# THE KINGDOM OF THAILAND

## FEASIBILITY STUDY
## ON
## THE BANG NARA
## IRRIGATION AND DRAINAGE PROJECT

## MAIN REPORT

DECEMBER 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

# THE KINGDOM OF THAILAND

FEASIBILITY STUDY

ON

# THE BANG NARA IRRIGATION AND DRAINAGE PROJECT

MAIN REPORT

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# PREFACE

In response to the request of the Government of the Kingdom of Thailand, the Japanese Government has decided to conduct a feasibility study on the Bang Nara Irrigation and Drainage Project and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Thailand a survey team headed by Mr. Yasushi MIYAZAKI of Sanyu Consultants Inc. two times during a period June, 1985 to March, 1986.

The team exchanged views with the officials concerned of the Government of Thailand and conducted a field survey in Changwat Narathiwat.

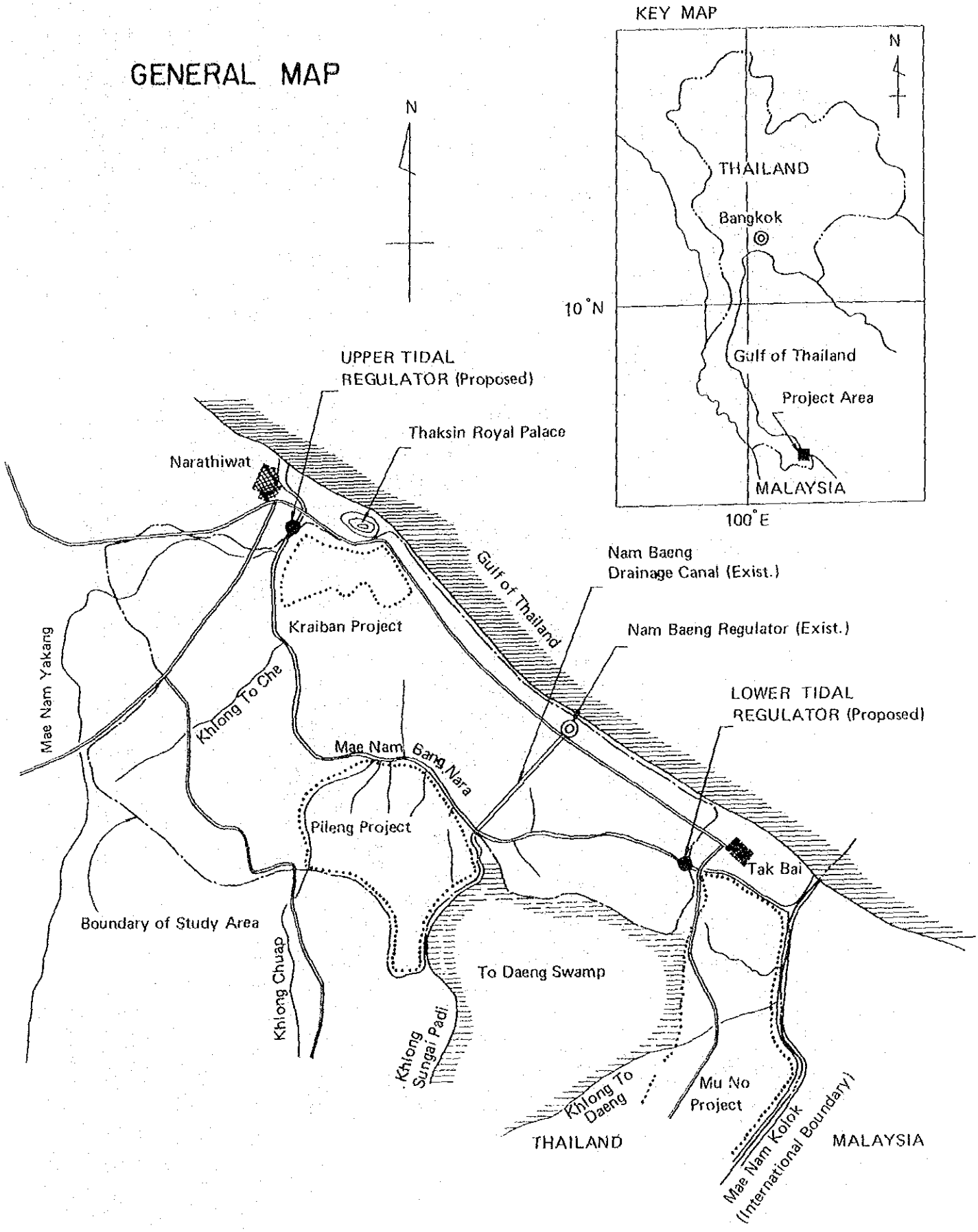
After the team returned to Japan, further studies were made and the present report has been prepared.

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.

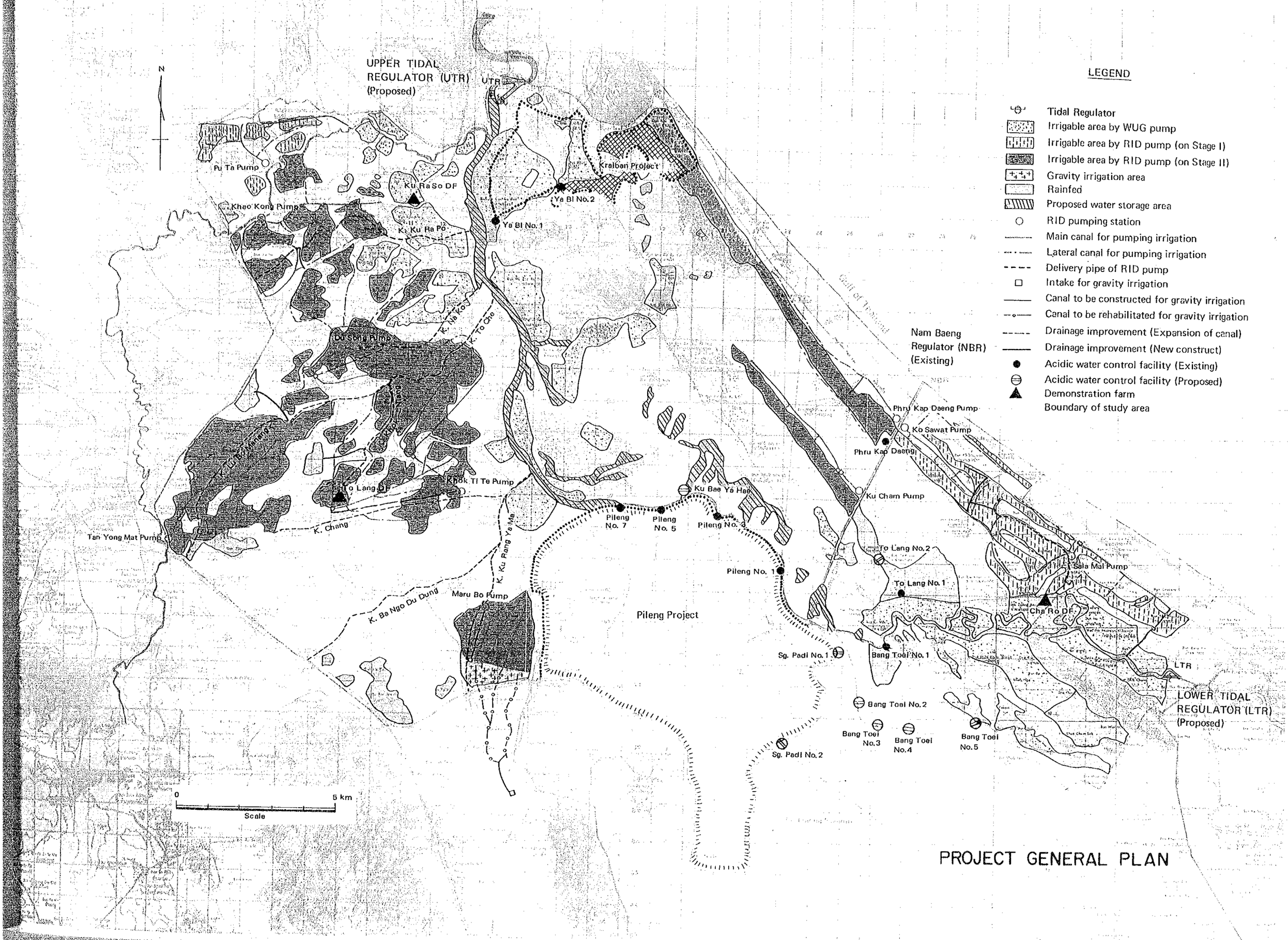
I wish to express my deep appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

December, 1986

Keisuke ARITA
President
Japan International Cooperation Agency


GENERAL MAP
N
KEY MAP
N
THAILAND
Bangkok
10°N
Gulf of Thailand
Project Area
MALAYSIA
100°E
UPPER TIDAL
REGULATOR (Proposed)
Thaksin Royal Palace
Narathiwat
Nam Baeng
Drainage Canal (Exist.)
Gulf of Thailand
Kraiban Project
Nam Baeng Regulator (Exist.)
Mae Nam Yakang
Khlong To Cha
LOWER TIDAL
REGULATOR (Proposed)
Mae Nam Bang Nara
Pileng Project
Tak Bai
Boundary of Study Area
Khlong Chuap
To Daeng Swamp
Khlong
Sungai Padi
Khlong To
Daeng
Mu No
Project
THAILAND
MALAYSIA
Mae Nam Kolok
(International Boundary)
0
5
10
15km

# PROJECT GENERAL PLAN



## CURRENCY EQUIVALENTS

- at 1986-February term -

| | | | | |
|---|---|---|---|---|
| US$ | 1.00 | = Baht 26.3 | = Yen | 180 |
| Baht | 1.00 | = US$ 0.038 | = Yen | 6.84 |
| Yen | 100.00 | = Baht 14.6 | = US$ | 0.56 |

## UNITS OF MEASUREMENT

1 rai = 0.16 ha = 1,600 sq.m

1 ha = 6.25 rai = 10,000 sq.m

## THAI FISCAL YEAR

October 1 to September 30, next year

## ABBREVIATIONS AND ACRONYMS USED

### THAI GOVERNMENT

| | | |
|---|---|---|
| ARD | : | Office of Accelerated Rural Development, MOI |
| BAAC | : | Bank for Agriculture and Agricultural Cooperatives |
| CDD | : | Community Development Department, MOI |
| CPD | : | Cooperatives Promotion Department, MOAC |
| DOA | : | Department of Agriculture, MOAC |
| DLD | : | Department of Land Development, MOAC |
| DMR | : | Mineral Resources Department, Ministry of Industry |
| DOAE | : | Department of Agricultural Extension, MOAC |
| DOF | : | Department of Fisheries, MOAC |
| DOH | : | Department of Highway, MOC |
| DOL | : | Department of Lands, MOI |
| DOLA | : | Department of Local Administration, MOI |
| HD | : | Harbor Department, MOC |
| LDD | : | Livestock Development Department, MOAC |
| MD | : | Meteorological Department, MOC |
| MOAC | : | Ministry of Agriculture and Cooperatives |

| | | |
|---|---|---|
| MOC | : | Ministry of Communications |
| MOF | : | Marketing Organization for Farmers, MOAC |
| MOI | : | Ministry of Interior |
| MOPH | : | Ministry of Public Health |
| NEA | : | National Energy Administration, Ministry of Science, Technology, and Energy |
| NEB | : | Office of National Environment Board, Ministry of Science, Technology and Energy |
| NESDB | : | Office of National Economic and Social Development Board, Office of the Prime Minister |
| NICA | : | National Institute of Coastal Aquaculture, DOF |
| NRDC | : | National Rural Development Committee |
| NSO | : | National Statistics Office, Office of the Prime Minister |
| OAE | : | Office of Agricultural Economics, MOAC |
| ORRAF | : | Office of Rubber Replanting Aid Fund, MOAC |
| PEA | : | Provincial Electricity Authority, MOI |
| PSU | : | Prince of Songkhla University |
| PWWA | : | Provincial Water Works Authority, MOI |
| RFD | : | Royal Forestry Department, MOAC |
| RID | : | Royal Irrigation Department, MOAC |
| RTSD | : | Royal Thai Survey Department |
| SRAO | : | Southern Region Agricultural Office, Office of the Permanent Secretary, MOAC |

GENERAL

| | | |
|---|---|---|
| ฿ | : | Thai Baht |
| BM | : | Bench Mark |
| EIRR | : | Economic Internal Rate of Return |
| EL | : | Elevation above Mean Sea Level |
| FAO | : | Food and Agriculture Organization |
| GDP | : | Gross Domestic Product |
| GNP | : | Gross National Product |
| GRBDS | : | Golok River Basin Development Study |
| HYV | : | High Yielding Variety |
| JICA | : | Japan International Cooperation Agency |

| | | |
|---|---|---|
| LTR | : | Lower Tidal Regulator |
| M. | : | Million |
| NBR | : | Nam Baeng Tidal Regulator |
| NPV | : | Net Production Value |
| Sg. | : | Sungai |
| SSIP | : | Small Scale Irrigation Programme |
| UTR | : | Upper Tidal Regulator, including Mae Nam Yakang |
| WUG | : | Water Users Group |
| WL | : | Water Level |
| cu.m | : | Cubic Meters |
| MCM | : | Million Cubic Meters |
| ha | : | Hectare |
| m | : | Meter |
| kg | : | Kilogram |
| km | : | Kilometer |
| sq.km | : | Square Kilometers |
| sq.m | : | Square Meters |
| ton | : | Metric Ton |
| p.a. | : | per annum |
| Yr | : | Year |
| hr | : | Hour |
| min | : | Minute |
| sec | : | Second |
| °C | : | Degree Centigrade |
| mS/cm | : | Milli Siemens per Centimeter (same as m.mho/cm) |
| HP | : | Horsepower |
| L.C. | : | Local Cost (Local currency cost which refers to the Project expenditure in Thai Baht but excludes the indirect foreign exchange cost) |
| D.F.C. | : | Direct Foreign Cost (Direct foreign exchange cost which includes all currency cost other than Thai Baht) |
| I.F.C. | : | Indirect Foreign Cost (Indirect foreign exchange cost which refers to the Project expenditure in Thai Baht and is equivalent to that on the import content of required goods and services) |
| F.C. | : | Foreign Cost (a total of the direct foreign exchange cost and the indirect foreign exchange cost) |

## GLOSSARY

| | | |
|---|---|---|
| Changwat | : | Province |
| Amphoe | : | District |
| Tambol | : | Sub-District |
| Muban | : | Village |
| Mae Nam | : | Large River |
| Sungai | : | Medium-Sized River |
| Khlong | : | Tributary of the Large River |

## PRESENTATION OF THE REPORT

The Final Report is presented in three separately bound volumes as below:

1. Executive Summary Report
2. Main Report
3. Appendices: Supporting Data

Unless otherwise specified the costs in this Report are expressed in Thai Baht.

MAIN REPORT

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(Supporting Data)

## CONTENTS OF EXECUTIVE SUMMARY REPORT

# SUMMARY

## 1. THE STUDY AREA

### 1.1. Location and Socio-Economic Overview

The Study area with the land area of 46,700 ha is situated in the northeastern part of Changwat Narathiwat and in the basin of Mae Nam Bang Nara with a total drainage area of 1,401 sq.km being penetrated through the low-lying coastal plain along the east coast of the Thai peninsula. It is located some 1,200 km far away from Bangkok.

The Study area covers portions of 4 Amphoe, viz. Muang Narathiwat, Yingo, Rangae and Tak Bai, occupying about 11 percent of the Changwat area and 18 percent of the Changwat population. The population of Narathiwat at the end of 1984 totals about 484,000, the majority of which are Thai Muslim and prefer to communicate in Jawi. The gross domestic product (GDP) of Changwat Narathiwat is compared to that for the rest of the country.

| | Changwat Narathiwat | Southern Region | Kingdom |
|---|---|---|---|
| 1983 per capita GDP (฿) | 12,900 | 16,200 | 18,800 |
| Per capita GDP growth rate | (1978 to 1983) | | |
| | 0.6% | 0.7% | 3.4% |

Agriculture is the main productive sector in Changwat Narathiwat accounting for 46 percent of total output, whereas the industrial sector has an output value of only 9 percent. This means that the Changwat economic structure has an obviously narrow base. Within the agricultural sector, the crop product occupies 90 percent of its total output value that is extremely high as compared with others and has the annual growth rate of 0.3 percent that is quite low. The livestock and fishery sectors have 7.3 percent and 1.4 percent of the total agricultural output respectively, but the annual growth rate has been recorded at 5.7 percent and 18.3 percent respectively.

### 1.2. Population and Farm Households

The demographic information in the Study area in the mid-1985 explains the population of 63,810, the households of 11,665 and the average family size of 5.5, in which the farm population constitutes 83 percent or 52,760 in 9,660 families. The average family size of 5.5 is considerably higher than the Narathiwat average of 4.8 and the Southern region of 5.2. Population growth rate slightly increased from 2.0 percent in the latter half of the 1970s to 2.1 percent.

There are several pattern farms which would be largely classified into sole paddy group (approximately 40 percent) and mixed paddy/rubber group (approximately 60 percent. Average farm size would be 1.9 ha and 2.5 ha, respectively. Such small farm size and the low productivity are combined to maintain the agricultural income low. The low farm income and relatively large family size to support account in part for the high proportion of the farmers with off-farm income which would be derived from the rubber tapper, unskilled construction labor and the seasonal employment in Malaysia.

It has been estimated that annual average per capita income in the Study area's farm households would be slightly above ฿4,000 which is compared to the Thai average rural per capita income of ฿5,580 in 1985 price. The 1985 poverty line in the Thai rural area of ฿3,870 per capita explains that some of the small and medium farmers (say, 20 to 30 percent) would be on the poverty line.

## 1.3. Land Use

The present land use survey outlines that the farm land would be composed of the paddy field of 12,430 ha (27 percent), the rubber planted area of 8,320 ha (18 percent), the coconut planted area of 4,380 ha (9 percent) and other miscellaneous. In addition, three Forest Reserves such as (1) Laem Nam Bang Nara I, (2) Kok Mai Rua, and (3) part of Laem Nam Bang Nara II have been designated with a total area of 12,400 ha (27 percent). The majority of such forests are located as swamp forests in the low-lying land around Mae Nam Bang Nara. (refer to Table S-1 in para. 2.2.1.)

Comparison of the aerial photographs taken in March 1984 with those in 1975 indicates very little change. This means that the land use in the Study area has been stabilized to a high degree with the exception of intrusions into residual upland forest and swamp forest for pasture and paddy field development both by the Government agencies and by individual illegal settlers.

Changwat Narathiwat Office explains that in the Study area, (1) any wildlife propagation site and archaelogical and historical and cultural treasure have not been recognized to date, and (2) at present, there is no wildlife conservation site, but a study area (50 ha) for the wildlife inside the Forest Reserve "Kok Mai Rua", while the non-hunting area is in the Forest Reserves "Laem Nam Bang Nara I and II".

## 1.4. Agriculture

The climate of the Study area which is typical of an equatorial location with a full-time maritime exposure is featured by uniform temperatures throughout the year (annual mean: 27.2°C), high humidity (annual mean: 80.7%) and heavy rainfall.

The greatest single influence on the rainfall pattern is caused by the northeast monsoon during the period of November to January which accounts for about 50 percent of annual rainfall. Annual rainfall varies from about 2,500 mm at Narathiwat and 2,200 mm at Tak Bai along the coast to less towards the inland with the record of 1,600 mm at Rangae. The rainfall is of highly seasonal nature with the period of February to April for low rainfall. The months of May to August during the southwest monsoon have moderate rainfall averaging about 200 mm per month, and during this period, the off-season paddy and field crops cannot grow without having irrigation.

For the present paddy field, the main-season paddy which is rainfed and photo-sensitive is cultivated with the transplanting in September and October and the harvesting in February and March. Salient features of paddy production in the Study area are presented below:

- Some of the paddy field is flooded directly from Mae Nam Bang Nara, Mae Nam Yakang and their small tributaries, and also inundated by the impeded poor drainage.

- Due to the variability in the onset of monsoon rains, most of the area is subject to suboptimal time of the preparation of nursery bed and land and subsequent transplanting.

- Early finish of the monsoon rains is quite common resulting in dry fields and moisture stress during the grain development and maturation after flowering in January when the risk of heavy rain and flood passes.

- The soils have a rather low level of fertility with the nitrogen and phosphate required to get the satisfactory yields. Some areas are underlain by an acid sulfate material and also rendered unproductive by the water deficit problems when the soils are over-drained.

- These factors, being coupled with lower input, low yield and return and more attractive return to the off-farm work, have indicated the reason why 30 to 40 percent of the paddy field is not planted. This tendency could be expected to be further aggravated unless the appropriate measures are taken to reduce the risk factors and to make the paddy production more attractive.

- Paddy production data by Amphoe concerned with the Study area explain that average rates of planted/total field and harvested/planted would be 68 percent and 87 percent, respectively. With an average yield for the planted area that is estimated at 1.4 ton per ha, a total annual production of the main-season paddy accounts for some 12,100 ton which would be insufficient to meet the local demand in the Study area.

Rubber is the dominant perennial crop. The area planted is 8,320 ha accounting for some 30 percent of the total agricultural land in the Study area, with the following factors:

- While some of the rubber grow in the better soils with fair drainage, the rubber planted in the flood-prone area is water-logged for part of the year with consequent reductions in yield.

- The rubber production practices are featured by a low input-low output approach. Most of the current rubbers are either unselected seedling material of low yield potential or over-aged, and have not been fertilized.

- Most of the farmers tap daily but suspend during the period of rainfall and inundation. Standards of tapping are generally low, especially among hired tappers, resulting in excessive bark consumption and damaged and infected panels. Standards of on-farm processing to unsmoked sheet are also low with the use of sulphuric acid.

- Out of the total rubber planted area, about 74 percent or 6,190 ha would be suffering from the decrease of tapping days due to annual flooding and inundation as well as less response to the replanting with improved higher yielding clones, resulting in low production.

## 1.5. Mae Nam Bang Nara

Mae Nam Bang Nara is running through the low-lying coastal plain being parallel to the east coast, with a total length of about 60 km and two outlets at Narathiwat to the ocean and Mae Nam Kolok connection, about 2 km upstream of its river mouth at Taba. It has a total catchment area of 1,401 sq.km dividing into 677 sq.km for Mae Nam Bang Nara and 724 sq.km for its major tributary, Mae Nam Yakang. It has been estimated that its average annual runoff would account for 1,834 million cu.m, of which 700 million cu.m are from Mae Namg Bang Nara and 1,134 million cu.m from Mae Nam Yakang, and about 60 percent of which is being concentrated during the rainy season from November to next January.

In connection with this Project, RID constructed the Nam Baeng tidal regulator in the Tak Bai area in 1983 with the excavation of the Nam Baeng drainage channel which is connected to the middle course of Mae Nam Bang Nara. Although this scheme would have given an effect of reduction of the annual inundation during heavy rains, there would be a tendency to promote the drainage over the low-lying swamp areas in its vicinity during the dry season.

The following three major problems with respect to the current conditions involved in Mae Nam Bang Nara have been pointed out:

(1) Salinity Intrusion

Mae Nam Bang Nara which has less slope is tidal and brackish throughout its entire course being directly affected by the tidal oscillations with the salinity intrusion into the river during the high tides. A wide seasonal fluctuation of the salinity is observed throughout its course, especially higher during the dry season; hence, this has refused an effective utilization of this water for agriculture.

(2) Annual Inundation and Flooding

Heavy rainfalls in spells of 3 to 5 days occur during the northeast monsoon particularly in December resulting in frequent flooding and inundation over the low-lying areas along Mae Nam Bang Nara with its peak water level at about EL +2 m. On the other hand, attenuation of the flood water in Mae Nam Yakang from Rangae to its mouth occurs due to the overtopping at river bank and the subsequent flooding takes place over the high-lying land towards Mae Namg Bang Nara. Additionally, there are deep and prolonged inundation and impeded drainage in the eastern part of the Study area with the flood originating from the Bang Nara tributaries.

(3) Inflow of the Acidic Water

In the vicinity of the bifurcation of the Nam Baeng drainage channel from Mae Namg Bang Nara and other small drainage channels recently excavated, as well as in the area of the Pileng land settlement project, the sulfate ions are being dissolved from the leachate of actual acid sulfate soils in connection with the dehydration of pyrite. The field observation shows that there would be sites with the Bang Nara water of pH value close to 4 during the less rainfall period.

## 1.6. Existing Constraints and Development Approach

The farm households numbered at 9,660 in the Study area have relatively small farm size as compared to other regions partly in connection with the traditional southern land inheritance system and additionally suffer from the unstable and low productivity of main season paddy with many risk factors. On the other hand, the rubber production would have less incentive for its improvement due to the inundation and impeded drainage problems. Although the off-farm employment is popular to support their low farm income and large family size, the present income level is low being close to the Thai rural poverty line.

Particular attention has been paid to the average wage rate of ฿150 per day earned in the neighbouring Malaysia which is more than two times higher than the Study area wage of ฿60 per day. This would have been related to the severe problem in terms of the socio-economic undervelopment and further generated the social-psychological and security problems in this border changwat; therefore, it has been recognized that the economic development in the Study area is an urgent matter.

It would not be easy to enlarge the above mentioned small sized farm households taking into consideration less impact from the new land development and settlement scheme currently promoted by the Government because of its small scale as well as the less feasibility for the reclamation of swamp forests in terms of the problem soils. Under this circumstance, the top priority should be given to development of the Bang Nara water resources which have not been utilized to date. In line with this, it would be an approach to promote, on maximum scale, an in-situ agricultural development through the construction of tidal regulators at two outlets with the control of acidic water inflow and the subsequent provision of irrigation and drainage facilities.

## 2. PLAN FORMULATION

### 2.1. Objectives

The planning and formulation of the agricultural development in quick yielding manner should be made in line with the prime objective related to the social welfare and poverty alleviation as well as the national rural development policy.

The proposed Project has been formulated in line with a strategy that the water resources in the Mae Nam Bang Nara basin should be made available for irrigation development while the annual inundation during the heavy rains should be alleviated to a possible extent. In order to attain this strategy, it would be essential to build, in addition to existing Nam Bang tidal regulator, a tidal regulator (or a salinity barrier) at each side of Narathiwat and Tak Bai along Mae Nam Bang Nara for the purpose of the exclusion of salinity intrusion and the provision of water storage for irrigation development, and concurrently to reduce the annual inundation over the low-lying area along Mae Nam Bang Nara through proper operation of the relevant tidal gates.

The next step would be (1) to provide the irrigation and drainage facilities for the possible service area with an aim to enhance the agricultural productivity in existing farm land, and (2) to stabilize this area from the socio-economic-political viewpoint in such manner that the irrigation distribution system would be planned to be capable of actual delivery of water to the maximum number of farmers within a scope that the national

socio-economic policy would permit. And, at the same time, a full support from the Government agencies concerned would be extended to the Muban families who could get the maximum benefits at the earliest practicable date.

## 2.2. Agricultural Development Plan

### 2.2.1. Land Use Plan

#### (1) Land Use

The land use plan in the Study area as formulated under the Project is given in Table S-1.

The perspective for new land development is limited to minor extent involving the rehabilitation of land on the fringes of swamp forests and ridge depression. The proposed Project would not incorporate any component to reclaim the swamp forests for paddy field because of poor soil conditions and related high development cost.

Table S-1. Land Use Plan

(Unit : ha)

| Land Type | Present Total in the Study Area | The Project | | | | | | | Outside the Project |
|---|---|---|---|---|---|---|---|---|---|
| | | Irrigation Development and Drainage Improvement 1/ | | | Drainage Improvement | | | Conversion to Fruit | |
| | | Paddy Field | Right-of-Way | Total | High-lying | Low-lying | Total | | |
| Paddy Field | 12,430 | 9,980 | 340 | 10,320 | 520 | - | 520 | - | 1,590 |
| Rubber Area | 8,320 | - | - | - | 6,190 | 60 2/ | 6,250 | - | 2,070 |
| Coconut Area | 4,380 | - | - | - | - | - | - | - | 4,380 |
| Orchard | 1,180 | - | - | - | - | - | - | - | 1,180 |
| Forest Reserve | 12,400 | - | - | - | - | - | - | - | 12,400 |
| Communal Copse | 600 | - | - | - | - | - | - | 60 | 540 |
| Others | 7,390 | - | - | - | - | - | - | - | 7,390 |
| Total | 46,700 | 9,980 | 340 | 10,320 | 6,710 | 60 | 6,770 | 60 | 29,550 |

1/ ..... Including those for irrigation development only.

2/ ..... With operation of the tidal gates.

(2) The Project Service Area

The area to be served by the irrigation development and drainage improvement under the proposed Project would be enumerated by development component as shown below:

Table S-2. Project Service Area

(Unit: ha)

| | Drainage Improvement | Irrigation Development | | | | Total |
|---|---|---|---|---|---|---|
| | | WUG Pumping | RID Pumping | Gravity | Total | |
| (1) Irrigation Development Only | | | | | | |
| Paddy Field | - | 3,520 | 1,990 | 140 | 5,650 | 5,650 |
| (2) Irrigation Development + Drainage Improvement | | | | | | |
| Paddy Field | - | 350 | 3,940 | 40 | 4,330 | 4,330 |
| (3) Drainage Improvement Only | | | | | | |
| Paddy Field | 520 | - | - | - | - | 520 |
| Rubber Area | 6,250 | - | - | - | - | 6,250 |
| Sub-total | 6,770 | - | - | - | - | 6,770 |
| Total | 6,770 | 3,870 | 5,930 | 180 | 9,980 | 16,750 |
| Paddy Field | 520 | 3,870 | 5,930 | 180 | 9,980 | 10,500 |
| Rubber Area | 6,250 | - | - | - | - | 6,250 |

(3) Irrigation Development

- It would be a basic principle to make supplemental irrigation for the main-season paddy and full irrigation for the off-season field crops and vegetables in existing rainfed paddy field.

- With the target to maximize the irrigable area on the basis of the available water resources in line with the objective as mentioned in para. 2.1. existing rainfed paddy field of 9,800 ha would be converted into the irrigated one by pumped up water from the proposed Bang Nara storage and its upstream Mae Nam Yakang. In the water storage balance simulations, the minimum river maintenance flow of 5 cu.m per sec for the lower reaches of Mae Nam Bang Nara in terms of water environment and river entrance sand bar at Narathiwat estuary and the future demand of 1 cu.m per sec including the domestic water supply for Narathiwat Municipality have been taken into consideration.

- With a view to diverting the available streamflow in the Bang Nara tributaries, existing rainfed paddy field of 180 ha in the upstream of Khlong Maru Bo would be irrigated in the gravity manner with an aim to improve the rainfed field as much as possible.

- Taking into account the impounding water level of the Bang Nara water storage, the proposed irrigation schemes would depend upon the pumping method as a whole. Under this circumstance, two modes of the pumping irrigation have been delineated:

  Portable pumping scheme:

  ° Existing paddy field below EL +2 m on an average which is distributed on the fringe of the Bang Nara water storage would be irrigated by portable lift pumps utilizing existing small tributaries and drains reversely from the water storage. It could be mentioned that this type of the small pumps have been procured and operated by many farmers or their groups in the Mae Nam Chao Phraya Basin and Northeast Region. This is hereinafter referred to as "WUG pumping irrigation scheme".

  Fixed pumping scheme:

  ° Existing paddy field with EL +2 to 13 m would be irrigated by fixed type pumps with some improvement of existing small tributaries and drains from the Bang Nara water storage. Following this, the main and lateral canals would be provided upto the outlets into each terminal service unit. This is referred to as "RID pumping irrigation scheme".

- The service area proposed under the irrigation development as mentioned above is summarized below:

(Unit: ha)

| | | | |
|---|---|---|---|
| * Pumping irrigation from the Bang Nara Water Storage and Mae Nam Yakang | | | |
| Paddy field, below EL +2m on an average by portable pump | 3,870 | (40) | (39) |
| Paddy field, EL+2 to 13 m by fixed pump | 5,930 | (60) | (59) |
| Sub-total | 9,800 | (100) | (98) |
| * Gravity irrigation from the Bang Nara tributary | 180 | | ( 2) |
| Total | 9,980 | | (100) |

(4) Drainage Improvement

Apart from the effect of flood mitigation over the low-lying land along Mae Nam Bang Nara by two proposed tidal regulators, appropriate drainage improvement scheme would be provided for 7 sub-areas over the high-lying land covering the western part of the Project area where the overtopping of Mae Nam Yakang occurs and the eastern part with the flood originating from the Bang Nara tributaries. This scheme which intends not to prevent the flooding but to alleviate deep and prolonged inundation and impeded drainage would serve existing paddy field of 4,850 ha and rubber planted area of 6,190 ha with the improvement of existing river tributaries and drains by widening and deepening.

(5) Irrigated Cropping Patterns

The irrigated cropping patterns composed of 98 percent of the main-season paddy, 2 percent of the perennial forage crops and 25 percent of the off-season field crops and vegetables would be introduced under the Project.

Increased production of the main-season paddy would contribute to overcome the present rice deficit in the Study area. In view of the current Government policy not to increase the rice production due to the depression of its export and the unfavorable farm gate price, the production of off-season paddy has not been incorporated into a plan.

Extent of the off-season field crops and vegetables which would take a form of the collective cultivation on the basis of a Muban cooperative has been worked out at the realizable level taking into account the availability of farming labor and the possible marketing of such products to the neighboring Malaysia in connection with completion of the on-going Taba New Town Development Scheme as well as the increasing local demand including that of Hadyai/Songkhla region.

It is also intended that with a view to promoting the livestock development, the perennial green mowed forage crops such as Torpedo and Para Grass have been incorporated into the irrigation plan in the area above EL +1.8 m which would not be so suitable for the paddy cultivation mainly due to soil property and would be cultivated on the basis of Muban cooperative operations. In addition, the promising fruit such as Long Kong which would not be directly irrigated could be introduced with the conversion of the present communal copse-wood land where a higher groundwater table would be kept in the vicinity of the paddy fields under irrigation throughout the year.

The proposed cropping patterns under the Project are shown in Table S-3.

Table S-3. Cropping Pattern with the Project

(Unit : ha)

| | Total Area | % | By Irrigation Type: WUG Pumping Below EL1.8m | WUG Pumping EL1.8 to 4m | WUG Pumping Total | By Stage: RID Pumping & Gravity EL 2 to 13 m | Stage I: WUG Pumping | Stage I: RID Pumping | Stage I: Total | StageII RID Pumping & Gravity |
|---|---|---|---|---|---|---|---|---|---|---|
| (1) Paddy Field | | | | | | | | | | |
| Service Area | 9,980 | 100 | 3,370 | 500 | 3,870 | 6,110 | 3,870 | 1,240 | 5,110 | 4,870 |
| Main-Season Paddy | | | | | | | | | | |
| Local Improved | 3,370 | | 3,370 | - | 3,370 | - | 3,370 | - | 3,370 | - |
| HYV (RD13) | 4,810 | | - | 364 | 364 | 4,446 | 364 | 903 | 1,267 | 3,543 |
| HYV (RD 7) | 1,600 | | - | 121 | 121 | 1,479 | 121 | 300 | 421 | 1,179 |
| Sub-toal | 9,780 | 98 | 3,370 | 485 | 3,855 | 5,925 | 3,855 | 1,203 | 5,058 | 4,722 |
| Off-Season Field Crops and Vegetables | | | | | | | | | | |
| Sweet Corn | 620 | | 210 | 31 | 241 | 379 | 241 | 77 | 318 | 302 |
| Mung Bean | 620 | | 210 | 31 | 241 | 379 | 241 | 77 | 318 | 302 |
| Groundnuts | 620 | | 210 | 31 | 241 | 379 | 241 | 77 | 318 | 302 |
| Vegetables | 620 | | 210 | 32 | 242 | 378 | 242 | 77 | 319 | 301 |
| (Tomato) | (310) | | (105) | (16) | (121) | (189) | (121) | (38) | (159) | (151) |
| (Chilli) | (310) | | (105) | (16) | (121) | (189) | (121) | (39) | (160) | (150) |
| Sub-total | 2,480 | 25 | 840 | 125 | 965 | 1,515 | 965 | 308 | 1,273 | 1,207 |
| Perennial Forage | | | | | | | | | | |
| Torpedo/Para Grass | 200 | 2 | - | 15 | 15 | 185 | 15 | 37 | 52 | 148 |
| Total | 12,460 | 125 | 4,210 | 625 | 4,835 | 7,625 | 4,835 | 1,548 | 6,383 | 6,077 |
| (2) Conversion from Communal Copse-Wood Land (not irrigated) | 60 | | 20 | 3 | 23 | 37 | 23 | 8 | 31 | 29 |
| Tree Fruit | | | | | | | | | | |
| Long Kong | | | | | | | | | | |

## 2.2.2. Agricultural Production

The agricultural production without and with the condition of the Project in its service area is compared in terms of planted area, yield and production.

Table S-4. Agricultural Production Without and With the Project

| | Planted Area | | Yield | | Production | | |
|---|---|---|---|---|---|---|---|
| | | */ | | */ | | */ | |
| | Without | With | Without | With | Without | With | Incremental |
| | ....(ha)... | | ..(ton/ha).. | | .....(ton)..... | | |
| | | | | */ | .... At full development | | |
| Main-Season Paddy | | | | | | | |
| (1) Irrigation and Drainage Improvement | | | | | | | |
| | 7,018 | 9,780 | | | 9,766 | 31,710 | 21,944 |
| (Local Improved) | (2,366) | (3,370) | (1.3) | (2.8) | (3,076) | (9,436) | (6,360) |
| (HYV-RD 13) | (3,489) | (4,810) | (1.4) | (3.4) | (5,018) | (16,354) | (11,336) |
| (HYV-RD 7 | (1,163) | (1,600) | (1.4) | (3.7) | (1,672) | (5,920) | (4,248) |
| (2) Drainage Improvement Only | | | | | | | |
| | 354 | 354 | 1.3 | 1.7 | 460 | 602 | 142 |
| Total | 7,372 | 10,134 | | | 10,226 | 32,312 | 22,086 |
| Off-Season Field Crops and Vegetables (Irrigation) | | | | | | | |
| Sweet Corn | - | 620 | - | 3.0 | - | 1,860 | 1,860 |
| Mungbean | - | 620 | - | 1.2 | - | 744 | 744 |
| Groundnut | - | 620 | - | 1.8 | - | 1,116 | 1,116 |
| Vegetables | - | 620 | | | | | |
| (Tomato) | (-) | (310) | (-) | (15.0) | (-) | (4,650) | (4,650) |
| (Chili) | (-) | (310) | (-) | (12.0) | (-) | (3,720) | (3,720) |
| Total | | 2,480 | | | | | |
| Perennial Forage Crop (Irrigation) | | | | | | | |
| Torpedo/Para Grass | - | 200 | - | 40.0 | - | 8,000 | 8,000 |
| Rubber (Drainage Improvement) | | | | | | | |
| | 6,250 | 6,250 | 0.71 | 0.96 | 4,438 | 6,000 | 1,562 |
| Tree Fruit | | | | | | | |
| Long Kong | - | 60 | - | 4.0 | - | 240 | 240 |
| Bang Nara Water Storage Fisheries | | | | | | | |
| | | (Water Surface Area) | | | | | |
| | - | 1,390 | - | 0.15 | - | 209 | 209 |

### 2.2.3. Water Storage Fisheries Development

With the construction of two tidal regulators and acidic water flow check facilities for the strategic basins, the Bang Nara water storage would have a potential to promote the freshwater capture fisheries under extensive low-input farming with the review of storage morphometry, water quality still being slightly acidic and nutrient increases. Management of this fisheries would be developed with the stocking and restocking with appropriate fish species at adequate levels if the fisheries are sufficiently productive and economic. (Refer to Table S-4 in para. 2.2.2.)

## 2.3. Project Facilities

### 2.3.1. Tidal Regulators

#### (1) Location and Size

In addition to existing Nam Baeng channel and its outlet tidal regulator with a total gate opening width of 24 m, the most appropriate plan has been proposed to establish the Upper Tidal Regulator with a total gate opening width of 120 m to be located some 6 km upstream of the Narathiwat river mouth and about 1 km downstream of Mae Nam Yakang's confluence and of the Lower Tidal Regulator with a total gate opening width of 24 m some 7 km upstream of the Mae Nam Kolok connection. These two sites have been identified by RID with a top priority for the urgent construction, and RID has already completed the topographical survey and geological and soil mechanics investigations required even for the detailed design work.

During the course of regulators' site selection, some of the possible alternative sites have been thoroughly examined from the viewpoints of development potential of the available water resources, probable influence to the regulators' downstream reaches and river mouths, proper operation of the relevant facilities and required cost. As far as the structural alternatives of tidal regulators are concerned, a type of the vertical lift gated concrete structure and non-overflow typed embankment closure has been employed taking an advantageous structural stability in comparison with another type composed of the ungated overflow typed embankment closure and water level drawdown control structure by vertical lift gates. Then, a total gate opening width of each tidal regulator has been given on the basis of existing river width in the vicinity of each site taking into account a relationship between the construction cost and the extent to alleviate the annual inundation, with additional investigation of such supplemental ways as river channel excavation, removal of the sand bar at Narathiwat river mouth and so on.

It has been experienced that the ocean outlet of the Nam Baeng channel with the regulator about 400 m upstream from its channel end has been open sometimes during the high flood season and soon been blocked from the ocean side by sand bar generated with approximately 2.5 million cu.m per annum of the longshore sediment moves along the coast. The current procedures to open the sand bar by digging a narrow ditch across the bar and then adding the Bang Nara flood flow for flushing sand would be continued taking into account the technical difficulty to maintain the entrance even with the provision of a breakwater or training wall system; therefore, no structural improvement of the existing Nam Baeng Tidal Regulator and its ocean outlet has been incorporated in the Project.

The preliminary design of two tidal regulators is shown in nine Drawings as attached at the end of this Report, and major design dimensions of such regulators are explained in Table S-5.

(2) Water Storage Effect

With the proper operation of the regulators' tidal gates, a fixed impounding water level of Mae Nam Bang Nara as compared to its present tidal variation would be maintained, and this results in the establishment of a water storage necessary for irrigation.

It would be possible to raise a full water level of the water storage upto EL +1.1 m of the gate top at the Upper Tidal Regulator that is the lowest among the three; however, this requires the right-of-way for the submerged area including 2,700 ha of the paddy field and 60 ha of the rubber area. When a long dike along both sides of Mae Nam Bang Nara with 25 check gates at its tributaries is provided to eliminate the above-mentioned land loss, this arrangement would invite such disadvantages as high cost for the initial construction, difficulty in the operation of such many gates and poor drainage in the farm land adjacent to the dikes.

Taking into consideration the environmental constraints of existing swamp forests in the Laem Nam Bang Nara II Forest Reserve as well as the wildlife and riverside regimes, a normal impounding water level of the non-bunded water storage would be given at EL +0.4 m that any farm land is not submerged. In view of a perspective that excessive drawdown of the impounding water level for long period in the critical dry years would cause irreversible environmental damage to the ecology of swamp forests as well as the unfavorable dehydration of potential acid sulfate soils in the tributaries, the lower limit of the impounding water level would be taken at EL -0.2 m.

Table S-5. RID Tidal Regulators

| Item | Upper Tidal Regulator | Lower Tidal Regulator |
|---|---|---|
| **Regulator Body** | | |
| - Total gate opening width | 120 m | 24 m |
| - Elevation of sill | EL -4.0 m | EL -5.0 m |
| - Elevation of gate crest | EL +1.1 m | EL +1.6 m |
| - Impounding water level | | |
| High | EL +0.4 m | EL +0.4 m |
| Low | EL -0.2 m | -0.2 m |
| - Flood conditions | | |
| ° At 5-yr return period: | | |
| Upstream level | EL +2.23 m | EL +1.47 m |
| Downstream level | EL +1.63 m | EL +1.44 m |
| Max. outflow | 1,229 cu.m/sec | 185 cu.m/sec |
| -do- velocity | 1.65 m/sec | 1.25 m/sec |
| ° At 50-yr return period: | | |
| Upstream level | EL +3.25 m | EL +1.92 m |
| Downstream level | EL +2.32 m | EL +2.20 m |
| Max. outflow | 1,911 cu.m/sec | 326 cu.m/sec |
| -do- velocity | 2.20 m/sec | 2.04 m/sec |
| - Gate | | |
| ° Clear span | 20.0 m | 12.0 m |
| ° Gate height | 5.1 m | 6.6 m |
| ° Type | | |
| One-leaf roller, shell | 5 spans | - |
| Two-leaf roller, shell | 1 span | - |
| One-leaf roller, girder | - | 1 span |
| Two-leaf roller, shell & girder | - | 1 span |
| ° Seal | 3-side rubber | 3-side rubber |
| ° Operating speed | 0.3 m/min. | 0.3 m/min. |
| **Connection Channel** | | |
| - Length | 700 m | 340 m |
| - Bed width | 150 m | 30 m |
| - Elevation of bed | EL -4.0 m | EL -5.0 m |
| **Bang Nara Closure Dam** (Earth Fill with Riprap Protection) | | |
| - Length | 220 m | 75 m |
| - Max. height | 8.5 m | 8.5 m |
| - Elevation of crest | EL +3.5m | EL +2.5 m |
| - Crest width | 9.0 m | 9.0 m |

Dimensions of the Bang Nara water storage to be established immediately after the completion of two tidal regulators are summarized below:

Impounding Water Level and Water Storage

| | Water Level | Water Storage |
|---|---|---|
| Full Water Level | EL +0.4 m | $15.8 \times 10^6$ cu.m |
| Low Water Level | EL -0.2 m | $11.3 \times 10^6$ cu.m |
| Difference: | Effective Water Depth = 0.6 m | |
| | Effective Water Storage = $4.5 \times 10^6$ cu.m | |

Water Storage Surface Area: 1,390 ha
of which : river course, 510 ha
swamp forest, 880 ha

Catchment Area: 1,401 sq.km
of which: Mae Nam Bang Nara, 677 sq.km
Mae Nam Yakang, 724 sq.km

Annual Average Inflow: $1,834.3 \times 10^6$ cu.m (1956 to 1985)
of which: $700.6 \times 10^6$ cu.m from Mae Nam Bang Nara
$1,133.7 \times 10^6$ cu.m from Mae Nam Yakang

Annual Average Irrigation Diversion: $38.6 \times 10^6$ cu.m (1955 to 1985)

(3) Inundation Alleviation Effect

The hydraulic flood simulations study indicates that approximately 160 ha of the paddy field and 60 ha of the rubber area which are low-lying along Mae Nam Bang Nara would be protected from the current inundation when the target heavy rainfall with a five-year return period is applied. More particularly, a significant effect has been given to a conclusion that the Lower Tidal Regulator would function to eliminate the current flood invasion into Mae Nam Bang Nara due to the flooding of Mae Nam Kolok. This flood invasion amounts to 10 million cu.m which would be equivalent to the channel storage volume of Mae Nam Bang Nara.

2.3.2. Irrigation and Drainage Facilities

(1) WUG Pumping Irrigation Scheme

As soon as the Bang Nara water storage is established, the above-mentioned irrigable area would be in a possible situation to be serviced by a series of portable pumps (self-priming centrifugal pump directly coupled with gasoline engine on common base), when the water users' groups are properly organized and the on-farm work including the pump procurement is provided under the Government technical and financial assistance. This arrangement would correspond to the planning and formulation of a quick yielding project as are emphasized in para. 2.1.

Table S-6. RID Pumping Irrigation Scheme

| No. | Subproject | Service Area (ha) | Diversion Channel 1/ (km) | Pump 2/ Max.Q (cu.m/sec) | Pump 2/ No. of Units | Main and Lateral Canals (km) |
|---|---|---|---|---|---|---|
| STAGE I | | | | | | |
| 1. | Pu Ta | 230 | - | 0.32 | 2 | 5.1 |
| 2. | Sala Mai | 490 | 1.3 | 0.68 | 2 | 11.8 |
| 3. | Ko Sawat | 520 | - | 0.72 | 2 | 15.0 |
| | Sub-total | 1,240 | 1.3 | 1.72 | 6 | 31.9 |
| STAGE II | | | | | | |
| | (First Package) | 1,130 | - | 1.55 | 6 | 39.0 |
| 4. | Khao Kong | 560 | - | 0.77 | 2 | 16.9 |
| 5. | Phru Kap Daeng | 380 | - | 0.52 | 2 | 14.3 |
| 6. | Ku Cham | 190 | - | 0.26 | 2 | 7.8 |
| | (Second Package) | 2,000 | 6.6 | 2.76 | 6 | 52.7 |
| 7. | Du Song | 880 | 3.1 | 1.22 | 2 | 20.0 |
| 8. | Khok Ti Te | 1,120 | 3.5 | 1.54 | 4 | 32.7 |
| | (Third Package) | 1,560 | 4.6 | 2.15 | 5 | 28.3 |
| 9. | Tan Yong Nat | 1,090 | - | 1.50 | 3 | 18.9 |
| 10. | Maru Bo | 470 | 4.6 | 0.65 | 2 | 9.4 |
| | Sub-total | 4,690 | 11.2 | 6.46 | 17 | 120.0 |
| | Total | 5,930 | 12.5 | 8.18 | 23 | 151.9 |

1/ ..... Deepening of the Bang Nara tributaries from the Bang Nara water storage to the pumping plants.
2/ ..... Inclined mixed or axial flow type.

Table S-7. RID Drainage Improvement Scheme

| No. | Subproject | Catchment Area (ha) | Drainage Channel 1/ Improvement (km) | Drainage Channel 1/ Construction (km) | Drainage Channel 1/ Total (km) | Service Area Paddy Field (ha) | Service Area Rubber Area (ha) |
|---|---|---|---|---|---|---|---|
| STAGE I | | | | | | | |
| 1. | Ban Lo Mo | 1.2 | - | 2.5 | 2.5 | 70 | 50 |
| 2. | Ban Sala Pradu | 1.8 | - | 1.1 | 1.1 | 130 | - |
| 3. | Khlong Sala Mai | 10.0 | 5.0 | 1.7 | 6.7 | 500 | - |
| | Sub-total | 13.0 | 5.0 | 5.3 | 10.3 | 700 | 50 |
| STAGE II 2/ | | | | | | | |
| 4. | Khlong Ku Ra Po | 26.4 | 9.0 | 0.8 | 9.8 | 590 | 240 |
| 5. | Khlong Na Ko | 9.8 | 4.9 | - | 4.9 | 520 | 280 |
| 6. | Khlong To Che | 39.8 | 21.1 | 2.5 | 23.6 | 2,290 | 1,740 |
| 7. | Khlong Chang | 90.3 | 25.0 | 0.8 | 25.8 | 750 | 3,880 |
| | Sub-total | 166.3 | 60.0 | 4.1 | 64.1 | 4,150 | 6,140 |
| | Total | 179.3 | 65.0 | 9.4 | 74.4 | 4,850 | 6,190 |

1/ .... Widening and deepening of the Bang Nara tributaries.
2/ .... (1) First package : Khlong Ku Ra Po
(2) Second package : Khlong Na Ko + Khlong To Che (To Che + Khok Niang) + Khlong Chang (Chang)
(3) Third Package : Khlong To Che (Lu Bo Manang) + Khlong Chang (Ba Ngo Du Dung + Ku Rong Ya Ma)

(2) RID Irrigation and Drainage Scheme

In connection with the completion of two tidal regulators which are the key facilities in the Project, the associated RID irrigation and drainage facilities would be in the stage of full scale construction. RID would be responsible for the construction and O & M of fixed type pumping stations and subsequent canal systems for 10 schemes to irrigate 5,930 ha of existing paddy field, while the water users' groups would be responsible for the terminal irrigation on-farm work and related services. RID would also be responsible for the construction and subsequent O & M of 7 drainage improvement subprojects. The preliminary design of the proposed RID irrigation and drainage facilities is presented in three Drawings at the end of this Report.

2.3.3. Acidic Water Inflow Control Scheme

In relation to the present inflow of acidic water into Mae Nam Bang Nara as explained in para. 1.5, attention has been paid to the target basins including that of the Pileng land settlement scheme and those of its vicinity including six small rivers and drains called "Khlong Sg. Padi", "Khlong Bang Toei, "Ku Bae Ya Hae drain", "Khlong To Lang", "Pru Kap Daeng drain" and "Khlong Ya Bi".

The following countermeasures to protect the Bang Nara water storage from acidification have been established:

- During the rainy season, the sulfate ions which are formed during the previous dry season are dissolved by heavy rainfalls and then flushed away in a form of floods to the ocean.

- During the dry season, it is essential to keep the groundwater level at about 0.4 m below the ground surface with the provision of well-designed water level control facilities so-called "Acidic Water Flow Check Facilities".

At present, RID has completed the sluice gates at 4 sites of the Pileng area, one at Khlong Bang Toei, one at Khlong To Lang, one at Khlong Ya Bi and one at Pru Kap Daeng drain and is presently constructing one sluice gate at Khlong Ya Bi. Following this, RID has a plan to provide additional check structures for the remaining four rivers such as Ku Bae Ya Hae drain, Khlong Bang Toei, Khlong To Lang, and Khlong Sg. Padi and to complete a series of the acidic water flow check facilities at 17 sites covering the above-mentioned seven target basins. When proper control mode and operation rule are observed by the RID operators in connection with the effort to neutralize the acidity in the Bang Nara storage by mobilizing a large amount of the Yakang freshwater inflow through operation of the tidal regulators, there would be fundamentally no problem with respect to the effect on the water storage quality for irrigation.

The agricultural development covering the area where the sulfate ions are currently dissolved would be left over for future consideration, taking into account the less benefit to be derived from the development and also the relative difficulty in water conveyance from the Bang Nara storage when the acidic water flow check facilities are operated.

Table S-8. RID Acidic Water Inflow Control Scheme (STAGE I)

| No. | Sub-basin | Acidic Water Flow Check | | Catchment Area (sq.km) | Paddy Field to be Controlled (ha) |
|---|---|---|---|---|---|
| | | Already Constructed | To be Constructed | | |
| 1. | Khlong Ya Bi | Ya Bi No.1<br>Ya Bi No.2 | - | 21.0 | 345 |
| 2. | Ku Bae Ya Hae Drain | - | Ku Bae Ya Hae /1 | 14.3 | - |
| 3. | Pileng Drains | Pileng No.7<br>Pileng No.5<br>Pileng No.3<br>Pileng No.1 | - | 51.2 | - |
| 4. | Sg. Padi | - | Padi No.1 /1<br>Padi No.2 /1 | 78.2 | - |
| 5. | Khlong Ban | Bang Toei No.1 | Bang Toei No.2 /2<br>Bang Toei No.3 /2<br>Bang Toei No.4 /2<br>Bang Toei No.5 /2 | 13.0 | 24 |
| 6. | Khlong To Lang | To Lang No.1 | To Lang No.2 /1 | 12.8 | 410 |
| 7. | Pru Kap Daeng Drain | Pru Kap Daeng | - | 8.9 | 10 |
| | Total | 9 sites | 8 sites | 199.4 | 1,005 |

/1 ... Gate type.
/2 ... Fixed weir type.

## 2.4. Rural Infrastructure

It is understood that the provision of rural infrastructure in the Project area has received some strengthening in recent years due to its location adjacent to the Malaysian border and to a fact that this is recognized as a security sensitive area. While the Changwat Narathiwat is progressively developing towards the Thai national average for rural areas, the measures to overcome

deficiencies in the social and physical infrastructure in the Project area are already being incorporated into the departmental plans and proposals. Under this circumstance, any component of the rural infrastructure sector related to the Project has not been included in the Project.

## 3. PROJECT IMPLEMENTATION PROGRAMME

### 3.1. Organization and Management

#### 3.1.1. Project Implementing Agencies

There would be a wide range of the Government agencies to provide the services for water resources and related agricultural development in the Bang Nara Irrigation and Drainage Project. Such agencies would include the following:

1) Royal Irrigation Department (RID)
2) Department of Agriculture (DOA)
3) Department of Agricultural Extension (DOAE)
4) Department of Land Development (DLD)
5) Livestock Development Department (LDD)
6) Department of Fisheries (DOF)
7) Cooperative Promotion Department (CPD)
8) Department of Local Administration (DOLA)
9) Community Development Department (CDD)
10) Office of Rubber Replanting Aid Fund (ORRAF)
11) Marketing Organization for Farmers (MOF)
12) Bank for Agriculture and Agricultural Cooperatives (BAAC)
13) Southern Regional Agricultural Office (SRAO)

#### 3.1.2. Project Management and Implementation

(1) Project Lead Agency

The key issue for successful implementation of the subject Project would focus upon realization of the proposed irrigated agricultural development programme through the operation of demonstration farms, the organization of active water users' groups with subsequent development of on-farm facilities, and the implementation of various extension services to the Project farmers.

It is recommended that an appropriate agency to serve as a coordinating lead agency would be the Office of the Permanent Secretary of the Ministry of Agriculture and Cooperatives (MOAC) which has both the mandate and authority needed to take a broad overview of the rural area development.

(2) Project Policy and Steering Structure

It has been mentioned by RID that a special board to be chaired by the Minister of Agriculture and Cooperatives would be organized as a Central Steering Committee for the Project, both for overall planning and decision-making functions at the national level. The Board would have its members comprising the Permanent Secretary of MOAC and the heads of all line departments concerned including RID, DOA, DOAE, DLD, DOF, LDD and CPD; the Changwat Narathiwat Governor; Directors of ORRAF and MOF; General Manager of BAAC; and the representatives of DOLA and CDD, Ministry of Interior as well as the Budget Bureau and the National Economic and Social Development Board.

An existing Changwat Development Committee which advises the Governor and serves as a coordinating body at Changwat level would be fully mobilized with the Project policy structure and function at area development level. The Committee under the chairmanship of the Narathiwat Governor would have the members including the Director of SRAO; the Chief of Changwat Planning Unit; Changwat heads of all involved departments inclusive of RID, DOAE, DLD, DOF, LDD, CPD, CDD, ORRAF, MOF, and BAAC; and Amphoe heads of Muang Narathiwat, Tak Bai, Range and Yingo.

(3) Special Task Force Unit

It is needless to say that the development and successful achievement of irrigated agriculture under the Project requires a multi-disciplinary approach. Taking into account the information of communities and target groups as well as the current problems from a combination of agronomic, economic, and social causes, it would be imperative, among others, to organize a Special Task Force Unit in the Project to commence the favorable operation of three demonstration farms during the initial period of detailed design work for two tidal regulators and to facilitate the formation of viable water users' groups during the pre-construction stage of RID major irrigation work.

The Special Task Force Unit would be composed of the community development workers in CDD, agricultural extension specialists in DOAE, irrigation engineers in RID, cooperative promotion specialists in CPD and administrative personnel in Changwat Narathiwat and, when necessary, anthropologists or rural sociologists from the Center for the Southern Thailand Studies at Pattani campus of the Prince of Songkhla University.

## 3.2. Construction and O & M of Major Work

### 3.2.1. Mode and Procurement of Construction Work

RID would be solely responsible for initial construction and subsequent O & M of such major work as (1) two tidal regulators, (2) 8 acidic water flow check facilities, (3) 7 drainage improvement schemes and 10 RID pumping irrigation systems down to tertiary outlets.

It is suggested that all the major work construction would be awarded on the basis of international competitive bidding in accordance with the premise that the Project would be financed by an international lending agency. Aside from the large contract for a simultaneous construction work of the two tidal regulators, the size and phasing of contracts for other major work would be dictated by the rate at which detailed design and contract documents could be prepared; therefore, the contracts for such work would probably be too small to be of little interest to international contractors, and such work would be packaged for execution by the local contractors. The manufacture and installation of tidal gates and RID pumping equipment at 10 stations would be procured from the overseas manufacturers.

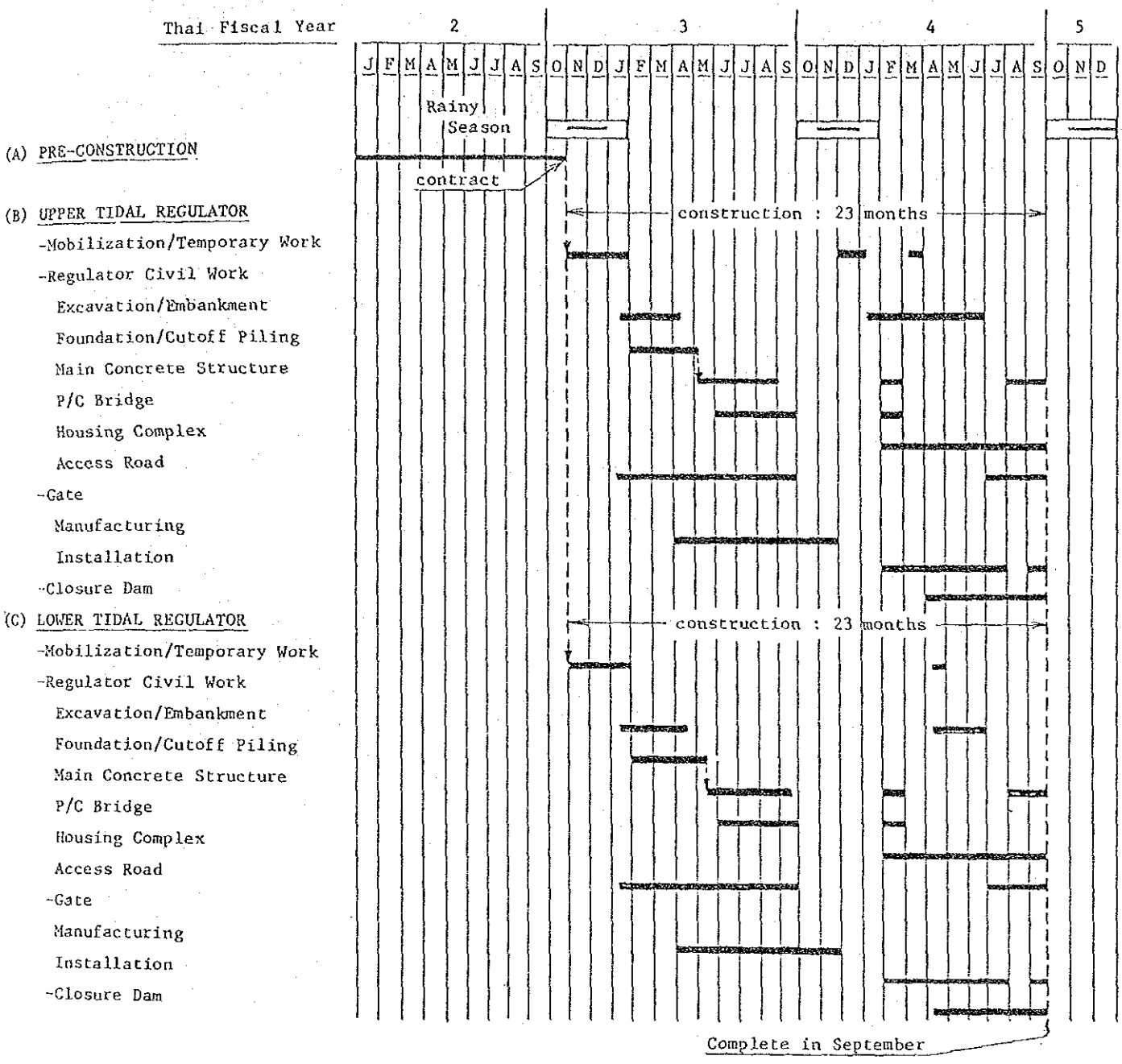
### 3.2.2. Construction of Two Tidal Regulators

Taking into account the scale and conditions of construction work, the construction period of two tidal regulators would require at least 23 months (1.9 years) on the basis of a package contract under the simultaneously proceeding programme from the start to completion in view of an effective mobilization of the construction machinery. Before this, at least one year would be taken for the pre-construction activities including the detailed design, access road, power line, contracting and so forth. It has been learned that RID has completed the land acquisition for the Lower Tidal Regulator, while the official procedure to acquire the land for the Upper Tidal Regulator has been in progress without any difficulties. The proposed construction schedule for two tidal regulators is outlined in Figure S-1, indicating the suspension of work by machinery during the rainy season from October to January.

### 3.2.3. Construction of RID Irrigation and Drainage Scheme

It is suggested that construction of part of the RID irrigation and drainage systems which are located in the relatively low-lying areas would be commenced in the Project Year 4 taking into account more quick accrual of the anticipated benefits to be derived from the two tidal regulators' construction, the Government's financial load on the Project as well as the assumed rate of water users' group's formation and subsequent on-farm development as is compiled in Figure S-2. Construction of all the RID facilities would take 6 years with four packages, each of which

Figure S-1. Construction Schedule: Two Tidal Regulators



would need 2 years for completion including the procurement of incline pumps to be imported. This construction schedule has been conceived on the basis of (1) sound yearly distribution of the construction cost, and (2) combination of the drainage and irrigation subprojects on the premise that the drainage improvement proceeds prior to irrigation development. Composition of four packages as envisaged is explained in Tables S-6 and S-7.

## 3.3. On-Farm Work Development

### 3.3.1. Size of Tertiary Irrigation Service Units

Taking into account the Project farm size and piece-meal distribution of the irrigation service areas as are specifically featured in the Project, it is suggested that an appropriate size of a tertiary unit would range from 20 to 30 ha in comparison with the present RID standard size of 50 ha. As is designed on three sample areas, an appropriate average size of the tertiary unit would be about 20 ha. With the reduction of this size, the section of tertiary canals from the RID turnouts would be smaller resulting in considerable decrease of the current troubles such as right-of-way and canal maintenance, and there would be the increasing possibility to construct by the water users' groups.

### 3.3.2. Demonstration Farms

The first task to be carried out by the Special Task Force Unit would be the final location and planning of three demonstration farms, the formation of water users' groups concerned, and the construction of water source work and on-farm facilities. It has been tentatively proposed to locate three demonstration farms as given below:

(1) Ban Ku Ra So (13.8 ha) in WUG pumping scheme (Stage I)
Tambol Lamphu, Amphoe Muang Narathiwat

(2) Ban To Lang (23.5 ha) in RID Khok Ti Te pumping scheme (Stage II)
Tambol Tanyongmilo, Amphoe Rangae

(3) Ban Cha Ro (26.1 ha) in WUG pumping scheme (Stage I)
Tambol Phraiwan, Amphoe Tak Bai

As is scheduled in Figure S-2, the Special Task Force Unit would complete three demonstration farms after the formation of respective water users' group at the end of the Project Year 2 and would commence the actual operation of irrigated agriculture by

using deep wells as temporary water source until the switch over to the Project irrigation water sources. It is anticipated that the demonstration activities at three sites would be terminated in the Project Year 9 in connection with the field training of agricultural extension workers, and then all the activities at these demonstration areas would be transformed to the normal operations by respective water users' groups.

### 3.3.3. Construction of On-Farm Work

After the formation of water users' group for each tertiary unit, the relevant on-farm work would be in construction stage and it is suggested that the executing agency for this would be the water users' group. It is stressed that the farmers in each tertiary unit would be organized to contribute, free of charge, all the unskilled labor and land for construction, while such water facilities as made of concrete and other materials would be constructed on local contractor basis or force account basis under the guidance of RID.

## 3.4. Consulting Services and Staff Training

### 3.4.1. Consulting Services

To ensure the rapid and sound execution of the Project, the services of a consultant team which would be composed of the foreign and Thai local firms in a joint-venture manner would be provided under the Project during the five-year service period to assist RID in detailed design and construction for two tidal regulators and irrigation and drainage facilities, as well as to carry out the advisory services for the Project-related agricultural development inclusive of strengthening the Special Task Force Unit and assisting DLD in programming and monitoring a soil improvement scheme. It is estimated that about 300 man-months of consultant effort would be required.

### 3.4.2. Staff Training

Under the Project, emphasis would be placed upon local on-the-job and in-service practical training in specific technical skills including the field of tidal regulator operation, irrigated agricultural extension services, on-farm irrigation development practices, problem soil improvement and organization of water users' groups which would be particularly directed towards the needs of staff of the Project implementing agencies. The Project would also provide the overseas training in a total amount equivalent to about 30 man-months with the objective which is the mind broadening exposure to relevant activities in other countries and the rapid application of the expertise acquired to concentrate the maximum benefits on the Project. Visits would be arranged to the on-going similar-natured projects with a proven record of success in the neighbouring countries.

## 3.5. Project Implementation Schedule

The proposed construction/implementation programme and related scheduling for various Project components have been established on the basis of the Project Year (Thai Fiscal) as is specified in Figure S-2. The Project implementation schedule explains that the construction of major work by RID would take 7 years from the Project Years 3 to 9, and relevant on-farm work construction would be carried out during 8 years from the Project Years 4 to 11. The last water users' groups in the Project, Stage II which would be organized to construct their on-farm work in the Project Year 11 and to start irrigation in the Project Year 12, would reach a full production in the Project Year 16.

## 3.6. Staging of the Project Development

### 3.6.1. Concept for Staged Development

It has been worked out to implement the proposed Project in two stages within the RID's responsibility taking into account the elevation of irrigable areas for existing rainfed paddy field by pumping, scope of the initial construction cost required for major work of the associated irrigation and drainage schemes, and the quick accrual of the anticipated benefits to be derived from the investment for two tidal regulators.

- Stage I Development:

  (1) Construction of the Upper and Lower Tidal Regulators to be supplemented with that of the acidic water flow check facilities at 8 sites.

  (2) Construction of the major work relevant to the RID pumping irrigation and associated drainage improvement schemes in the relatively low-lying areas.

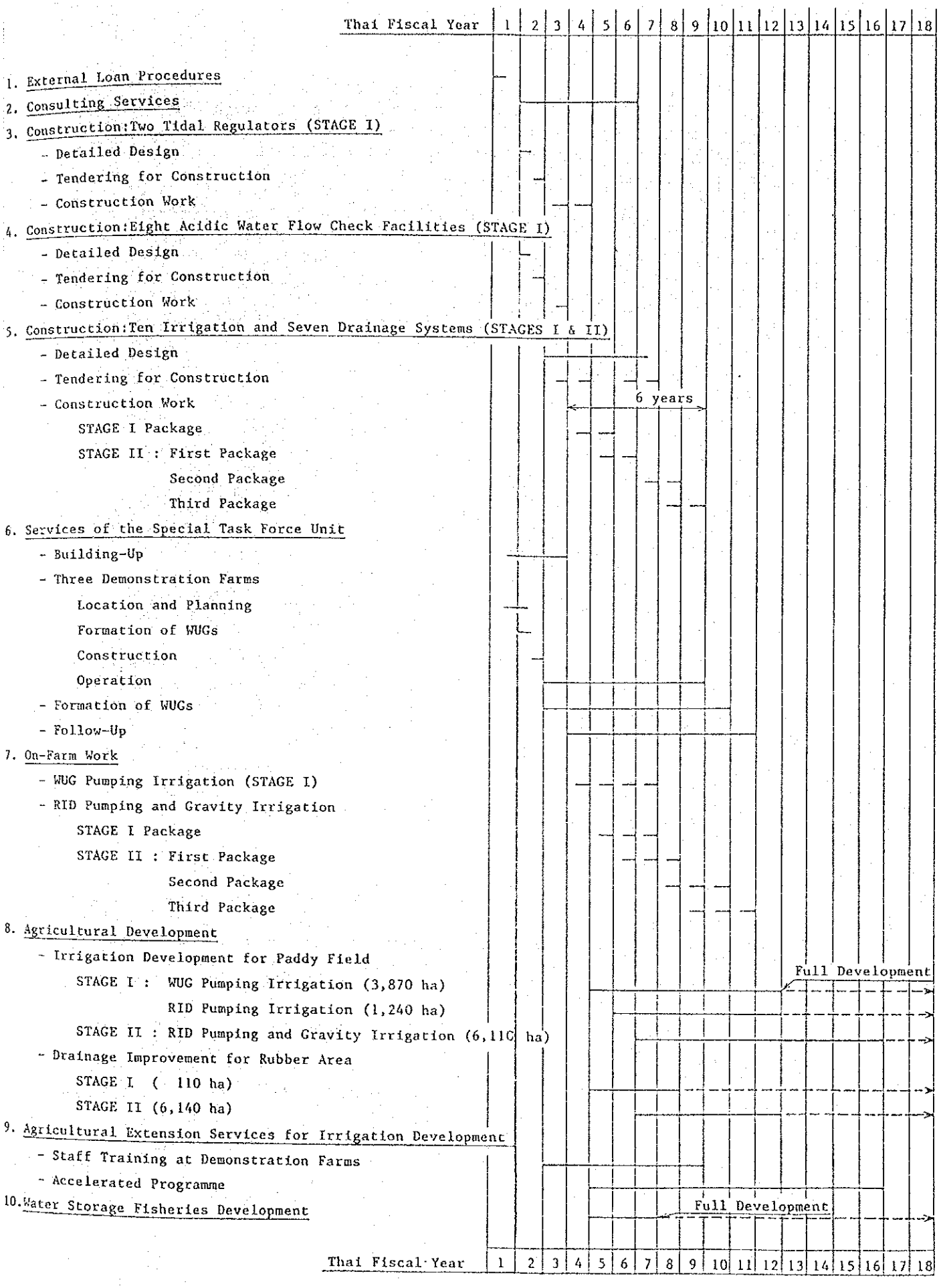
- Stage II Development:

  Construction of the major work related to the RID drainage improvement and pumping and gravity irrigation schemes in the high-lying areas.

### 3.6.2. Stage I Development

° As soon as the two tidal regulators are completed by RID, the Bang Nara water storage with control of the acidic water inflow would be established after the first rainy season and be ready to bring irrigation. It has been envisaged that 3,870 ha of existing paddy field largely below EL +2 m on average which is distributed on the fringes of the water storage would be commenced to irrigate with portable pumps under the water users' groups for agricultural development.

Figure S-2. Project Implementation Schedule



- In addition, it has been contemplated that a proper arrangement for early construction of the major work for some of the RID pumping irrigation schemes in the relatively low-lying areas which are located in the vicinity of the proposed demonstration farms and are qualified with the completion of detailed design for short period as well as with the comparatively procurable budget for the construction would be made by the Government in view of the quick yielding of the Project. These schemes would involve 3 subprojects of the RID pumping irrigation at Pu Ta, Sala Mai and Ko Sawat covering the irrigable area of 1,240 ha in total and associated drainage improvement subprojects at 3 locations such as Ban Lo Mo, Ban Sala Pradu and Khlong Sala Mai covering the service area of 700 ha for paddy field and 50 ha for rubber area in total.

- Construction period of the RID facilities in the Stage I would take 3 years, which would develop the irrigated agriculture covering existing rainfed paddy field of 5,110 ha that is equivalent to 51 percent of the total Project service area.

3.6.3. Stage II Development

- It has been considered that RID would commence the construction of major work for the irrigation and drainage facilities in high-lying areas at adequate period being subject to the Government financial arrangement after the completion of two tidal regulators which is the key facilities in the Project. It would be desirable that the commencement date of major work construction for the Stage II development by RID be given immediately after completion of the tidal regulators because of quick accrual of the full benefits to be realized from the tidal regulators as well as in due consideration of the progress on the formation of the water users' groups concerned and the subsequent development of on-farm work.

- RID would be responsible for construction of 7 pumping irrigation schemes and one gravity irrigation scheme in the higher-lying areas above the WUG pumping scheme. These irrigation schemes would be constructed in closer connection with the drainage improvement schemes concerned over 4,850 ha of existing paddy field and 6,190 ha of rubber planted area.

- Construction of the RID facilities in the Stage II which would serve the irrigated agriculture over 4,870 ha of existing paddy field would need a period of 5 years, while the water users' groups would be responsible for the terminal irrigation on-farm work and related services.

## 3.7. Cost Estimate

### 3.7.1. Project Cost

The base cost for the Project which includes the construction cost and its associated cost has been estimated on the basis of price level at 1986-February term dividing into local cost, indirect foreign cost and direct foreign cost at Baht currency rate. The base cost contains various taxes and duties related to construction work and equipment procurement to be incurred in the Project. The physical contingency has been taken at 10 percent of the base cost. The price contingency has been given by the escalation factor of 3 percent per annum for both the local and foreign currencies. Breakdown of the Project cost thus estimated is compiled in Table S-9.

### 3.7.2. O & M Cost

The RID annual O & M cost at full development would be ฿3.27 x $10^6$ for the Stage I development and ฿9.86 x $10^6$ for the Project as a whole including (1) salaries and wages, (2) fuel and repair for O & M equipment, (4) RID pump electricity, and (5) general expenditures, while the annual cost for O & M of the water users' group pumps including the cost for gasoline and repair would be ฿657 x $10^3$ at full development.

Table S-9. Project Cost Summary

(Unit: ฿ x $10^6$)

| | ENTIRE PROJECT | STAGE I |
|---|---|---|
| A. MAJOR WORK | 696.63 | 421.67 |
| A.1. Tidal Regulators | 358.33 | 358.33 |
| A.1.1. Upper Tidal Regulator | 266.86 | 266.86 |
| 1. Civil Work | 128.65 | 128.65 |
| 2. Gate Work | 138.21 | 132.21 |
| A.1.2. Lower Tidal Regulator | 91.47 | 91.47 |
| 1. Civil Work | 49.13 | 49.13 |
| 2. Gate Work | 42.84 | 42.84 |
| A.2. Acidic Water Flow Check Facilities | 15.83 | 15.83 |
| A.3. Irrigation and Drainage System | 322.47 | 47.51 |
| A.3.1. Drainage Improvement | 94.24 | 5.94 |
| A.3.2. RID Pumping Irrigation | 227.13 | 41.57 |
| A.3.3. RID Gravity Irrigation | 1.10 | - |
| B. DEMONSTRATION FARMS | 1.80 | 1.80 |
| C. WUG PUMPS AND ON-FARM WORK | 63.41 | 33.64 |
| C.1. WUG Pumping | 26.03 | 26.03 |
| C.2. RID Pumping and Gravity | 37.38 | 7.61 |
| D. O & M EQUIPMENT | 9.00 | 5.38 |
| E. LAND ACQUISITION | 20.99 | 6.60 |
| F. CONSULTANTS AND TRAINING | 76.10 | 45.65 |
| G. ENGINEERING AND ADMINISTRATION | 73.10 | 43.04 |
| BASE COST ( (A) to (G) ) | 941.03 | 557.78 |
| H. PHYSICAL CONTINGENCIES | 94.12 | 55.78 |
| I. PRICE CONTINGENCIES | 171.21 | 73.75 |
| PROJECT COST ( (A) to (I) ) | 1,206.36 | 687.31 |

# 4. PROJECT EVALUATION

## 4.1. Economic Analysis

The proposed Project would result in producing immediate and tangible benefits to about 4,100 farm households for the Stage I development and to about 8,700 farm households after full development of the Project.

### 4.1.1. Project Benefit

Comparison of the net production value without and with the Project is made in Table S-10.

### 4.1.2. Economic Internal Rate of Return

Using the discounting costs and benefits over a 50-year evaluation period, the economic internal rate of return for the Project has been calculated as given below:

| Discount Rate | 6% | 8% | 10% | 12% |
|---|---|---|---|---|
| (1) Project as a Whole | | | | |
| Present Worth Value (¥ x $10^6$) | | | | |
| Benefit | - | 931.6 | 660.8 | 484.3 |
| Cost | - | 716.9 | 641.7 | 580.2 |
| Benefit-Cost | - | +214.7 | +19.1 | -95.9 |
| Benefit/Cost | - | 1.30 | 1.03 | 0.83 |
| Economic Internal Rate of Return: 10.3% | | | | |
| (2) Stage I Development | | | | |
| Present Worth Value (¥ x $10^6$) | | | | |
| Benefit | 654.4 | 457.0 | 332.5 | - |
| Cost | 480.5 | 437.1 | 401.5 | - |
| Benefit-Cost | +173.9 | +19.9 | -69.0 | - |
| Benefit/Cost | 1.36 | 1.05 | 0.83 | - |
| Economic Internal Rate of Return: 8.4% | | | | |

Table S-10. Net Production Value Without and with the Project

(Unit : ฿ x $10^6$)

| | Project as a Whole */ | | | | Stage I Development */ | | | |
|---|---|---|---|---|---|---|---|---|
| | Without | With | Incremental | % | Without | With | Incremental | % |
| */ .... at full development. | | | | | | | | |
| Main-Season Paddy | | | | | | | | |
| (1) Irrigation and Drainage Improvement | | | | | | | | |
| | 13.44 | 82.73 | 69.29 | | 6.45 | 37.74 | 31.29 | |
| (Local Improved) | | (21.66) | | | | (21.66) | | |
| (HYV - RD13) | | (44.80) | | | | (11.80) | | |
| (HYV - RD 7) | | (16.27) | | | | (4.28) | | |
| (2) Drainage Improvement Only | | | | | | | | |
| | 0.59 | 0.97 | 0.38 | | - | - | - | |
| Total | 14.03 | 83.70 | 69.67 | 49 | 6.45 | 37.74 | 31.29 | 51 |
| Off-Season Fields Crops and Vegetables (Irrigation) | | | | | | | | |
| Sweet Corn | - | 1.64 | 1.64 | | - | 0.84 | 0.84 | |
| Mung Bean | - | 2.45 | 2.45 | | - | 1.26 | 1.26 | |
| Groundnuts | - | 3.14 | 3.14 | | - | 1.61 | 1.61 | |
| Vegetables | - | 37.38 | 37.38 | | - | 19.19 | 19.19 | |
| (Tomato) | (-) | (29.72) | (29.72) | | (-) | (15.24) | (15.24) | |
| (Chilli) | (-) | (7.66) | (7.66) | | (-) | (3.95) | (3.95) | |
| Total | - | 44.61 | 44.61 | 31 | - | 22.90 | 22.90 | 37 |
| Perennial Forage Crop (Irrigation) | | | | | | | | |
| Torpedo/Para Grass | | | | | | | | |
| | - | 1.06 | 1.06 | 1 | - | 0.28 | 0.28 | 1 |
| Rubber (Drainage Improvement) | | | | | | | | |
| | 43.21 | 59.68 | 16.47 | 11 | 0.75 | 1.05 | 0.30 | 1 |
| Tree Fruit | | | | | | | | |
| Long Kong | - | 9.27 | 9.27 | 6 | - | 4.79 | 4.79 | 7 |
| Bang Nara Water Storage Fisheries | | | | | | | | |
| | - | 2.38 | 2.38 | 2 | - | 2.38 | 2.38 | 3 |
| Total | 57.24 | 200.70 | 143.46 | 100 | 7.20 | 69.14 | 61.94 | 100 |

## 4.2. Farm Incomes

The farm budgets have been prepared for two model farms, viz. (1) sole paddy farm and (2) mixed paddy/rubber farm with such different farm sizes as small, medium and large.

Table S-11. Farm Budgets

(Unit: ₱ x $10^3$)

Sole Paddy Farm

| Size | Small | | Medium | | Large | |
|---|---|---|---|---|---|---|
| | Without | With | Without | With | Without | With |
| Paddy Field (ha) | ---- 1.2 ---- | | ------ 1.8 ---- | | ------ 2.8 ---- | |
| Family Size | ---- 4.8 ---- | | ------ 5.0 ---- | | ------ 6.3 ---- | |
| Farm Income | 7.9 | 22.5 | 10.4 | 32.8 | 16.2 | 52.7 |
| Off-Farm Income | 10.0 | 10.0 | 10.0 | 10.0 | 8.0 | 8.0 |
| Total | 17.9 | 32.5 | 20.4 | 42.8 | 24.2 | 60.7 |
| (Per Capita) | (3.7) | (6.8) | (4.1) | (8.6) | (3.8) | (9.6) |

Mixed Paddy/Rubber Farm

| Size | Small | | Medium | | Large | |
|---|---|---|---|---|---|---|
| | Without | With | Without | With | Without | With |
| Paddy Field (ha) | 0.8 | | 1.2 | | 1.3 | |
| Rubber Area (ha) | 0.6 | | 1.0 | | 2.0 | |
| Family Size | 5.0 | | 5.2 | | 6.1 | |
| Farm Income | 11.8 | 23.0 | 15.4 | 32.3 | 22.1 | 46.8 |
| Off-Farm Income | 8.0 | 8.0 | 8.0 | 8.0 | 10.0 | 10.0 |
| Total | 19.8 | 31.0 | 23.4 | 40.3 | 32.1 | 56.8 |
| (Per Capita) | (4.0) | (6.2) | (4.5) | (7.8) | (5.3) | (9.3) |

It is expected that the annual farm incomes after a full development of the Project would exceed, as a whole, ฿5,580 of the Thai average rural per capita income as stated in para. 1.2, and this would greatly contribute towards the improvement of their living standard.

## 4.3. Indirect Effects of the Project

Aside from the direct economic benefit, the Project would generate both the indirect and associated socio-economic benefit/impact and exert various influences on the Muban societies:

- In connection with the increased agricultural production as envisaged, it is anticipated that the agro-industries such as post-harvest treatment processing, marketing and distribution would be developed and the related employment opportunities would be increased.

- With the positive technical backup and agricultural extension services under the Government agencies concerned, the water users' groups would be brisk in their movement, and a collective cultivation of the off-season field crops and vegetables, perennial forage crops and fruit tree on the basis of Muban cooperative service unit taking into account special land-lease arrangement within such Muban would lead towards a viable promotion of the cooperative movement as well as a unique creation of the mutual aid system in the lowest level of the administration system. This would promote the development of Muban concerned in every way with the additional Government effort in terms of the family planning and social welfare programmes.

- The increased farm incomes would leave the Project farmers more surplus to be invested for education opportunities of their children, and the socio-economic disparity between the neighboring Malaysia would be alleviated on the basis of the improvement of their living standard. This would be surely connected to easing of the present social-psychological problems in the area to a large extent.

It may be noted that strict attention has been paid to the environment at the Narathiwat estuary during the Study as follows:

- The present estuary flow at Narathiwat during the non-flood period would be mainly dominated by such tidal flow as flood and ebb tide discharges with some freshwater contribution to the ebb discharge from the upstream basins of Mae Nam Yakang and Mae Nam Bang Nara. In the case that incorporates all of the Yakang river flow into the water storage during the non-flood period, there would be only the tidal flow along the lower reaches of Mae Nam Bang Nara when no release of the freshwater takes place from the Upper Tidal Regulator. This

would invite some of the adverse effect to the Narathiwat estuary in terms of water environment and river entrance sand bar. The Project plan has incorporated a countermeasure that the minimum river maintenance flow of 5 cu.m per sec as mentioned in (3) of para. 2.2.1 would be always released to alleviate salt water intrusion and carry away waste after construction of the Upper Tidal Regulator in order to conserve the water-related environmental conditions as are currently seen. On the other hand, the irrigation water abstraction from Mae Nam Bang Nara would account for only 2.7 percent of its average annual runoff. With these considerations, there would be fundamentally no problem with respect to the environments in the Narathiwat estuary.

## 5. RECOMMENDATION

5.1. The proposed Project which intends to increase the production of main-season paddy and off-season field crops and vegetables on existing paddy fields and of existing rubbers and to result in higher income and increased employment for the area's small farmers, would be technically sound and socio-economically viable taking into appropriate account various environmental issues related. With adequate overall management and coordination among the Governmental agencies, well-coordinated institutional set-up for the Project farmers and proper operation and maintenance of the Project facilities, it should be a great and valuable asset to the Bang Nara river basin where the development has been made to lesser extent.

The Government should, therefore, take the next procedures and necessary arrangements for immediate implementation of the Project covering an irrigable area of 9,980 ha (or 62,400 rai) which has been given a high priority by the Government.

5.2. The formation of water users' groups at the pre-construction stage is the key recommendation to ensure the quick-yielding implementation of the Project in connection with their timely development of the tertiary irrigation service units including the WUG pumping irrigation scheme.

To realize this, it is suggested to organize the Special Task Force Unit on multi-disciplinary basis in the Project during its beginning stage to commence the favorable operation of demonstration farms and to facilitate the prompt formation of active water users' groups. This Unit which streamlines the specific forms of cooperation between the line agencies concerned would be composed of the community development organizers, agricultural extension workers, irrigation engineers, cooperative promotion experts, rural sociologists and Changwat administrative personnel.

5.3. The impounding water level of the proposed Bang Nara water storage has been given in due consideration of a countermeasure not to cause irreversible environmental damage to the ecology of the Laem Bang Nara II Forest Reserve as well as the status of potential acid sulfate soils over the storage-related basins. It is recommended that the Government would carry out the regular monitoring and evaluation on the above related matters during and after the Project implementation.

# CHAPTER 1 INTRODUCTION

## 1.1. Authorization

In response to the request made by the Government of the Kingdom of Thailand (hereinafter referred to as "the Government") on 13 February 1985, the Government of Japan decided to implement the feasibility study on the Bang Nara Irrigation and Drainage Project (hereinafter referred to as "the Study") within the general framework of technical cooperation between Japan and Thailand as signed on 5 November 1981. Subsequently, the Government of Japan dispatched the Preliminary Survey Team for the Study during the period of 10 to 23 March 1985 through the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of technical cooperation programs of the Government of Japan.

The Preliminary Survey Team headed by Mr. Masakuni KAWAMATA, Director, Planning Department of Chugoku-Shikoku Regional Agricultural Administration Office, Ministry of Agriculture, Forestry and Fisheries, and the Thai officials concerned headed by Mr. Suthep Thingsabhat, Chief Engineer for Civil Engineering, Royal Irrigation Department, Ministry of Agriculture and Cooperatives (hereinafter referred to as "RID") had a series of discussions with the exchange of their views in the field as well as in the head office about the Scope of Work for the Study. As a result, both sides have agreed upon the Scope of Work for the Study on 22 March 1985.

On the basis of the agreed Scope of Work for the Study, JICA dispatched the Japanese Study Team (hereinafter referred to as "Study Team") headed by Mr.Yasushi Miyazaki for commencement of the field work on 1 June 1985, in accordance with the relevant laws and regulations in force in Japan and in close cooperation with the Government authorities of Thailand. It is stated in the Scope of Work for the Study that RID

shall act as counterpart agency to the Study Team and also as coordinating body with relation to other relevant organizations for smooth implementation of the Study.

This Final Feasibility Study Report (100 copies) has been prepared in accordance with the Scope of Work for the Study, summarizing all of the work and study after completion of all the services required as well as all of the findings and recommendation of the Study Team including the detailed implementing arrangement and formulation and preparation of the proposed Project.

## 1.2. The Study Area

The proposed Project is located in Changwat Narathiwat of the Lower Southern region of Thailand being adjacent to the Thai-Malaysian border with 46,700 ha of the Study area initially delineated by the Thai authority and subsequently amended by the Study Team. The Mae Nam Bang Nara has a drainage area of 1,401 sq.km with three mouths (two natural and one artificial) and is situated in the center of the Study area which lies on the low-lying coastal plain along the east coast of the Thai peninsula. At present, Mae Nam Bang Nara is tidal and brackish throughout its course being directly affected by the tidal oscillations of the Gulf of Thailand, so that the agricultural development in the Study area is strongly handicapped due to the salinity intrusion into the river during the high tides and the frequent inundation along the river during the heavy rains.

In line with the strategic policy established by the Government of Thailand with a particular emphasis upon achievement of the poverty alleviation and reinforcement of the security management as well as in continuation with the implementation (1975 to 1984) of the Muno project along Mae Nam Kolok, a border river to mitigate the flooding and drainage problems and to facilitate the land reclamation around the fringes of To Daeng swamp, the proposed Project has been conceived since the early

1980s to develop the agricultural land and water resources potential involved in the Bang Nara river basin, on the basis of the provision on Bang Nara water storage through the construction of three tidal regulators. To date, the Nam Baeng tidal regulator was constructed in 1983 in the area of Tak Bai with excavation of the Nam Baeng drainage canal which is connected to the middle course of Mae Nam Bang Nara; however, it has been recognized that the benefit accrual from this regulator would be minimal; thereby, the construction of other two regulators is an urgent matter for subsequent agricultural development of the Study area in an orderly manner.

Reference is made to the Golok River Basin Development Study (hereinafter referred to as "GRBDS") for the Thai and Malaysian Government under the technical assistance of the Australian Government, which was initiated in September 1983 and finalized with the Draft Final Report in May 1985. Mae Nam Kolok or the Golok River in Malaysian language which is international has a catchment area of about 2,100 sq.km, of which about one-fourth of the subject Study area on its south-eastern corner is included within GRBDS. More particularly, GRBDS has adopted some artificial boundaries in Thai side to cope with the flow of Nam Baeng drainage canal and to include the narrow sand split lying between Tak Bai lagoon and the Gulf of Thailand as well as the To Daeng swamp being partly drained into Mae Nam Bang Nara. The Study Team has considered that the data and information with respect to the Thai territory so far compiled by the Australian Team should be the great asset to avoid a duplicate work of the survey required for the Study, expedite the Study by applying the already available information and finally maintain the consistency of project proposals to be made by GRBDS and the subject Study.

## 1.3. Objectives of the Study

(1) The objectives of the Study as called for in the Scope of Work are:

1) To review the agricultural studies related to the Bang Nara river basin and its tributaries;

2) To conduct a feasibility study on the irrigation and drainage project of the Bang Nara river basin; and,

3) To undertake on-the-job training of the Government's officials during the course of the Study.

(2) The basic components as specified in the Scope of Work, upon which the Study has been based, is outlined below:

1) PHASE I (PRE-FEASIBILITY) STUDY ..... June 1985 to November 1985.
to conduct the preliminary study on the agricultural development plan of the Study area.

2) PHASE II (FEASIBILITY) STUDY ..... December 1985 to date.
to carry out the feasibility study of the Bang Nara Irrigation and Drainage Project on the basis of the findings and recommendation in the Phase I Study.

The Scope of the Phase I Study is stipulated covering the following main activities:

1) To collect and review the relevant existing data and information, including topography, meteorology, hydrology, geology and hydrogeology, soil, irrigation and drainage, agriculture, agro- and regional economy and institution, and others;

2) To carry out the required survey in the Study area in the fields of topography, meteorology, hydrology, agriculture, flood discharge, construction material and cost, and others;

3) To review the studies of existing and proposed irrigation and drainage projects and evaluate the agricultural development studies concerned.

For the Phase II Study, major activities are to be carried out in accordance with, but not necessarily be limited to, the following items:

1) Additional field survey and data collection including soil and land classification; geology; groundwater; socio-economy; regional economy and agro-institution; environment on water requirements, quality and soil improvement; and others;
2) Determination of the basic items for development plan in terms of land use and cropping pattern, water requirements, irrigation and drainage canal networks and facilities, estimation of yields, agro-institutional plan, social-institutional services, and others;
3) Formulation of the integrated development plan for the Project;
4) Preliminary design of the major structures of the Project;
5) Preparation of the implementation schedule;
6) Estimation of the Project costs and benefits;
7) Evaluation of the Project;
8) Operation and maintenance;
9) Environmental consideration; and
10) Recommendation.

(3) During the course of the Study, the Study Team prepared and submitted the following reports in English to the Government:

1) Inception Report (20 copies)
at the commencement of the field work in the Phase I Study (4 June 1985).

2) Progress Report (20 copies)
   at the end of the field work in the Phase I Study (23 September 1985).
3) Pre-Feasibility Study Report (100 copies)
   at the commencement of the field work in the Phase II Study following completion of the home office work for the Phase I Study (2 December 1985).
4) Interim Report (20 copies)
   at the end of the field work in the Phase II Study (12 March 1986).
5) Draft Final Feasibility Study Report (50 copies)
   after completion of the home office work for the Phase II Study (28 October 1986).

## 1.4. Undertaking of the Thai Side and Japanese Side

### (1) Undertaking of the Government of Thailand

In accordance with the Agreement on Technical Cooperation between the Government of Japan and the Government of the Kingdom of Thailand dated 5 November 1981, the Government shall accord benefits to the Study Team as follows:

1) to permit the members of the Study Team to enter, leave and sojourn in Thailand for the duration of their assignment therein, and exempt them from alien registration requirements and consular fees,
2) to exempt the members of the Study Team from taxes, duties and any other charges on equipment, machinery and other materials brought into Thailand for the conduct of the Study,
3) to exempt the members of the Study Team from income taxes and charges of any kind imposed on or in connection with any emoluments or allowance paid to the members of the Study Team for their services in connection with the implemention of the Study,

4) to bear claims, if any arises, against the members of the Study Team resulting from, occurring in the course of, or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the members of the Study Team.

To facilitate smooth conduct of the Study, RID shall take necessary measures in cooperation with other relevant organizations:

1) to secure permission for entry into private properties or restricted areas for the conduct of the Study;
2) to secure permission for the Study Team to take all data and documents related to the Study out of Thailand to Japan;
3) to provide the medical services as needed. Its expenses will be chargeable on members of the Study Team; and
4) to ensure the safety of the members of the Study Team when and as it is required during the course of the Study.

RID shall, at its own expense, provide the Study Team with the following:

1) available data and information related to the Study;
2) topographical survey;
3) geological survey such as test boring for the major structure sites;
4) soil survey such as soil group classification and range of infiltration;
5) additional survey related to the Study, if necessary;
6) counterpart personnel;
7) suitable office space with necessary equipment in Bangkok and Project site including the computer services in the RID Irrigation Engineering Center;
8) appropriate number of vehicles with driver in the Project area; and
9) credentials or identification cards.

(2) Undertaking of JICA

For the implementation of the Study, JICA shall take the following measures:

1) to dispatch, at its own expense, the Study Team to Thailand;
2) to perform technology transfer to the Thai counterpart personnel during the course of the Study.
3) to provide the following equipment for the implementation of the Study, which remained the property of JICA during the field work and subsequently transferred to RID upon request;

| | | | |
|---|---|---|---|
| 1) | Water level recorder | : | 3 units |
| 2) | Rainfall recorder | : | 3 units |
| 3) | Current meter | : | 3 units |
| 4) | Water sampling apparatus | ; | 3 units |
| 5) | Water quality checker | : | 3 units |
| 6) | Peat auger | : | 3 units |

## 1.5. Organization of the Study

(1) The JICA-Advisory Committee

The Committee is responsible for direction, supervision and evaluation of the Study Team's activities and studies, being composed of six members:

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MAFF ... Ministry of Agriculture, Forestry and Fisheries
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The Study Team is composed of twelve specialists. Their names and titles are listed below:

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| 12) | Survey & Maps; | Mr. Toshiaki SIMAUCHI (for the Phase I Study only) |

(3) The RID Working Group

The counterpart personnel of the Government of Thailand are members of RID who are specially organized into a Working Group. They have assisted the Study Team in data collection and field survey in Thailand, and have advised the Study Team with respect to the guidelines of the Study on behalf of the Government of Thailand. The counterpart personnel and their positions are given below:

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| 1) | Team Leader: | Mr. Sanan SIRION (Design Division) |
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| 11) | Hydrologist: | Mr. Atthaporn BUDDHAPALIT (Hydrology Division) |
| 12) | Hydrologist: | Mr. Panya POLSAN (Hydrology Division) |

| | |
|---|---|
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# CHAPTER 2 BACKGROUND

## 2.1. Thai Agriculture and Rural Economy

(1) Out of Thailand's population of about 47 million, about 40 million live in the rural areas where there are about 5 million farm households and 1.8 million non-farm households. The rural sector of Thailand is exceptional in many ways: (a) it is a major net exporter of food grains; (b) it has grown and diversified rapidly over a long and sustained period; (c) farmers have been found to respond vigorously to relative price incentives; (d) ownership and usufruct of cultivated land are widely and fairly evenly distributed; and (e) labor mobility within rural areas and between rural and urban is very high in both directions.

The performance and growth of the agricultural sector in Thailand has been the determining factor in the dynamism of the rural economy. During the years 1960 to 1975, Thai's agricultural sector performed exceptionally well with the growth rate exceeding 5 percent annually which had been achieved mostly through expansion of the cultivated area. Since 1975, however, growth has slowed to about 3.5 percent per annum which has resulted primarily from an increasing shortage of land suitable for agriculture. The agricultural sector growth during the Fifth Plan period at 2.8 percent per annum should be compared to the average 5.1 percent per annum for that of GNP, and agriculture as a proportion of GNP declined from 24 percent in 1981 to 20 percent in 1984.

The agricultural sector is still important to Thai's economy and society, because it remains the major employer and foreign exchange earner. At present, agriculture contributes full or part-time employment for about 60 percent of the country's labor force and 65 percent of the total population. The agricultural products account for 60 percent of the total export value. Furthermore, with real agricultural GDP per capita growing at 2.8 percent per annum in the past two decades and the relatively even distribution of farm holdings, the

agricultural performance has contributed to a substantial reduction in rural poverty.

(2) The process at work in Thai agriculture over the past quarter century has been the commercialization and diversification of the rural sector, predominantly in response to opportunities in world trade. The key factors in this development have been efficiency of private markets, the extension of road system, the reduction in forest land, the rapid expansion of cultivated area, the expansion of irrigation, the introduction of new crops in response to market opportunities, and explosive mechanization. In recent years, however, the slowdown of agricultural production growth is more pronounced for the crop subsector. Its deterioration occurred primarily because earlier growth had been achieved through expansion of the cultivated area, but more recently, poor marginal lands increasingly came under cultivation and average yields which are already low relative to other developing countries decreased further.

The value of agricultural produce sold by farmers in the 1983/84 season shows that Thai's agricultural production is structured to produce only a few crops with emphasis upon rice and food crops such as cassava, sugarcane, maize, mungbeans and sorghum which account for over 40 percent of the value of produce earned by the farmers and also for 57 percent of the value of agricultural exports or 37 percent of all exports. A fact is emerging that countries all over the world have policies to achieve food self-sufficiency with the promotion of domestic production so that technology is being introduced and the output of food crops is expanding more rapidly than demand, as a result, the world trade in food crops has declined in connection with the decreasing demand for imports in consuming countries and consequently the competition in trading has intensified. Price levels have sunk and the economic growth in Thailand has slowed down.

(3) While the real agricultural growth was recently falling off, one of the fundamental trends has been the relatively rapid increase in the

income of rural farm households from off-farm sources. Farm family income from sources other than home consumption and sale of farm products by their producers grew at about 12 percent per annum over the six-year period of 1972 to '78 which was substantially faster than agricultural income. In 1978/79, it is estimated that about 48 percent of average farm household net income originated from sales of farm products, 6 percent from hiring out factors of agricultural production to other farmers, 13 percent from home consumption, and 33 percent from other activities such as sales of non-agricultural products, hiring out labor for non-agricultural use, remittances and so on.

Recent information suggest that with the declining quality and size of farm endowments, proportionately more efforts are generally invested in non-farm activities. Available data also show that off-farm employment tends to smooth income over time and to be of higher productivity, and the off-farm income thus tends to offset the farm income inequalities.

(4) The main objectives of the Government's agricultural policy are (a) to increase agricultural production, (b) to alleviate rural poverty and reduce inter-regional income disparties, (c) to expand agricultural exports rapidly to help the balance of payments, and (d) to better utilize the available land suitable for agriculture, protect against deforestation and conserve natural resources.

The Government's efforts to pursue the above mentioned objectives involve the following major strategies:

- Creation of an environment in which the private sector will have the needed incentives and confidence to boost production, marketing and exports;

- Generation of appropriate technical packages to aid product intensification and crop diversification;

- Demarcation of the poverty areas in which the line departments are to focus their programmes, particularly for agriculture, rural infrastructure (physical and social) and community development; and

- Establishment of a land use policy for better utilization of land suitable for agriculture, including the required legal and regulatory framework to give individual farmers title to their land and a clear demarcation of zones reserved for forestry and conservation.

More particularly, when the Thai's agricultural sector is to regain some of its previous growth momentum, all the parties concerned should cooperate in seeking the speedy solution of (1) crop production problems with respect to intensification with greater use of purchased inputs and crop diversification into higher value products and of (2) marketing problems including undiversified export markets, protectionism by trading partners and price instability. Otherwise, such problems will mount and become insoluble. Some of the recent opinions to restructure the Thai's agricultural production so that it conforms with trends in world trading are introduced below:

- There should be a reduction in cultivation of rice and food crops which would not have good market prospects. The latter include cassava, sugarcane, black matpe beans and tabacco.

- Cultivation area should be properly controlled for the crops whose markets are reaching saturation levels. These crops are maize, sorghum, pineapples, rubber, oil palms, coconuts, coffee and kenaf. There should be simultaneous emphasis upon the intensification for production of these crops.

## 2.2. The Southern Region : Changwat Narathiwat

(1) The Southern region of Thailand has 14 Changwats covering about 71,000 sq.km with an estimated population of 6 million, of which approx. 90 percent live in rural areas. The region would be geographically, economically, ethnically and politically rather different from the core of Thailand. The long distance from Bangkok, the lack of land transportation during the long period of history, the economically different structures compared with the central parts, the fairly large share of Thai Muslim population and other factors have set the South relatively isolated from the rest of Thailand.

The general economic activity in the Southern region presents a different picture from others, describing that rubber plantations, coconut growing and tin mining prevail while paddy and fruits are less represented; however, the general income of the people has been, for a long time, sufficient to support a moderate living standard. This might be one of the reasons why the Central Government never seriously bothered about this region in comparison with others which enjoyed the Government assistance, interests and projects.

(2) Until recently, the economic activity in the South was dominated by fishing, paddy and coconuts with forestry, livestock, fruit and field crops playing subsidiary roles. However, with construction of the railway in the 1920s and the all-weather roads in the 1960s, the land transportation links were improved with the rest of country. Further, the tin mining, the large-scale planting of rubber during the 1920s to 1960s, and the introduction of irrigation in the 1940s brought far-reaching changes. These developments encouraged the movement of population from the coastal areas and superimposed an export-oriented economy upon traditional subsistence basis; however, the primary activities with the exception of increased fish production have failed to develop significantly, and there has been little diversification into secondary and tertiary activities.

Current settlement patterns reflect the region's primarily rural nature. Some expansion of towns has occurred where required to meet the commercial and service center needs of the rural areas, but few major urban concentrations have developed and migration from rural to urban has been insignificant. There has been a little change in rural settlement with the movement from relatively densely populated paddy areas on the eastern coastal plain to sparsely populated inland and western coastal areas.

Communications with both Bangkok to the north and Malaysia to the south are steadily upgrading. Port development as well as expansion of the regional power supply and distribution system have made the Southern region less subject to production and marketing constraints in recent years; therefore, the region has become increasingly integrated into the national economy.

(3) The Southern regional economy is dominated by the primary sector. Crops, of which rubber is by far the most important, contributed 26 percent of the total value added. Trends in the rubber sector have a major impact, both directly and indirectly, on the overall regional growth. Paddy is another crop of importance, production of which still plays a crucial role in the smallholder economy although not as important as in other regions. Even in the rubber areas many farmers cultivate paddy field for their own subsistence and this guarantees their independence and security against fluctuations in international commodity prices. Other crops include a wide range of fruit and vegetables which collectively form an important sector, and since the growth rate of this sector was above the average for crops as a whole, there would be opportunities for further expansion.

Most crop farming with the exception of rubber in the South is done on the eastern coast accounting for nearly 90 percent of the region's 660,000 ha of paddy field because its topography and watershed location. Paddy production was increased in response to an increase in the area under cultivation and not as a result of any significant increases in

yield. It is generally considered that further major expansion of the paddy area is unlikely and increasing production will have to be achieved by intensifying the use of existing paddy field or from the use of high yielding varieties.

Since these existing paddy areas are economically backward in the Southern region, high priority has been accorded to their development by the Government. At present, about 60,000 ha of its area is nominally irrigated during the wet season by about 30 irrigation systems ranging in size from 1,000 to 4,000 ha. Three large-scale projects (Pattani, Ta Pi-Phum Duang and Songkhla Lake) are being implemented or under study. The "South Thailand Regional Planning Study" prepared by the Ministry of Overseas Development, London (1974) indicates that there is a large scope for expanding irrigated area in the South. The Government's recent policy to accord priority to irrigation projects in this region is based upon its recognition of this potential and its decision to accelerate the development of such areas and integrate these fully with the rest of the country.

(4) The Fifth National Economic and Social Development Plan (1982-1986) has laid down spatial development strategies to diffuse growth and decentralize economic activities to the regions to achieve the alleviation of rural-urban disparities and reinforce the security management. In this effort, the Southern border provinces of Pattani, Yala, Satun and Narathiwat have been identified as one of five "Specific Areas" for accelerated development, aiming to readjust the local economic structures to achieve greater diversification which would help solve social problems as well as reinforce security management in the border area.

The Southern border provinces, in which the Study area in Changwat Narathiwat is included, have a distinct social structure as compared with the rest of the Southern region. The majority of the population (80 percent) are Thai Muslim and prefer to communicate in Jawi rather than Thai. There are ethnic and family ties across the border with the

neighbouring Malaysia. The Fifth Plan summarizes three major problems in the Southern border provinces, viz. (1) economic problems connected to the present narrow and undiversified production structures, (2) socio-psychological problems with respect to the unique social structures, and (3) security problems. With this critical mind, the development targets and measures have been established, in which a great emphasis has been placed upon the alleviation of poverty and backwardness in rural areas that should be surely in connection with development of the proposed Project, More particularly, the Plan indicates the following:

(a) The poor fishing villages in Narathiwat and Pattani will be given help by establishing a career development project which should increase their income. There will also be projects on health, education, and nutrition in these poor fishing villages. Coastal land management projects will be carried out to help fishing industries in the areas.

(b) Deserted and devastated forest lands will be allocated to the landless farmers in the form of security villages, co-operative villages, and self-help land settlements.

(c) The Pattani irrigation system will be completed, particularly with regard to on-farm distribution canals so that the farmers' poverty problems may be solved. Complementary economic crops will be introduced on small-scale rubber plantations in order to raise additional farmer income. Other general poverty alleviation programmes will also be implemented in these areas.

(5) Changwat Narathiwat covers an area of 4,228 sq.km and has a population of 484,000 at the end of 1984 representing 7.6 percent of the Southern population. In 1983, Changwat Narathiwat had the gross domestic product of ฿6,000 million which is 6 percent of the Southern regional output. For the five years of 1978 to 1983, the annual growth rate of Narathiwat was 2.7 percent, which is lower than 2.8 percent of the

Southern region and 5.6 percent of the Kingdom. Per capita GDP of Narathiwat in 1983 that was ฿12,900 was 20 percent below the Southern region and 32 percent below the Kingdom as a whole; while the per capita GDP growth rate during the period of 1978 to 1983 was 0.6 percent in Narathiwat, 0.7 percent in the Southern region and 3.4 percent in the whole Kingdom. (refer to Table VI-1-1, Appendix VI)

Agriculture is the main productive sector accounting for 46 percent of total output, whereas the industrial sector has an output value of only 9 percent. This means that Changwat economic structure has an obviously narrow base. Within the agricultural sector, the crop product occupies 90 percent of its total output value that is extremely high as compared with others and has the annual growth rate of 0.3 percent that is quite low. The livestock and fishery sectors have 7.3 percent and 1.4 percent of the total agricultural output respectively, but the annual growth rate has been recorded at 5.7 percent and 18.3 percent respectively. This suggests that the crop production sector has been stagnant due to the soils of low fertility, deep and prolonged flooding, impeded drainage, damages caused by drought and virtually the neglect of irrigation facilities.

(6) The whole of Southern Thailand is characterized by a relatively underdeveloped hierarchy of service centers and low level of urbanization. The South Thailand Regional Planning Study, although undertaken nearly ten years ago, remains an important data source on settlement patterns in the Southern region. In this study, seven major areas of influence have been identified in the Southern Thailand, one of which is named "Yala area of influence" where the three southernmost Changwat such as Yala, Pattani and Narathiwat are grouped together being predominantly Thai Muslim areas. The homogeneity in terms of administration, communications, social services and commerce of this subregion is probably the best established in the Southern region. This is largely due to its cultural character which marks it off from the rest of the Southern region and its southerly containment by the Malaysian border.

Until the introduction of rubber into the area economy, the population of the Yala area of influence was concentrated on the eastern coastal plain with rice production as the basis of local economy. Pattani and, to a lesser extent, Narathiwat were traditional centers of this subregion providing the real links with the rest of Thailand through the ports. The introduction of rubber, the construction of railway and the subsequent establishment of regional highway network have radically changed this pattern. Yala is the center that has grown from these developments, and has, in a similar way to Hadyai, outstripped the growth of its older established neighbours in a relatively short time. Yala's population is presently almost equal to the combined total of the other two centers such as Pattani and Narathiwat and has maintained its high growth rate based upon commerce and communications. All three centers are administrative seats of the Changwat Government and, at this functional level, retain their own distinctive areas of influence.

The competition for dominance in the Yala area of influence would be between Yala and Pattani. The South Thailand Regional Planning Study explains that the location of Pattani airport, the expansion of Pattani port and also some facilities of the Prince of Songkhla University have obviously helped to redress the balance in the face of regional development which favors Yala; however, it is questionable whether the continued balancing of these centers is a better choice since a wastful duplication of the services may tend to undermine the benefits that could accrue to this subregion with the development of a more rational urban hierarchy based upon one dominant center.

The South Thailand Regional Planning Study applied a weighted point-score system to 33 urban service factors classified under four functional groupings such as administration, communications, social services and commerce. A total of 140 service centers in the Southern Thailand were distributed under the five grades where Yala and Pattani were given Grade I and Narathiwat was ranked Grade IA. The areas of

influence of these Grade I centers overlap considerably and many arguments would be voiced in favor of resisting the temptation to lump them into one area of influence. While Narathiwat obviously has almost total dominance of the area to its south and east, Pattani similarly holds a strong sway over a relatively small but densely populated area along the coast when a large-scale Pattani irrigation project is close to completion and the Lower Sai Buri irrigation project is under investigation. Yala, however, with its nodal location and strength in communications is the one center that appears to have influence over the wider area and subsequently was chosen to define the whole as its area of influence.

Of the ten service centers identified in Changwat Narathiwat, Tan Yong Mas (Amphoe Rangae headquarters) was classified Grade III while Yingo, Tak Bai and Sg.Padi of Amphoe headquarters as Grade IV and Sg.kolok as Grade II. The study mentions that the distribution of such centers within Yala area of influence appears to be the best balances in the southernmost Changwat. It is noted, however, that Sg.kolok and Betong ranked at Grade II centers are border towns and Tak Bai which is being urbanized by a Taba New Town Development Scheme is also situated at the Malaysian border.

## 2.3. Government's Rural Development Policies
### - Development Needs of the Bang Nara River Basin -

(1) The rural development policies in Thailand are formulated under the National Rural Development Committee (NRDC), chaired by the Prime Minister, with 17 members representing the four ministries of Interior, Agriculture and Cooperatives, Public Health and Education as well as NESDB, Budget Bureau and others. There are formalized links between NRDC and Changwat and Amphoe level development committees and working groups with Tambol committees.

The rural development policy is an integral part of the national socio-economic policy, and its formulation and implementation have

attracted a considerable political interest and support. The Fifth National Economic and Social Development Plan (1982-1986) represents a departure in that it puts less emphasis upon overall economic growth in terms of national output and income as a goal, and pays a considerable attention to the issues of equity, national long-term stability and operational efficiency.

The Fifth Plan has the following objectives:

- To adjust the Thai's economic structure to cope with the changing world economic conditions through the decentralization of industry, intensification of agricultural production, promotion of exports and reduction of imports;

- To develop a social structure in response to the economic change particularly through the rural infrastructural services;

- To alleviate the poverty with a particular emphasis upon the previously neglected rural areas, through the formulation of rural development programmes on designated areas and through the efforts to encourage greater participation of beneficiaries in development activities;

- To coordinate the economic and social development efforts to meet the natinal security goals concomittantly through the targeting of development efforts on sensitive areas where feasible;

- To reform the national development administration system with the mobilization of private sector's cooperation through the improved procedures at all levels inclusive of greater local participation.

(2) NESDB jointly with officials concerned, worked out a policy direction of the Sixth Plan (1986-1991) as a preparation of its full text in 1985. The past development and limitations cited, together with

the consideration of opportunities and possibilities in developing the country in the near future, indicate that the direction of the Sixth Plan should comprise one target, three guidelines and nine main plans:

- The target:

  The general economic growth must be more than 5 percent per annum on average with a particular emphasis upon expansion to support job creation, income distribution and the stabilizing of economic equilibrium, so that they will have consistent progress.

- Three guidelines:

  (a) To develop major economic and social sectors following the Fifth Plan, and concurrently, new opportunities must be created to make the economic progress benefit the public as widely as possible with a top priority on the limits and stability of the fiscal and monetary systems;

  (b) To increase efficiency, qualities of production, marketing and technology to enable Thailand to be competitive with other countries, including the agricultural sector; and

  (c) To restructure the development management of the Government to be suitable to the limits of its ability and fiscal position, by sharing the relevant burden between the Government, state enterprises and private sectors.

- Nine main plans, in which the rural development sector is included dividing into three parts:

  (a) To continue solving rural problems which remain after the Fifth Plan, and to develop areas along the border so as to increase the security for people in such areas;

(b) To improve the efficiency of the Government in solving the rural development problems; and

(c) To improve the rural development mechanism so as to get better cooperation from the parties concerned.

(3) The Fifth Plan includes three major implications of direct relevance to the development of the Bang Nara river basin under the subject Project:

- The first theme of the Fifth Plan and the most relevance to the Bang Nara river basin is the need for structural adjustment as a means to reduce the disparity of income and social services both between and within the regions. At present, the Bang Nara basin has a very narrow economic base being composed almost entirely of paddy and rubber, with the income levels and services lower than other areas in the Southern Thailand. The Fifth Plan suggests the following:

  ° Greater emphasis should be placed upon the intensification of agricultural production and the improvement of its productivity rather than the expansion of cultivated area taking into account existing constraints of the low yields and extremely limited unexploited land resources.

  ° There should be the diversification of agriculture which is appropriate for the Bang Nara river basin with relation to its location and specific conditions. The Plan aims at diversifying the economic base of the Southern region by stressing industrial and agricultural marketing development in the Songkhla-Hadyai regional growth center. It is also anticipated that the border marketing trade of agricultural commodities with Malaysia would become an important income source for many of the basin population.

° The Plan identifies the geographical target areas for rural development and poverty alleviation, one of which is the Southern border region where the Changwat Narathiwat is located.

- The second is the poverty alleviation in the previously neglected rural areas. The Bang Nara river basin is by most measures relatively disadvantaged. The Fifth Plan's rural development and poverty alleviation policy is directed at Muban level, and a number of the issues have been identified as generally common to the poverty areas including the need to strengthen the joint community and group activities, to develop the water resources for both agriculture and rural supply through the construction of Muban level water facilities, to encourage the labor-intensive construction of Muban irrigation and drainage systems, to promote the agricultural extension services including livestocks, to improve the Muban access roads, to construct community buildings and facilities and to provide the improved basic social welfare services including health, nutrition and education. The Plan notes that projects which stress the economic growth do not always filter through to poverty groups; hence, the particular emphasis has been placed upon Muban programmes directed at poverty alleviation under such projects.

- The third concerns the policy of reforms to the system of development administration, in particular, the Plan stresses the improved procedures for development planning and implementation with a major goal to improve the extent of local participation. The Local Government has been traditionally controlled by the Central Government with respect to budgeting and development issues. Greater decentralization of the decision making is an integral part of the Government policy to encourage the rural communities to participate in development and to follow through after initiated.