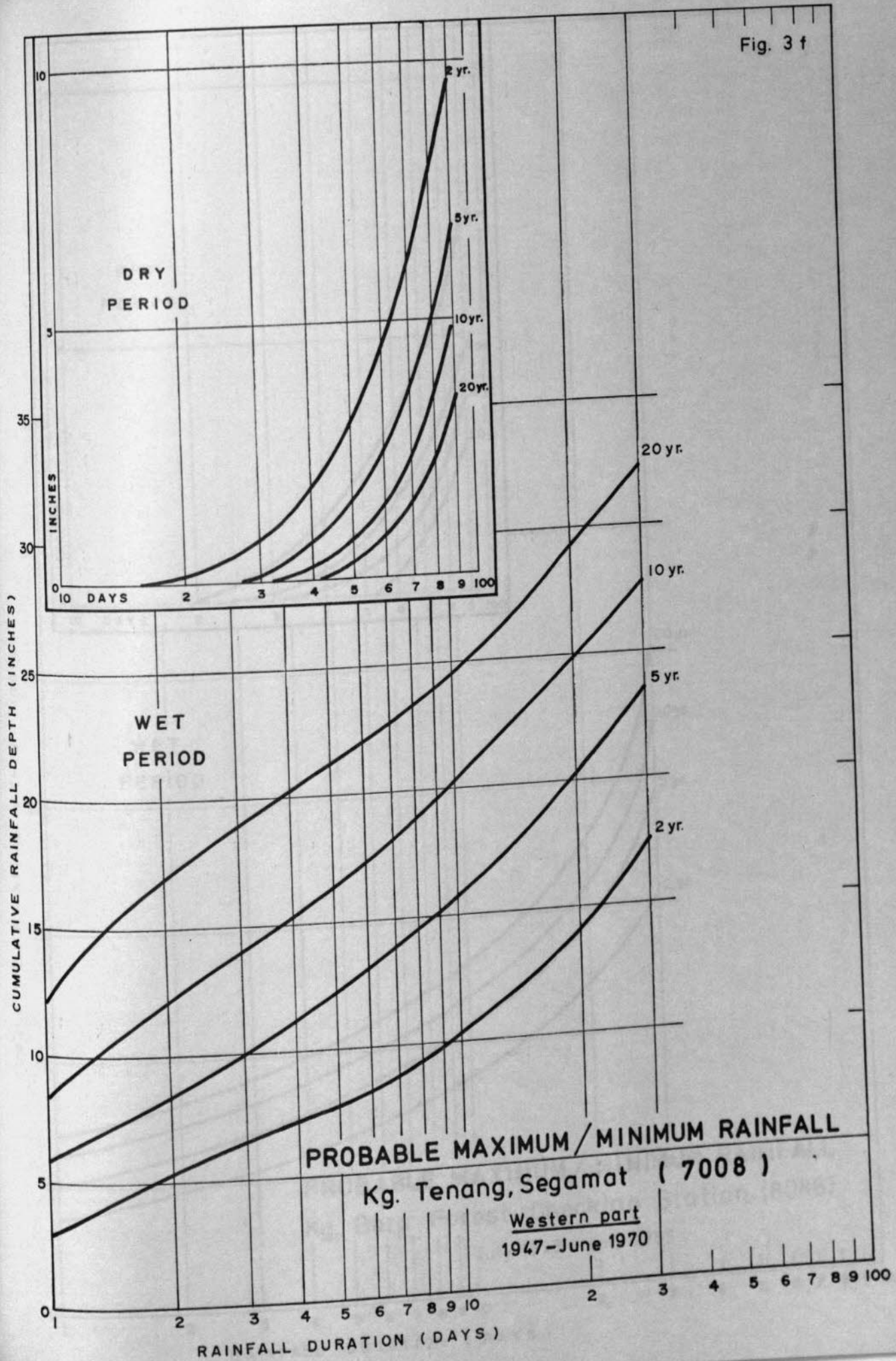


Fig. 3 g

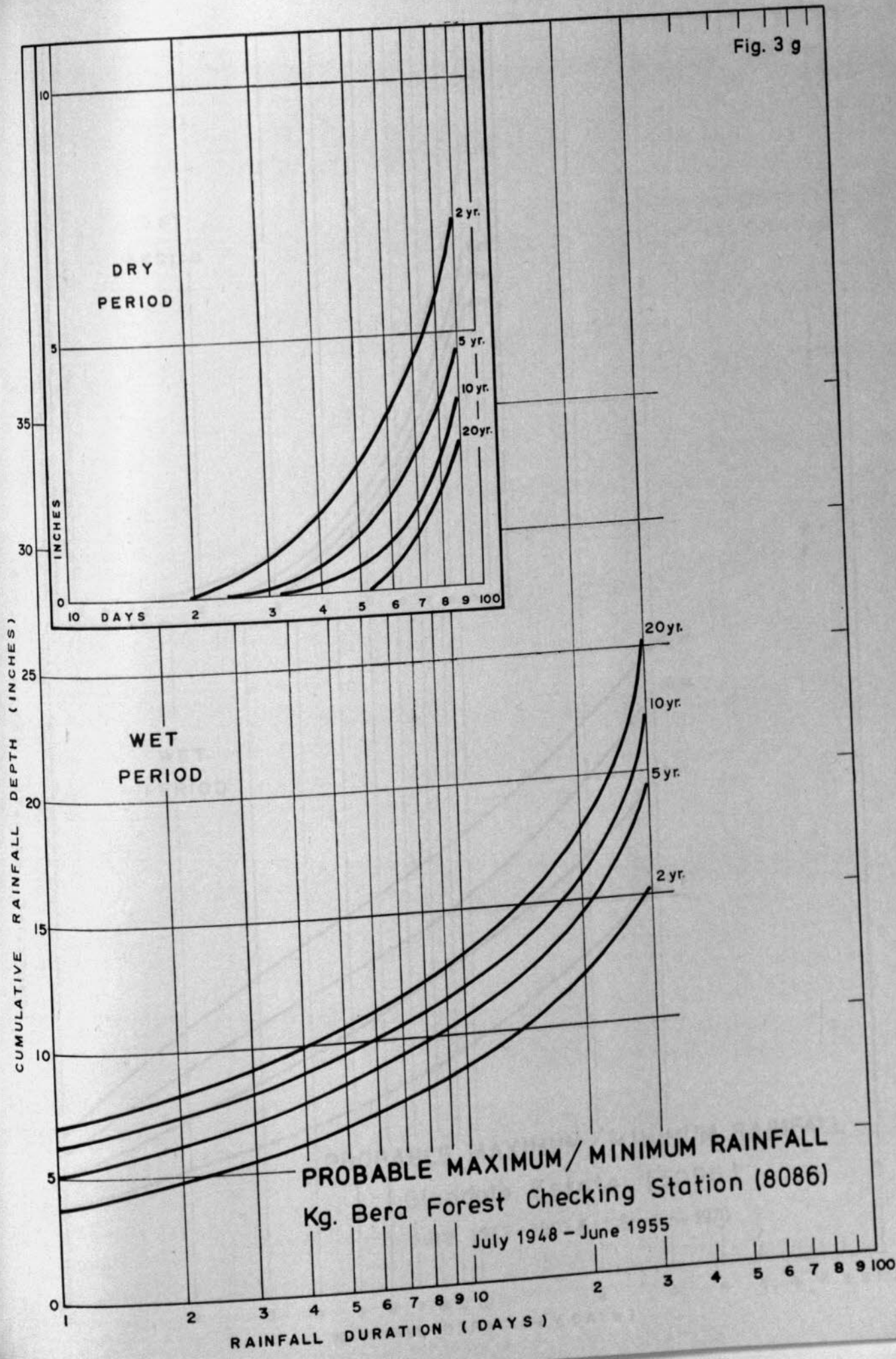


Fig. 3 h

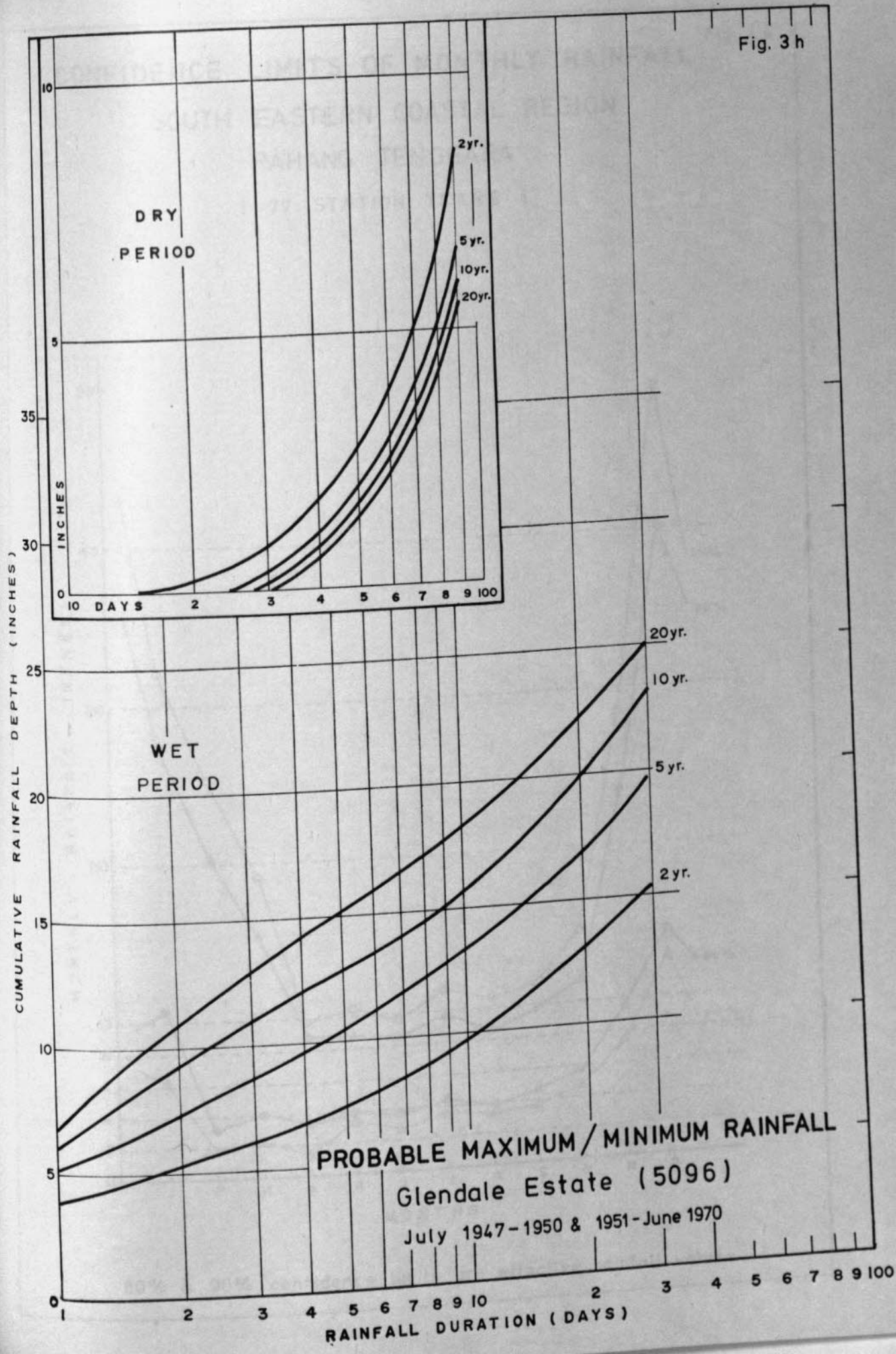
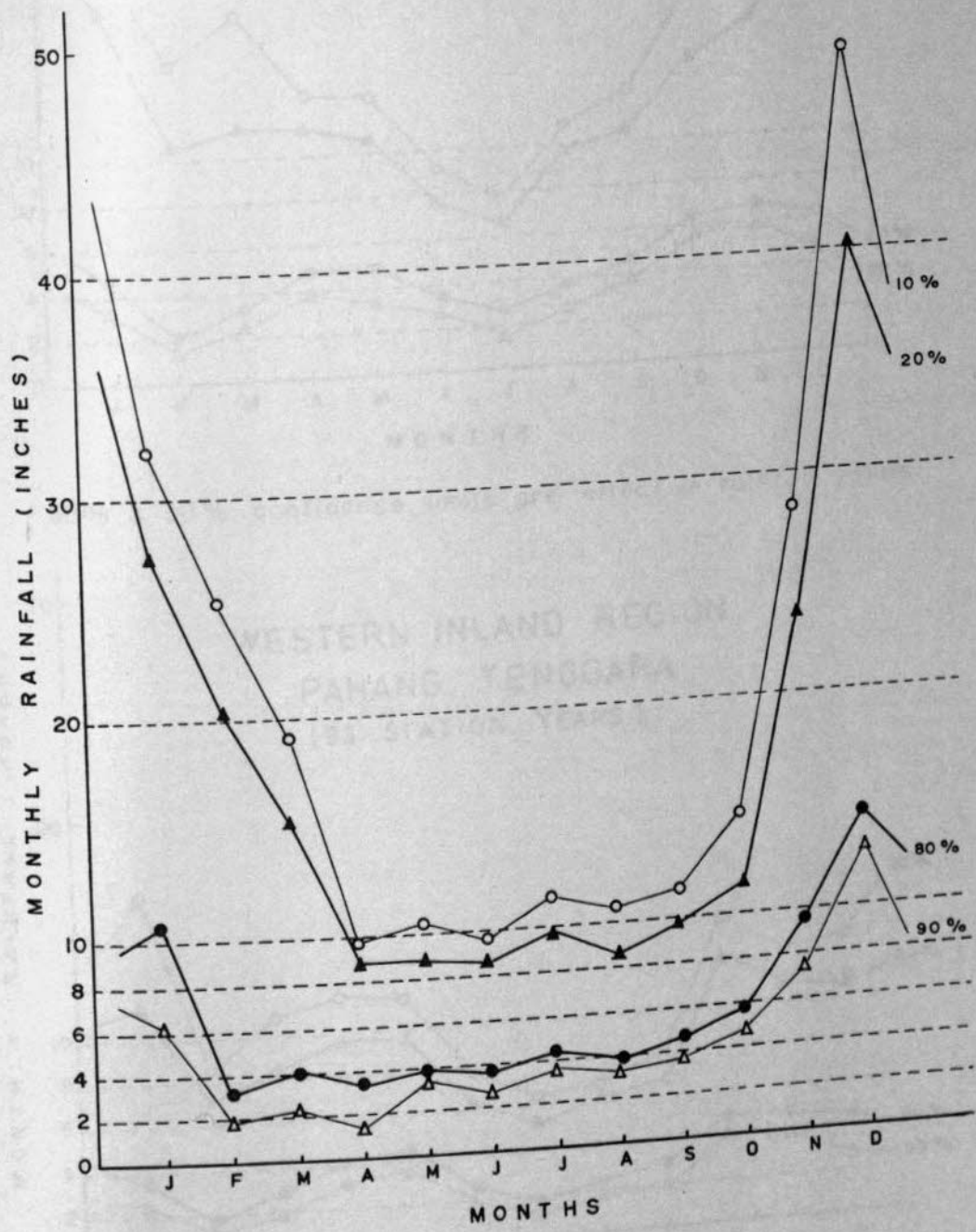


Fig. 4 a

CONFIDENCE LIMITS OF MONTHLY RAINFALL SOUTH EASTERN COASTAL REGION PAHANG TENGGARA (77 STATION YEARS)



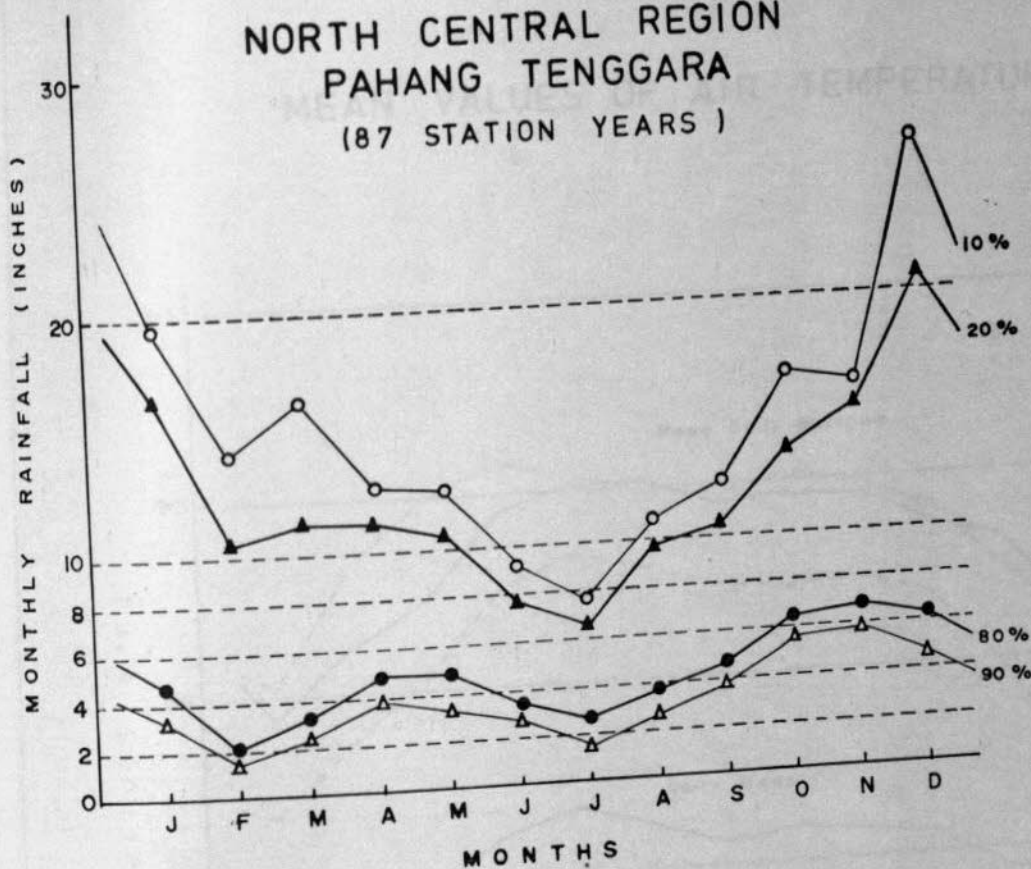
80% & 90% confidence limits are effective rainfall values.

Fig. 4b & 4c

CONFIDENCE LIMITS OF MONTHLY RAINFALL

NORTH CENTRAL REGION PAHANG TENGGARA

(87 STATION YEARS)



80% & 90% confidence limits are effective rainfall values.

WESTERN INLAND REGION PAHANG TENGGARA

(93 STATION YEARS)

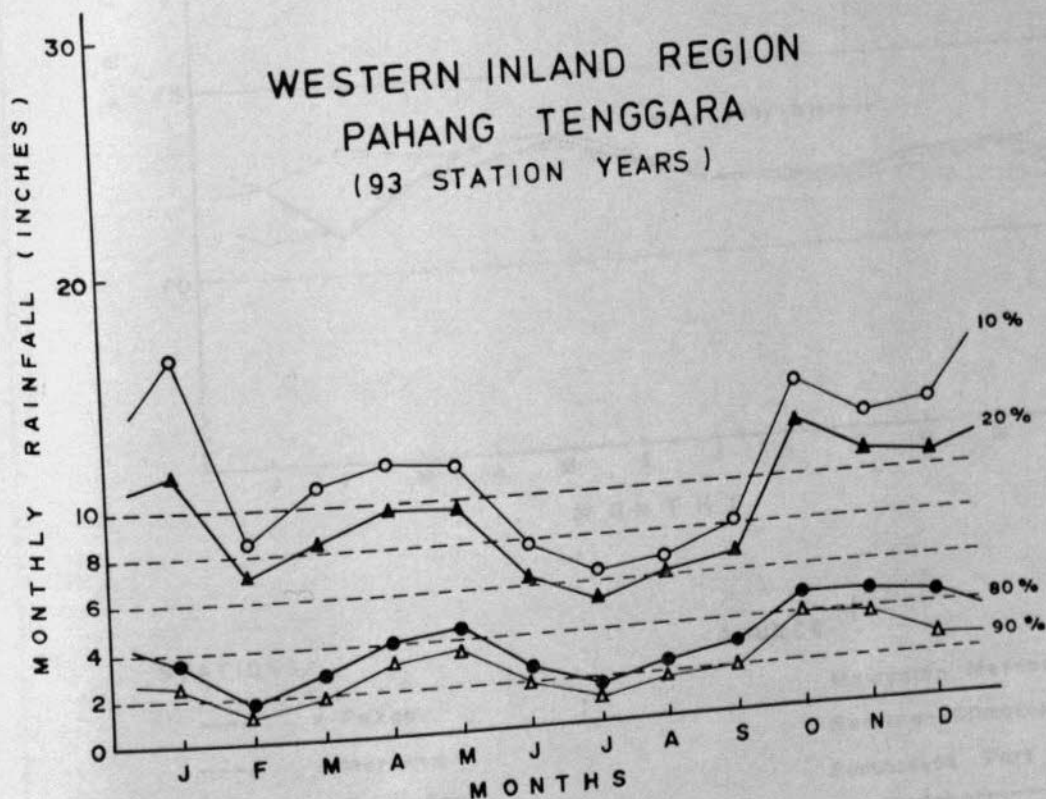
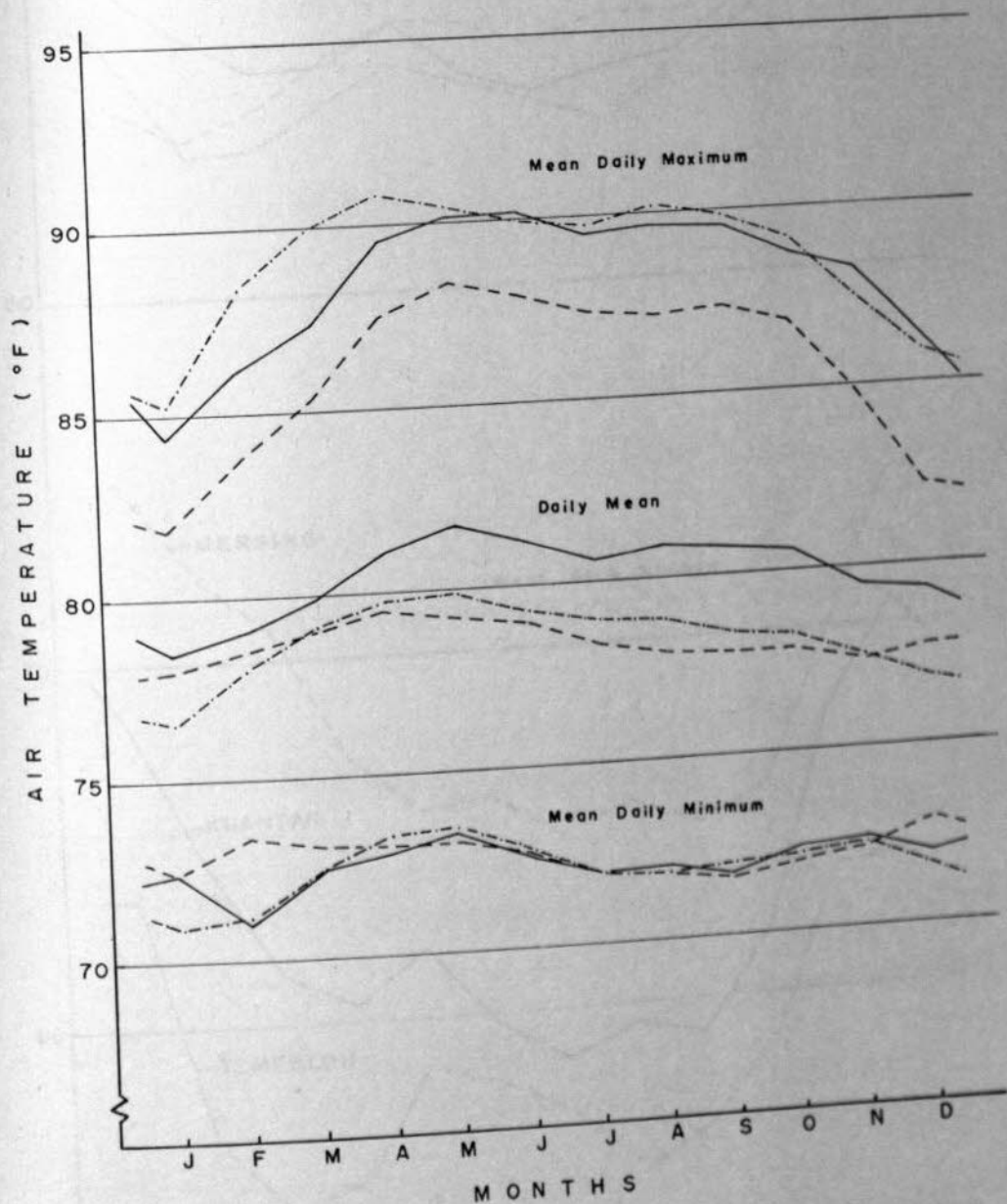


Fig. 5

MEAN VALUES OF AIR TEMPERATURES



STATIONS:

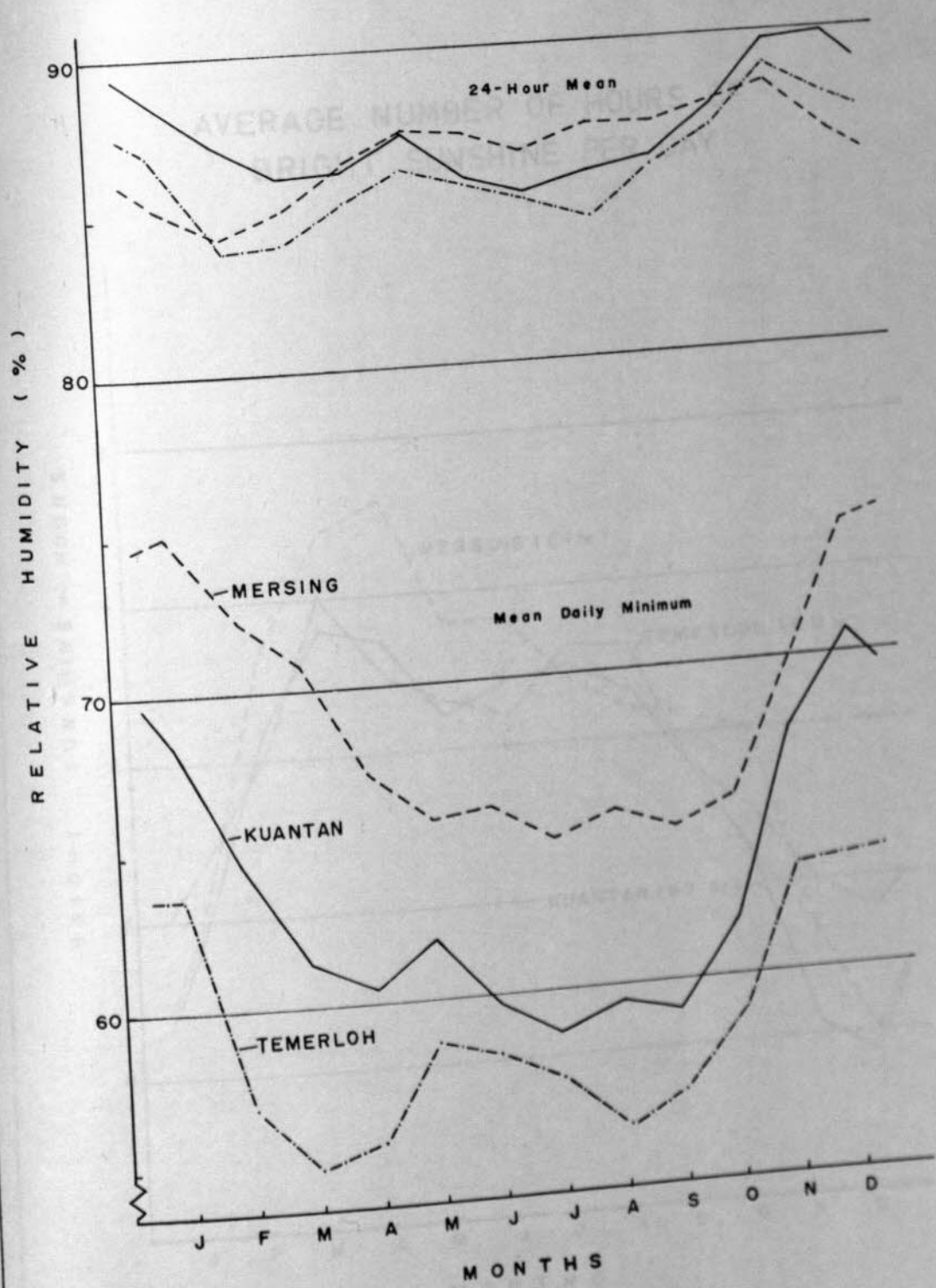
- = Pekan
- - - = Mersing
- ... = Temerloh

SOURCE:

Malaysian Meteorological
Service - Climatological
Summaries Part III

Fig. 6

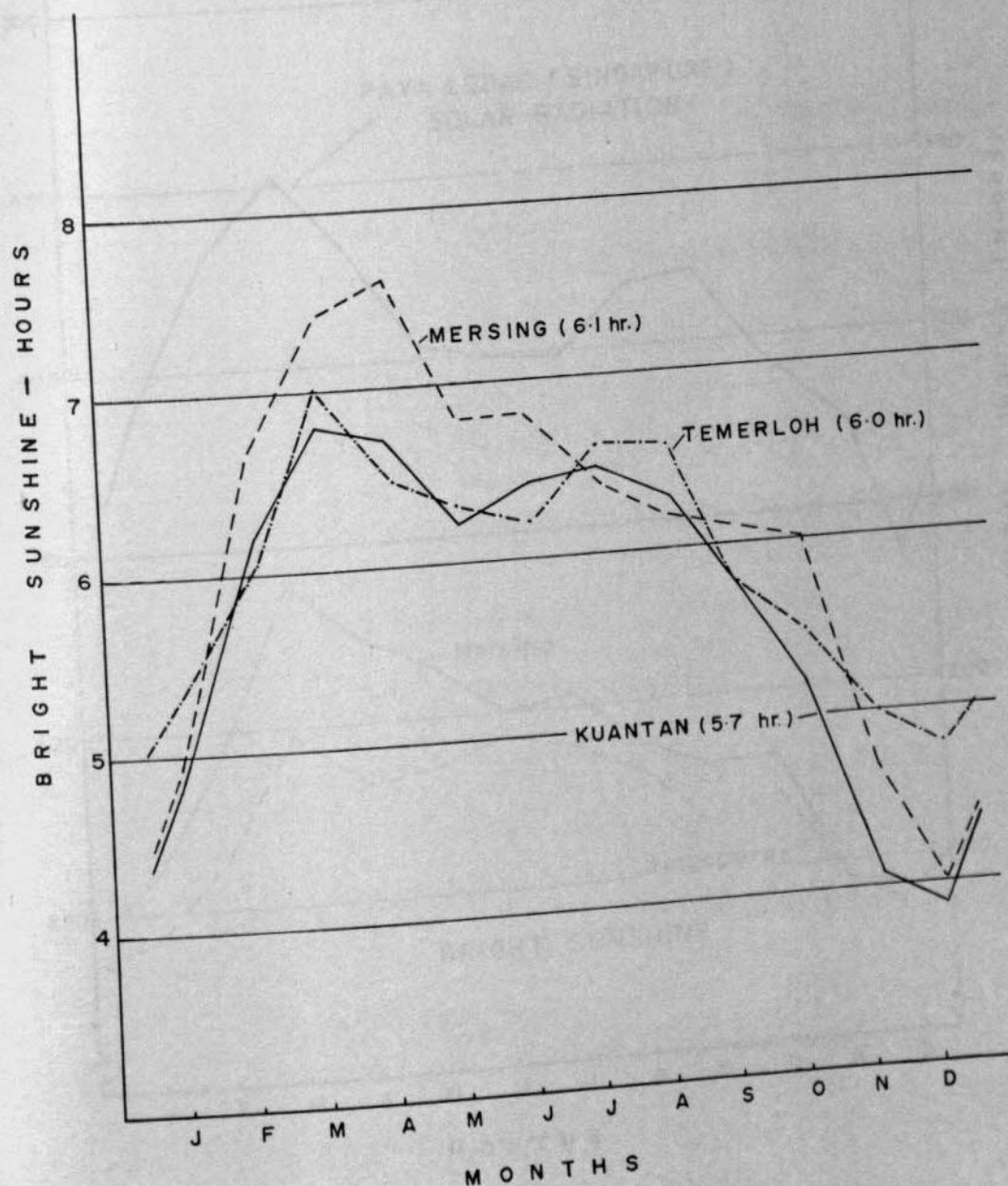
MEAN RELATIVE HUMIDITY (%)



SOURCE: Malaysian Meteorological Service - Climatological Summaries Part III.

Fig. 7

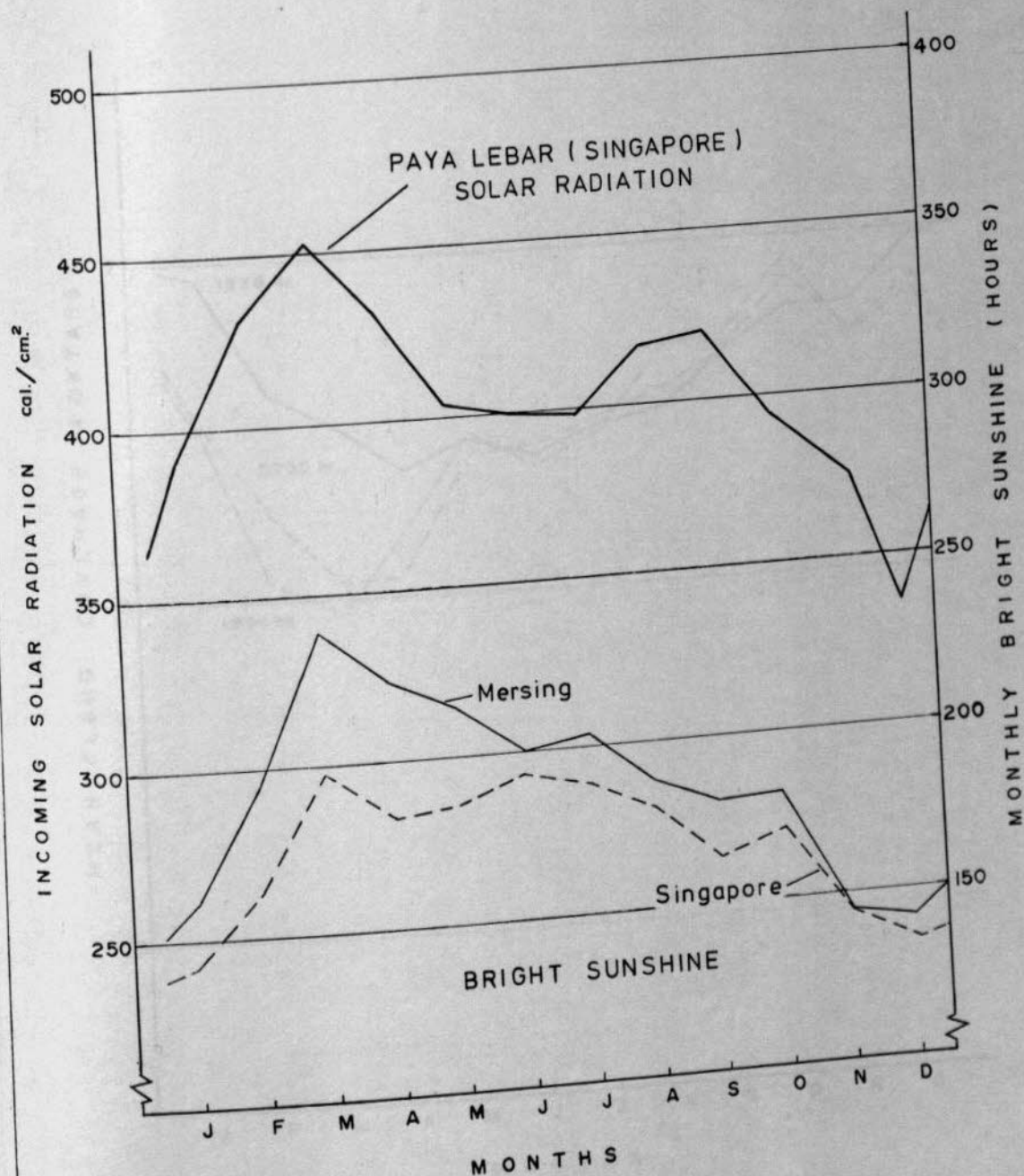
AVERAGE INCOMING SOLAR RADIATION
MEAN MONTHLY BRIGHT SUNSHINE
AVERAGE NUMBER OF HOURS OF
BRIGHT SUNSHINE PER DAY



SOURCE:
Malaysian Meteorological Service

Fig. 8

AVERAGE INCOMING SOLAR RADIATION & MEAN MONTHLY BRIGHT SUNSHINE

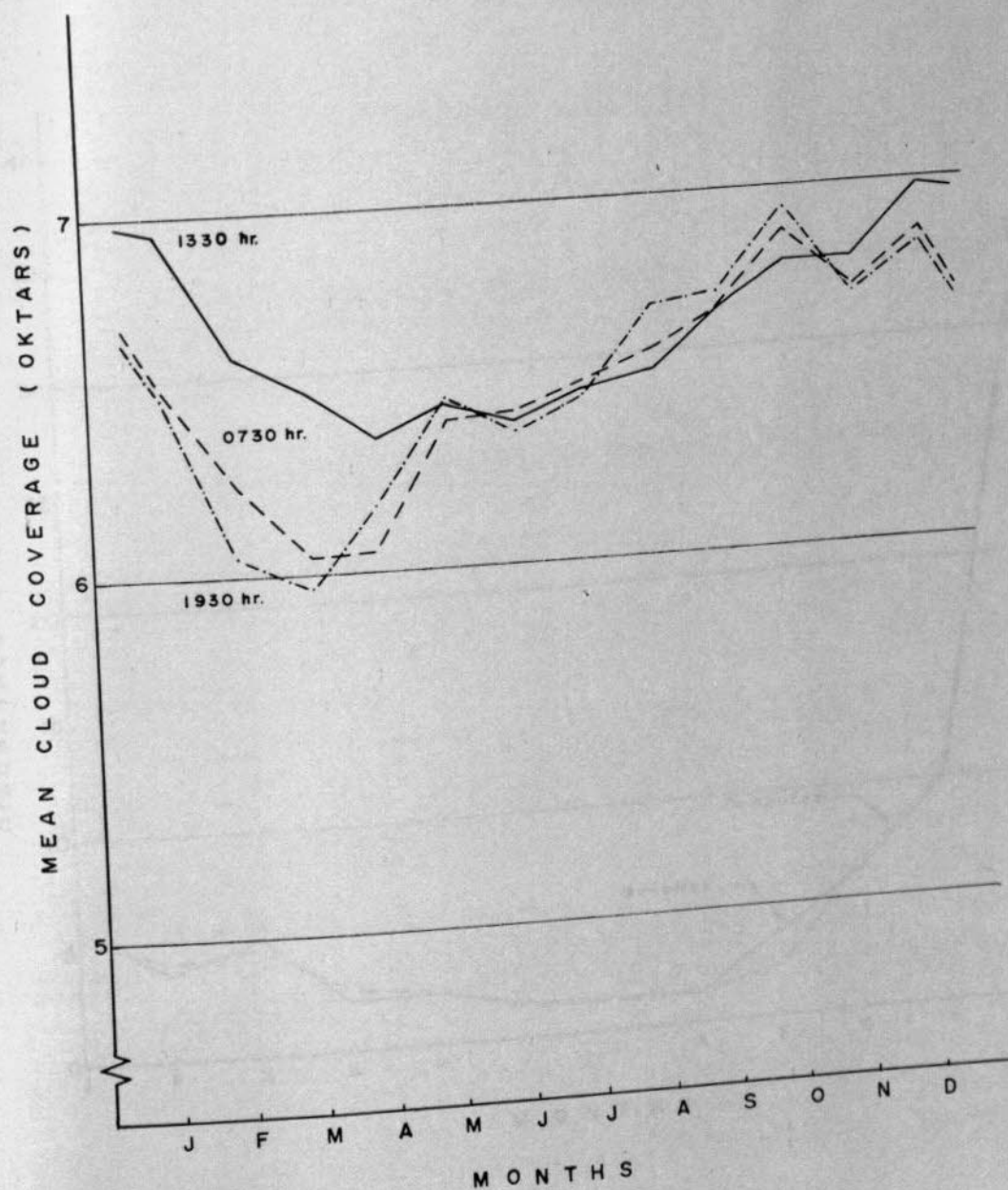


SOURCE:

Malaysian Meteorological Service.
Singapore Meteorological Service.

Fig. 9

MEAN MONTHLY CLOUD COVERAGE at Kuantan (1959-1968)



SOURCE:

Malaysian Meteorological Service.

Fig. 10 a

COMPUTED & MEASURED RIVER DISCHARGES in SUNGEI BESUT at JERTEH 1956

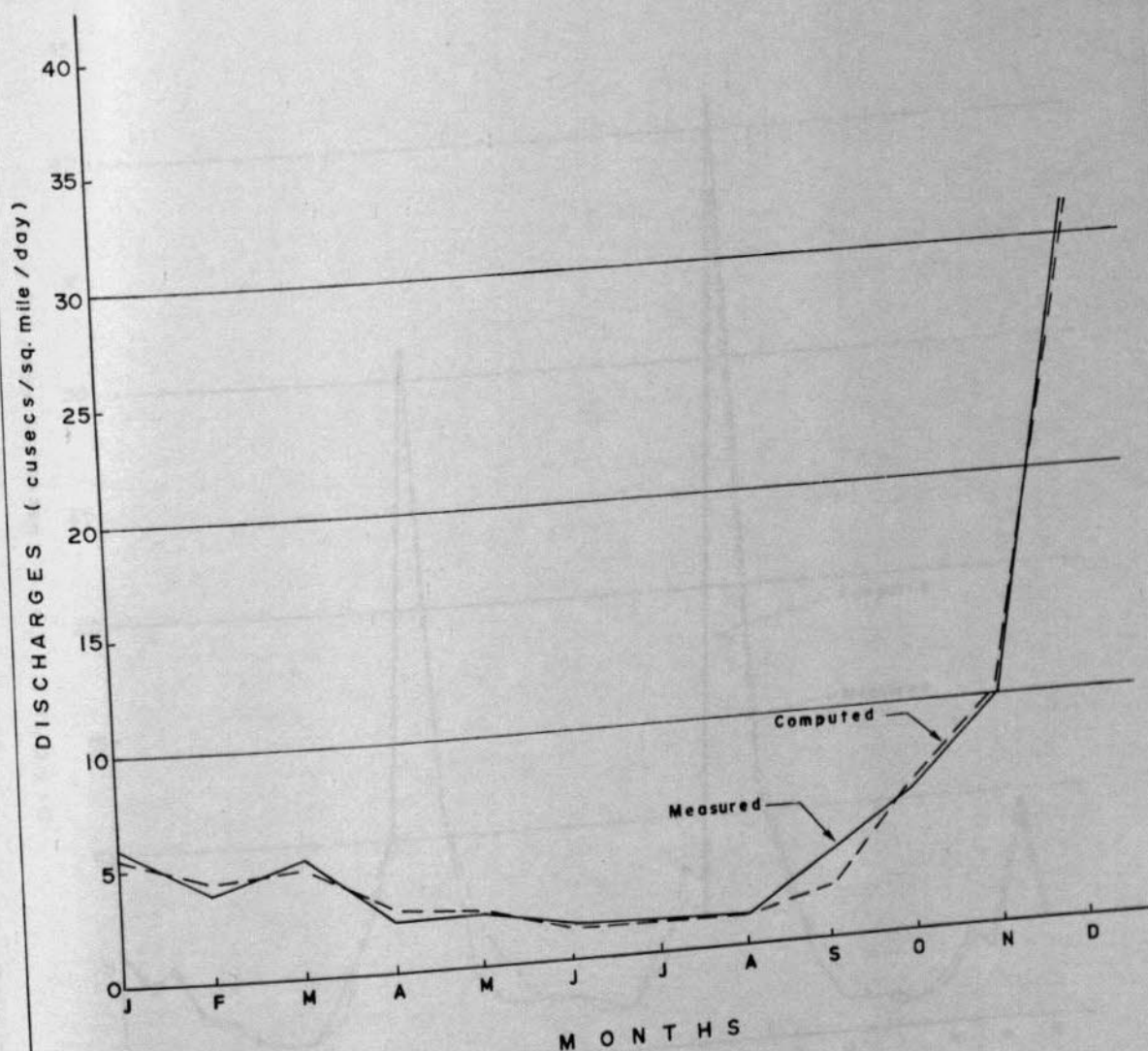


Fig. 10 b

COMPUTED & MEASURED RIVER DISCHARGES
in SUNGEI BESUT at JERTEH
1956, 1957, 1958

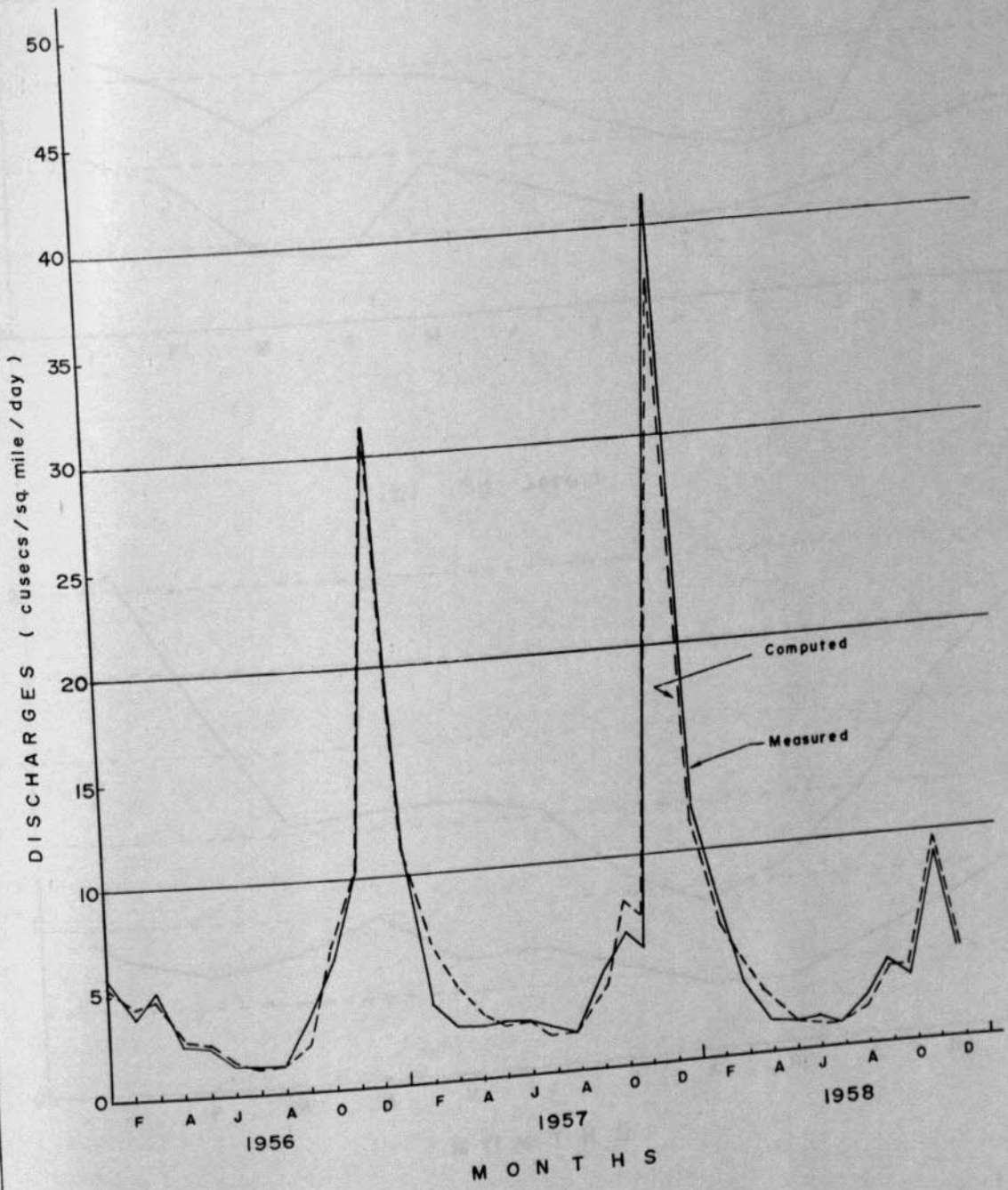
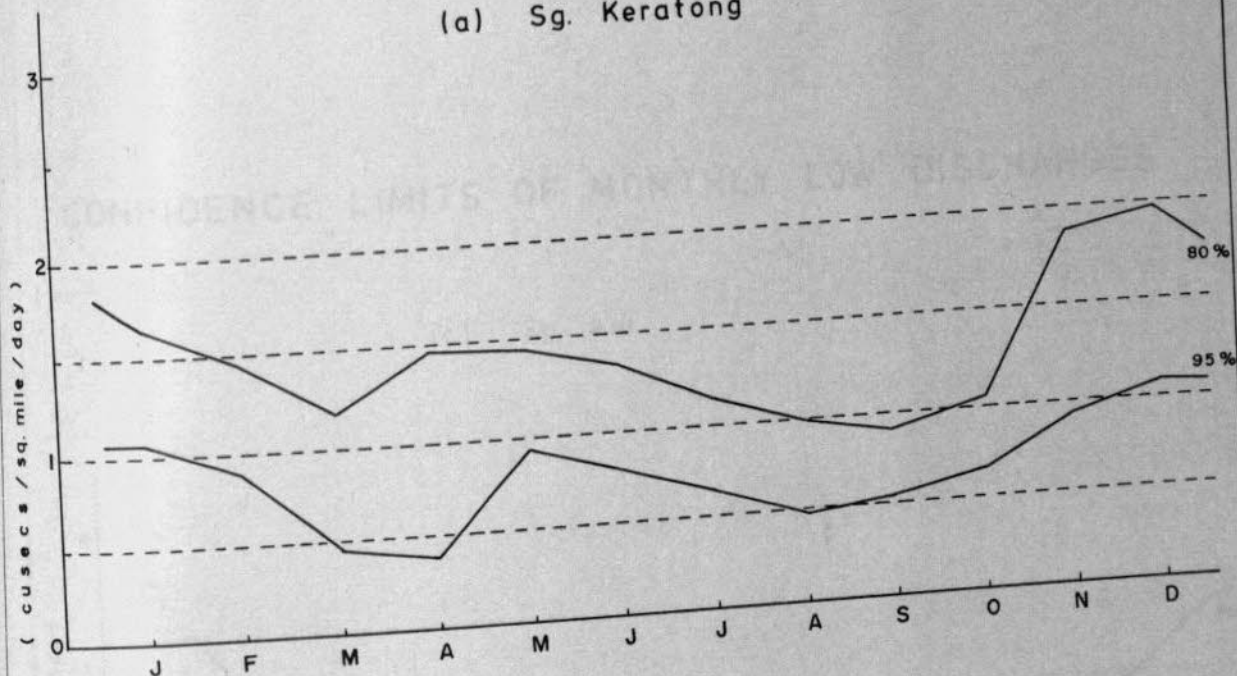


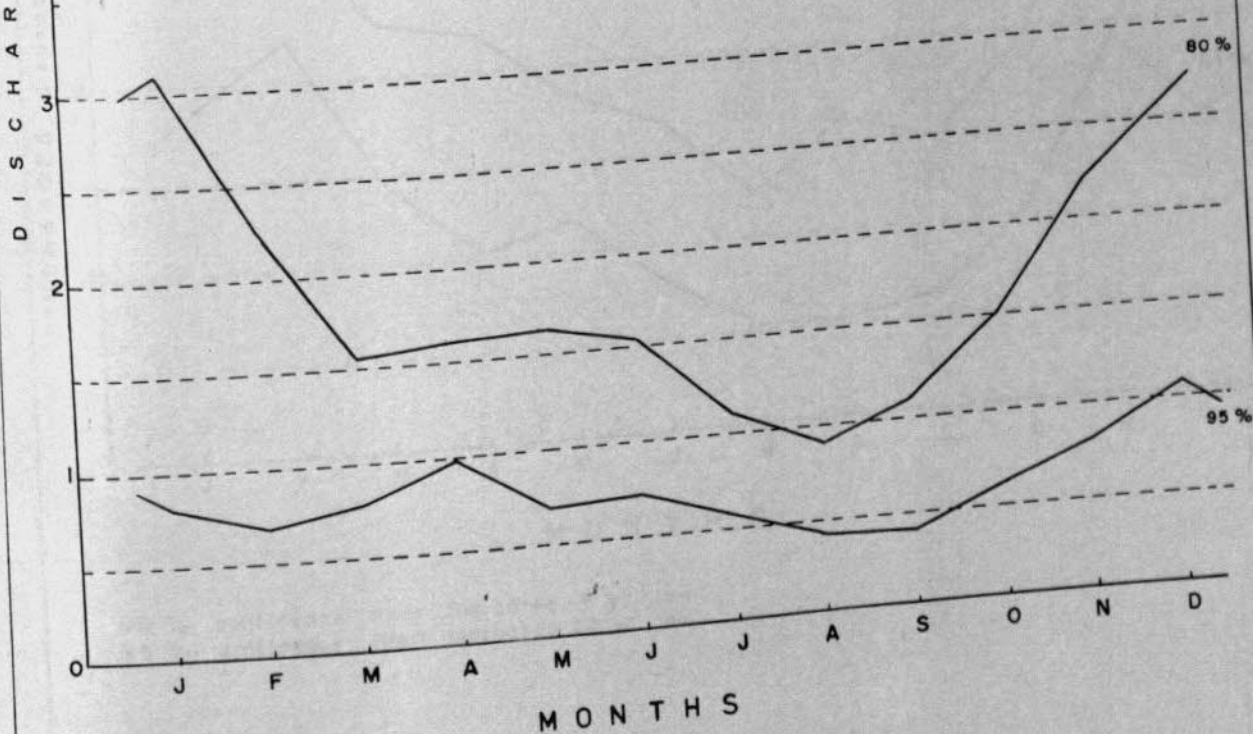
Fig. 11a

CONFIDENCE LIMITS OF MONTHLY LOW DISCHARGES

(a) Sg. Keratong



(b) Sg. Jeram

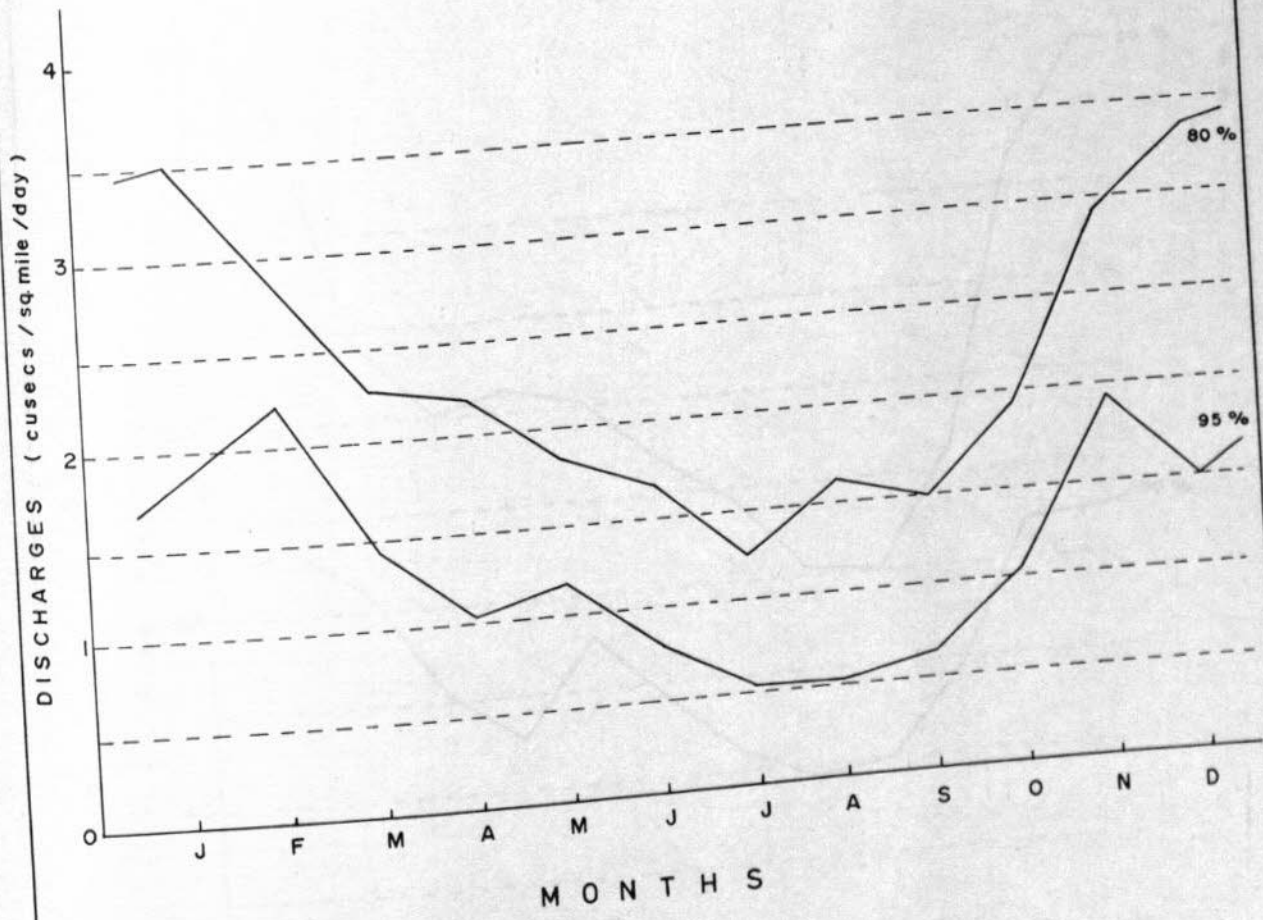


80% confidence limit indicates 5 yr. low
 95% confidence limit indicates 20 yr. low

Fig. 11 b

CONFIDENCE LIMITS OF MONTHLY LOW DISCHARGES

(c) Sg. Aur

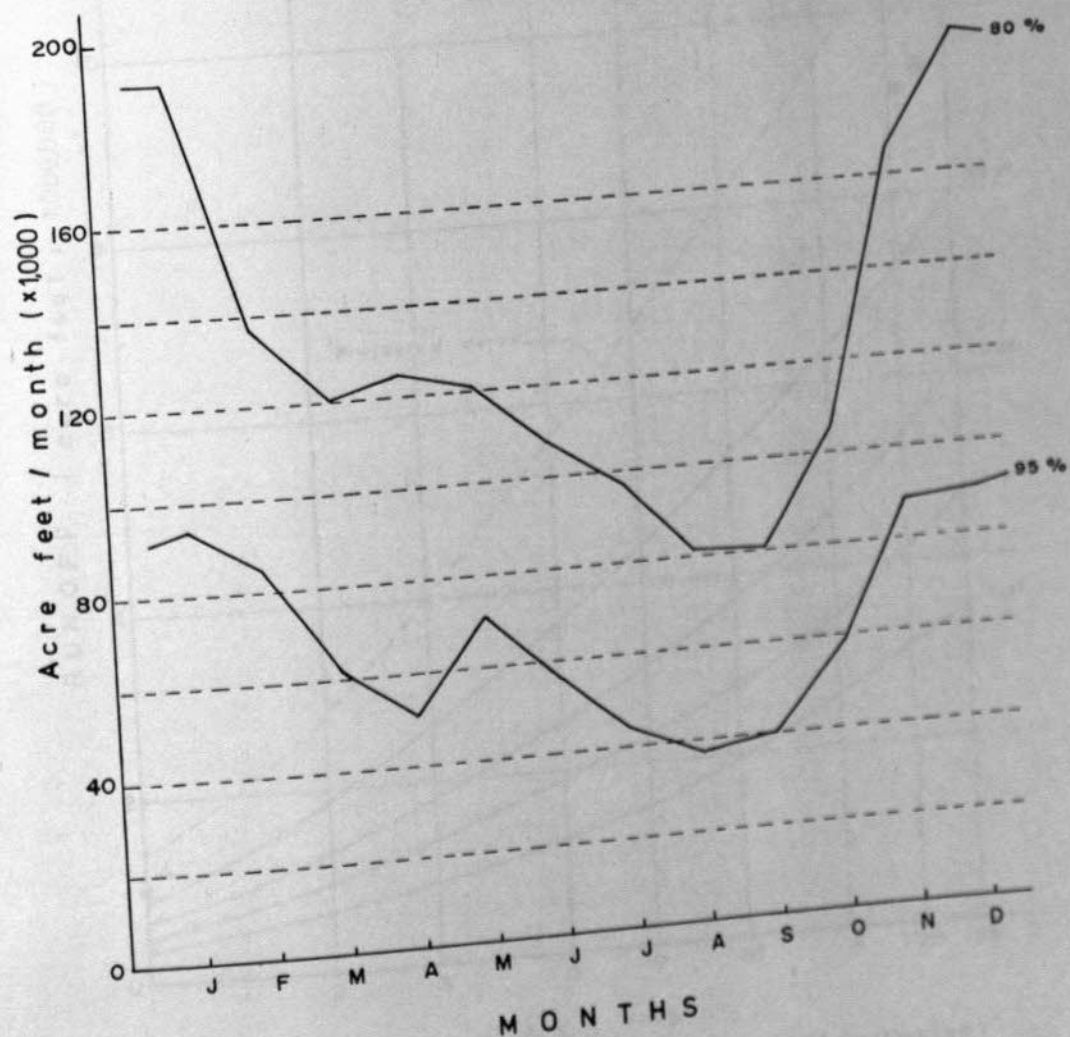


80 % confidence limit indicates 5 yr. low
95 % confidence limit indicates 20 yr. low

Fig. 12

5-YEAR and 20-YEAR LOW MONTHLY DISCHARGES SG. ROMPIN at KG. SAWAK

(Catchment area 1240 sq. miles)

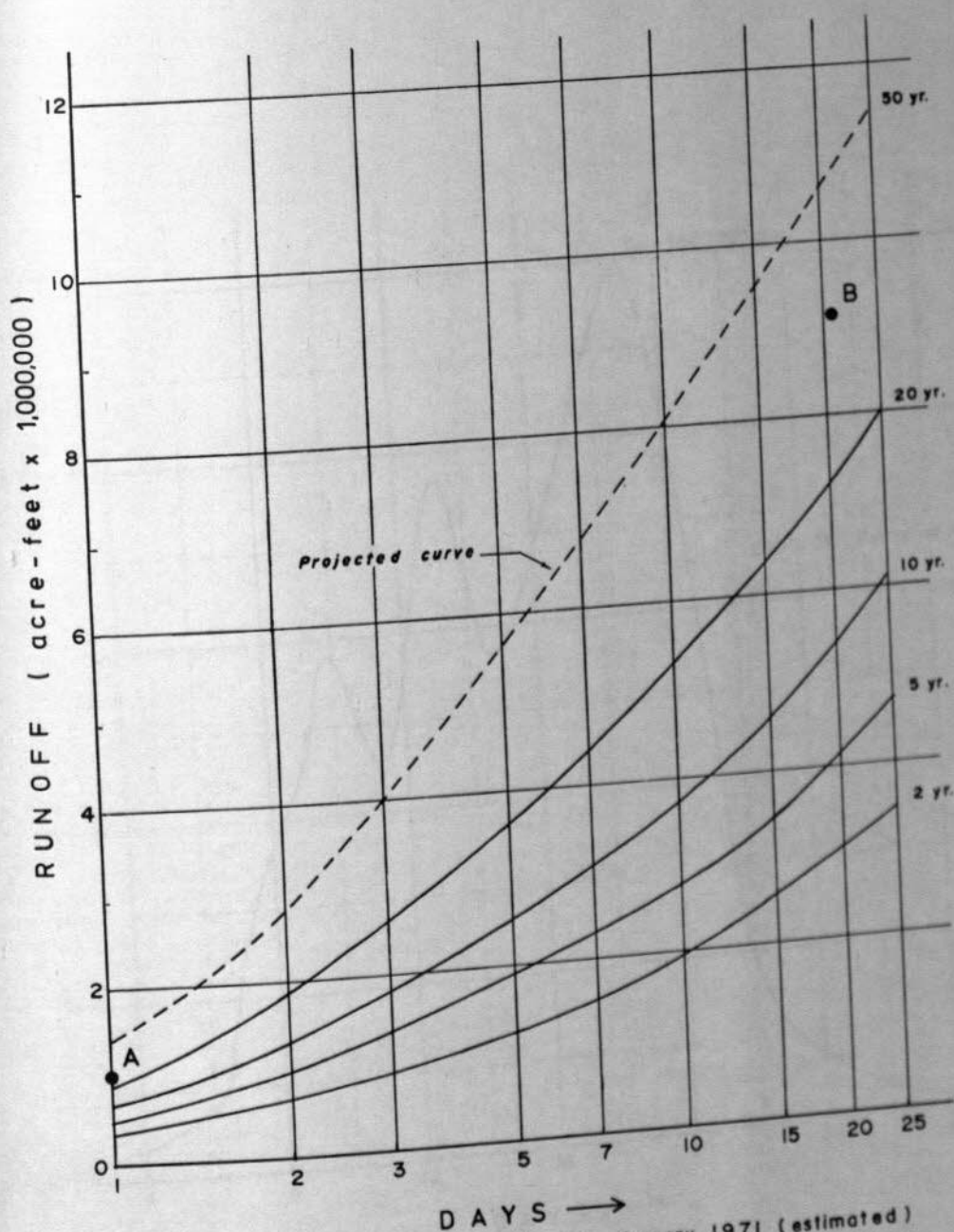


80 % confidence limit indicates 5 yr. low
95 % confidence limit indicates 20 yr. low

Fig. 13

RUNOFF FREQUENCY-DURATION CURVES of DISCHARGES in SG. PAHANG at TEMERLOH (Catchment area 7,690 sq. miles)

BASED ON RAINFALL RECORDS IN THE CATCHMENT



Point A = peak discharge at Temerloh, January 1971 (estimated)
Point B = volume of 1970-71 flood at Temerloh (estimated)

Fig. 14

MAXIMUM PROBABLE FLOOD
SG. PAHANG at LUBOK PAKU
(Catchment area 9,850 sq. miles)

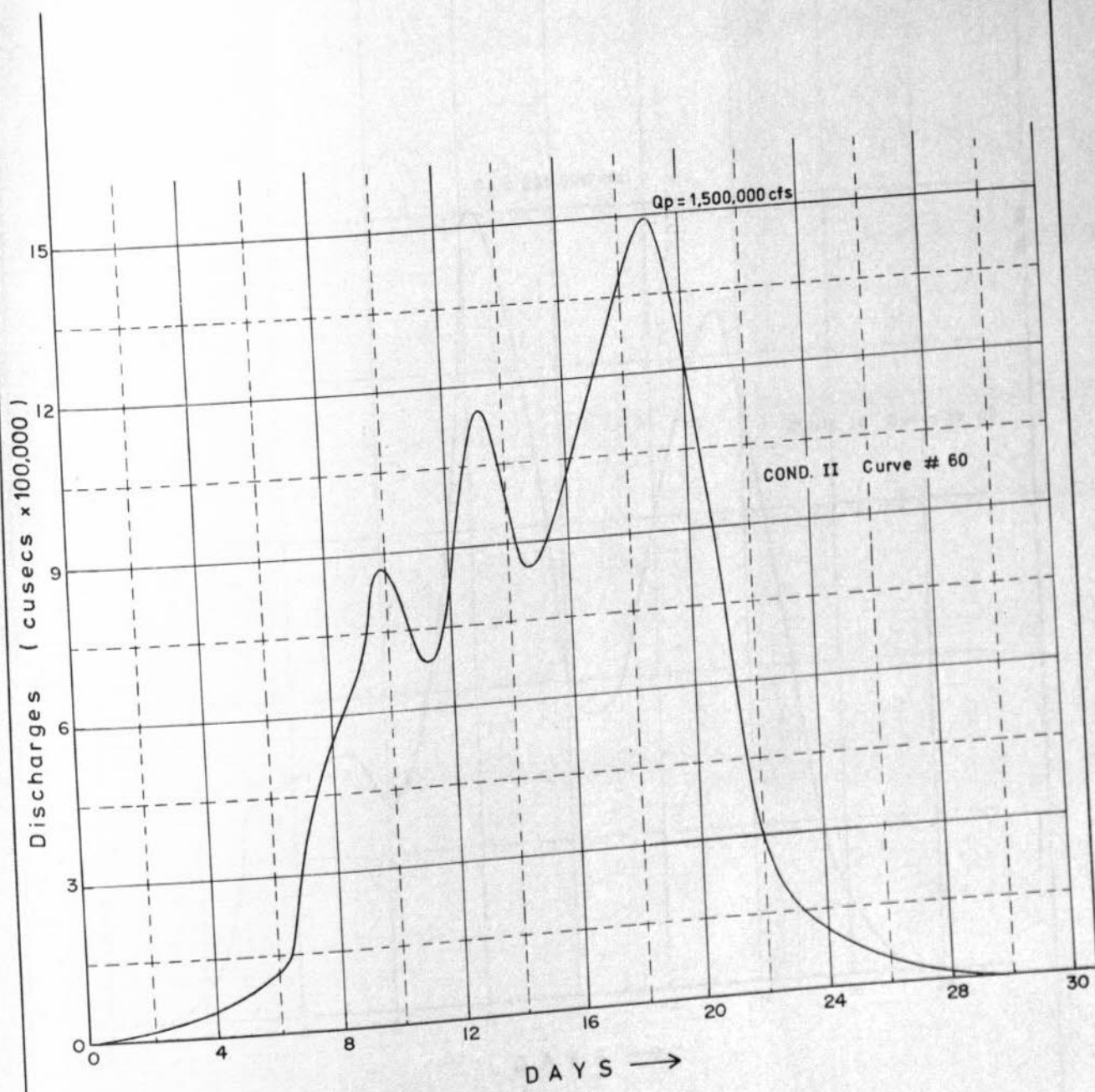


Fig. 15

MAXIMUM PROBABLE FLOOD

SG. ROMPIN at KG. SAWAK

(Catchment area 1,240 sq. miles)

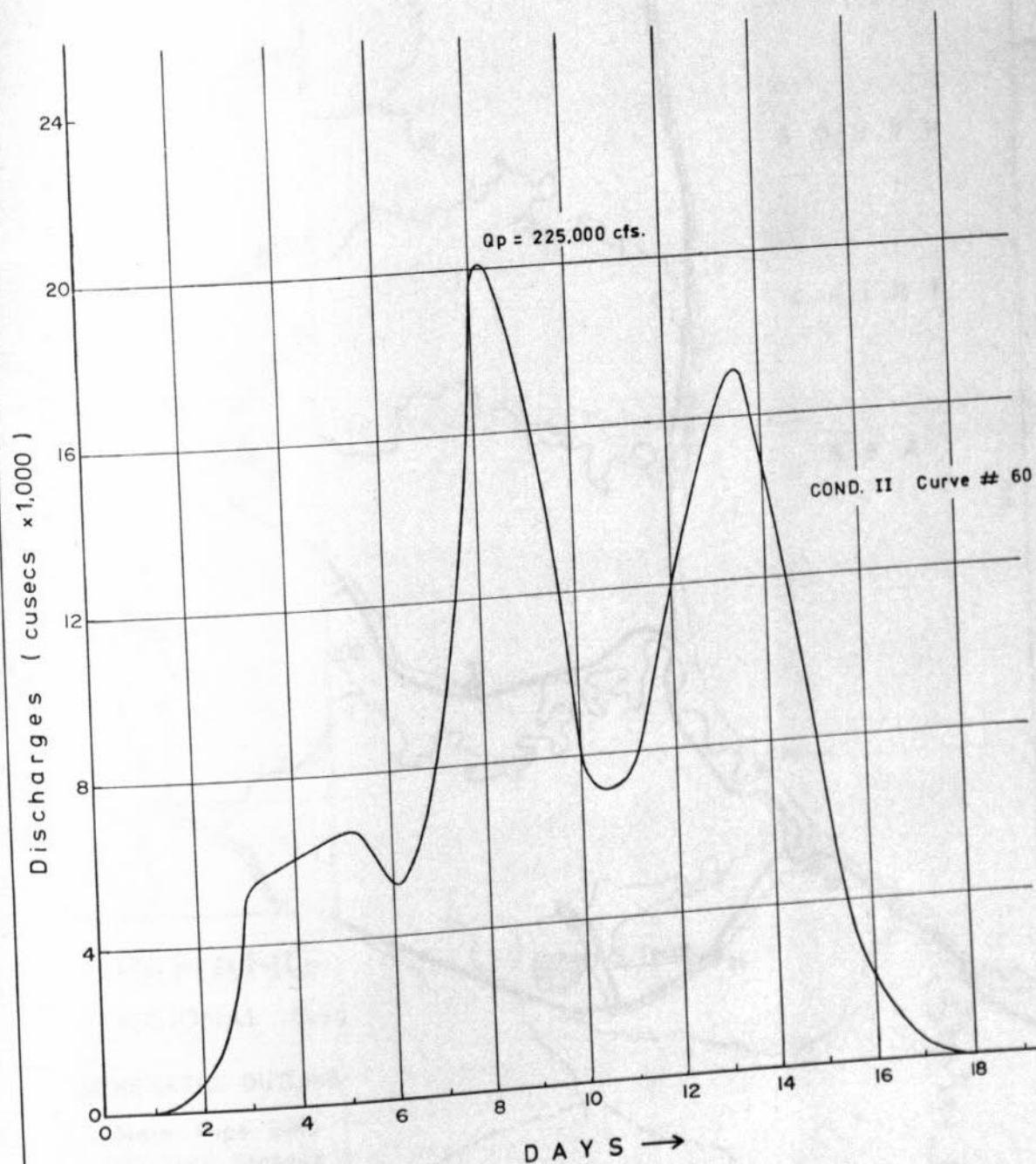


Fig. 16

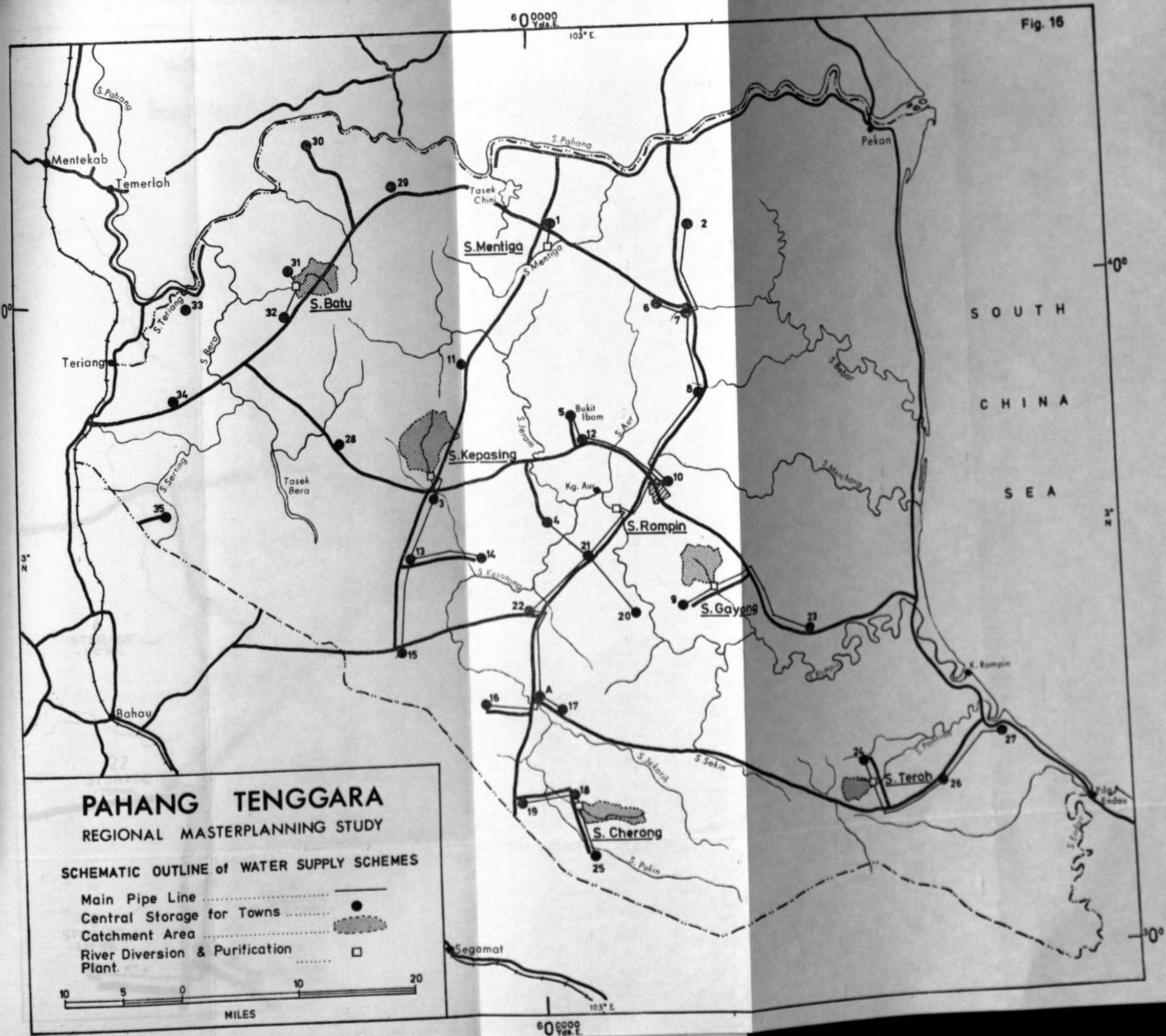


Fig. 16a

WATER SUPPLY SCHEME

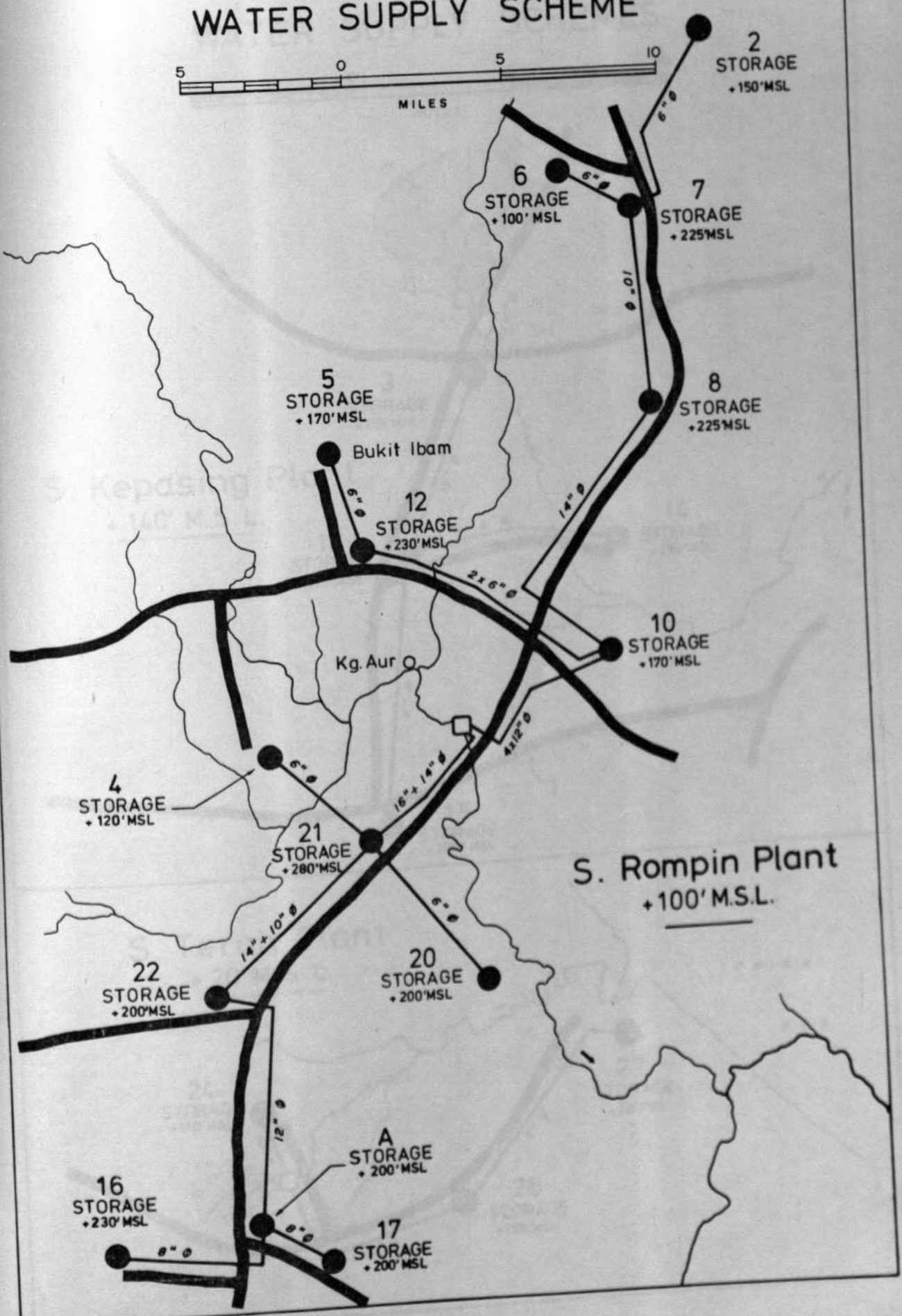


Fig. 16b

WATER SUPPLY SCHEMES

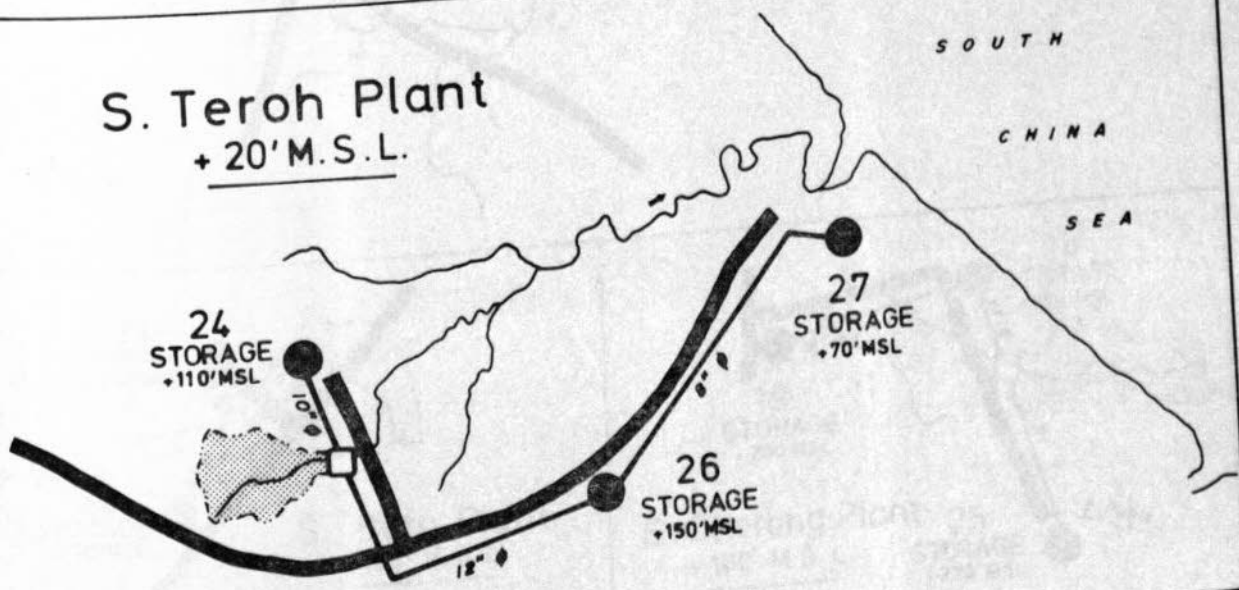
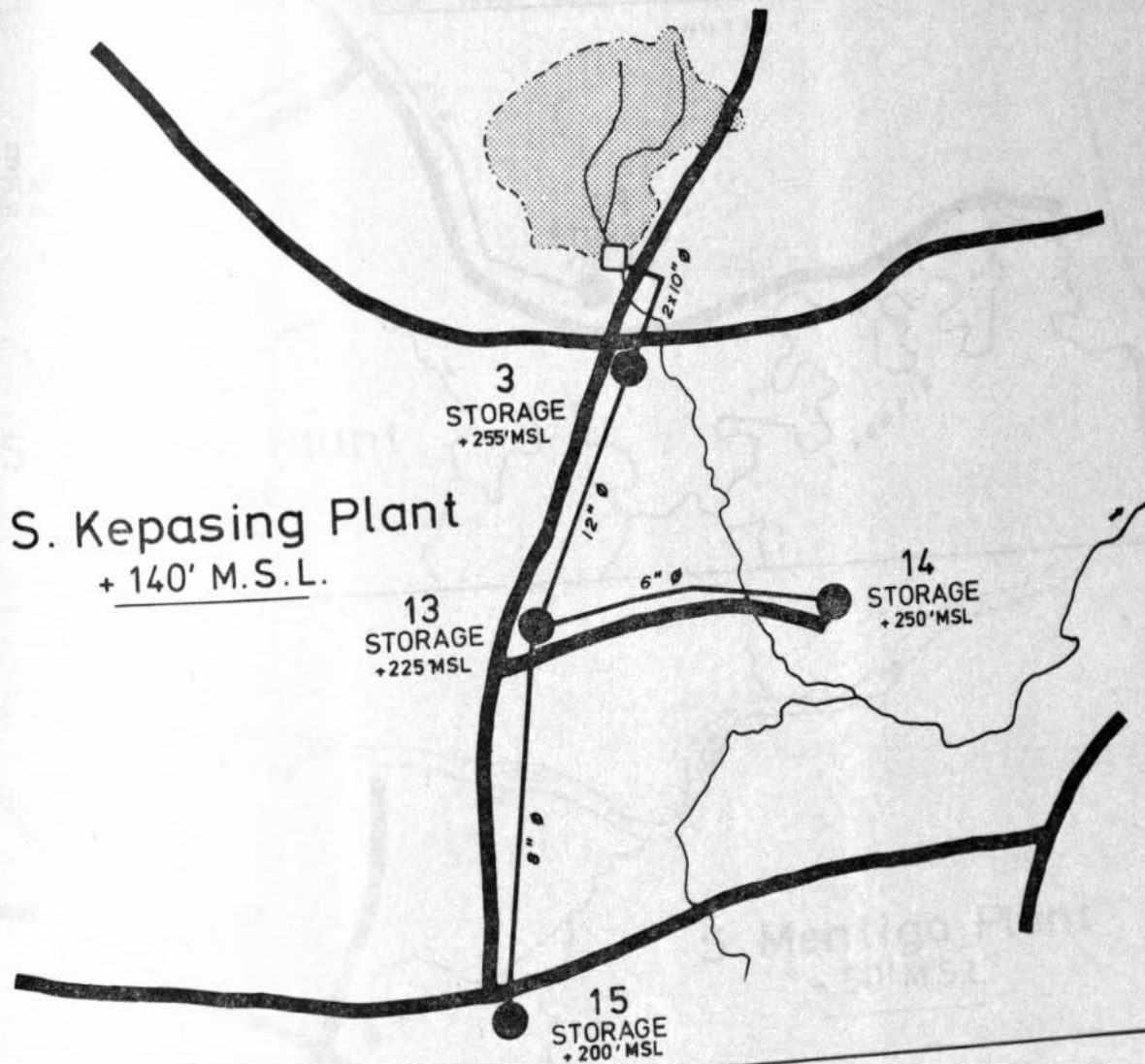


Fig. 16c

WATER SUPPLY SCHEMES

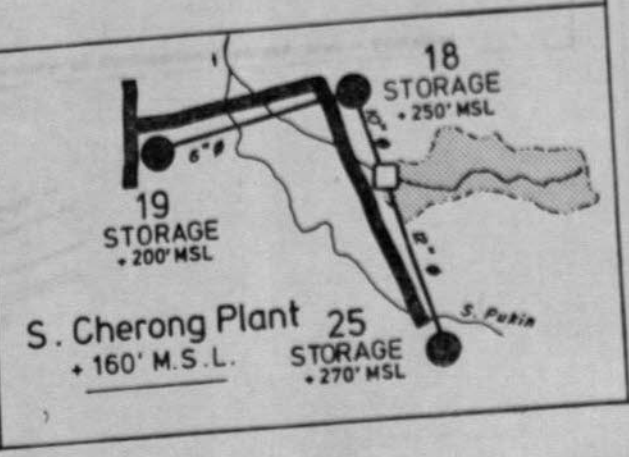
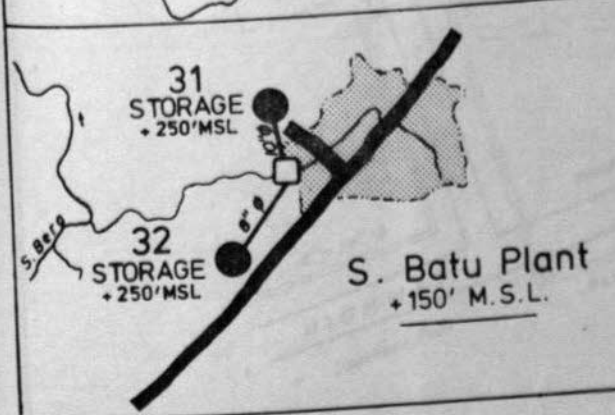
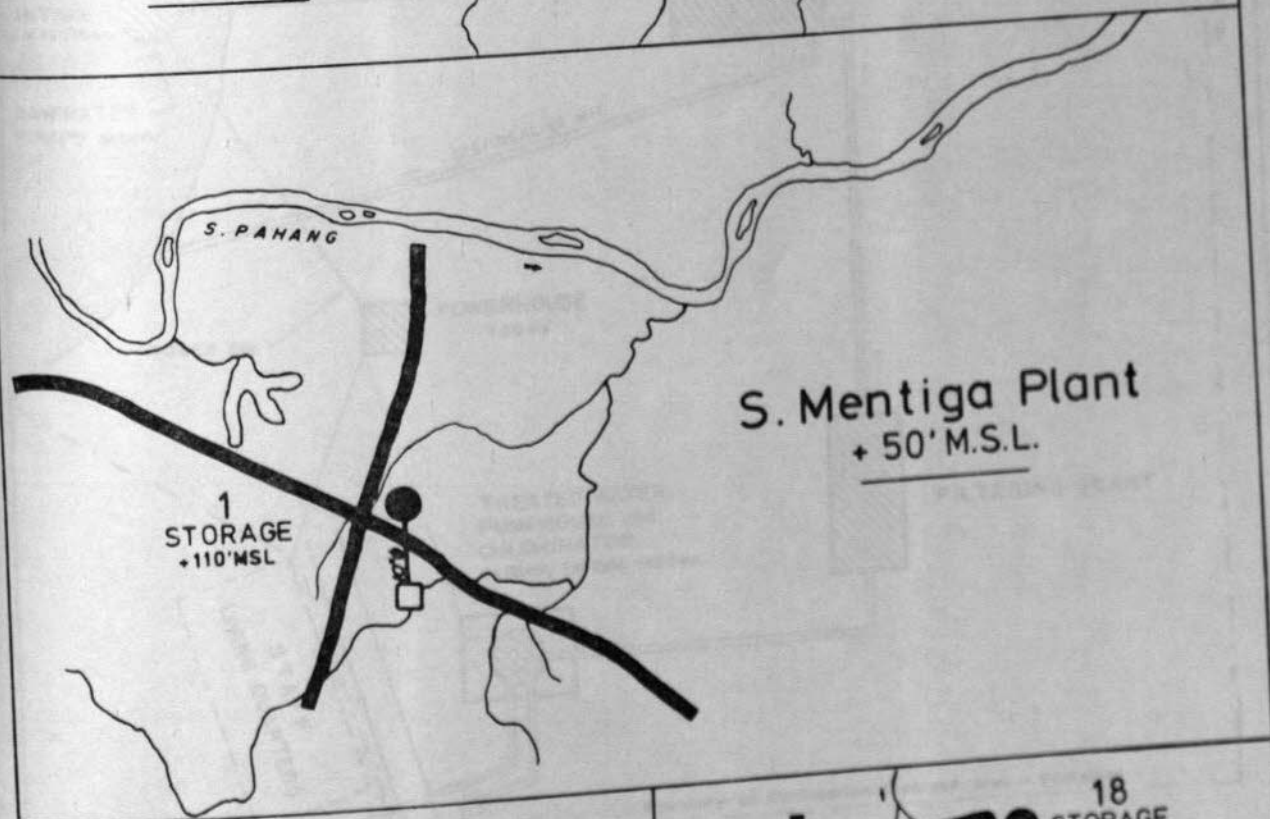
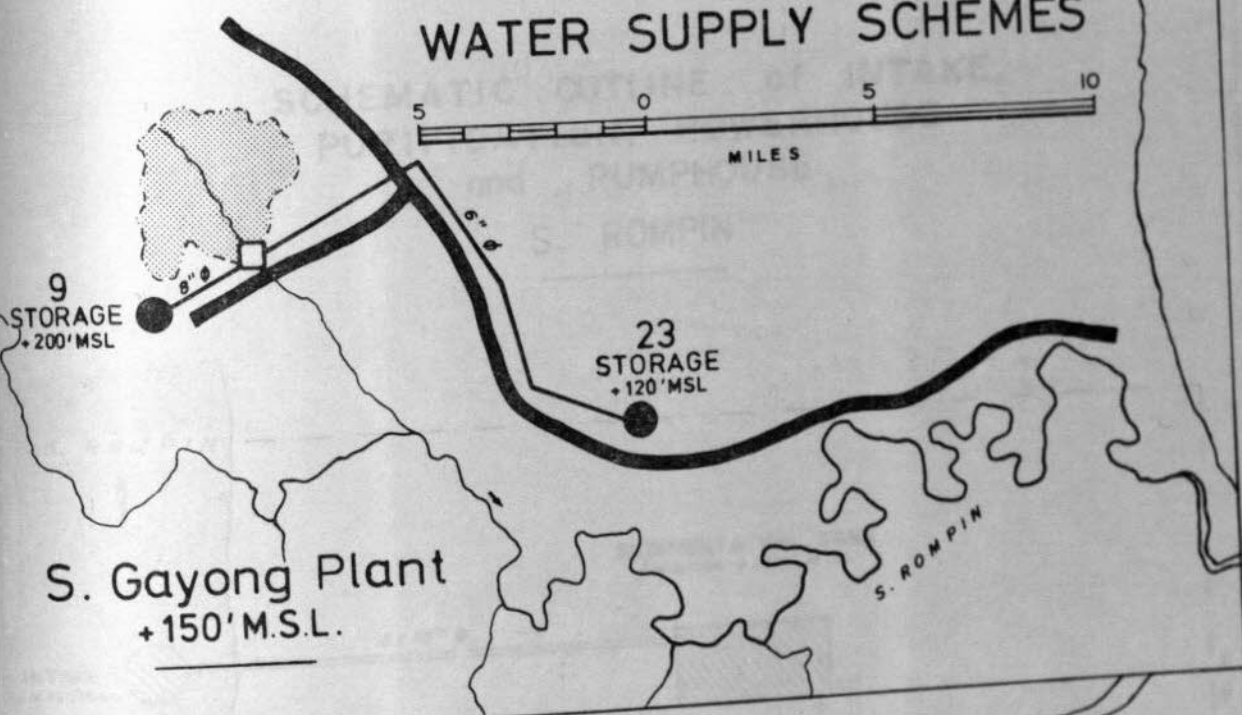


Fig. 17

SCHEMATIC OUTLINE of INTAKE, PURIFICATION, POWERHOUSE and PUMPHOUSE S. ROMPIN

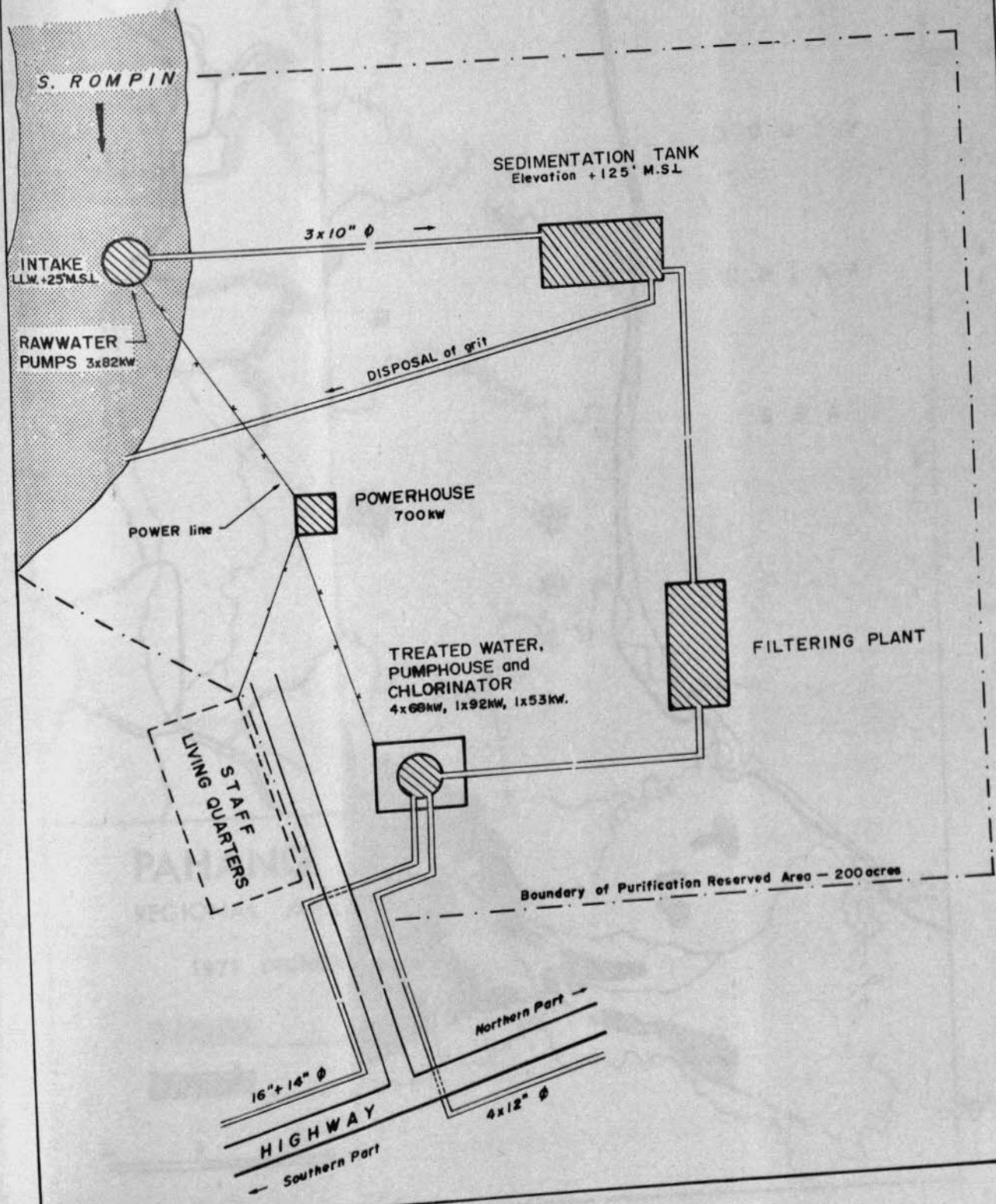
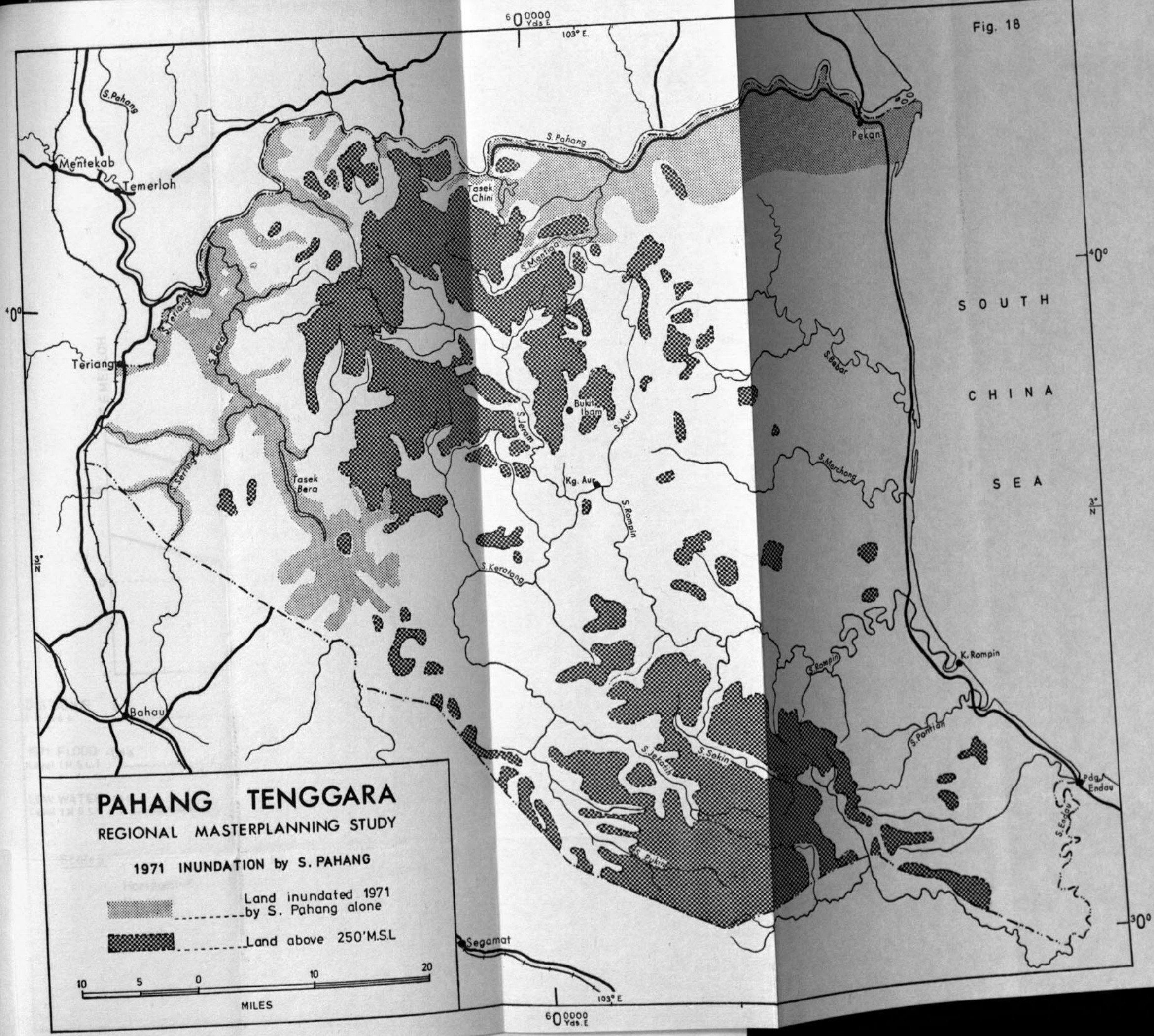
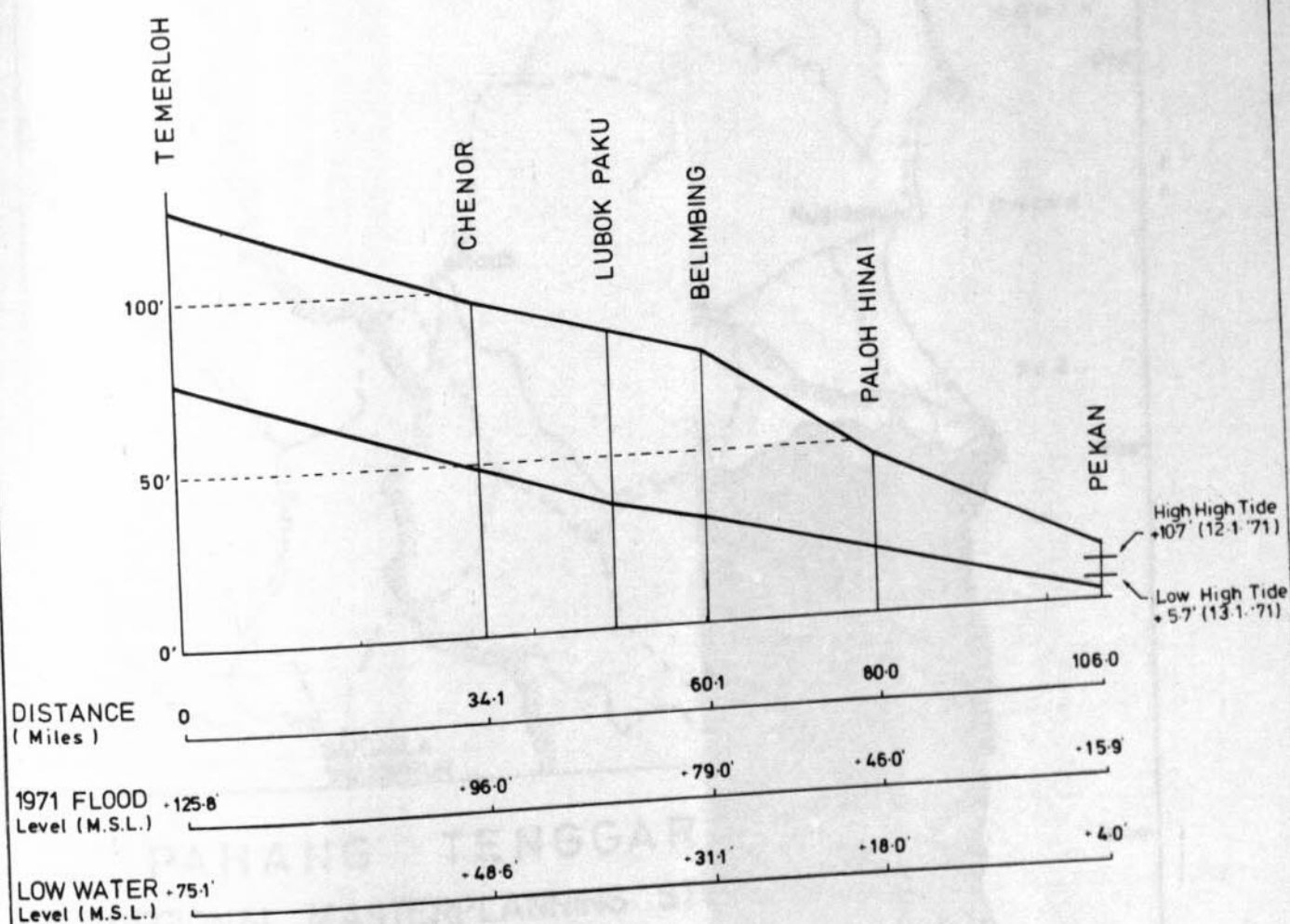


Fig. 18



LONGITUDINAL SECTION of S. PAHANG (FLOOD 1971)



Scales:

Horizontal: 1 inch to 20 miles
Vertical : 1 inch to 50 feet

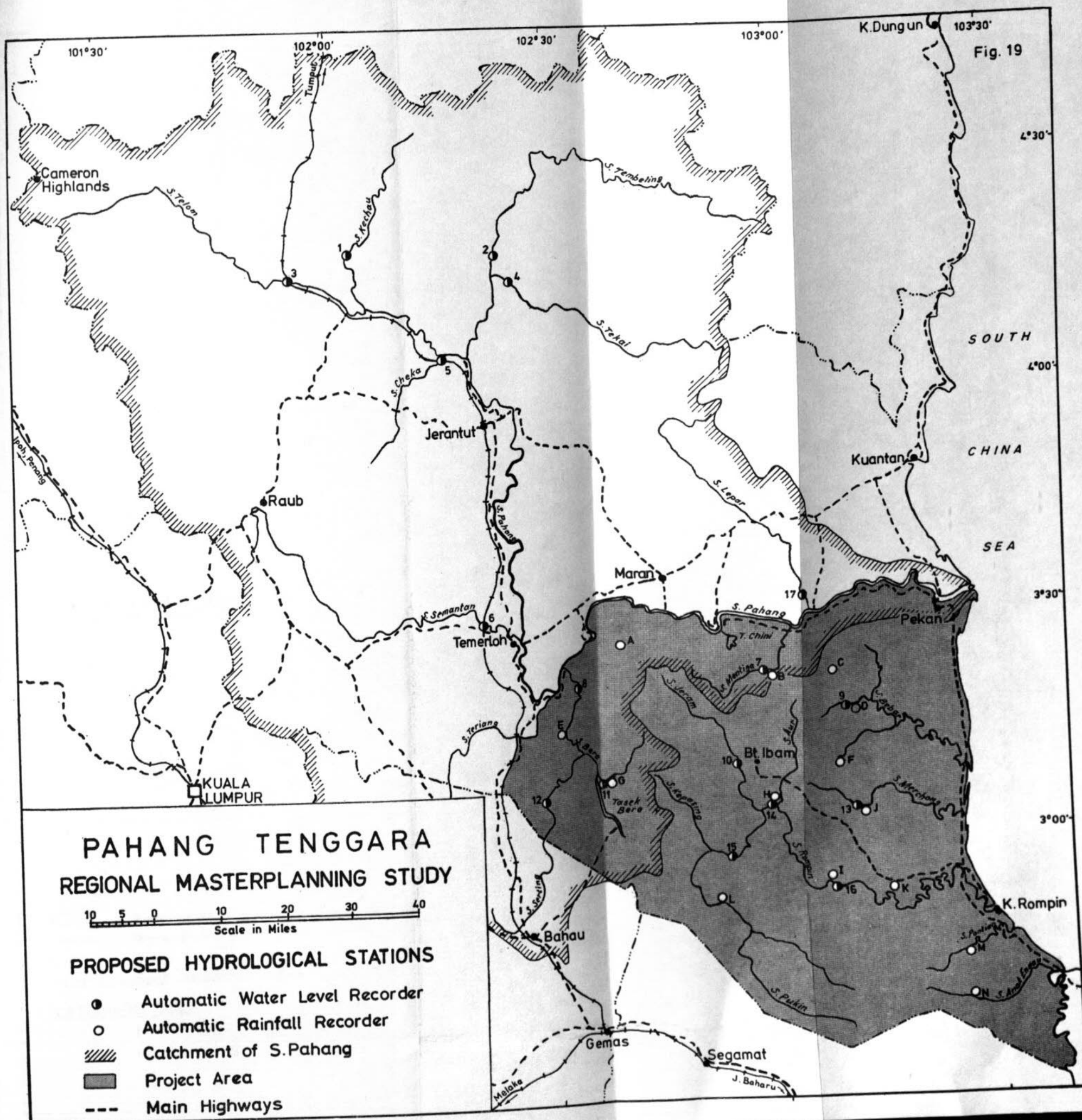


Fig. 20

LOCATION of RESERVOIRS, S. JERAM and S. MENTIGA

1 0 1 2 3 4 5 6
MILES

SURFACE AREA at +130' MSL = 6,900 ac.
CAPACITY = 200,000 acre feet

SURFACE AREA at +130' MSL = 20,200 ac.
CAPACITY = 431,350 acre feet

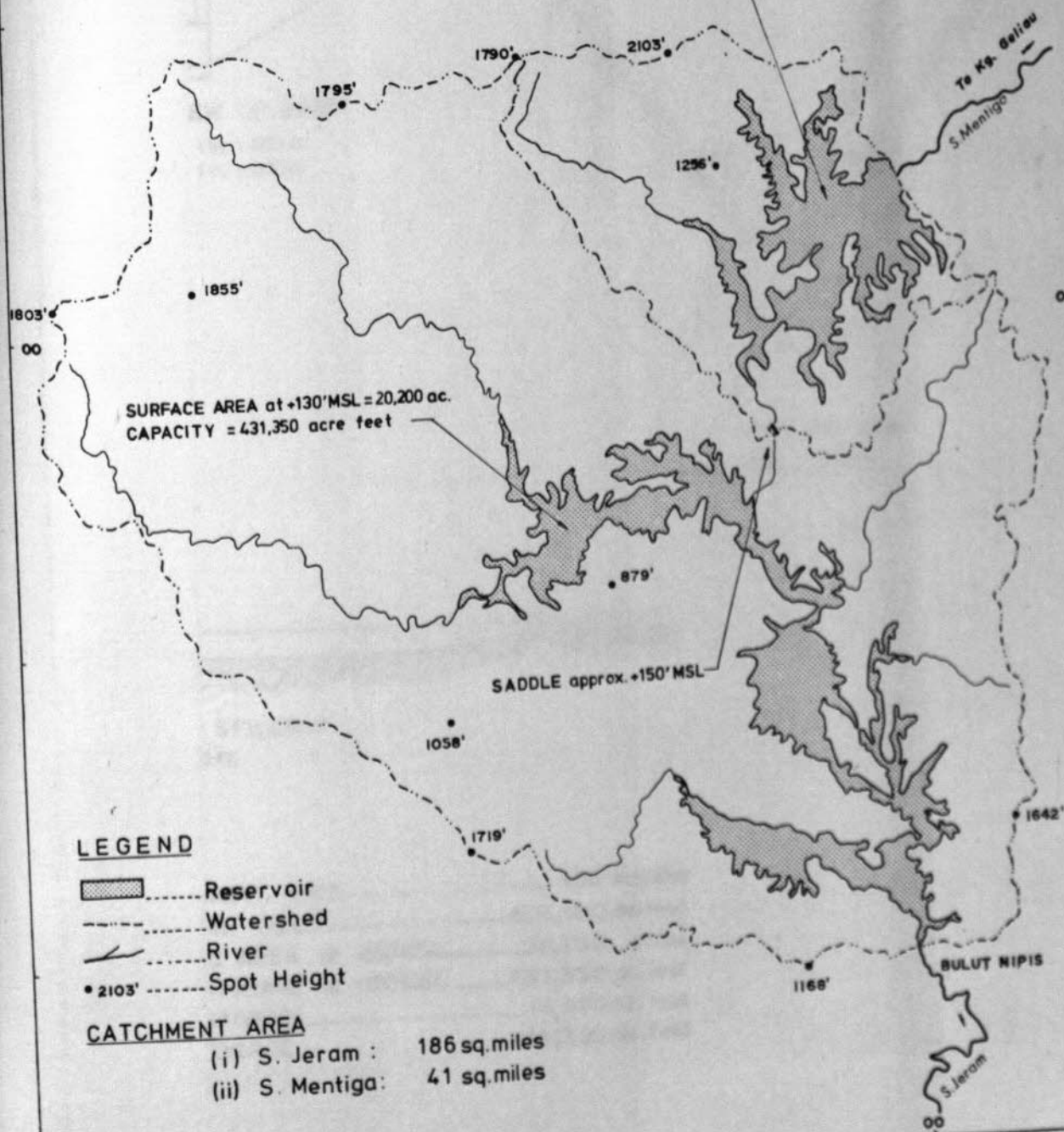
SADDLE approx. +150' MSL

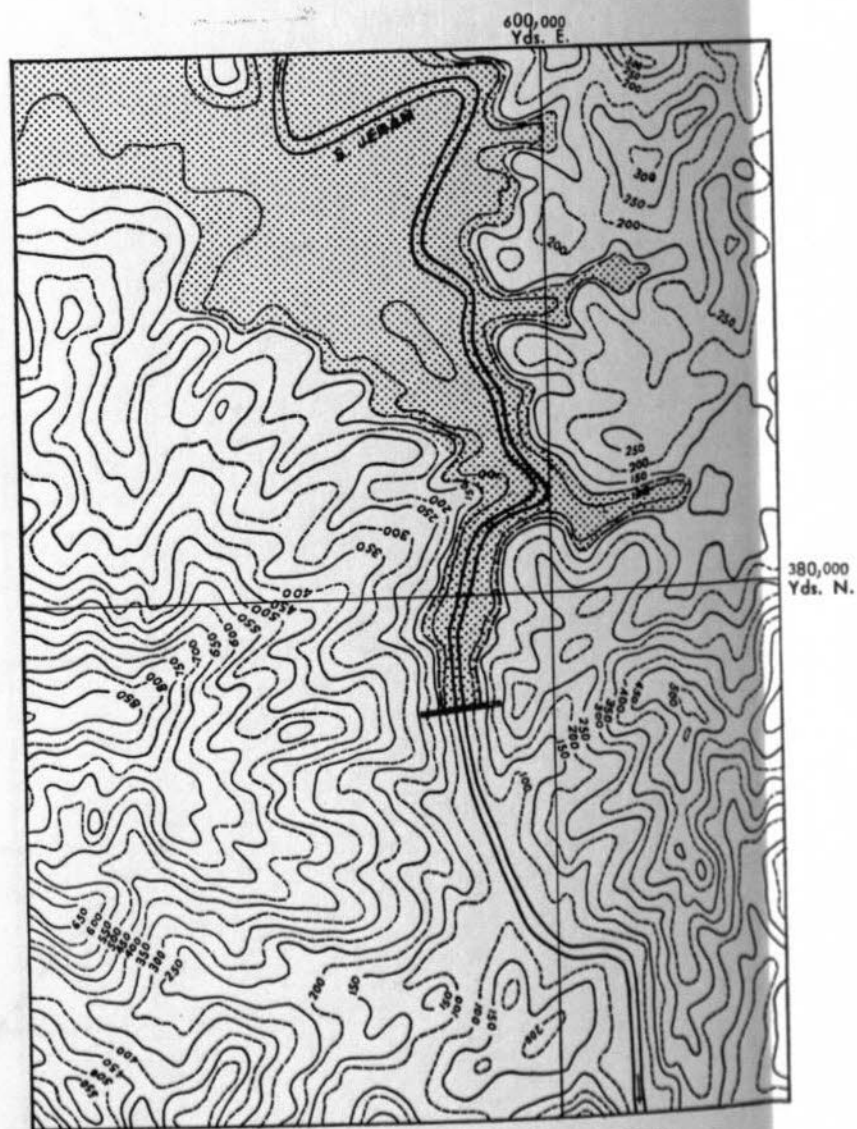
LEGEND

-  Reservoir
-  Watershed
-  River
-  Spot Height

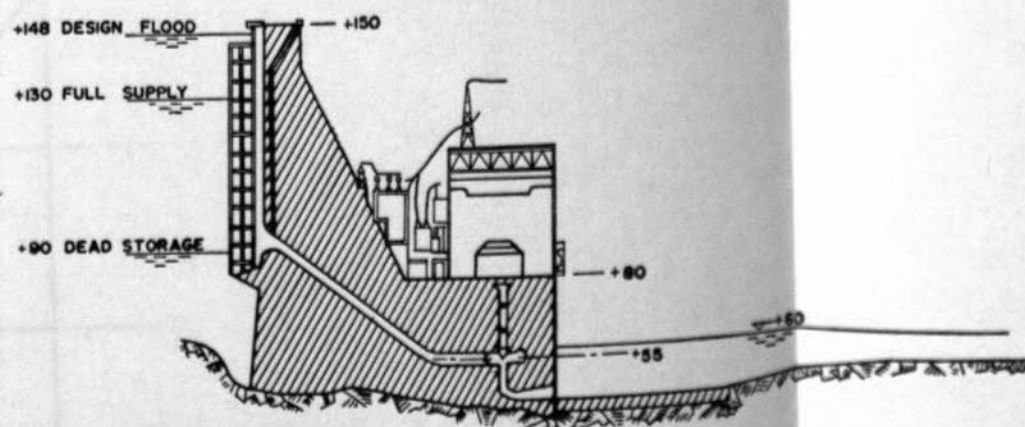
CATCHMENT AREA

- (i) S. Jeram : 186 sq.miles
- (ii) S. Mentiga : 41 sq.miles

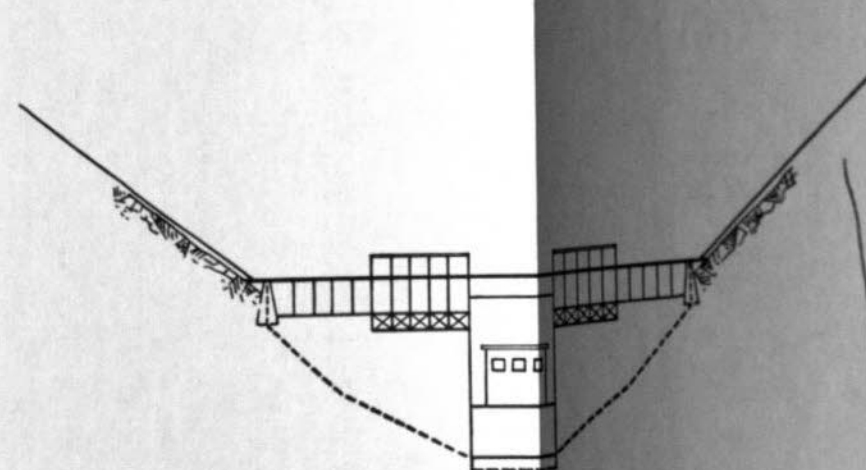




LOCATION SG. JERAM AT BULUT NIPIS
Scale: 1:25,000

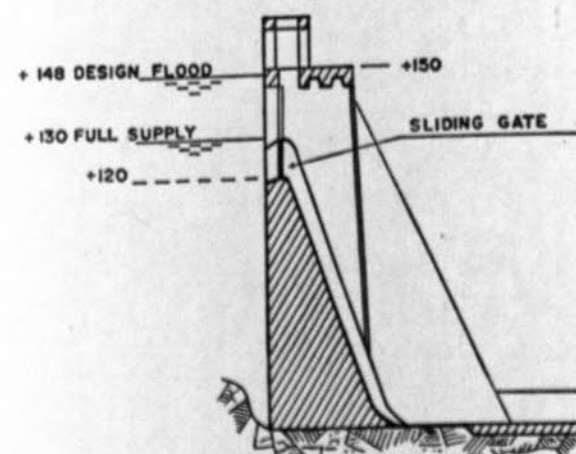


CROSS SECTION OF DAM AND POWER HOUSE
Scale: 1 in. : 50 ft.



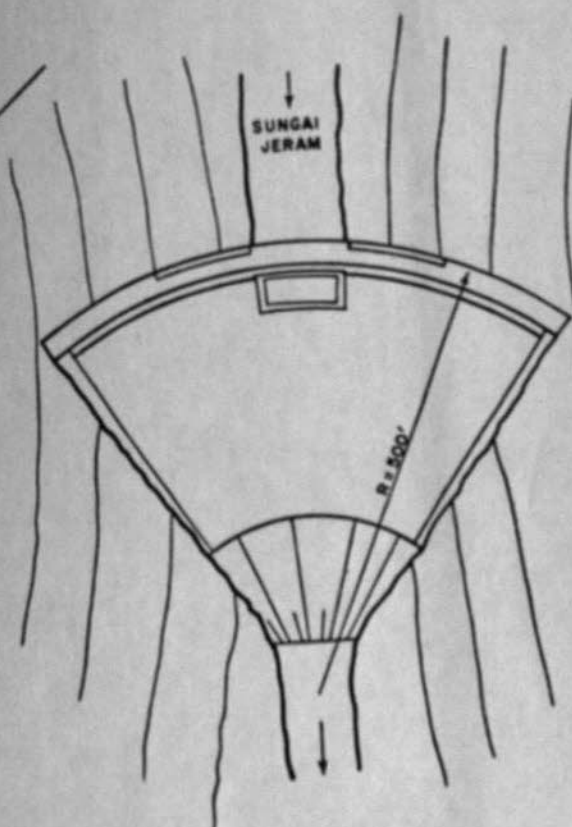
DOWNSTREAM VIEW OF DAM

Scale: Vertical 1 in. : 100 ft.
Horizontal 1 in. : 200 ft.



CROSS SECTION OF SPILLWAY

Scale: 1 in. : 50 ft.



PLAN VIEW OF DAM

Scale: 1 in. : 200 ft.

CATCHMENT AREA	186 sq. miles
AVERAGE YIELD	452,400 ac. feet
SURFACE AREA at +130MSL	20,200 acres
FULL STORAGE at +130MSL	431,350 ac. feet
DEAD STORAGE	15,970 ac. feet
NET STORAGE	415,380 ac. feet

Fig. 22

