BASIC DESIGN STUDY FOR NATIONAL PRAWN FRY PRODUCTION AND RESEARCH CENTRE PROJECT IN MALAYSIA

March 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

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Preface

In response to the request of the Government of Malaysia, the Government of Japan decided to conduct Basic Design Study on the National Prawn Fry Production and Research Centre Project and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA sent to Malaysia a study team headed by Dr. Akihiko Shirota, Chief, Coastal Fisheries Development Division, Japan Sea Regional Fisheries Research Laboratory, Fisheries Agency, from October 24th to November 13th 1984.

The team had discussions with the officials concerned of the Government of Malaysia and conducted field survey in Pulau Sayak area, Malaysia. After the team returned to Japan, further studies were made and the present report has been prepared.

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

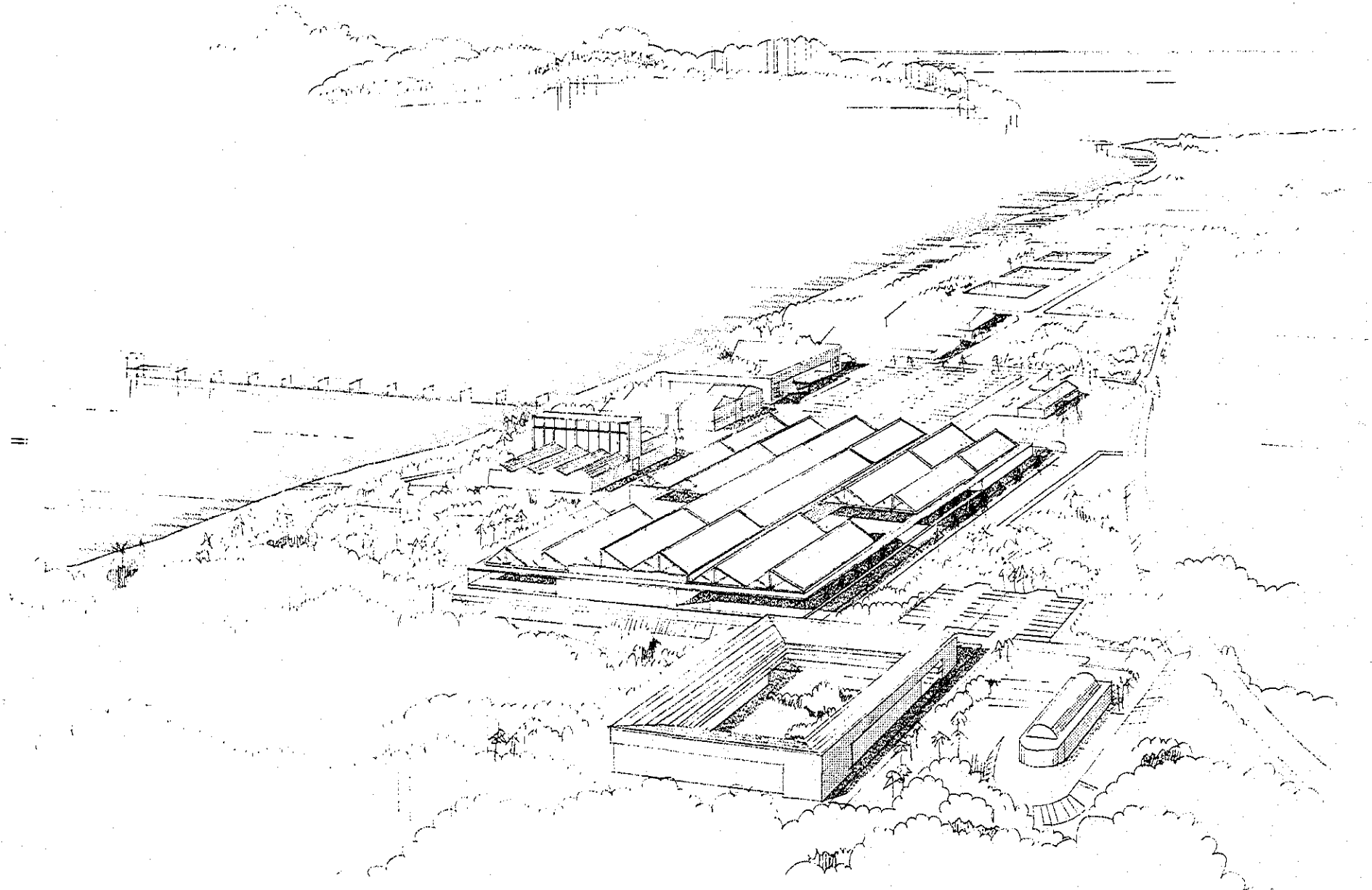
I wish to express my deep appreciation to the officials concerned of the Government of Malaysia for their close cooperation extended to the team.

March 1985

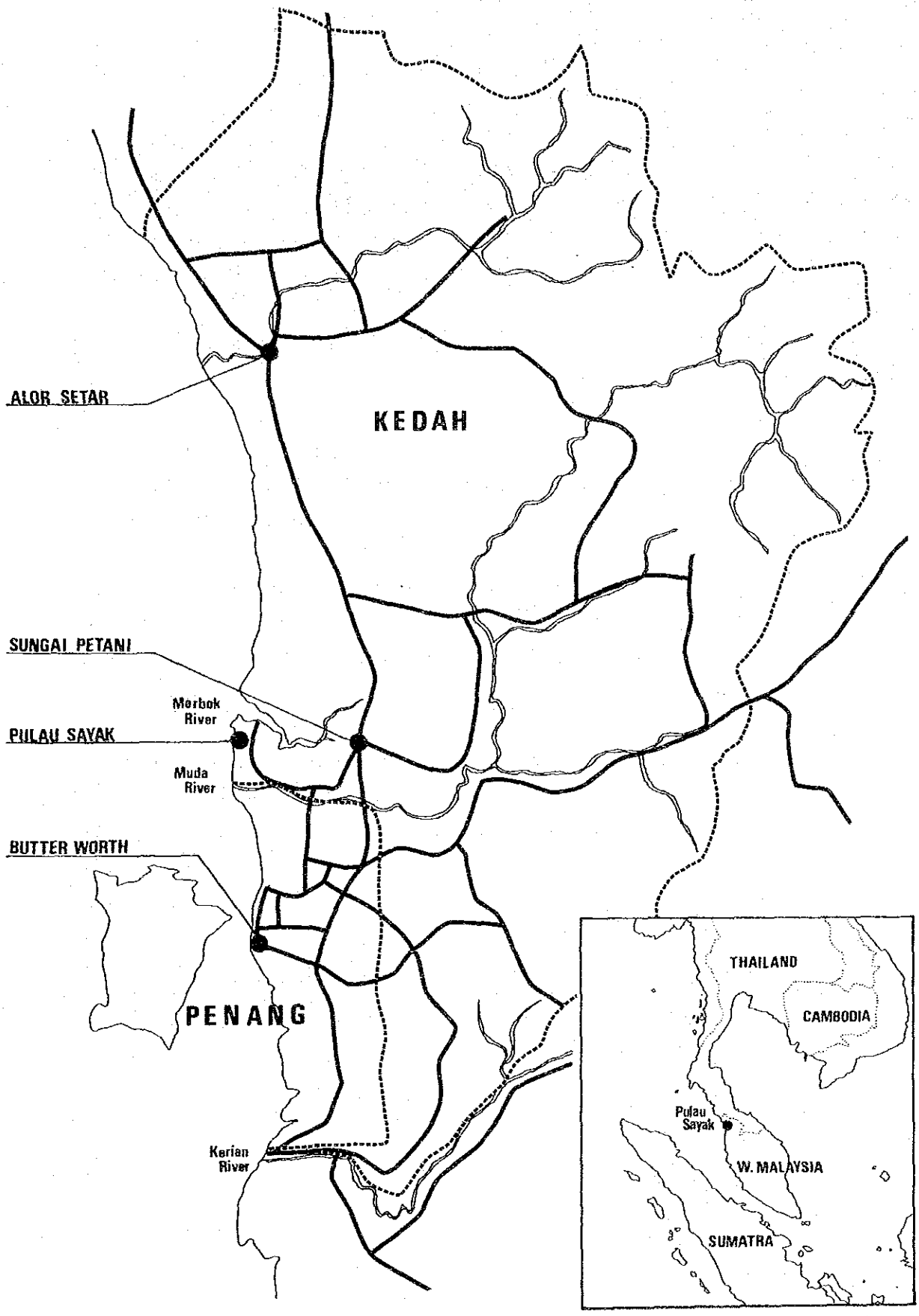
Keisuke Arita

President

Japan International Cooperation Agency



National Prawn Fry Production and Research Centre



Location of the Site

Abbreviations

1MP : First Malaysia Plan (1966-1970)
2MP : Second Malaysia Plan (1971-1975)
3MP : Third Malaysia Plan (1976-1980)
4MP : Fourth Malaysia Plan (1981-1985)
5MP : Fifth Malaysia Plan (1986-1990)

(Alphabetical order)

DOF : Department of Fisheries
EPU : Economic Planning Unit
FRI : Fisheries Research Institute in Penang
GDP : Gross Domestic Product
GRP : Gross Regional Product
JICA: Japan International Cooperation Agency
JKR : Department of Works and Utilities (Jabatan Kerja Raya)
JPT : Drainage and Irrigation Department (Jabatan Parit dan Taliayer)
JT : Department of Telecommunication (Jabatan Telecom)
LKIM: Fisheries Development Authority of Malaysia (Lembaga Kemajuaan Ikan Malaysia)
LLN : National Electric Authority (Lembaga Letrik Negara)
MOA : Ministry of Agriculture
NAP : National Agriculture Policy
NEP : New Economic Policy
NPFPRC: National Prawn Fry Production and Research Centre
RC : Reinforced concrete

SUMMARY

Summary

Malaysia is in the final year of the Fourth Malaysia Plan (4MP) (1981-1985). The annual growth rate target of 7.6 % in the Plan was revised downward because the worldwide recession from 1979 to 1982 greatly affected the Malaysian economy.

In the Mid-Term Review of 4MP, the development policy of agriculture was revised as the National Agriculture Policy (NAP) which was formulated in January, 1984. According to NAP, the current agriculture policies which have been commodity oriented and independent of one another should be modified to solve conflicts and competition for the requisite resources of land and labour with the roles of each crop. The new policy advocates long-term and integrated development of agriculture to eradicate poverty among small-scale and unorganized farmers and fishermen.

The fishery sector is an increasingly important part of Malaysia. The fish consumption has proportionately increased with the rise in the standard of living and the economic development. Since 1975 the fish import has exceeded its export. About 90,000 fishermen are engaged in fishing of which half of them are categorised in the poverty rank. The coastal fisheries have been overexploited and the development of aquaculture is low. The government has emphasized the development of aquaculture, in particular, the prawn culture with the objectives to divert gradually small-scale fishermen to fish farmers, improve their socioeconomic conditions by increasing their income, and generate foreign exchange earnings through export. The government has proposed this project to help resolve these constraints and the project includes a development of 21,000 ha for the tiger prawn and 3,000 ha for the giant prawn by the year 2000 for Peninsular Malaysia.

Fisheries in Malaysia is divided into two fields under the Ministry of Agriculture (MOA). One is the Fisheries Development Authority of Malaysia (Lembaga Kemajuaan Ikan Malaysia: LKIM) which controls organizations of fishermen and associations of fishing business and produces fisheries product by project base, and the other is the Department of Fisheries (DOF) which formulates fisheries policies, provides infrastructural arrangement, conducts research work, technical training, statistics, etc. The DOF shall be the executing body of the above devlopment plan.

The DOF has been conducting research works on technology of prawn hatching and rearing, and currently it is operating six small-scale hatcheries for the giant prawn and distributes fry to small-scale fish farmers. In case of the tiger prawn, the DOF has already established the hatching technology at high stocking density at its research level. Hence, the DOF has the responsibility to spearhead the production and promote prawn culture development as enunciated in NAP.

According to the preliminary study on this project which was carried out by Japan International Cooperation Agency (JICA) in July, 1984, it was understood that the establishment of National Prawn Fry Production Centre (NPFPRC) would provide facilities for fry production, research works and technical training that would play a very important role for DOF to implement the prawn culture development. The rationale for NPFPRC is to encourage prawn production by small-scale fish farmers and the private sectors which would generate cash incomes and also increase the foreign exchange earnings of the country. Under these circumstances, JICA dispatched the Basic Design Study Team in October 1984 to clarify the significance and justification of the Grant Aid by the Japanese Government.

The study team examined the contents of proposed prawn fry production, relevant research works and technical training. The proposed site belongs to Kuala Muda District, in Kedah state, and is located along the shore near Pulau Sayak which is connected with asphalted state road of 17 km distance to the trunk road between Alor Setar, state capital, and Butterworth, Penang State. The site does not have any problems for the construction from viewpoints of infrastructural aspects such as accessibility, electricity, water supply, telephone, drainage, etc. On the other hand, the bottom of the sea facing to the proposed site is shallow and silty to 3-5 km from the shore, with the water depth ranging 1.4-3.3 m at spring tide. The salinity of sea water becomes low after heavy rain due to the the influence of the discharged water from the Merbok river located near the site. However, it was found that the rainfall more than 10 mm per day will not occur for more than three days continuously according to meteorological data. Consequently, it was judged that the sea water near the shore can be used for fry production by providing a sea water

storage with the capacity of 3-4 times of the daily water consumption of NPFPRC.

The annual fry production target by NPFPRC was set at 55 million of the tiger prawn and 5 million of the giant prawn at the year 2000. The prawn fry produced will be distributed without charge once as an initial input to small-scale farmers. Necessary facilities are shown in the following table.

Facilities	Outline of specification
1. Sea water intake	Pumps and pipes, RC jetty and RC water reservoir
2. Water supply	Pumps and pipes, RC sedimentation tanks, RC filtering tanks, RC filtered water tanks, RC dechlorination tanks and RC elevated tanks
3. Fry production building	RC one story building and hatchery
4. Research/Administration building	RC 2 story building: 1,520 m^2 Outdoor experimental pond (soil bottom with RC wall): 50 m^2 x 4
5. Training and accommodation building	RC 2 story building: 2,646 m^2
6. Drainage	Drainage for rainwater Drainage for culture water Septic tank for sewage Storage tank for chemical waste
7. Aeration	Air blowers, pipes and belongings
8. Machinery building	160 m^2

Facilities	Outline of specification
9. Equipments	Physical and chemical equipments, transportation vehicles, glass and plastic equipment, water tanks, machines and equipment for aeration, feed preparation and cleaning

Malaysian portion is estimated at M$ 1,623,237 of the total project cost. The construction period is required to be about 13 months. The work schedule should take into consideration the meteorological condition of the proposed site.

The basic design of NPFPRC is formulated taking into consideration not to apply too much sophisticated technology for the operation of fry production. The water tanks are arranged in five production units in order to carry out an effective operation.

The total annual operation cost including depreciation cost is estimated at M$ 2,235,205 (M$ 1,274,621 without depreciation cost), and the price of one fry at this operational cost would be M$ 0.037 at full-scale production. This price is much cheaper than the current wholesale price of prawn fry (M$ 0.05 per fry produced by private hatcheries). The operation of NPFPRC is not viable financially because the prawn fry produced by NPFPRC will be distributed free of charge to small-scale fish farmers as mentioned earlier. However, considerable profit can be expected from the operation of prawn rearing through the supply of fry from NPFPRC. It is obvious that NPFPRC will contribute an important role in the aquaculture development in Malaysia.

Consequently, it can be justified that the present Grant Aid of the Japanese Government should be proceeded for the implementation of NPFPRC. It is recommended that DOF requests the technical cooperation of aquaculture experts from developed countries on aquaculture to establish a rational operation system of NPFPRC, even though DOF has already established the hatching technology of prawn fry at research and/or small-scale production level.

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1. INTRODUCTION

1. Introduction

Fish is the main source of animal protein in Malaysia. Fish production of coastal fisheries has fulfilled the fish demand. The fish consumption has increased in proportion with the rise in the standard of living and the economic development, whilst the fish production increased only a little. Since 1975, the fish import exceeded the fish export. The reasons for the decrease in fish production are attributed to (1) overexploitation of fish resources of the coastal area, mainly by trawl fisheries, and (2) less development of aquaculture.

About 90,000 fishermen are engaged in the coastal fisheries and about half of the fishermen are categorized as poor due to low productivity. The employment rearrangement for the low-income fishermen is one of the national plans of the government. Aquaculture is considered to be one of the highest potential working fields for them. The government has been developing freshwater and marine aquaculture through the Third Malaysia Plan (1976-1980) and the Fourth Malaysia Plan (1981-1985). Progresses have been made in the seed production and rearing techniques of freshwater giant prawn (Macrobrachium rosenbergii) and some fishes in freshwater environment, and cockle (Anadara granosa), mussel (Perna (=Mytilus) viridis), oyster (Ostrea folium), tiger prawn (Penaeus monodon), white shrimp (Penaeus merguensis), sea bass (Lates calcarifer), groupers (Epinephelus spp.) in marine environment. Aquaculture production was about 10% of the total fish production. However, the cockle occupied about 90% of the aquaculture production, and the price is about one third of the average fish price. The government has included the development of aquaculture, specially prawn culture, in its long-term plan of the National Agriculture Policy (NAP) in 1984. Prawns are expensive and attractive to fishermen. The most important point for prawn culture is the stable supply of prawn fry. Fry production techniques of the freshwater giant prawn and the tiger prawn have already been developed at laboratory scale. The Malaysian government is considering as a next step to develop mass production technique of prawn fry and its extension through training programme. The Government has proposed the establishment of a National Prawn Fry Production and Research Centre (NPFPRC). The Japanese Government has

been requested to provide aid in financing. Following receipt of the request, the Japanese Government appointed the Japan International Cooperation Agency (JICA) to pursue the request. A preliminary survey team was dispatched to discuss this proposal and to conduct the site survey. Based on the preliminary survey report, when JICA has arranged to dispatch a basic design survey team to establish NPFPRC in the site of the Fisheries Research Institute in Penang, the Malaysian Government has made another request to shift the construction site from Penang to Pulau Sayak in the Kedah State in September 1984. The Japanese Government accepted the request and received information on the new site. After confirming that there were no more changes except the site shift in the minutes by the preliminary survey team, JICA dispatched a basic design survey team from 24 October to 13 November 1984.

The purpose of this study is (1) to clarify the reason of the site shift from Penang to Pulau Sayak, (2) to discuss the NPFPRC role, function and general layout with government officials concerned, mainly staff of Department of Fisheries, (4) to make a site survey, (4) to collect documents necessary for the cost estimation of its basic design, and (5) to examine the appropriateness of the project as the Japan's Grant Aid.

This report is an analysis of the results of the survey. Investigation of appropriateness and an evaluation of the project are also done, with the most suitable proposal for the basic design. The list of request items by the Malaysian Government both at the preliminary survey and the basic design survey is shown in Table 1.1. The minutes of discussion, members of the team, related parties of Malaysia, are shown in Annex.

2. BACKGROUND OF THE PROJECT

2. Background of the project

2.1 Location, area, population of Malaysia

Malaysia is situated at 0°54'N-7°28'N, 99°44'E-119°30'E, and it consists of West Malaysia (southern half of the Malaya Peninsula) and East Malaysia (northwestern part of the Borneo Island). The West Malaysia (Peninsular Malaysia with 11 states) is connected to the Asian continent in the north at the border of Thailand, and the East Malaysia (Sarawak and Sabah) faces the Philippines across the Sulu Sea. The proposed site is located in the State of Kedah which is situated in the northern part of the Peninsular Malaysia, and faces the Straits of Malacca.

The total area of Malaysia is 330,000 km^2 (Peninsular Malaysia: 132,000 km^2, Sabah:74,000 km^2, Sarawak:124,000 km^2), which is about 90% of the total area of Japan. The population is 14,261,000 in total (estimated value in 1980), about the same population in Tokyo. Regional populaton is 11,849,000 (83% of the total) in Peninsular Malaysia, 1,098,000 (8%) in Sabah, and 1,314,000 (9%) in Sarawak. The population growth rate was 2.84% in 1970-1980. The concentration of the population in the urban area was prominent in these period (Table 2.1).

2.2 GDP and GRP of Kedah, Perlis and Penang

At the national level the total GDP and per capita GDP were M$ 25,376 million and M$ 1,779 in 1980, respectively (as of value in 1970). The average annual growth rate of GDP and per capita GDP were 8.1% and 5.1% in 1970-1980, respectively. The manufacturing industry and agriculture contributed 21.2% and 22.9% of the GDP, respectively (Tables 2.2 and 2.3). The GRP (Gross Regional Product) and per capita GRP of Kedah and Perlis were low compared to Penang and the other States.

2.3 Economic policy and achievement

The Malaysian economic development programmes, the First Five-Year Plan (1956-1960) and the Second Five-Year Plan (1961-1965) were formulated before the formation of the Federal States. Sabah and Sarawak formulated their five-year development plan in early 1960 and it was integrated to the First Malaysia Plan (IMP),1966-1970, after

the formation of Malaysia in 1963.

The main objectives of 1MP were: (1) to firm up lasting foundation for national unity, and (2) to increase the income, (3) to increase the productivity of the poor in the rural area, (4) to increase the employment opportunity, (5) to introduce new economic activities. However, these objectives were not achieved due to the shortage of the budget, and insufficient administration and management functions.

The New Economic Policy (NEP) covering 1971-1990 was enunciated in the Mid Term Review of the Second Malaysia Plan (2MP), 1971-1975. The objectives are: (1) poverty eradication to promote national unity, and (2) restructuring of society and the reduction in the overall income disparity among the major races in the country. Based on NEP, the Third Malaysia Plan (3MP), 1976-1980 was formulated and followed by the present Fourth Malaysia Plan (4MP), 1981-1985.

The decade of the seventies (1970s) witnessed rapid growth and the mean annual economic growth was 8.1%. The per capita income increased from M$ 1,142 (US$ 371) in 1970 to M$ 3,639 (US$ 1,639) in 1980 representing a rate of growth of 12.3% per annum. However the worldwide recession from 1979 to 1982 due to the second oil crisis adversely affected the international trade practices. The export from developing countries to developed countries remarkably declined and the economic growth retarded greatly compared with that in the 1970s. Malaysian economy was also affected the recession. The Mid-Term Review of 4MP, published in March 1984, showed that the mean annual economic growth was 6.2% which was 75% of the targeted value. It is also indicated in the Mid-Term Review that the government will promote the economic activity by private sector, while maintaining the targets of NEP. In the Mid-Term Review, the agriculture policy which includes the fishery industry, was formulated as National Agriculture Policy (NAP). The NAP is a long-term policy to integrate land, labour and role of each product to improve the conventional development policy.

2.4 *Fisheries in Malaysia and fisheries programme in 4MP*

The fisheries sector's contribution to the GNP accounts for only 3%. However, the fishery sector is an increasingly important part of the Malaysian economy in the following aspects.

1) Source of protein supply
2) Promotion of employment

3) Export earning industry

In the fisheries administration, both DOF and Fisheries Development Authority (LKIM) which are mutually independent, are under the jurisdiction of the Ministry of Agriculture (MOA). DOF performs such operations as formulation of policies, technological audit of related institutes, improvement of fisheries infrastructure, evaluation of resources, arrangement of statistics, etc., and LKIM as audit of fish markets, fisheries associations and fishermen's cooperatives, fish production and sales by project oriented. Fisheries in Malaysia is mainly comprised of coastal marine fisheries. Production of inland fisheries accounts for only less than 2% of total fisheries production. The actual aquaculture production is difficult to be grasped due to overlapping by the two fisheries administrations. According to the publications of DOF, the aquaculture production in 1979 was about 73,000 ton, of which 63,000 (86%) was cockle, 9,500 ton (13%) freshwater fishes and less than 1% others (Table 2.4). Trends in marine and inland fisheries landings are shown in Table 2.5. Inland fisheries production shows slightly increasing trend while marine fisheries shows a peak during 1980-1982. This peak in marine fisheries production in Malaysia was mainly from trawl fisheries in the coastal waters. DOF recognized that the coastal fisheries have been already overexploited since 1974, when marine production in the west coast of Peninsular Malaysia showed its first peak. The number of crews of licensed fishing boats also increased since 1963 to about 90,000 in 1982 as shown in Table 2.6. According to DOF, about half of the fishermen are categorized in the poverty rank and the rearrangement and upgrading their job is one of the important policies of the government.

The import of fishery products has a surplus and increased steadily since 1976, even though the marine production showed a peak for the first time (Table 2.7). The reason attributed to the increase in demand for fish which is caused by the increase in population and rise in the standard of living.

Under this situation, the government has been making efforts to develop offshore fishing and aquaculture with the aim to provide relief to small-scale fishermen and to increase the fish production in 3MP and 4MP. The fisheries development policy in 3MP were as follows.

1) Improvement of fisheries infrastructure ..... fishing port, pier/jetty for fish landing, telecommunication system, etc.
2) Fisheries management ..... enforcement of fisheries laws
3) Test fishing operation ..... development of offshore fishing grounds
4) Financial assistance to fishermen and fish farmers.....grant of subsidy
5) Training of fishermen and fish farmers
6) Development of model fishing village ..... promotion for settlement of fishermen
7) Promotion of aquaculture ..... brackish water and freshwater aquaculture, and mass production of seeds

The main emphases of the Fisheries Development Plan in 4MP are indicated below.

1) Assistance to fishermen in underdeveloped areas ..... Improvement of productivity, job arrangement
2) Development of offshore fisheries, and brackish water and freshwater aquaculture
3) Technical training to fishermen (6,820 trainees)
4) Grant of subsidy for fishing gears, boat and initial investments in all kinds of aquaculture
5) Promotion of research on aquaculture technology of profitable fish species and mass production of seeds

The trend of budget allocation to fisheries sector, based on these policies, is shown in Table 2.8. The allocation for fisheries in the agriculture and fisheries sector increased progressively at 1.8%, 2.3% and 5.0% in 2MP, 3MP and 4MP, respectively.

2.5 Aquaculture plan in NAP

The government has stressed on aquaculture development in fisheries development policy in 4MP. In the Mid-Term Review of the 4MP the government has further formulated policy for the participation of the private sector in aquaculture development. The formulation of policies in the agricultural sectors is now underway based on NAP in

the Fifth Malaysia Plan (5MP) for the target year of 2000. The policies for fisheries development in this plan includes effective exploitation of fishery resources by modern fishing technology and aquaculture development through:

1) development of offshore fisheries, by domestic and foreign experts on fisheries and arrangement of fishing boats, and
2) promotion of aquaculture for domestic supply of fishes and export earning.

The following aquaculture projects are specified.

1) Tiger shrimp (Penaeus monodon)
2) Sea bass (Lates calcarifer)
3) Mussel (Perna (=Mytilus) viridis)
4) Cockle (Anadara granosa)
5) Pond culture of freshwater fishes (including the giant prawn)
6) Freshwater fish culture in abandoned mining pools
7) Freshwater fish cage culture in abandoned mining pools
8) Freshwater fish culture in reservoirs (including cage culture)

Targeted production of aquaculture in 1990 and 2000

Species	Quantity (ton/year)	
	1990	2000
1) Tiger prawn	8,442	22,000
2) Sea bass	1,450	3,950
3) Mussel	2,100	8,100
4) Cockle	106,000	148,400
5) Freshwater fishes	19,940	23,620
Total	135,932	206,070

The annual programme for the development of aquaculture facilities is shown in Table 2.9.

3. OUTLINE OF THE PROPOSED SITE

3. Outline of the proposed site

3.1 Construction site and the peripheral areas

The proposed site (5°35'N and 100°20'E) is located in Kuala Muda District of the Kedah State in the west coast of north Peninsular Malaysia. The proposed site lies along the coastal area just south to the river mouth of the Sg. Merbok (Merbok river), 60 km south from Alor Setar, the capital city of the Kedah State, and 35 km north from Butterworth of the Penang State (Fig. 3.1). A trunk road runs between Alor Setar and Butterworth through Sg. Petani city (population ca. 50,000). The proposed site is situated 20 km from Sg. Petani.

Rice cultivation is active and extensive in the Kedah State due to wide and fertile lowland which is called the granary of the country. However, Kedah is low in the economic level compared with other states because of poor mineral resources and shortage of the land for large-scale plantations. Mangrove swamps are thickly distributed along the estuary of Sg. Merbok. The government proposed the development of the area for aquaculture of brackish water fishes in 3MP and 4MP; e.g. Ban Merbok Project by Department of Fisheries, and Sg. Merbok Pond Complex Project by LKIM. However, these projects are still in the initial stages and remarkable results have not been obtained.

The coastal area of the proposed site is very shallow and there is no fishing port. Local fishery activities in the area are in small scale and less developed.

3.2 Natural conditions

3.2.1 Climate

The western part of the Peninsular Malaysia is sheltered by the central mountain range running from north to south of the peninsula and by Sumatra Island over the Straits of Malacca. Therefore, the temperature and humidity in the area (and also at the proposed site) persist high throughout the year with much rain and are not influenced much by monsoon. Mean annual precipitation is about 2,160 mm. Mean monthly precipitation is high in the rainy season from May to October and low in the dry season from November to April. The mean hourly precipitation is also high on several occasions reaching above 100 mm. Daily precipitation above 10 mm for more than three consecutive days

occurred once a month or several times a year on the average. (Table 3.1). Mean monthly temperature ranges from 26°C to 29°C, mean monthly velocity of the wind is 1.5-2.4 m/sec and mean monthly daylight hours is 5-9 hours/day (Meteorological data by Penang International Airport and Alor Setar Airport, 1983).

3.2.2 Topography

The proposed site is located along the coastal bay just south of Pulau Sayak which is situated in the southern part of the estuary of the Sg. Merbok. Pulau Sayak is separated from the mainland about 100 m apart at high tide, and it is connected at low tide, leaving a short channel of several meters wide.

The proposed site is about 2.8 ha, and 200 m long east to west and 220 m wide north to south. As shown in Fig. 3.2, this site is composed of several blocks of No. 1470, 1472, 1475, 1618, 1818 and 2118. The block No. 1471 is excluded because of cemetery.

An access road runs near the northeastern end of the proposed site. The road is on higher elevation than the site, and runs uphill from north to south. The difference in elevation between the site and the road is about 1 m in the northern side and about 6 m in the southern side. A creek to drain rain water to the sea runs in the southern end of the site.

The difference of the existing ground level in the site is about 1 m in the most part, but about 9 m only in the southern part beyond the creek. The western side facing to the seashore is about 3 m above the mean sea level and about 0.5 m higher at high tide. The location of boring and land survey results are shown in Fig. 3.3 and Fig. 3.4, respectively.

3.2.3 Geology

The geological conditions of the proposed sites and the peripheral area consisted of shale and mud stone based on documents obtained (Fig. 3.5). The boring survey showed that topsoil of the proposed site is covered with whitish brown beach sand of about 3 m thick on the average and gradually deepened towards the seashore. Underneath is a shale layer which has alternate layers of weathered and fresh shale. The shale is exposed in the southern end of the site. Soil profile based on boring survey is shown in Fig. 3.6.

According to a chart, a contour line of 5 m deep extends offshore about 5 km at the river mouth of Sg. Merbok. Therefore, the coastal area is estimated to be a shoaling beach covered with thick silty clay. Our sounding survey data also showed that the coastal area was a shoal: 1.5 m and 2.2 m deep at 50 m and 500 m distant from the shoreline at neap tide, respectively. The bottom surface was sandy from the seashore to offshore about 50 m apart, grayish soft silty clay till about 300 m offshore, and then muddy presumably originated from Sg. Merbok (Fig. 3.8).

3.2.4 Salinity of sea water

The salinity of the sea water off the proposed site may be influenced by the river water of Sg. Merbok, draining into the sea at some distance north of the proposed site. The salinity may also fluctuate due to tidal range, because the high tide separates the Pulau Sayak and the mainland, and the low tide connects them as mentioned earlier. Our survey showed that the salinity was 3.0-3.3% at both the surface and the bottom at all stations. Although our survey was conducted during the rainy season, fine weather continued throughout the survey period. As a result, the salinity record was considered to be higher than expected in our data. Lower salinity is likely to be recorded in the rainy season. Lower salinity is known to affect mass production of prawn fry. It is considered that the intake of sea water from this area may not affect the prawn production under normal weather conditions. However, special attention should be considered with regard to the salinity of sea water at high tide during the rainy season.

3.2.5 Earthquake

Occurrence of earthquake is very rare in Malaysia, based on data on distribution of the seismic centres in Southeast Asia (Fig. 3.10).

3.3 Infrastructure

3.3.1 Road

Roads are managed by Jabatan Kerja Raya (JKR), including the roads in Kedah State. Road conditions are generally good in Malaysia. The trunk road between Alor Setar and Butterworth and a 10-m-wide state road (covered with asphalt of 5 m wide) from the trunk road to the proposed site are also good.

3.3.2 Power supply

Electrical power is supplied by Lembaga Letrik Negara (LLN). Power is accessible from a high voltage (11KV) power line installed under the access road. Voltages can be lowered through transformers to 415 V and 240 V to NPFPRC. However, electricity failure is known to occur 2-3 times a month and it takes almost a day to resume the electricity supply in the longest interruption. The installation of a power generator for emergency should be considered.

3.3.3 Water supply and drainage

Water is supplied by JKR. There is a water service line under the access road supplying the existing hatchery for freshwater prawn (Macrobrachium rosenbergii). It can meet further demand of about 300 ton/day.

Drainage is managed by Jabatan Parit dan Taliayer (JPT). There are no drainage facilities in and around NPFPRC. Any drainage work in the site is beyond the administrative conduct of JPT.

3.3.4 Telephone system

Telephone system is operated by Jabatan Telekom (JT). Lines are distributed in this area, however, there are no extra lines at present. New telephone lines should be installed from the trunk road. Fortunately, Kota K. Muda substation system is scheduled to be improved in 1985. Pulau Sayak is included in its service area and the telephone lines will be easily installed at NPFPRC after the improvement.

3.3.5 Gas supply

Presently, a gas supply system through piping does not exist, however, gas supply by installing LPG (liquid propane gas) cylinders is prevailing.

3.4 Construction work

3.4.1 General background

Construction business is not active in Malaysia due to decrease in government investment for infrastructure and less participation of private sectors in housing development. In public works construction in 1984, investment both by federal and state government was M$ 7,252

million, 8.5 % lower than that in 1983. The investment for bridge construction and waterworks by Ministry of Works and Utilities reached only M$ 948 million in 1984, 7.7% lower than that in 1983 (M$ 1,027 million). Construction projects by Ministries of Education, Defence, Health and Home Affairs were estimated to M$ 548 millon, 16% lower than those in 1983.

Housing construction has been declining due to less activity of private developers caused by increase in interest rate of loan by commercial banks. However, construction of private hotels and office buildings are active. There were only 6 approvals for hotel construction in 1983 and it increased to 13 in 1984.

The supply of construction materials is presently stable because of the decrease in demand for construction and increase in domestic production. For example, cement production was 5,510,000 tons in 1983, and 660,000 tons were imported. The Kedah Cement has started operation in 1984. Demand and supply for cement will be balanced in the near future.

Cement and steel bar prices have been controlled since 1983. The cement price is M$ 192/ton and the prices of the steel bar of 10, 15, 18 mm in diameter (British Standard Specification) is M$ 891, 930, 995 in Peninsular Malaysia, respectively. The prices have not changed at the time of our survey (October 1984).

Malaysia is short of skilled workers and this shortage sometimes affects construction works of high techniques, such as bridge construction.

3.4.2 Construction materials

According to JKR, construction cost in tender offers increased in Malaysia in recent years. It reached its peak in the first half of 1982, and declining sharply in a year. Since the second half of 1983, the cost has dropped to that of 1980 and stabilized. The reasons are (1) slumping or declining in construction boom in the first half of 1982, and (2) competitive bargaining of tender offers since then. Considering these conditions, JKR prepared Schedule of Rate (for the supply of all labour, materials, tools, plants and appliances) in 1982 (Table 3.3) and the rates are indicated by district for public works in 1984, after JKR examined and identified the rate changes by item. Table 3.4 shows the change rate of "Schedule of Rate" in Sg. Petani.

JKR district office in Sg. Petani controls public works at Kg. Pulau Sayak. Based on the revised rates work prices of steel bars and metals increased and those of materials for masonry decreased.

3.4.3 Labour

Standard wages by work item prepared by JKR is shown in Table 3.5. Total numbers of labourers in construction works were 346,000 in 1983, and forcasted to increase to 369,000 in 1984. As mentioned earlier, the recent shortage of skilled workers has caused problems in civil works. The shortage for skilled workers still persists, though the number of construction works decreased recently and the demand for skilled workers also decreased. This shortage can be supplemented by recruitment of Malaysian workers from Singapore and Indonesian labourers.

4. PROJECT

4. Project

4.1 Background and objectives of the project

The aquaculture development plan for 2000 formulated by the government is a grand plan, as mentioned before. In addition to the conventional aquaculture development, the plan includes development of the protected mangrove forests of about 21,000 ha into culture ponds for the benefit of low-income fishermen and private sectors to increase the aquaculture production.

The tiger prawn is regarded as the most suitable species for culture because of its high profitability as foreign exchange earner and a source of animal protein.

This development shall be led by private investment, although it was conducted by the government before. The government has stressed the aquaculture development as a countermeasure for job rearrangement for low-income fishermen. The development areas in the year 2000 will reach 9,000 ha by the government and 12,000 ha by private sectors. The freshwater fish culture was being developed for low-income fishermen in 3MP and 4MP. This freshwater aquaculture development plan laid emphasis on the polyculture of fishes and giant prawn (Macrobrachium rosenbergii) to help augment the income of fishermen. This plan shall be continued till the year 2000.

The Department of Fisheries considers the stable supply of seeds as one of the most important factors for success in aquaculture development, and it has made efforts to import aquaculture techniques and seed production techniques of various fishes and prawns, including technical training abroad of local staff. The artificial breeding of the giant prawn was succeeded for the first time in the world in Malaysia. Six hatcheries were constructed in Malaysia. Presently giant prawn larvae are reared at the density of about 50 individuals/liter, however, the rearing at higher density are conducted on trial for higher efficiency. Concerning the tiger prawn, larval rearing at the density of 100-140 larvae/liter was succeeded in the laboratory level at FRI, however, the techniques were not implemented on a large-scale or hatchery scale.

The level of seed production technique in Malaysia is not low, compared with other countries. In case of large-scale development, the government has recognized the necessity of applied and practical

researches on mass production, artificial breeding, nutrition, disease prevention, etc.

Besides, the government stresses not only on the smooth realization of governmental policies by private sectors but also on the training of fishermen and private aquaculturists on aquaculture and seed production techniques.

A plan to construct an aquaculture and training centre was raised in 4MP. However, the stagnation of international economy affected largely the Malaysian economy and consequently the achievement has been delayed away from the target in 4MP. The whole development plans on aquaculture including the above-mentioned centre were also delayed. The establishment of NPFPRC for mass production of prawn fry shall greatly contribute to the development of fisheries in Malaysia in general.

4.2 Project planning considerations

4.2.1 Function of the Project

Table 4.1 shows the considerations for the appraisal of the request items for this project based on documents and information obtained in Malaysia. The following items are considered appropriate for the NPFPRC functions as requested by the Malaysia;

(1) Prawn fry production, mainly tiger prawn fry and partially giant prawn fry

(2) Research on prawn breeding, mass production of prawn fry and other related aquaculture systems.

(3) Technical training on breeding of prawn and other related aquaculture systems

4.2.2 Scale of prawn fry production system

Prawn fry production of two species shall be conducted as mentioned above. The government is attempting to cooperate with private sector to develop the aquaculture by the year 2000 and carries out the following activities:

(1) Culture ponds developed by the government shall be leased to low-income fishermen.

(2) Tiger prawn fry produced in NPFPRC shall be distributed to small-scale farmers and for sea-ranching purposes, if there is surplus.

(3) Accordingly, NPFPRC shall produce prawn fry to assist development of prawn fry culture by small-scale fishermen.

Based on the above-mentioned government roles, the fry production scale of NPFPRC is calculated as follows.

Tiger prawn

$A = B \times C$, $C = D/E$, $D = F/G$

where,

A: Number of prawn fry to be produced at NPFPRC

B: Maximum annual development area for culture pond by the government: 750 ha/year (See Table 2.9)

C: Density of prawn fry (PL20) to be released into ponds

D: Number of cultured prawn at harvest

E: Survival rate from stocking to harvest: 50 % (estimated survival rate in the year 2000)(real survival rate at the time of formulation of NAP was 35.5% on the average and 64% at maximum value)

F: Quantity of prawn at harvest: 1,000 kg/ha/year (conservative value of culture plan in NAP (See Table 2.9)

G: Weight of prawn at harvest: 28 g/prawn on the average (real value)

Therefore, number of prawn fry to be produced at NPFPRC is:

$A = (B \times F)/(E \times G)$

$= (750 \times 1{,}000{,}000\ (g))/(0.5 \times 28)$

$= 53{,}571{,}427$

$=$ ca. 53,600,000

The annual production of prawn fry is estimated to be 55 million in 2000. This production is 2.5% over the demand considering the probable efficient operation.

Giant prawn

$A = B \times C \times D$

where,

A: Number of fry to be produced at NPFPRC

B: Development area of 900 ha for polyculture with giant prawn, which is 30% of the total area of 3000 ha to be developed for freshwater fish culture by government and private sectors by 2000 (Table 2.9) (cited from NAP)

C: Density of prawn fry to be released into ponds: 12,346 fry/ha (5,000 fry/acre)

D: Ratio of fry production at NPFPRC: 0.5 (The contribution of the government is assumed to be still high even in 2000, because the production cost of this species is too high to give incentives to private sectors to invest giant prawn hatchery, compared with tiger prawn.

Therefore, the number of fry to be produced at NPFPRC is:

A = 900 X 12,346 X 0.5

= 5,555,700

= ca. 5,560,000

The maximum daily consumption of freshwater for 5.56 million fry production is estimated to be more than 300 tons. Freshwater shall be supplied by JKR and their capacity to NPFPRC shall be 300-350 ton/day. Freshwater will also be utilized for daily work and research at NPFPRC. This capacity may not be enough to meet the fry production demand. Therefore, the projected annual fry production calculated to 5 million fry in the year 2000, based on the freshwater demand of 300 tons or less should considered.

4.2.3 Fry production method

(1) Basic consideration

Following basic considerations are determined based on the biological characteristics of the tiger and giant prawns, technical level in Malaysia, and topographical conditions of the construction site.

1) The water temperature affects the period of larval stages. The period is short at 29-30°C for both species. The water temperature of 26-29°C at the proposed area is slightly lower than the optimum temperature. From the stocking of mother prawns, through spawning,

hatching, larval stage to postlarval stage the operation shall be conducted in temperature controlled room.

2) The technique of prawn fry production at the laboratory level is relatively high in Malaysia, especially in the rearing density of hatched larvae; 100-140/liter for the tiger prawn and 60/liter for the giant prawn. The projected rearing density for mass production in the year 2000 at NPFPRC is set up at the minimum value at the laboratory level as mentioned above (100/liter for the tiger prawn, 60/liter for the giant prawn).

3) At the initial stage of operation, mother tiger prawns shall be procured from wild sources and that of giant prawns shall be of both wild and cultured. At later stage cultured prawns of both species shall be used as spawners in artificial maturation technique.
There is a seasonal fluctuation in the availability of wild mother tiger prawn; lean season from May to August, and peak season from September to next April. However, mother giant prawn are available throughout the year. Accordingly, the fry production of giant prawn shall be conducted during the lean season of tiger prawn.

4) The whole operation shall be suspended for one month before the peak season to repair and disinfect the fry production facilities.

5) Staff engaged in fry production shall be divided into 5 groups for disease prevention: 4 groups for fry production (for 4 units, separately), and 1 group for food organisms.

(2) Fry production method of the tiger prawn

The fry production method of the tiger prawn is summarized in the following table.

Proposed rearing conditions

Item	Rearing stage			
	Mother Prawn	Mother to Nauplius	N to PL5	PL5 to PL20
Tank	Holding T.	Hatching T.	Indoor larval T.	Outdoor postlarval T.
Density	4-14/2 ton	M:1/0.3 ton	N:100/l	PL5:10/1
Decrease rate*		No. of E 350,000E/M Spawning rate: 50% Hatching rate: 70%	Survival rate:40%	Survival rate:50%
Rearing period	0.5 days	M to E 1-3 days E to N 12-15 h	N to Z 36-45 h Z to M 4-5 days M to PL1 3-5 days PL1 to PL5 5 days	PL5 to PL20 15 days
Annual production scheme				
(1) Lean season (May to August)				
M:4, 30 days, 2 cycles		29,400,000	11,760,000	5,880,000
(2) Peak season (September to next April)				
M:40, 5 days, 10 cycles		235,000,000	98,000,000	49,000,000
Total (per year)	2,240	274,400,000	109,760.000	54,880,000

E: egg, M: mother prawn, N: nauplius, PL: postlarva, T: tank, Z: zoea

*: These proposed values are based on the real values at the laboratory level in Malaysia.

Based on the above rearing conditions and the availability of mother prawns in the lean season, the size and number of tanks and water volume are proposed for the efficient operation of the facilities, proper maintenance and management (cleaning, feeding) as summarized in the following table.

Size and number of tanks, and water volume in one rearing cycle*

Item	Rearing stage				
	Maturation**	M collection	M to N	N to PL5	PL5 to PL20
Tank	Maturation T.	Holding T.	Hatching T.	Larval T.	Postlarval T.
No. per cycle	630	200	200	24,500,000,	9,800,000
Density	4-5/m^2	5-7/m^2	1 M/0.5 ton	100 N/lit.	10 PL5/lit.
Period(day)	60	ca. 0.5	ca. 2	ca. 13	15
Tank volume(ton)	10	2	0.5	a. 5, b.10	a.20, b.40
No. of tanks	10	3	60	a.20, b.20	a.38, b.11
Total water volume (ton)	100	6	30	300	1,200
Water exchange rate	30%	100%	100%	5% (adding) (1-4 days) 10,20,30%(5-11) 50%(12-15)	0% (1-2 days) 5,10,20%(3-12) 30% (13-15)
Water volume (ton/day)	30	6	30	30-138	23-312
Maximum water volume (ton/day)***	30	6	30	138	312

M: mother prawn, N: nauplius, PL: postlarva, T: tank

*: per cycle in the peak season

**: Fry shall be produced from artificially matured mother prawns at later stage following the maturation study on experimental scale at initial stage.

***: See Fig. 4.2 (1)-(4) for the calculation of the maximum water volume.

Diatom and Artemia shall be fed to prawn fry. About 240 tons of diatoms shall be utilized for 4 days per rearing cycle during the peak season and 16 tanks (15 ton capacity) shall be used for diatom culture. Maximum water volume to be used shall be 60 ton/day for diatom culture. About 7.5 kg of Artemia shall be utilized in a day and they shall be hatched in 17 tanks (0.3 ton capacity). Water consumption shall be about 5 ton/day.

(2) Fry production method of the giant prawn

The fry production method of the giant prawn is summarized in the following table.

Proposed rearing conditions

Item	Rearing stage			
	Mother with non-eyed E	Mother with eyed E to Z	Z to PL1	PL1 to PL15
Tank	Maturation T	Indoor larval T	Indoor larval T	Outdoor postlarval T
Density	6/ton	37/ 5 ton T	Z: 60/lit.	PL1: 6/lit.
No. of E	10,000 E/M			
Spawning rate		90 %		
Hatching rate		90 %		
Survival rate			25 %	60%
Rearing period (days)	20	2-3	32-33	15
Annual production scheme				
(1) Lean season (May to August) of the tiger prawn	M:628, 4 cycles, Z:20,350,000 PL1:5.090,000 PL15:3,050,000 = 2,512			
(2) Peak season (September to next April) of the tiger prawn	M:268, 6 cycles, Z:13,020,000 PL1:3,250,000 PL15:1,950,000 = 1,608			
Total (per year)	4,120	33,370,000	8,340,000	5,000,000

E: egg, M: mother prawn, PL: postlarva, T: tank, Z: zoea

*: These proposed values are based on the real values at the laboratory level in Malaysia.

Based on the above rearing conditions and the availability of mother prawns in the lean season, the size and number of tanks and water volume are proposed for the efficient operation of the facilities, and proper maintenance and management (cleaning, feeding) as summarized in the following table.

Size and number of tanks, and water volume in one rearing cycle*

Item	Rearing stage								
	Mother with non-eyed egg	Mother with eyed egg to PL1				PL1 to PL15			
Tank	Maturation T	Indoor larval T				Outdoor postlarval T			
No. per cycle	628 (May to Aug.)	Z: 5,090,000				PL1: 1,270,000			
Density	6/ton	60/liter				6/liter			
Period (day)	ca. 20	ca. 35				ca. 15			
Total water volume (ton)	100	200				260			
Tank volume (ton) and number	10-ton X 10	2.5-ton X 2 10-ton X 20				20-ton X 5 40-ton X 4			
Water exchange rate**	a	b	c	d	e	f	g	h	i
Total	30	30	20	30	50	30	30	30	30
Freshwater	100	80	50	60	70	88	90	95	100
Sea water	0	20	50	40	30	12	10	5	0
Water volume (ton/day)									
Total	50	50	40	60	100	78	78	78	78
Freshwater	50	40	20	36	70	69	70	74	78
Sea water	0	10	20	24	30	9	8	4	0
Maximum water volume (ton/day)***									
Freshwater	50		75			180			
Sea water	6		60			30			

*: Lean season of the tiger prawn (May to August)

**: a: first day, b: 2-20 days, c: hatching to 10 days, d: 11-20 days, e: 21-35 days, f: first day, g: 2 days, h: 3 days, i: 4-15 days.

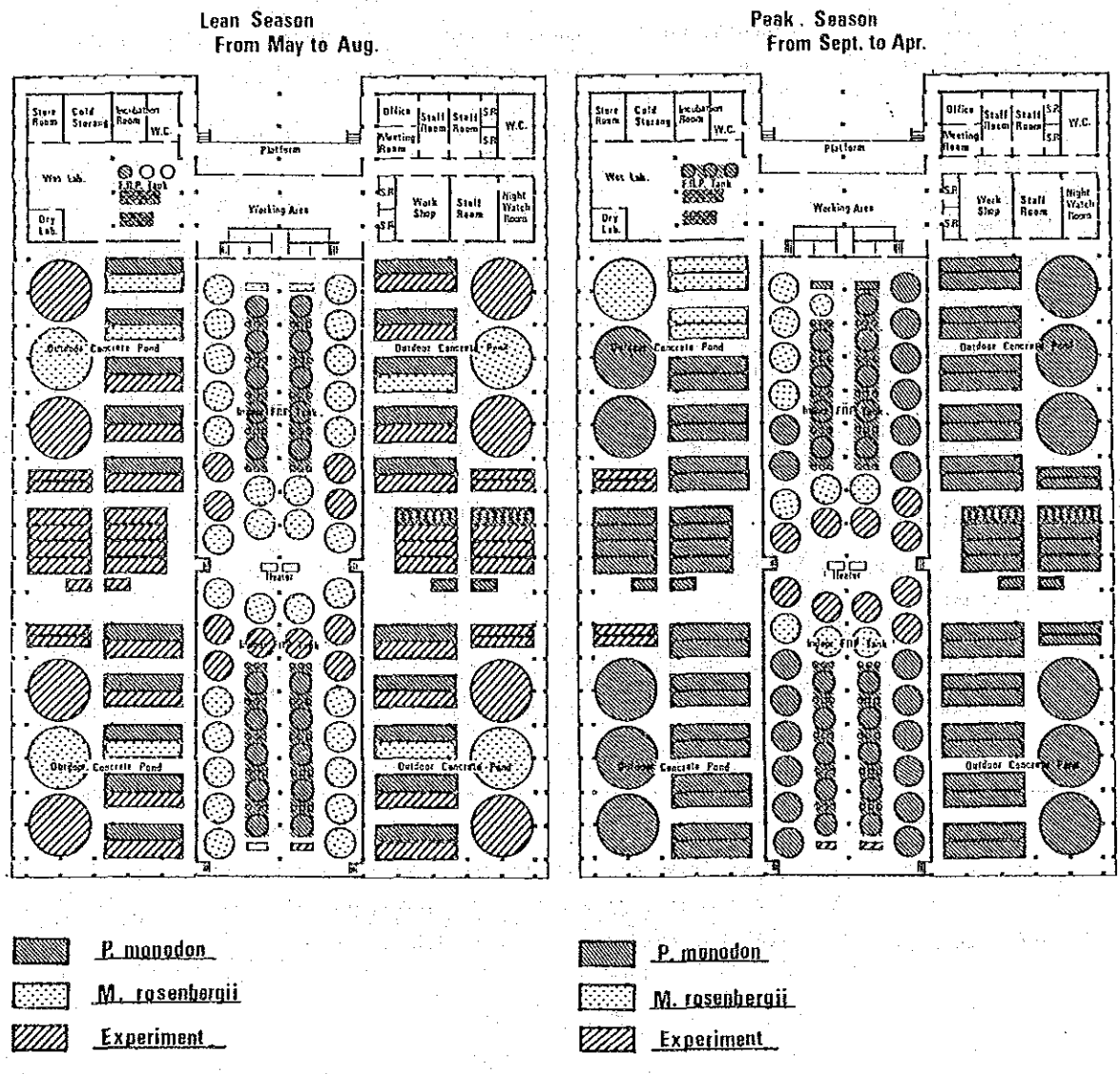
***: See Fig. 4.2 (1)-(2) for the calculation of the maximum water volume.

Artemia shall be used for fry production of the giant prawn. The fry production of the giant prawn shall reach its peak in the lean season of the tiger prawn. About 7.6 kg of Artemia shall be needed in a day in this season. 17 tanks (0.3-ton volume) shall be needed for hatching Artemia.

(4) Tanks for fry production and their operation system

Based on the afore-mentioned fry production methods, yearly operation schedule of water tanks and water use by season of the tiger prawn is shown in Fig. 4.1 and Fig. 4.2 (1)-(4).

Maximum daily water demand is calculated by tank, by season, by water quality, and is shown in the following figure and table.



Schedule of Tank Use

List of tanks and maximum water volume

Name of tank	Lean season*				Peak season*			
	Tank		Maximum water vol. (ton/day)		Tank		Maximum water vol. (ton/day)	
	Volume (ton)	Number	SW	FW**	Volume (ton)	Number	SW	FW**
1. Maturation tank								
a. tiger prawn	10	10	30	--	10	10	30	--
b. giant prawn	10	10	6	50	10	6	4	50
2. Holding tank								
a. tiger prawn	2	1	2	--	2	3	6	--
b. giant prawn	--	--	--	--	--	--	--	--
3. Hatching tank								
a. tiger prawn	0.5	6	3	--	0.5	60	30	--
b. giant prawn	--	--	--	--	--	--	--	--
4. Indoor larval tank								
a. tiger prawn	5	20	30	--	5 10	20 20	138	--
b. giant prawn	10	20	60	75	5 10	1 4	27	18
5. Outdoor postlarval tank								
a. tiger prawn	20	20	77	--	20 40	38 11	312	--
b. giant prawn	20 40	5 4	30	180	20 40	4 1	13	97
6. Diatom culture tank								
a. tiger prawn	2	16	6	--	15	16	63	--
b. giant prawn	--	--	--	--	--	--	--	--
7. Artemia hatching tank								
a. tiger prawn	0.3	5	1	--	0.3	17	5	--
b. giant prawn	0.3	17	5	--	0.3	4	1	--
8. Indoor experimental tank	2.5	2	5	--	2.5	2	5	--
9. Outdoor experimental tank	10	4	12	--	10	4	12	--
10. Outdoor experimental pond	50	4	60	--	50	4	60	--
Total	--	114	327	305	--	225	706	165

*: Lean season of the tiger prawn (May-August), and peak season (September -next April)

**: SW: sea water, FW: freshwater.

4.2.4 Research work on fry production

NPFPRC shall conduct applied and practical research works to establish mass production techniques of prawn fry. The subjects of research shall be according to the aquaculture plans in NAP and 4MP. There may be technical problems on aquaculture at the Fisheries Research Institute and considering this perspective four research laboratories are proposed as indicated below.

1. Fry production and breeding laboratory
   (Research on technical improvement for stable and efficient fry production)
   1) Maturation of mother prawn
   2) Increase in spawning rate and hatching rate
   3) Increase in survival rate in the free swimming larval stage
   4) Increase in survival rate in the postlarval stage
   5) Sorting and selection of planktons for food organisms
   6) Economic improvement of fry production system

2. Feeds and nutrition laboratory
   (Research on growth and maturation of prawns, and nutritional studies on the feed)
   1) Nutritional requirement of mother and larval prawns
   2) Sorting and selection of planktons for food organisms (with lab. 1)
   3) Improvement of formulated feed

3. Rearing environment laboratory
   (Research on the improvement of rearing environment for fry production)
   1) Optimum rearing environment (with lab. 1 and 4)
   2) Development of simplified fry production method (with lab. 1.)
   3) Development of rearing methods of recirculated water system

4. Disease prevention laboratory
   (Research on disease prevention)
   1) Diagnosis
   2) Efficacy of medicines and chemicals
   3) Microbiological study on rearing environment

4.2.5 Technical training programme

Technical training on fisheries started in 1953 in Malaysia, which has a remarkable long history, compared with other Southeast Asian countries.

The government stressed the technical training of the marine fisheries for fishermen. Since 1970, the emphasis has been laid to provide training on the inland aquaculture.

Short-term technical training was conducted for 2,400 trainees between 1970-1980 in Bukit Tingii Inland Fishery Training Center near Kuala Lumpur and in other hatcheries. Job rearrangement for low-income fishermen was formulated in FMP, and thus technical training on freshwater aquaculture technique has been offered to 5,820 persons of the projected 6,820 trainees in 1981-1985. The development of tiger prawn culture in brackish water area is one of the important targets of NAP formulated by the Mid-Term Review of 4MP. The training on tiger prawn culture was initiated in 1983 at 600 persons per year mainly for govenment employees and private aquaculturists. However, there are no special training facilities, and the training has been tentatively conducted in existing government facilities in various areas. The NPFPRC, when established with the prawn fry production system and the research laboratories, will probably be the most appropriate centre for the technical training.

The training programme shall be conducted by DOF as indicated in 5MP. The technical training includes lectures on general aquaculture using textbooks, and simple practices and observational tours of aquaculture facilities.

The contents of the text is shown in Table 4.2. The contents of the training course is shown below.

(1) Fry production of the tiger prawn
(2) Fry production of the giant prawn
(3) Maturation of brood stock
(4) Nursing of prawn fry
(5) Culture of live food organism
(6) Other aquaculture courses

The training programme by DOF in 5MP is shown in the following table.

Training programme in brackish water aquaculture (1986–1990)

Course	a	b	c	d	e
1. Tiger prawn culture	A	12	20	240	2
2. Brackish water culture of prawns and fishes in general	B,D	3	20	60	3
3. Maturation of brood stock	C,D	2	20	40	3
4. Nursing of prawn fry	A	10	20	200	2
5. Culture of live food organism	A	5	20	100	1

a: Trainee, b: No. of courses per year, c: No. of trainees per course, d: Total number of trainees per year, e: Duration per course (week), A: Aquaculturist (fish farmer), B: Junior fisheries expert, C: Senior fisheries expert, D: Pond manager.

The technical training at NPFPRC shall be as follows:

1. Lecture

   Lecture using textbooks for 20 trainees in a class.

   Audiovisual education shall be offered, if necessary.

2. Practice

   Basic practices for 20 trainees in a class.

   Biological observations and drawings

   Microscopic observations and drawings

   Artemia and diatom culture

   Manipulation of equipments and apparatus

   Others

3. Observational tour

   Observational tours of culture facilities for about 20 trainees in a class

   Fry production and research facilities of NPFPRC, neighbouring brackish water culture ponds, and related neighbouring culture system.

4.3 Basic design

4.3.1 Basic design principles

The basic design of NPFPRC is based on the following principles:

(1) Tropical climate of high temperature and high humidity and other natural conditions shall be considered for facility planning including facility design, arrangement, structure and specification.

(2) The application of local construction method and use of local materials, and simple operation and maintenance of facilities shall be considered to minimize the construction, operation and maintenance costs.

(3) The existing hatchery centre adjacent to NPFPRC shall be considered in the arrangement of facilities.

(4) The zoning of facilities shall be considered to clarify the function of each unit facility (prawn fry production, research and administration, training).

(5) Stable and appropriate environment for fry production shall be considered in facility planning by separating drainage system from water supply system, and by providing with suitable water temperature and sufficient daylight for prawn larvae.

(6) The harmony with peripheral landscape shall be considered in basic design.

(7) Effect of sea spray and corrosion at the coastal location.

4.3.2 Function of the facilities

The NPFPRC facilities are divided into three units: (1) prawn fry production, (2) research and administration, and (3) training.

(1) Fry production unit

The fry production unit shall be consisted of water intake facilities, water reservoir, elevated tank, indoor and outdoor fry production facilities. The indoor ponds shall provide with temperature controlling system. The fry production unit shall also include an office room, a wet laboratory, and a place for packing and shipment of prawn fry.

(2) Research and administration unit

This unit shall include space for the administration, and applied research on technique improvement of fry production. The research section shall be consisted of four laboratories (fry production and breeding, feeds and nutrition, rearing environment, disease prevention) and a library, outdoor experimental ponds, etc.

The administration section shall be consisted of a director's room and an office room.

(3) Training unit

The training unit shall be consisted of lecture rooms, training rooms and laboratories for training fry production and culture techniques to fishermen and government technicians. Accommodations for trainees shall be provided.

List of facilities in each unit is tabulated below.

List of facilities by unit

Facility unit	Facilities needed
(1) Fry production	A) Sea water intake jetty, pump station
	B) Sea water reservoir reservoir, pump, air blower
	C) Sea water supply sedimentation tank, sand-filtering tank, filtered water tank, elevated tank
	D) Freshwater reservoir reservoir
	E) Freshwater supply dechlorination tank, elevated tank
	F) Indoor fry production tanks (Artemia incubation, brood stock, hatching, larval rearing), wet laboratory, dry laboratory, incubation room, cold storage,working area, office, staff room, lavatory, and store room
	G) Outdoor fry production system tanks for diatom culture, prawn postlarvae (PL1-PL20), experiment and sand-filtering tank for diatom concentration
(2) Research and Administration	A) Research facilities four laboratories (breeding, feed and nutrition, environment, disease prevention), library, staff room, outdoor experimental ponds.

List of facilities by unit (continued)

Facility unit	Facilities needed
	B) Administration facilities office, director's room, staff room, conference room, clerk room, telephone switchboard room, store room, lavatory.
(3) Training	A) Training facilities lecture room (including audio-visual room), laboratory for trainees, library, instructor's room
	B) Accommodations bed room, lavatory, shower room, dining room, kitchen, recreation room
(4) Others	A) Machinery facilities transformer substation, generator room, oil storage,
	B) Watchman box
	C) Parking lots
	D) Drainage facilities

4.3.3 Land preparation and general layout plan

(1) Land preparation

There are a number of coconut trees growing naturally in the proposed site. Preservation of these trees along the access road and shoreline shall be considered. Rainwater in the proposed site shall be drained into the sea at the southern end of the site through the existing creek. Consequently, the drainage will not affect the intake of sea water from the northern side. The site shall be prepared in three finished grades (low, middle and high) making the best use of the topography, as shown in the next page.

1) Low finished grade area

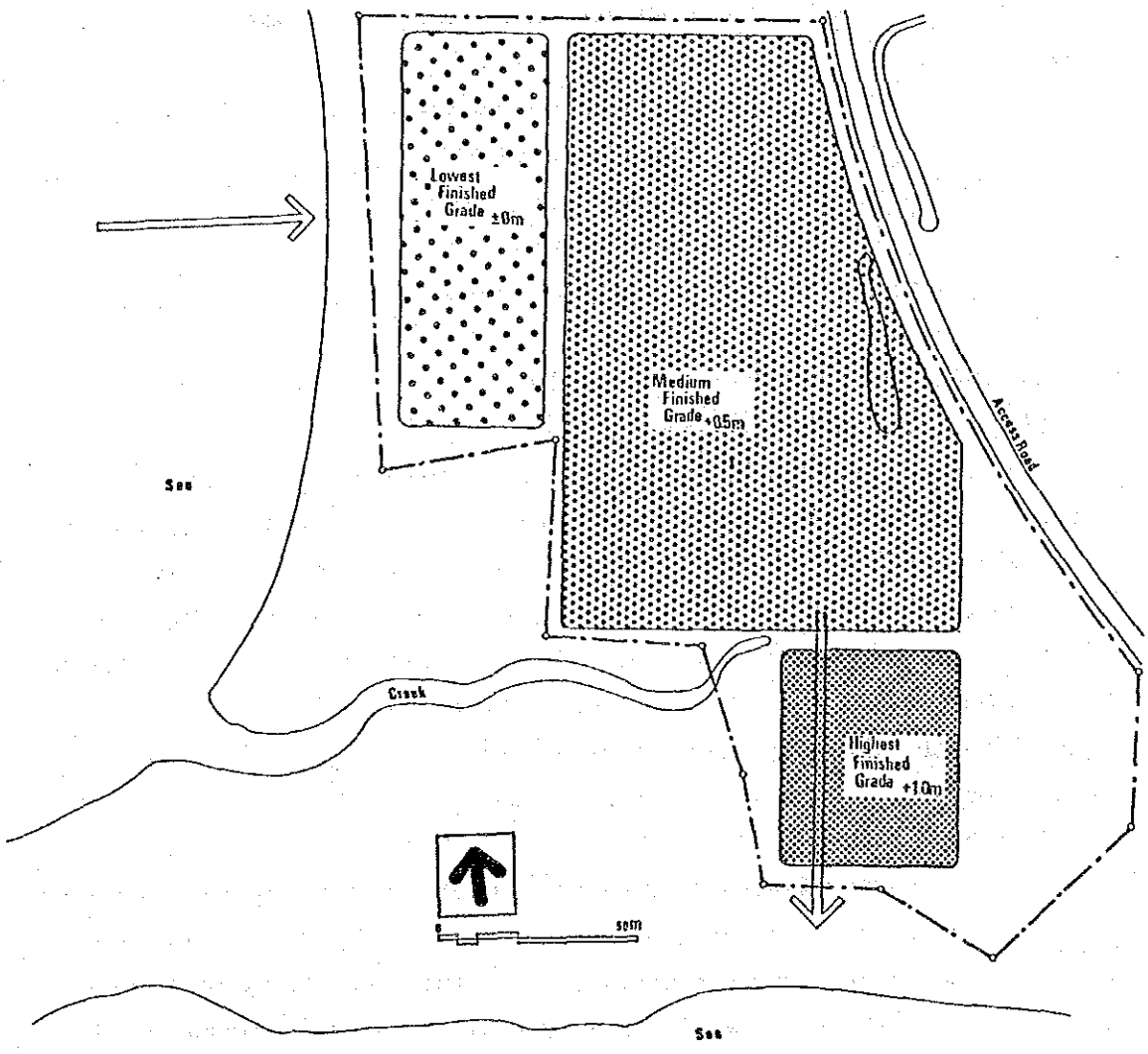
The low finished grade area on the western side of the site along the sea shore. The height is +3.0 m above MSL. The seawater reservoir is located in this area in order to facilitate the water flow by gravity through an open ditch from the offshore intake to the reservoir.

2) Middle finished grade area

The middle finished grade area is the eastern side of the site along the access road. The height is +3.5 m above MSL. The level is determined by the minimum gradient to drain waste water.

3) High finished grade area

The high finished grade area is the southern side exposing the shale. The level is +4.0 m above MSL. The level is determined by the minimum quantity of excavation of this area.

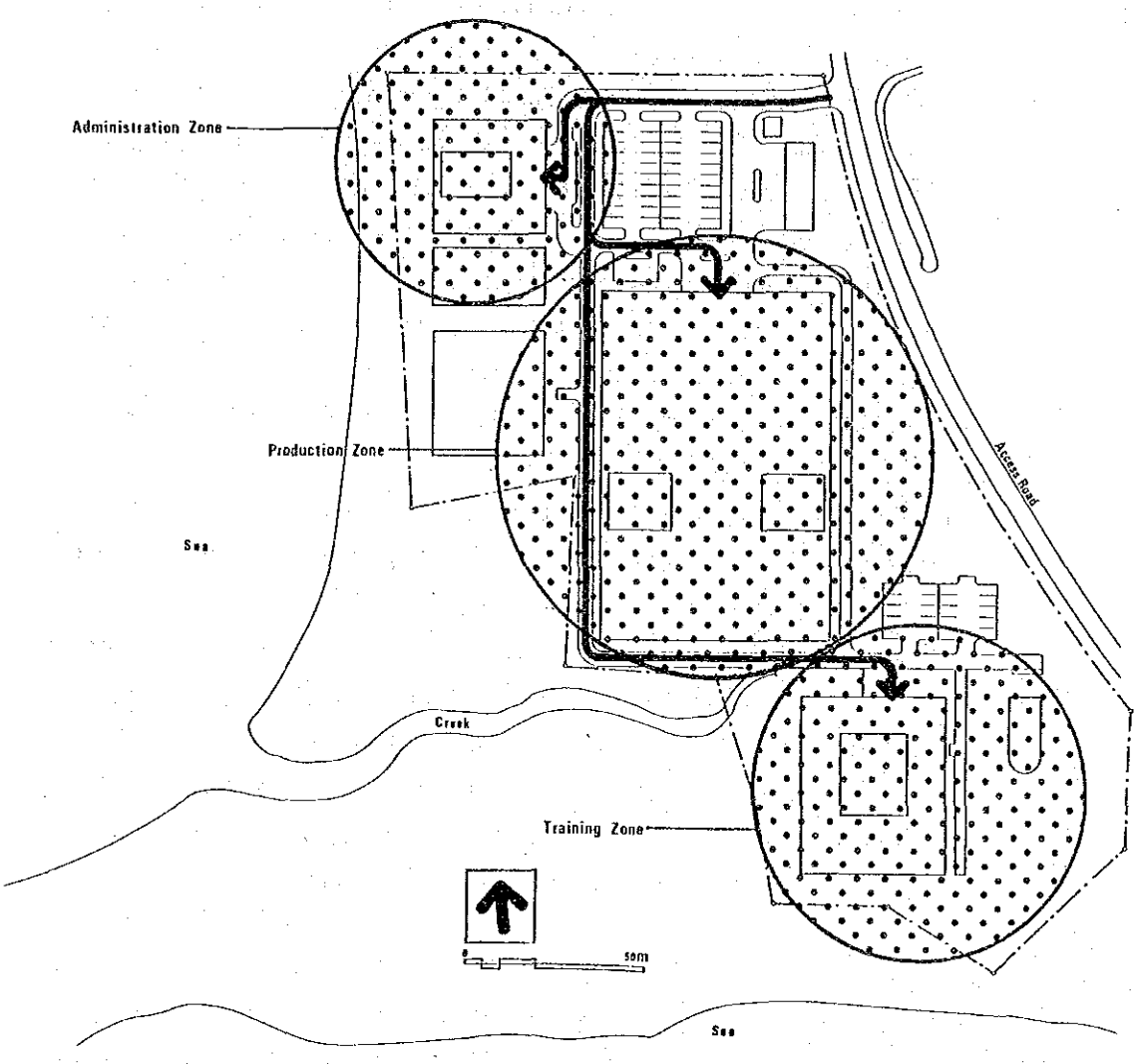


Land Level

(2) General layout

The general layout is based on the following principles.

1) Three facilities (prawn fry production, research and administration, training) are designated by zones based on the functions, administration and operation system and working hours, as shown in the following figure.



Zoning in the Site

2) The approach from the access road to NPFPRC is arranged on the northern side of the site because of the minimum difference of the height between the access road and the site. Roads in the site runs through the watchman box to the research and administration zone, fry production zone, and training zone.

3) The research and administration facilities are arranged at the northern side close to the entrance, considering (1) the overall control of the operation of NPFPRC, and (2) the existing office of Department of Fisheries located in the north of the site.

4) The fry production facilities including water intake facilities, water reservoir, elevated tank are arranged in the low finished grade area near the shore. Fry production facilities are arranged in the middle finished grade area to facilitate drainage of pond water by gravitational flow to the southern side of the site to the sea. In addition, parking lots are arranged facing to the fry production facilities to facilitate loading and unloading of prawn (brood and fry).

5) The training unit is located in the southern part of the site, so that the research and fry production is exposed to minimum disturbance by trainees.

6) The machinery facilities are arranged along the access road close to the research and administration, and fry production facilities consuming much electricity, to shorten distribution lines from the transmission line.

7) The water intake facilities are arranged on the southern side not to be affected by rainwater drainage.

4.3.4 Water intake plan

The water intake and supply system of sea water and freshwater to NPFPRC is planned as follows;

(1) Water demand

1) Sea water

Sea water is mostly used for fry production of tiger prawn. As described in 4.2.3, the period from May to August is the lean season

of mother tiger prawn. Only 4 prawns can be collected in a day on the average during this season. Accordingly, the operational ratio of the production facilities is low. The monthly sea water demand for fry production is estimated to be totally about 7,400 tons during the season (250 tons/day). From September to next April is the peak season of mother prawn and about 200 mother prawns can be collected in 4 days on the average. The monthly sea water demand is estimated to about 14,000 tons (470 tons/day), almost double the capacity compared with that in the lean season. However, the maximum daily sea water demand is much more than the average 470 tons/day, because the water change rate in one culture cycle is shifted day by day. The water demand in the second half of one culture cycle is usually higher than the first half. The maximum daily sea water demand is defined as the maximum amount of daily sea water demand in one culture cycle. The maximum daily sea water demand is estimated about 706 tons. The schedules of daily water demand in both the peak and lean seasons are shown in Fig. 4.2 (1)-(4). The daily sea water demand for research works and training is small.

2) Freshwater

Freshwater is mostly used for fry production of the giant prawn and some for domestic use. During the peak season of mother tiger prawn, the operational ratio of fry production of the giant prawn shall be kept low because most of the water tanks are utilized for tiger prawn fry. The estimated monthly freshwater demand of the period is about 2,000 tons (less than 70 tons/day). During the lean season, fry production of the giant prawn shall be increased for the effective use of the idle water tanks. The estimated monthly freshwater demand during the period is totally about 3,200 tons (about 107 tons/day). However, the maximum daily freshwater demand is estimated to be 305 tons because of the reasons similar to sea water demand (Fig. 4.2 (1)-(2)).

The freshwater consumption for other purposes, such as domestic use and research works, is assumed to be almost constant. The daily water demand for domestic use and research works is assumed to be 11.9 ton (125 liter/person/day) and 1 ton/day, respectively. Consequently, the maximum daily freshwater demand is estimated at 318 tons/day.

(2) Sea water intake and supply system

The sea water intake system of NPFPRC is planned taking into consideration of the following seashore conditions;

1) Sea water quality both at 1-2 km offshore and near to shoreline might be similar because the seashore is shallow up to the distance of 5 km offshore. Consequently, the sea water can be taken near to the shoreline to save the cost.

2) The sea bottom is sandy up to 50 m from the shoreline, silty from 50 m to 3 km, and muddy from 3 km offshore. Based on the result of boring test at the proposed site, the sand layer is expected to run to a depth of 6 m under the sea bottom at least up to 100 m from the shoreline.

The salinity above the sandy bottom is often low because of seepage of the groundwater, according to a DOF officer. Based on these conditions, the sea water shall be taken from more than 50 m offshore to avoid the influence of groundwater seepage, and sea water shall run to NPFPRC through an open ditch (not through a pipe, to avoid siltation inside the pipe).

3) The water depth 50 m offshore is 1.35-3.25 m at ordinary spring tide. The sea water intake can be installed 1.0 m above the bottom. A sedimentation tank shall be installed due to unavoidable inflow of silt.

4) Salinity drop may occur after heavy rainfall influenced by the freshwater inflow from the Merbok River located in the north of Pulau Sayak. According to the meteorological data both of Penang and Alor Setar Airports, continuous rainfall over 10 mm/day may last maximum 3 days during the peak season of mother tiger prawn (Sept. - Apr.). Accordingly, there may be no problems in fry production by storing sea water of about 3.5 times of maximum daily use.

5) Abundant barnacles were observed on rocky area near the site. This may attach to the inner surface of water pipes and cause problems. The sea water was rich in various kind of planktons, some of which may predate prawn fry. Consequently, the sea water shall be filtered by sand filter with back-wash system before use.

Based on these conditions, the sea water intake system is planned as follows;

1) Pumping up the sea water 1 m above the sea bottom at the point 100 m offshore,

2) Gravity flow of sea water to sea water reservoir through an

open ditch laid on a jetty made of precast concrete slab, RC girder and prestressed concrete piles,

3) Temporary storage in the reservoir,

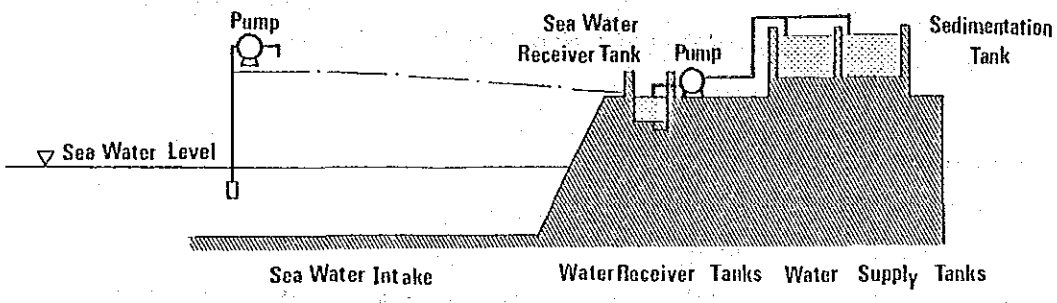
4) Transference to a sedimentiation tank by pumping and storage for 24 hours at least,

5) Pumping up silt-free sea water to a sand filtering tank with automatic back-wash system to remove predators of prawn larvae,

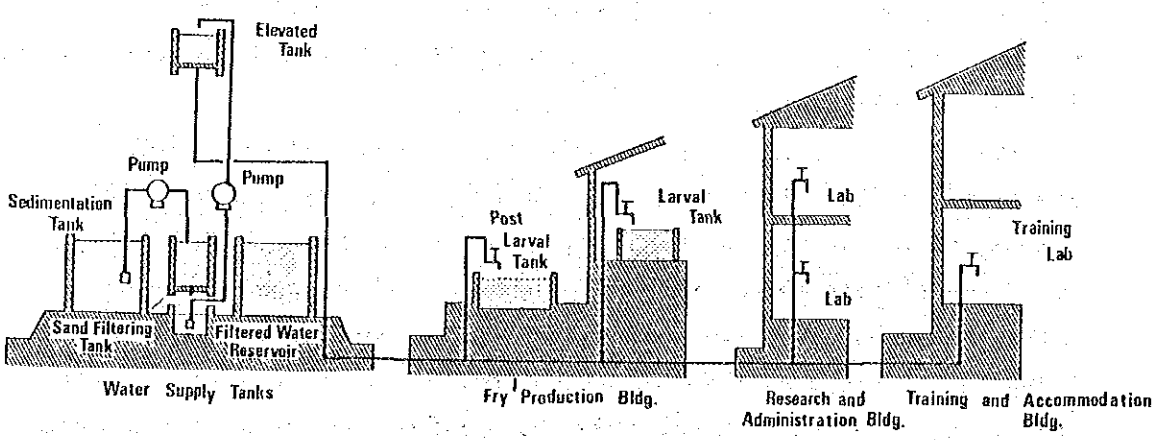
6) Transference of filtered sea water by gravity to a filtered water tank with storage capacity of maximum daily sea water demand,

7) Pumping up filtered sea water to an elevated tank.

The sea water intake system and sea water flow diagram are shown in the following figures;



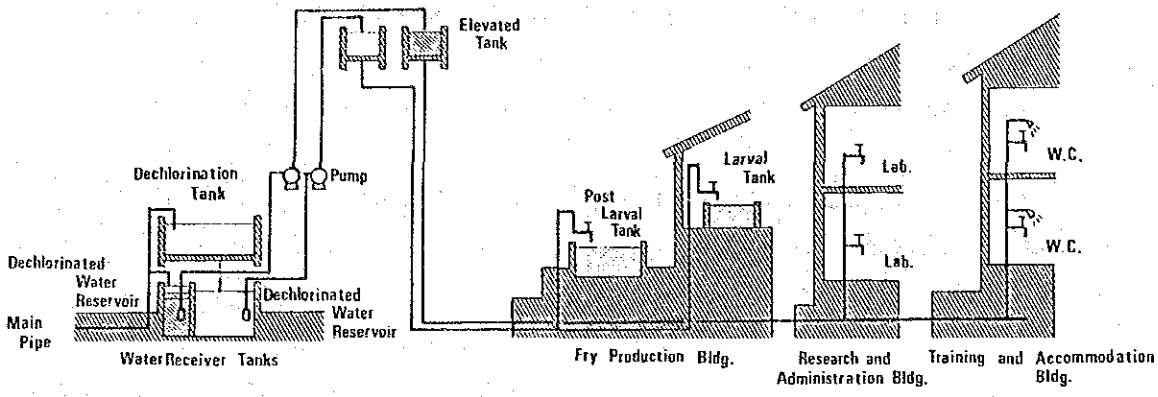
Sea Water Flow Diagram (Sea Water Intake)



Sea Water Flow Diagram

(3) Freshwater supply system

Freshwater is supplied to NPFPRC from tap water by JKR. Two freshwater reservoirs are provided before pumping up to two elevated water tanks. One is used for dechlorination of tap water for 24 hours before the use for fry production. The freshwater flow diagram is shown in the following figure.



Tap Water and Dechlorinated Water Flow Diagram

4.3.5 Architectural plan

(1) General plan

1) Fry production group

Water intake and supply system and rearing system are considered in the arrangement of the fry production group. Water is taken at the offshore area, runs through an open ditch to the site, and is stored in a reservoir. The sea water is then transferred to a sedimentation tank, a sand filtering tank, stored in a filtered water reservoir and finally pumped up to an elevated tank. The arrangement of the facilities is based on the shortest path of flow and the height levels of the elevated tank.

The procedures of fry production are: (1) unloading of mother prawn, (2) acclimatization of the mother prawn, (3) spawning, (4) rearing of larvae in indoor and then outdoor ponds, (5) shipment of fry. The facilities for these procedures, such as ponds, piping works, passages, are arranged to shorten the path of flow. From a viewpoint of disease prevention, the rearing system is divided into four independent units after spawning. Indoor and outdoor ponds are arranged to minimize dead space between the units, as shown in the following figure.

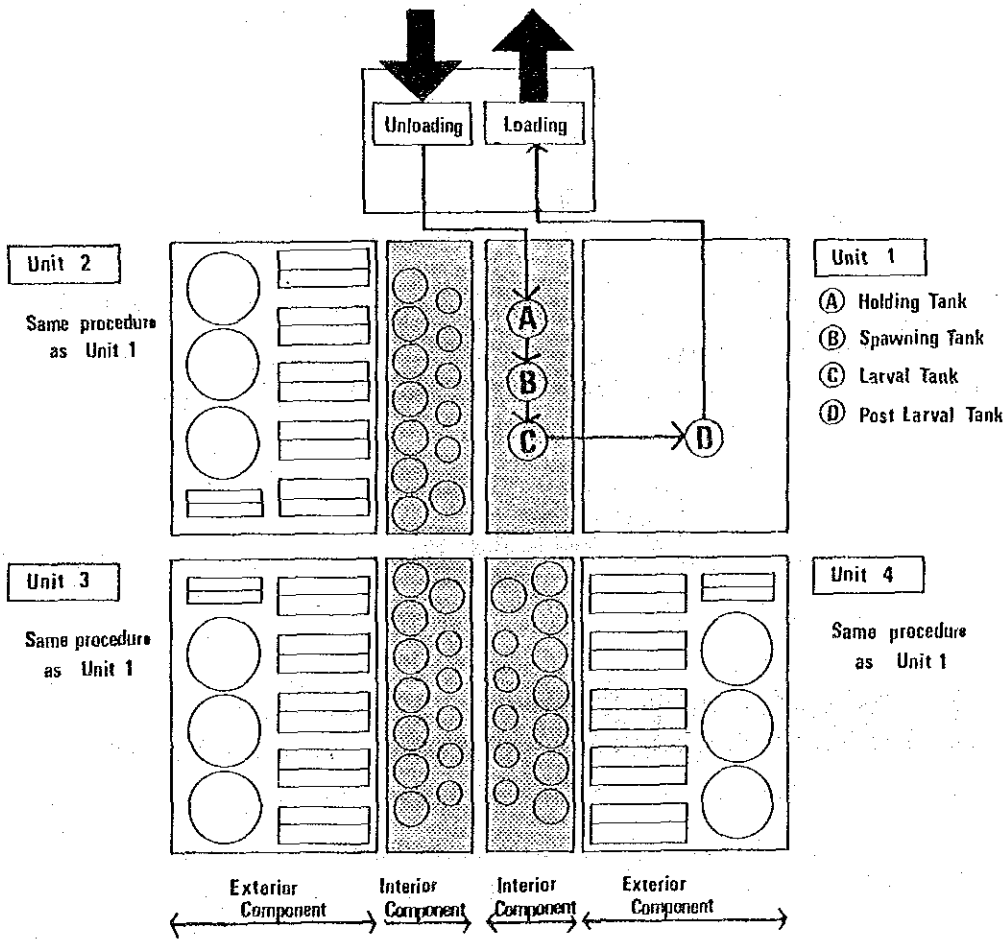
Sunshine is considered in the arrangement. The rearing unit, diatom culture tanks and brood stocking ponds are arranged on the southern side to receive much sunshine. The loading and unloading place and the offices located on the northern side. Connecting passageways are fenced with wire nets for security.

2) Research and administration group

The research facilities are arranged on the southern side close to the sea water reservoir and outdoor ponds, and the administration facilities on the northern side. A courtyard is arranged in between them for ventilation and lighting. Laboratories in the research facilities are arranged as follows: two laboratories (breeding and environment) in the ground floor (to be close with fry production facilities and outdoor ponds), and the other two (feeds and nutrition, and disease prevention) in the first floor. The research facilities and the administration facilities are connected with a roofed corridor.

3) Training group

The basic plan is similar to the research and administration



Units of Fry Production

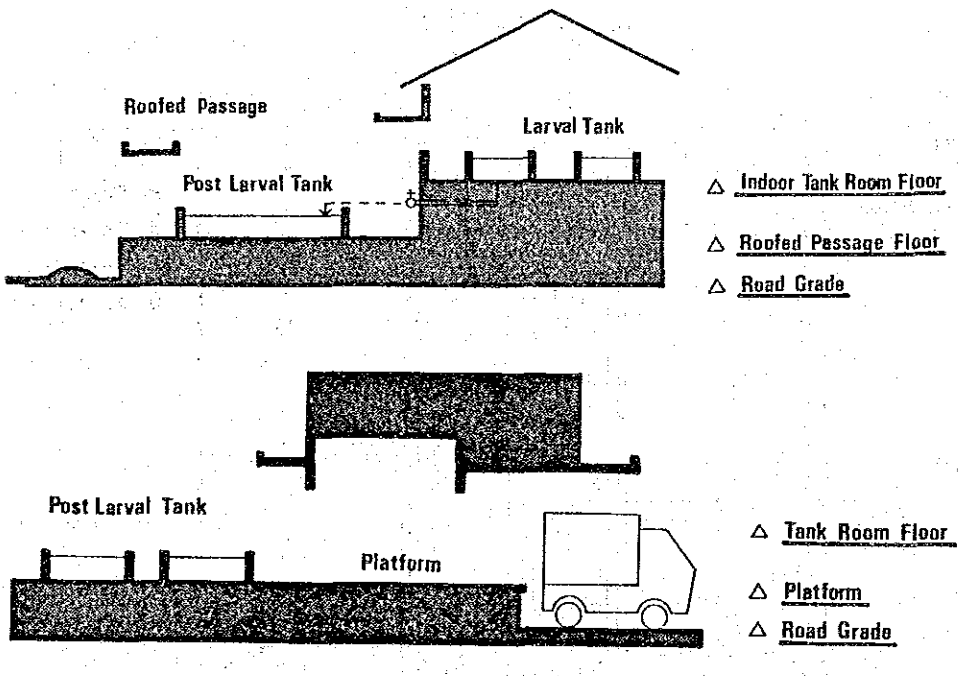
facilities. The training facilities are arranged on the northern side, and the accommodations building on the southern side. Both facilities are connected with a roofed corridor.

Planned architechtual area based on required facility areas for the NPFPRC and aforementioned general plan is summarized in the following table.

Architectural area required

Facility	Floor space (m^2)
1) Fry production	
a. water reservoir*	1,190m^{3*}
b. water supply tanks*	2,439m^{3*}
c. indoor ponds	2,800
d. outdoor ponds	3,344
2) Research and administration	1,520
3) Training	2,656
4) Others (machinery)	160

Remarks: *: indicated by volume.



Section of Fry Production Building

(2) Section plan

The floor of the research and administration, and the training buildings shall be about 1 m above the finished grade to avoid moisture.

The indoor ponds shall be about 1.5 m higher than the outdoor ponds in their bottom level, because the prawn fry shall be transferred by gravitational flow from the indoor ponds to the outdoor ponds. The platform for packing and shipping prawn fry shall be about 1 m higher than the road level (almost same height to lorry beds) to facilitate the loading work, as shown in the previous page.

(3) Construction method and materials

Two construction methods are common in Malaysia: (1) reinforced concrete for general buildings, and (2) structural steel for long span buildings such as factories and market facilities. NPFPRC shall be of reinforced concrete construction to prevent damage from salt. The following attentions shall be noted in construction works.

1) Earth work	Middle-sized bulldozers and back hoes procured locally shall be used. Rainy season may cause a problem during the earth work phase of construction. It should be done during the dry season.
2) Pile foundation	Piling foundation is required for the fry production building, the research and administration building and water supply tanks due to heavy load. Timber piles and precast concrete piles are locally available. Precast concrete piles are preferable due to probable high groundwater level.
3) Concrete work	Ready-mixed concrete is available, however, batch mixers on site are generally used by contractors, due to limitations in quantity and in transportation time. Construction joints are located under beams.
4) Reinforcement work	Steel bars are produced locally and most of main reinforcement are deformed. The strength and diameter are basically of the British Standards.

5) Form work　　Wood forms are popular in Malaysia. There is no problem in applying the form work technically.

Following finish materials shall be used, as listed below.

Area	Proposed finish materials
(1) Roof	Asbestos slate boards, corrugated vinyl chloride sheets, roof tile
(2) Exterior walls	Cement mortar on brickwork and paint finish
(3) Floor	Terrazzo tiles, cement mortar and trowel finish
(4) Inner walls	Cement mortar on brickwork and paint finish
(5) Inner ceiling	Direct ceiling with paint finish, suspended ceiling with accoustic boards

(4) Structural planning

1) Construction method

Reinforced concrete structure is the commonest construction method in Malaysia. Materials are abundantly available and the construction cost is reasonable, therefore, main skeleton shall be a rigid frame with reinforced concrete.

i) Research and administration building, training building, outdoor ponds, and machinery house.

The main skeleton shall be a rigid frame with reinforced concrete. Wooden trusses shall be applied. Side walls of of ponds are rigid frames with reinforced concrete. Exterior walls of other facilities are laid brick.

ii) Fry production building

The main skeleton for columns and girders shall be rigid frames with reinforced concrete, and roofs are wooden trusses.

iii) Water reservoir and elevated tank

They shall be rigid frames with reinforced concrete. Tank partitions shall be bearing walls.

iv) Water intake facilities

The facilities shall be rigid frames with precast concrete piles and the deck plate prefabricated to simplify offshore work.

2) Design criteria

i) Building law

The Uniform Building By-Laws was enacted in 1973 in Malaysia. The law comprises the following eight chapters;

Chapter 1. Preliminary
Chapter 2. Submission of Plans for Approval
Chapter 3. Space, Light and Ventilation
Chapter 4. Temporary Works in Connection with Building Operations.
Chapter 5. Structural Requirements
Chapter 6. Constructional Requirements
Chapter 7. Fire Requirements
Chapter 8. Miscellaneous

Concerning the "Structural Requirements", only principles are described; weight of materials, intensity of distributed load to be used in the building or structure, horizontal loads on parapets and balustrades, and minimum width of strip foundations by subsoil, are shown.

Other structural designs conform British Standard and British Standard Code of Practice, or Japanese Industrial Standards.

ii) Live load

Live load calculated by room is shown in Table 4.3.

iii) Dead load

Dead load shall be calculated by the weight of frame and finish materials following the standards, as shown in Table 4.4.

iv) Seismic force

As for the horizontal force, it is not necessary to calculate seismic force, because there is no earthquake in Malaysia.

v) Wind load

The skeleton is a rigid frame with reinforced concrete and the wind load is small in Malaysia. Therefore, the wind load shall not be considered.

vi) Foundation

The topsoil of the site is covered with beach sand, except the shale exposed in the southern part (for training building area). According to BH-2 boring survey data, the bearing capacity of soil is 4 ton/m^2. This layer is not suitable for bearing subsoil for NPFPRC. The bearing subsoil for NPFPRC shall be (1) weathered shale of 3.5-6.5 m deep, or (2) fresh shale 6.5 m deep or more. Wooden piles or precast concrete piles shall be applied for the former or the latter, respectively. The concrete piles shall be selected, due to heavy load per column on the research and administration building, the fry production building and the elevated tank. In case of wooden piles, their head should be below the groundwater level to prevent corrosion. Concerning the training building, the spread foundation shall be used on the shale layer. The bearing capacity of the layer is estimated to be 30-50 ton/m^2.

3) Materials for skeleton

Materials for main skeleton are described below;

i) Concrete

The proportion of concrete for main skeleton shall be 1:2:4. Twenty-eight-day-aged compressive strength shall be 3,000 psi (210 kg/cm^2).

ii) Reinforced steel bar

Mild steel bar (yield point: 36,000 psi = 2,500 kg/cm^2) and high tensile steel bar (60,000 psi = 4,100 kg/cm^2) shall be applied. The latter shall be used for main skeleton for columns and girders, and the former for others.

iii) Pile

Wooden and concrete piles are produced in Malaysia and shall be procured locally.

4.3.6 Installation

(1) Electricity installation plan

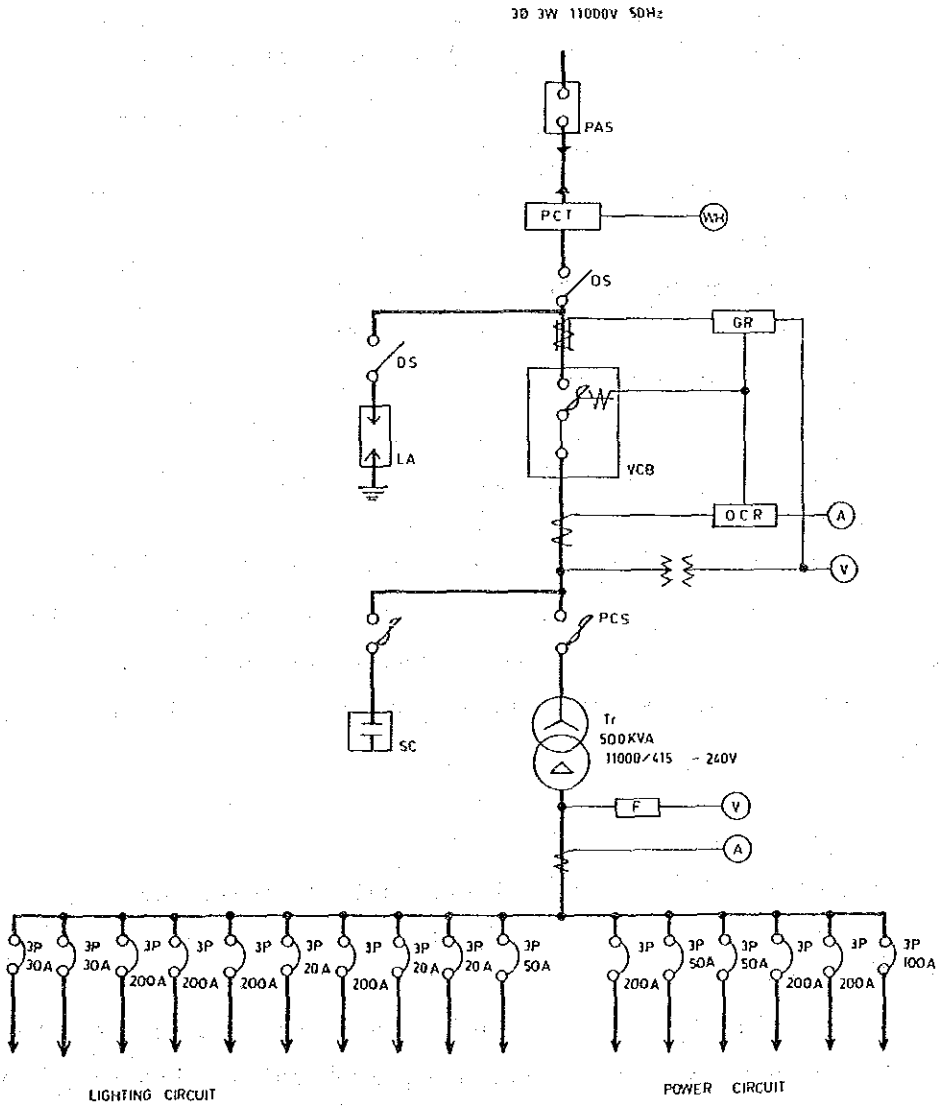
1) Electricity supply installation

A high voltage (11 KV) service line is running along the access

road. NPFPRC will receive electricity through this service line. Transformers shall be installed at the substation in the site to lower the voltage to 415 V (50 Hz) for motors and 240 V (50 Hz) for lighting.

2) Main power facilities

Electric poles shall be erected to distribute the power from the transformers to the control panel of the motor facilities and to switchboards for lighting. The distribution system is shown below.



Single Line Diagram

3) Electricity for motors

Electricity is distributed to motors through the control panel: (1) sea water intake pump, (2) sea water lifting pump, (3) freshwater lifting pump, (4) freezer and refrigerator unit, and (5) blower. An alarm for abnormal pressure shall be installed to the blower.

4) Lighting installation

Fluorescent lights shall be used for the interior illumination of the facilities. Lights shall be on surface mounted fixtures or pendant fixtures. Outdoor lighting fixture shall be water proofed. The followings are suitable luminous intensity of the facilities.

Facility	Luminous intensity (lux)
Research and administration	300
Fry production	
Indoor tanks	150
Other facilities	300
Training	300
Corridor and lavatory	100

5) Receptable

Receptacle shall be installed on walls. Wall outlets in the indoor pond facilities and outdoor outlets shall be water proofed. Circuits shall be separated by outlet unit: (1) general purposes, (2) research and experiments, (3) ventilation fans, and (4) air conditioning.

6) Telephone

An automatic telephone switchboard shall be installed.

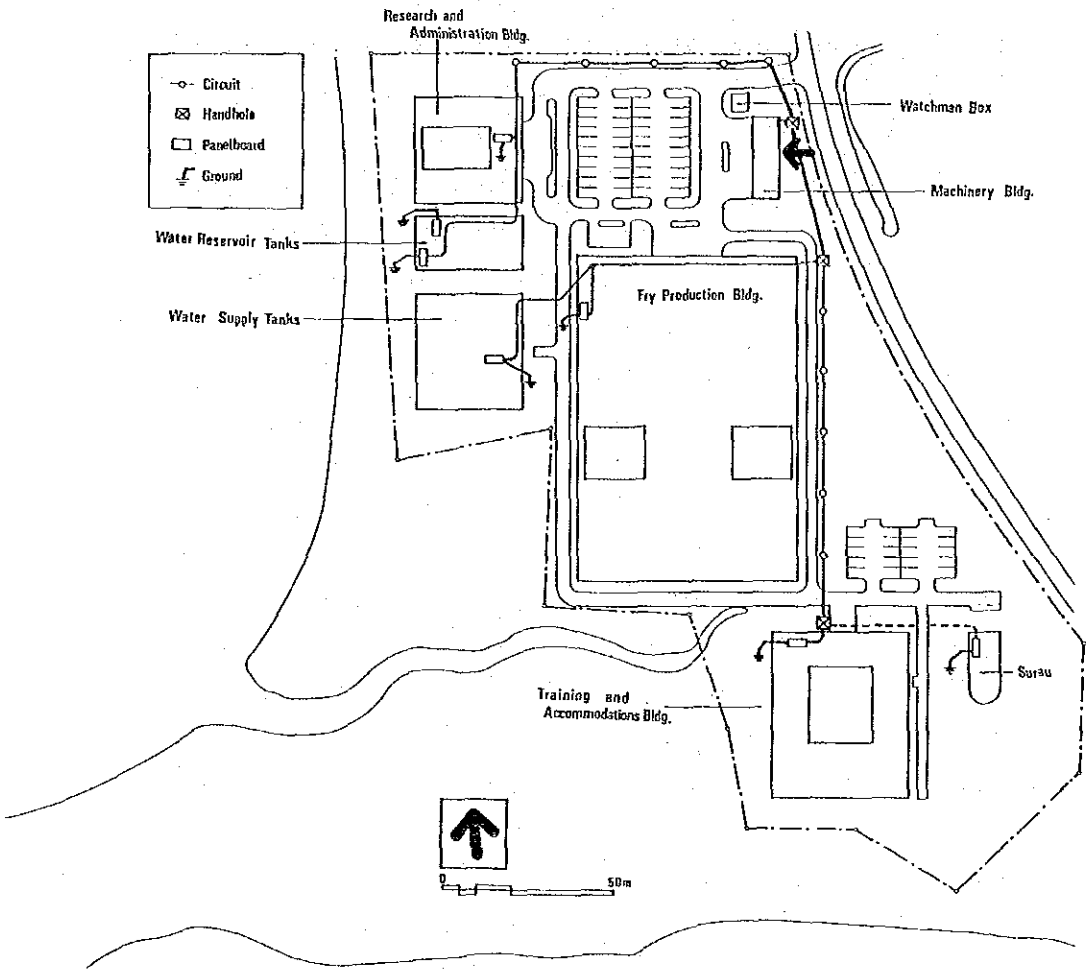
7) Generator

A generator shall be large enough to meet the demand for motors, lighting, freezers, refrigerators, and telephone switchboard. The generator should work automatically in case of the failure of power supply.

8) Lightning rod

Lightning rods shall be installed at the elevated tank and the training building.

The basic concept of the power distribution is shown below.



Power Layout

(2) Air conditioning and ventilation

The facilities are designed to make the most use of natural ventilation in order to minimize ventilation or air conditioning installations. The followings are indispensable ventilation and air conditioning installations.

1) Air conditioning

Air conditioners shall be installed in the following rooms.

Fry production facilities	office, staff room, incubation room, dry laboratory
Research and administration	director's room, office, clerk room, library, incubation room, researchers' room, conference room, guest room, telephone switch board room, laboratory
Training facilities	instructors' room, office, lecture room, training laboratory, library

2) Ventilation

Ventilators shall be installed in the following rooms.

Fry production facilities	indoor pond facilities
Research and administration ..	laboratory
Training facilities	training room, laboratory, kitchen.

3) Freezer and refrigerator

A large quantity of feed is stored in fry production systems. Prawn feed for fry production shall be stored as follows;

Freezer (-30°C, 2 ton capacity)
for fresh clam (about 330 kg) (local supply) for one week demand

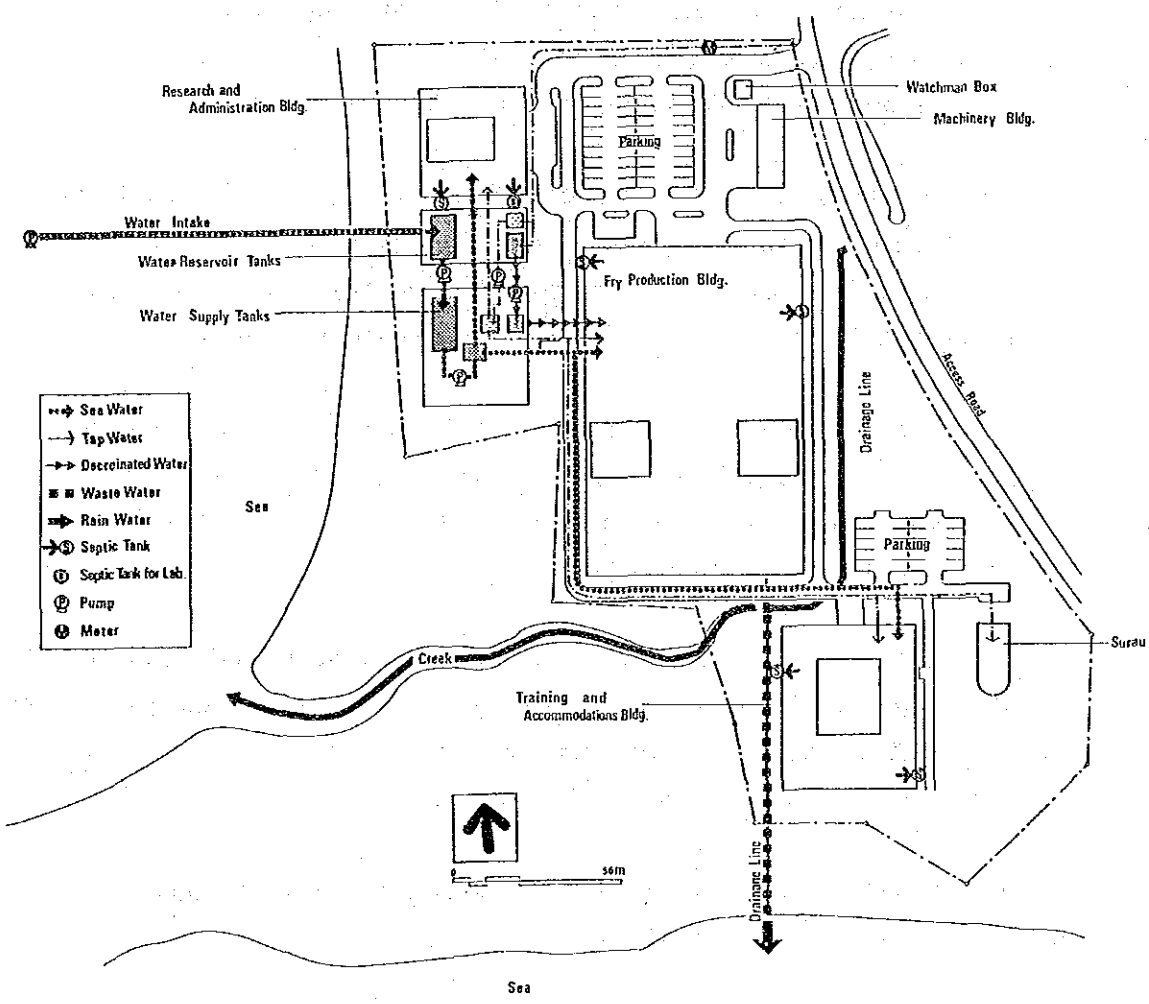
Refrigerator (+5°C, 4 ton capacity)
for formulated feed (about 160 kg) and imported canned Artemia egg (about 520 kg in total) for one month demand

4) Others

Ceiling fans shall be installed in other rooms.

(3) Drainage installation

Four separate drainage systems shall be installed as shown in the following figure: (1) rainwater, (2) sewage (3) waste water, mainly pond water, and (4) waste water including chemicals after experiments. Rainwater shall be drained to the sea through the existing creek which shall be repaired. Sewage and waste water including chemicals shall be stored in a septic tank and a storage tank, respectively. The former shall be collected by tank trucks, the latter shall be discharged after dilution with pond water waste through a proposed canal. The pond water waste shall be discharged into the sea through the proposed canal on the southern side of the site.



Water and Drainage Flow Diagram