BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
THE IMPROVEMENT OF RANGSIT CANAL
IN
THE KINGDOM OF THAILAND

JUNE 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of the Kingdom of Thailand the Government of Japan decided to conduct the Basic Design Study on the Project for the Improvement of Rangsit Canal and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Thailand a survey team headed by Mr. Ouchi Akira, Official, Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs from March 19 to April 8, 1989.

The team exchanged views with the concerned officials of the Government of Thailand and conducted a field survey. After the team returned to Japan, further studies were made. Then, a mission was sent to Thailand in order to discuss the draft report 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 sincere appreciation to the concerned officials of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

June 1989

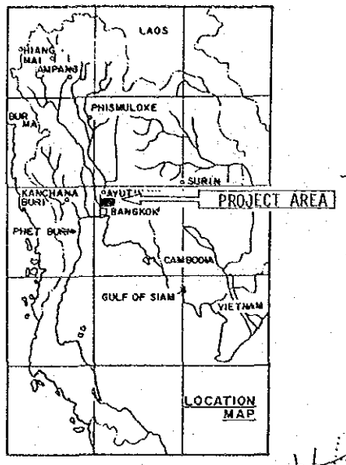
Kensuke Yanagiya

Kensuke Yanagiya

President

Japan International Cooperation Agency

LOCATION MAP



IRRIGATION PROJECT BOUNDARY
ADMINISTRATION BOUNDARY
DIKE
ROAD
RAILWAY
CANAL
DISTRICT
CANAL STRUCTURE

RANGSIT NUA PROJECT
RANGSIT TAI PROJECT
RAPHIPHATANA WEST BR. CANAL
RAPHIPHATANA SOUTH BR. CANAL
PREM PRACHAKORN CANAL
ROUTE NO. 1
CHAO PHRAYA RIVER
RANGSIT CANAL CENTER REG.
RANGSIT 1ST CANAL
ROUTE NO. 305
CHULALONGKORN REG./P.S/NAVI.
RANGSIT
DON MUANG AIRPORT
BANGKOK
HOK WA REG/SIPHON
HOK WA SAI LANG CANAL
PHRA THAMMARACHA REG./SIPHON/NAVI.
SAOWAPHA PHONGSRI NAVI.
SOMBOON NAVI.
SAEN SAEP CANAL
NONG CHOK
BAN KANAK CANAL
NAKHON NAYOK RIVER
1W-1R
1E-1R
1W
1E
2W-1R
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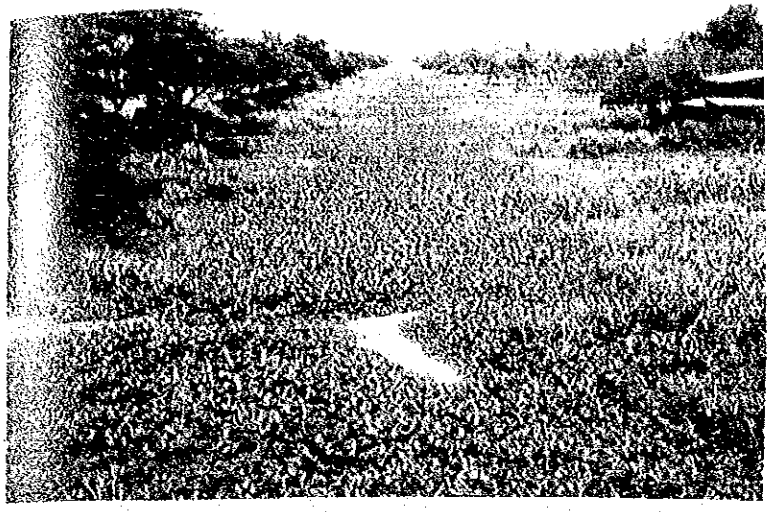
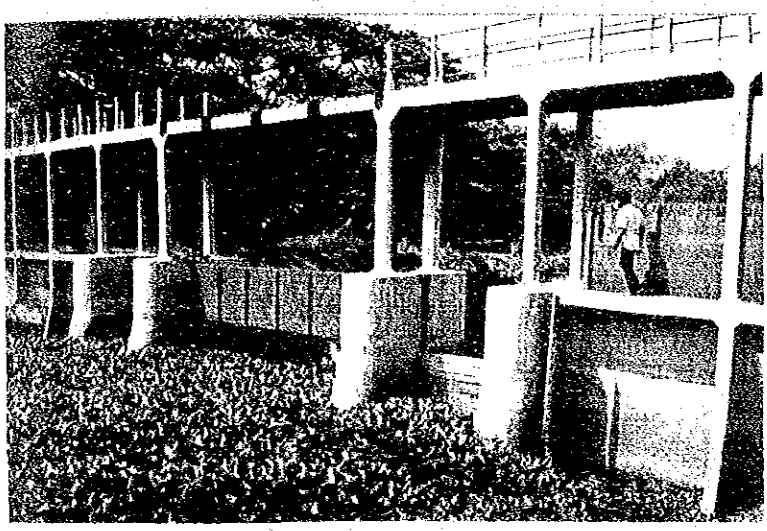
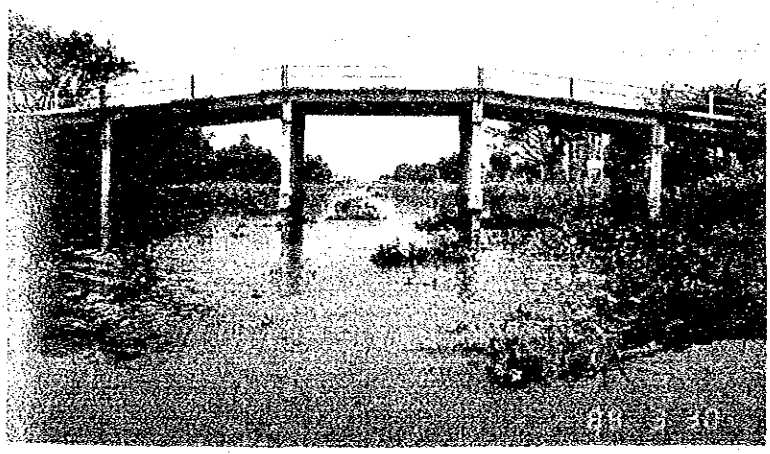


Water Floating Weeds in
Rangsit Canal
ランシット水路浮遊性雑草類の繁茂状況

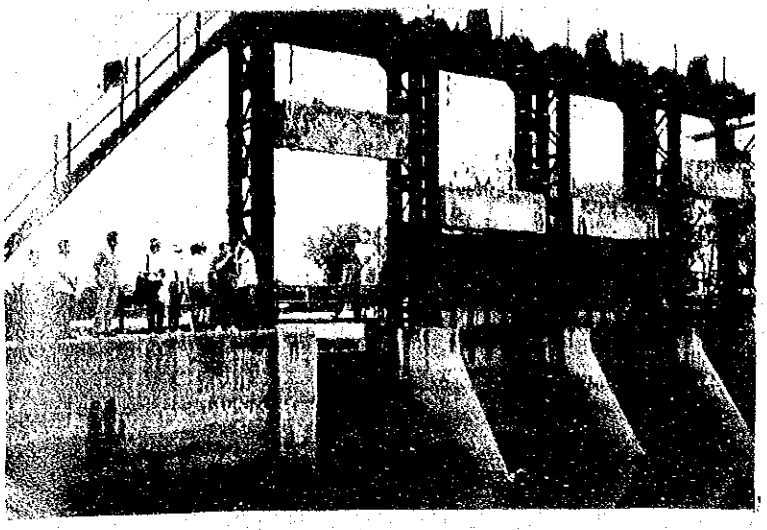


中央水位調整ゲート上流の浮遊性雑草
Water Floating Weeds in
front of Center Regulator



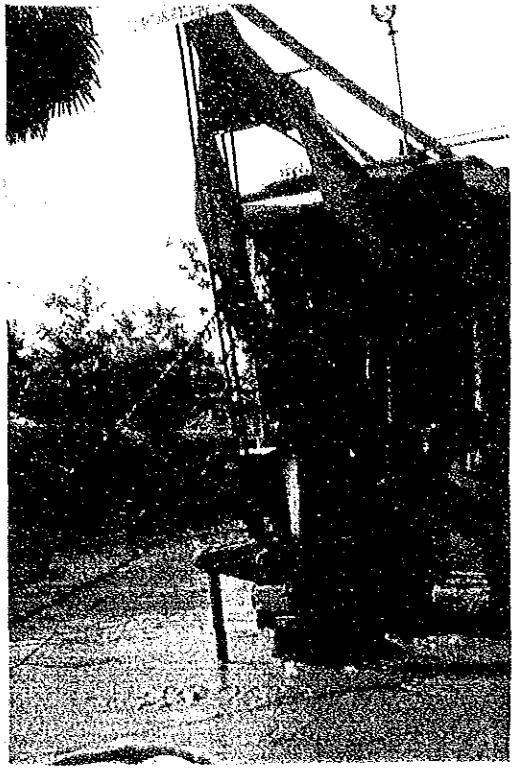
ランシット水路横断橋（コンクリート）
Concrete Bridge

ＲＩＤによる浮遊性雑草の除去状況
（カッターボート及び人力）
Removal of Floating Water Weeds
by Cutter Boat and Manpower



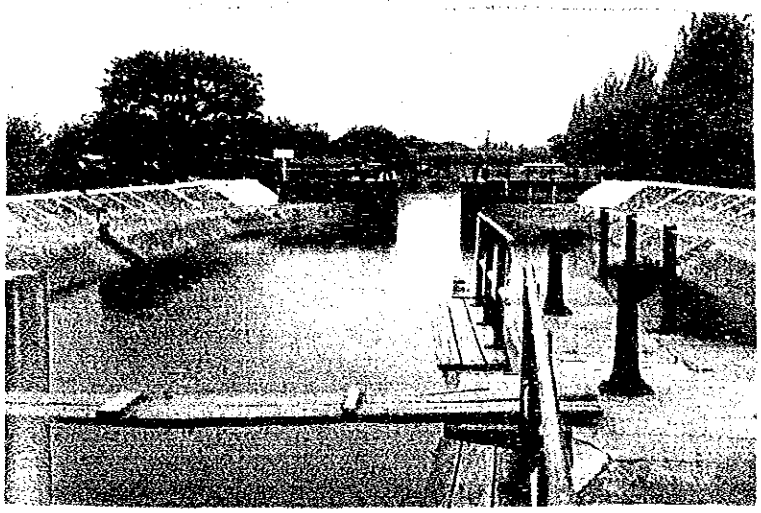
Regulator at Chulalongkorn

チュラロンコンの水位調節ゲート



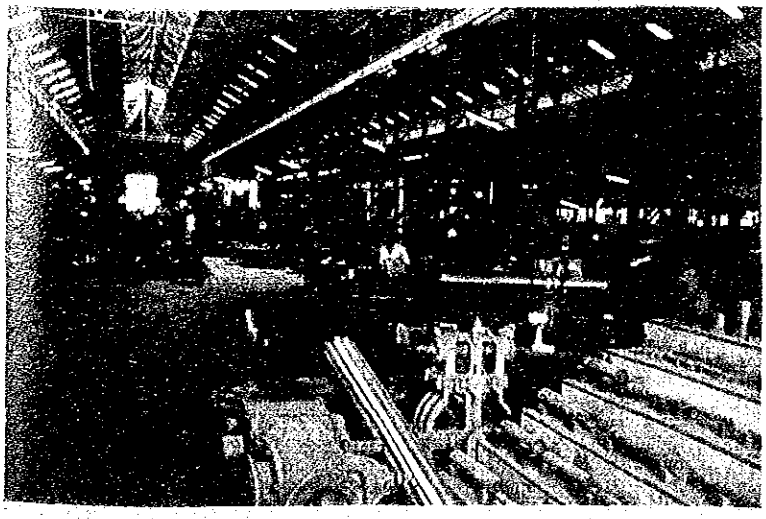
Old Dredging Machine of RID

ＲＩＤ所有のバケット式浚渫船



Chulalongkorn Lock

チュラロンコンの閘門



RID's Workshop　　ＲＩＤの工場

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ABBREVIATIONS AND CONVERSIONS

1. Abbreviations

MOAC	:	Ministry of Agriculture and Cooperatives
RID	:	Royal Irrigation Department
MED	:	Mechanical Engineering Division
MFA	:	Ministry of Foreign Affairs
JICA	:	Japan International Cooperation Agency
EOJ	:	Embassy of Japan
O/M	:	Operation and Maintenance
CIF	:	Cost Insurance and Freight
FOB	:	Free on Board
LC	:	Local Currency
FC	:	Foreign Currency
GDP	:	Gross Domestic Product
E/N	:	Exchange of Notes
P/Q	:	Pre-qualification

2. Measures

mm	:	millimeter(s)
m	:	meter(s)
km	:	kilometer(s)
cm	:	centimeter(s)
ha	:	hectare (6.25 rai)
sq.m	:	square meter(s)
cu.m	:	cubic meter(s)
MCM	:	million cubic meter(s)
kg	:	kilogram(s)
ton	:	metric ton (1,000 kg)
km/hr	:	kilometer per hour
sec.	:	second(s)
min.	:	minute(s)
hr	:	hour

3. Conversions

rai	:	0.16 ha
Baht	:	US$ 1.00 = Baht 25.280 = Yen 127.90

SUMMARY

1. Thailand, since 1961, has formulated and implemented six 5-year plans for national economic and social development. Taking advantage of abundant land, natural resources and labor, Thailand has diversified its industrial structure and, in parallel, achieved stable economic development. However, due to fluctuating international currencies, developing trade protectionism and unstable prices of trade commodities in current years, projections on the future of the national economy are becoming more and more difficult.

2. The Government of Thailand, therefore, reviewed the past development plans and started the Sixth National Economic and Social Development 5-year Plan (1987-1991). The plan puts stress on solving problems left unsolved in the past plans and is characterized by development policies which emphasize quality rather than quantity, more employment rather than growth rate and economic activities by private sectors rather than by governmental initiation.

3. For achievement of the above goals, the government is promoting upland crops, fruits and fish culture for 1) crop diversification and multiplication to meet export demands, 2) quality development for competitiveness in the world market and 3) crop production to meet market demands.

4. Diversification and quality development of crops require year-round irrigation, precise water control and drainage. Accordingly, water resources development, canal dredging and construction of drainage pumping stations are being implemented by the government.

5. The Rangsit area, that is, the areas of the Rangsit Nua and Rangsit Tai Projects, is located in the center of the Chao

Phraya Delta, and was developed in the 1930's. Since then, irrigation and drainage facilities have been maintained and repaired by RID. However, the facilities were designed for supplemental irrigation for wet season paddy and are now facing difficulties in meeting the intensive water use requirements for diversified crops.

6. The government is accordingly implementing canal dredging, rehabilitation and new construction of those facilities. However, due to a shortage of equipment for them, satisfactory results have not been achieved yet.

7. Rangsit Canal is one of most important canals for both the Rangsit Nua and Rangsit Tai Project areas which are a rapidly developing urban agricultural zone. However, the canal is sedimented by floods and choked with dense floating waterweeds which cause narrow cross-sections, irregular canal profile and resultant deterioration of canal functions.

8. Farmers who are practicing modern urban agriculture are facing a shortage of irrigation water and insufficient drainage caused by the deteriorated canal functions. The Government of Thailand, being aware of this, requested the Government of Japan to supply grant aid for the provision of the necessary equipment and materials for the canal improvement.

10. The Government of Japan, in response, decided to carry out a basic design study for concrete project formulation, and JICA subsequently dispatched a study team to Thailand during March 19 - April 8, 1989. The team held discussions and exchanged views and opinions with Thai personnel concerned regarding the project background, objectives, implementation system, project viability and cooperation components.

11. The team studied the situations of RID-owned equipment and their workability, O&M and workshop capacities and other relevant matters in Thailand and continued the study in Japan on the examination of equipment, operation and maintenance planning to prepare this report. JICA accordingly dispatched the team again to Thailand for presentation of this report.

12. The objective of this project is to provide the Government of Thailand with the equipment and materials necessary for improvement of Rangsit Canal. After the canal improvement is achieved, the proper functions of the canal will be recovered and improved to allow equitable distribution of irrigation water, catching of reusable water and water storage in the dry season and the dispersion of floods and conveyance of excessive water to pumping stations so as to shorten inundation to prevent or lessen crop damages. Furthermore, it aims to restore efficient year-round navigation and thereby contribute to local communications and the localeconomy.

13. Rangsit Canal is located in the two provinces of Pathum Thani and Nakhon Nayok and is about 50 km northeast of Bangkok. It has a total length of 54 km and is connected to the Chao Phraya River and the Nakhon Nayok River at its ends. Components of equipment for dredging of the canal are as follows.

Canal dredging	by backhoe dredger boat (bucket 0.6 cu.m)	2 units
Hauling on water	by barge (capacity 20 cu.m)	6
and	by tugboat (150 PS)	2
Reloading	by cramshell (bucket 0.6 cu.m)	2
Hauling on land	by dump truck (11 ton)	6
Reloading platform	by steel sheet pile (10 m)	256 tons

14. It has been estimated that a total of 13.0 months are required for implementation of this project consisting of 2.8 months for detail design, 2.7 months for bidding and contracting and 7.5

months for manufacturing, transportation and delivery. A total cost of 360 million Yen, equivalent ot approx. 70 million Baht, is estimated for the project to be granted by the Government of Japan. The Government of Thailand is accordingly required for preparation of the followings before the canal improvement.

- Provision of equipment, materials and labor for assembling the equipment in Thailand
- Preparation for mobilization of RID-owned machineries for dredging
- Acquisition of spoil banks

15. Benefits to be realized from provision of the equipment and subsequent dredging of the canal are as follows:

- Increase of agricultural production

  By the dredging, about 1,300,000 cu.m of water will be conserved and used for irrigation to produce additional yields equivalent to 28.7 million Baht of net income (equivalent to 144 million Yen)

- Improved drainage

  Drainage of the project area is carried out at present by regulators or a pumping station depending on outer water levels. Due to the narrowed canal cross-section and irregular canal profile, effects by regulator or pump operations are limited. By dredging the canal to improve its functions, work efficiency of the facilities is to be greatly improved and inundation duration is therefore to be shortened.

- Improved Navigation

  Dredging of the canal enables year-round navigation in the canal, though it had previously only been possible during the wet season, to contribute to local communications and the local economy.

- Secondary benefits to be expected form the equipment supplied under the project

  Present RID-owned dredging equipment are not appropriate for canals with various structures of different sizes and types, and therefore complete dredging was not possible in such canals up to the present. The equipment provided under the project are designed and selected for dealing with such conditions so that efficient dredging can be performed in most of similar canals.

16. The project area is shifting from conventional and extensively irrigated paddy farming into modern and intensive urban agriculture. Such a shift requires more intensive control of irrigation and drainage and a stable water supply as well as quick flood drainage. Improvement of Rangsit Canal by dredging for the effective control of water, increased water storage in the canal for irrigation and greater navigation convenience are expected to contribute to the economic development of Thailand. Consequently, benefits to be generated by use of the dredging equipment provided under the grant aid project are judged to be significant, and the project plan is therefore justifiable.

CHAPTER 1 INTRODUCTION

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Thailand, since 1961, has formulated and implemented six 5-year plans for national economic and social development. Taking advantage of abundant land, natural resources and labor, Thailand has diversified its industrial structure and, in parallel, achieved stable economic development. However, due to fluctuating international currencies, developing trade protectionism and unstable prices of trade commodities in current years, projections on the future of the national economy are becoming more and more difficult.

The Government of Thailand, therefore, reviewed the past development plans and started the Sixth National Economic and Social Development Plan (1987-1991). The plan puts stress on solving problems left unsolved in the past plans and is characterized by development policies which emphasize quality rather than quantity. The following basic policies are therefore employed in the plan.

1) Priority on economic balance through cautious economic operations during the first half of the period
2) Development orientation away from growth rate toward growth pattern in order to generate more employment
3) Diversification of production to meet market requirements rather than to simply promote conventional primary products
4) Industrialization by use of abundant resources locally available such as agricultural and labor resources instead of introducing heavy industries
5) Promotion of activities by private sector rather than by governmental initiation
6) Priority on medium and small projects rather than large ones

Among industry sectors in Thailand, the primary industries such as the agriculture, forestry and fishery sectors had long occupied first place in production. However, in recent years, along with the development of service industries, the share was dropped to third place in 1984, being overtaken by the manufacturing sector. The share became 16 % of GDP in 1987. Nevertheless, this does not mean negative growth in the primary industry. This implies hardships for Thai agriculture to keep pace with the growth of other industries since 70 % of the population us engaged in agriculture.

Development of the Chao Phraya Delta, which is the largest granary in Thailand, started since establishment of the former body of RID in the early 1900's. The lower delta was developed in the 1950's and the upper delta in 1960's. This indicates that irrigation and drainage facilities therein are as much as 30-50 years old.

Those facilities were, unlike modern ones, designed only for supplementary irrigation for wet season paddy, and they are therefore facing increasing difficulties in meeting with currently-required dry season crop irrigation and intensive water use for diversified crops.

The government, therefore, dredges canals and improves and rehabilitates those facilities to improve functions for irrigation and drainage as well as for intensive water use. However, due to the shortage of equipment for dredging, sufficient results have not been achieved yet. This is especially true for Rangsit Canal which is located in the center of the delta and is one of the most important canals. Rangsit Canal serves the North and South Rangsit Project areas which are as large as 166,500 ha and which are a rapidly developing urban area of Bangkok in the urban agricultural zone.

Rangsit Canal, however, suffers from functional deterioration due to the narrowed cross-section and irregular canal profile caused by sedimentation from floods and inflow and the growth of floating waterweeds in the canal. Deterioration of irrigation and drainage functions thus caused has already become an urgent problem for urban farmers to be solved. The Government of Thailand, aware of the necessity and urgency for the canal dredging, accordingly requested the Government of Japan to supply grant aid for the provision of the necessary equipment for dredging.

In response, the Government of Japan decided to carry out a basic design study for concrete project planning. JICA subsequently dispatched a team headed by Mr. A. Ouchi, Grant Aid Div., Econo. Coop. Bureau, Min. of Foreign Affairs, to Thailand for a basic design study during March 19 ~ April 8, 1989. The team studied the project background, objectives, implementation system, relevant equipment, present conditions and available equipment and their performances, and collected the relevant data.

On June 4, 1989, JICA again dispatched a team to Thailand for 7 days. The team was headed by Mr. N. Matsuda, First Project Management Div., Grant Aid Proj. Management Dept., JICA, and presented a draft final report on the project. This report, pursuant to the findings and results of the study made in both Thailand and Japan, presents the overall study outcome of the "Basic Design Study on the Improvement of Rangsit Canal."

Member of the basic design team, their itinerary, a list of personnel concerned and the minutes of discussions are also attached.

CHAPTER 2 BACKGROUND OF THE PROJECT

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2-1 Social and Economic Situation

Since the 1970's, Thailand has succeeded in achieving a diversified industrial structure and stable and high economic growth by the effective use of its abundant land, natural resources and labor. Per capita GDP was only $80 in the mid-1950's, and it has grown to exceed $1,000 in 1988 though local differentials still remain. Thailand overcame severe hardships during the oil crisis and is steadily walking the path to stable growth. With the growing economic status of NIES, Thailand is currently thought to be one of the countries with the most potential to be a new member.

One of causes of Thailand's success may be said to be its high capability in converting its industrial structure and economic policy. The Thai economy, since olden times, has been based on agriculture, and its roles in the national economy are quite significant. Seventy percent of the population are engaged in agriculture and its shares in total production and exports are so large. Agricultural productivity may be said to be not as good as in other nations, but diversification of agriculture away from conventional paddy, maize cassava, sugercane, etc., is underway. The agro-industry has accordingly become important for processing the diversified products.

In spite of such agricultural circumstances, the share of agriculture in the national economy is gradually becoming smaller in contrast to the growth of the manufacturing industry. The share of the primary industry in 1987 was 19 % while that of the manufacturing and construction industry accounted for 29 %. In exports, garments took first place over rice, and jewelry became one of the major items. Furthermore, in the atmosphere of the strong Yen, foreign investment in Thailand such as from Japan and Taiwan is rapidly increasing and many enterprises are advancing into Thailand in a rush.

The economic policy of the government has been characterized by maintenance of a free economy and the economy has been operated to maintain balance rather than achieve rapid growth. Since commencement of the First 5-year Plan (1962-1966) until the Sixth Plan, the basic goal was to establish social capital. The government was cautious in promoting large projects and much attention was paid to financial balance and foreign debts. As for industrialization, the rapid introduction of heavy industry as often observed in some developing countries was not employed, but by taking into account available technical levels and capital, gradual but steady industrialization has been made with the stress on light industries.

Such an economic policy is still alive, and Thailand, one of the so-called NAIC, aims to orient itself to be an industrialized country with an agricultural foundation rather than one that depends on the export of high-tech products. What must be done in the near future is the readjustment of local differentials in development and income. In the current data, net GDP growth rates in 1985 and 1986 remained at 3.5 % and 4.7 % respectively but recovered to 7.1 % in 1987 on account of increased exports since the second half of 1986.

In the same year, breakdowns of disbursements indicate growth rates as 16.3 % for export and 9.3 % for fixed capital. On account of the steady increase in domestic demand, growth in imports went up as high as 26.7 %. Growth by sector indicates -2.5 % negative growth in agriculture due to drought, 10.3 % in manufacturing and high growth in the tertialryindustries of which water supply, financing and service industries are the major ones.

Regarding international trade, the trade deficit decreased till 1986 and marked a slight surplus in that year. However, due to the recovery of markets, the increase of imports exceeded that of exports and the deficit is widening. On the other hand, the surplus in capital flow has continued and the overall balance shows a

surplus and therefore foreign currency reserves are steadily increasing. As for domestic prices, wholesale prices which had gone down since 1983 went up in 1987 but the increase in consumer prices has only been slight.

2-2 Sixth National Economic and Social Development Plan

2-2-1 Policy of the Plan

The following basic policies are employed under the Sixth plan.

1) Priority on economic balance through cautious economic operations during the first half of the period
2) Development orientation away from growth rate toward growth pattern in order to generate more employment
3) Diversification of production to meet market requirements rather than to simply promote conventional primary products
4) Industrialization by use of abundant resources instead of the introduction of heavy industries
5) Promotion of activities by private sector rather than governmental initiation
6) Priority on medium and small projects rather than large ones

2-2-2 Target and Strategy

The Sixth plan focuses on problems and constraints remained from the past plans on one hand, and also on rural development and future prosperity on the other hand, and sets the following targets.

> Maintenance of economic development over 5 % per annum and generation of employment for the new labor force of over 390,000 in the labor market.

- Special attention to establishment of economic development pattern, in parallel with maintaining the target economic growth, to solve or lessen problems remained from the past.
- Continuation and promotion of social development focusing on development of human resources so as to establish peace and fairness.
- Promotion of social development in conformity with overall national development, national identity and positive social values, and improvement of living standards in urban and rural areas.

To achieve the above targets, the three strategies of improved development efficiency, reorganization of production structure and proper allocation of income and prosperity are employed. For implementation of the strategies, the following ten programs are undertaken. Table-1 shows some of key indices of macroeconomic targets in the Sixth plan.

(Strategy-1 ; improvement of development efficiency)

1) Macroeconomy development programs
2) Human resources, social and cultural development programs
3) Natural resources and environmental development and conservation programs
4) Science and technology development programs
5) National development administration improvement programs
6) State enterprise improvement programs

(Strategy-2 ; reorganization of production structure and improvement of basic services)

7) Production, marketing and employment development program
8) Basic services improvement programs

(Strategy-3 ; proper allocation of development output)

9) Urban and specific area development programs
10) Rural development programs

2-2-3 Major Target in Agricultural policy

The share of the primary industry in national exports was as much as 60 % in 1985 and these products are important foreign currencies earners to support Thai economy. However, the share has gone down in the last 3 years due to low market prices of the products and increased exports of other commodities.

Thai agricultural policy had put stress on a few major crops such as paddy, cassava, sugercane, etc., and supporting the farm-gate price of paddy. Prices of these major crops were depressed due to overproduction in the world market so that Thailand had to control production even for paddy after 1984. The same was true for cassava due to import regulating by the EC. The government accordingly is making efforts to support farm-gate prices by promotion of exports of other agricultural products. To achieve the goal, the following measures are planned.

- Diversification and multiplication of crops to meet export demands
- Quality control to reinforce market competitiveness
- Lowering of production costs

In addition, other supporting measures such as relaxation of export constraints for agricultural products (e.g., export tax, export premium, etc.) and credit for farmers, rice millers and exporters are also planned. Concrete targets in the Sixth Plan are incorporated as follows:

1) Agricultural development
   - Development of rural poverty areas
   - Development of areas with sufficient rain

- Development of advanced farming areas (20-25 rai holdings)
  * Production of vegetables, fruit and quick-growing plants for both domestic and foreign markets
  * Improvement of major crops (paddy, maize and cassava)

2) Growth of production 2.9 % per annum

3) Shifting from quantitative production to quality production

2-3 Outline of Thai Agriculture

2-3-1 Status of Agriculture in Thai Economy

The GDP of the primary industries, of which agriculture is dominant, had always accupied first place in the Thai economy. However, due to the rapid growth of the manufacturing and service industries in recent years, their share became gradually smaller to 21.4 % in 1981 and 16.0 % in 1987. In 1981 first place was taken by manufacturing and in 1987 second place was taken by retailing.

The same emerged situation for exports so that products of the primary industries occupied 52.1 % of the total wxports in 1981 and 34.1 % in 1987. In 1985 export of manufactured products took first place, but agriculture's share is at a level of 30-40 % to indicate that it is still an important industry to support the Thai economy in foreign currency earnings.

2-3-2 Structure of Agriculture

1) Land use

Arable land occupies 20,570,000 ha equivalent to 40.1 % of the national territory. The acreage is slightly increasing but its rate of growth has decreased by conservation of land and forest resources. Of the arable land, 60 % is used for

paddy, 23 % for upland crops and 10 % for orchards. Lands for vegetables, flowers and grass do not exceed 1 % but have been steadily increasing along with increasing demands for fruit, vegetables, flowers, animal raising and dairy products. Owner-farmers account for 81 % on the average and the figure is 90 % in the Northeast and 70 % in the Central regions.

2) Households and farm size

Farming households and population number about 4,800,000 and 34,000,000 respectively to occupy about 50 % and 64 % of the national totals. As for farm size, 50 % are less than 1.6 ha, but the average is 4.2 ha.

3) Production means

Farming machinery is increasing but is owned by only 20 % of households. About 30,000 two-wheel tractors for tilling paddy fields and heavy 4-wheel tractors for tilling fields for vegetables or highly profitable crops are use by the lease method. There are about 1,100,000 manual sprayers and 100,000 for motor sprayers. For transportation, pick-up trucks and other diesel trucks are dominant. Causes of such low machinery utilization may be abundant hand labor, costly machinery and the unreliable supply of spare parts.

Seeds are commercially supplied and in case of a disaster seeds produced in the state-run seed multiplication farms are supplied or sold. Fertilizer is applied relatively sparingly at the same level of Burma and Nepal (23.4 kg/ha). This is due to the high price (4-5 Baht/kg) and loss of fertilizer by rainwater. However, in recent years, the beneficial effects of fertilizer input are being remarked on by vegetable farmers and more application is expected in the future. Farming labor is mostly supplied by members of each household but heavy labor such as seeding, harvesting and threshing is often managed by hired labor.

2-3-3 Agricultural Policy

As relaxation of the supply-demand balance for major conventional agricultural products progresses, Thai agricultural policy has been changed from the promotion of production and price supports for major crops to the promotion of exports by crop diversification, quality improvement and lowering of production costs. Agriculture is as important as manufacturing among Thai industries, and is regarded as the foundation of the national economy. Agriculture and the food industry are accordingly subject to development programs in the Sixth Plan for their dissemination and promotion through marketing, new commodity production and quality control of 199 agricultural and processed food products.

For crop selection, the government agencies concerned are giving energetic guidance to farmers to switch from paddy-dominant farming to highly beneficial cash crop farming. For areas with limited water sources, soybean, maize, vegetables, animal raising and dairy farming are promoted by extending services such as the supply of certified seeds and credit to farmers.

A committee for agricultural policy was established in 1986 upon changing of the rice price policy to secure paddy production and sales income for farmers. The committee programs measures for securing irrigation water during droughts, buying paddy to support prices when they are low, and supplies credit to farmers for living and to rice millers or exporters for purchasing.

2-3-4 Farm Income and Economy

Per capita net farm income is considerably low compared with that of other sectors, and the difference is increasing. In 1986 it was 5,343 Baht/year for agriculture and 47,237 Baht/year for other sectors. Local differences are also found. Assuming 100 as a national mean, the figures are 135 for the Central, 168 for the South, 98 for the North and 58 for the Northeast regions.

The farm economy in 1982 indicated gross farm income as 19,422 Baht and nonfarm income as 13,962 Baht to result in 33,384 Baht in total. Expenditures were 9,601 Baht for farming and 20,759 Baht for others.Net farm income was therefore 3,024 Baht, in which 84.3 % was for grains, 14.7 % for animal husbandry and 1.0 % for others.

2-4 Canal Dredging by Royal Irrigation Department

2-4-1 Organization

The Royal Irrigation Department (RID) is one of the departments under the Ministry of Agriculture and Cooperatives and its organization is shown in Figure-4. RID divides Thailand into 4 regions in each of which a section of the Mechanical Engineering Division of RID is set up (See Figure-5 for the organization). These sections have 65 units of dredging machinery (5 for floating waterweeds and including a pumping boat, bucket boat and shovel boat) and over 70 % were built before 1970. They are selected and used in accordance to canal conditions.

In addition, 6 barges and 2 tugboats are also available. However, dredged soils are mostly placed on both banks except for some special canals such as Rangsit Canal which has many structures in the canal or on both banks, and therefore barges and tugboats are less frequently used. As seen in Figure-7, Rangsit Canal belongs to Section 3. Its organization, annual budget and work volume are as follows:

1) Organization

Chief	1	pers.
Dredging staff	264	pers.
Transportation staff	6	pers.
Repair staff	10	pers.
other staff	10	pers.
Total	291	pers.

2) Budget Scale

1986/1987	31.8	mill. Baht
1987/1988	30.2	mill. Baht
1988/1989	30.1	mill. Baht

3) Work Volume

1986/1987	129.9 km	3.18 mill. cu.m
1987/1988	114.8 km	2.81 mill. cu.m

2-4-2 Working Conditions

- Work hours
  Standard 8 hours (8 am - 4 pm)
  Two-shift (sometimes three-shift) method practiced
- Work days
  22-23 days per month depending on holidays
- Work month
  10 months per year : September and October for repair
- Dredging frequency
  Programed for dredging once every 5 years for main canals and every 7 years for laterals but practically difficult due to the shortage of equipment and their superannuation.

2-5 Outline of the Request

The Government of Thailand requested, in the primary stage, grant aid for the provision of cutter boats for the removal of floating waterweeds (mostly waterhyacinth) from the following three areas.

- Chao Phraya Dam and its upstream reach
- Rangsit Canal
- Ban Sai

JICA ,in response, subsequently studied the request and discovered that the equipment were still not practically applicable and required high operation costs. JICA, therefore, suggested to the Government of Thailand selection of one of the three areas and examination of the applicable methods for improvement of canal conditions including the removal of floating waterweeds through implementation of a basic design study.

The Government of Thailand accepted the suggestion and then requested improvement of Rangsit Canal as that in most need of improvement. The canal plays an important role for people living along the canal in irrigation, drainage, navigation, domestic water,etc., but is currently suffering from functional deterioration caused by sedimentation and the growth of floating waterweeds and physical superannuation. Requirements for the dredging of Rangsit Canal are proposed and provision of the following equipment and materials is requested.

- Dredging boat (backhoe type)
- Transportation vessel (barge)
- Tugboat
- Reloading equipment (clamshell type)
- Transportation vehicle (dump truck)
- Reloading platform (steel sheet pile)

CHAPTER 3 OUTLINE OF THE PROJECT AREA

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3-1 Location and Topography

The subject project, Rangsit Canal, is located about 50 km northeast of Bangkok and is connected to the Nakhon Nayok River and the Chao Phraya River at its ends. The canal is located between the Rangsit Nua and Rangsit Tai Project areas which are as wide as 166,500 ha in total, complising a vast alluvial delta formed by the Mae Nam Chao Phraya (so-called Chao Phraya Delta).

Town of Rangsit, located along the west part of the canal, is quickly developing as an urban area of Bangkok due to its increased population and factories. A highway and a railway to connect Bangkok and Ayutthaya run across the town and Route No. 305 was constructed along the north bank of the canal in 1986. Rangsit Canal is an artificial canal with a length of 54 km constructed in the 1930's together with its branch canals to connect the two rivers by a straight line.

The project area, the areas of the Rangsit Nua and Rangsit Tai Projects, receives irrigation water diverted by the Rama VI Barrage through Raphiphatana Canal and Khlong 13 canal, and functions to distribute water equitably to each branch canal in an east-west direction. The canal also functions to lead water to Chulalongkorn Regulator and Pumping Station, which are located in the Chao Phraya side of the canal, for both irrigation and drainage.

The topography of the area is almost flat as is the adjacent area, as low as MSL 1.5-2.0 m. The land is slightly inclined from north to south but the gradient is as mild as 1:50,000, and therefore suffer floods of 0.4-0.5 m in the wet season. Its soils are poorly drained grey colored hydromorphic alluvial soils with very fine textures. And beneath them are acid sulfate soils characterized by yellow jarosite mottles and acidity. They are mostly used as paddy fields but in parts vegetables and fruits are also cropped on elevated ridges.

3-2 Meteorology and Hydrology

3-2-1 Meteorology

The climate in the project area belongs to the tropical monsoon type. It is characterized by two seasons: a wet season during November-April due to sea winds bringing the southwest monsoon and a dry season during May-October due to land winds bringing the northeast monsoon from high pressure areas in the Asia continent.

Meteorological observation in Thailand is carried out mostly by the Department of Meteorology and RID. Temperature, rainfall, humidity, solar radiation, wind speed and wind direction are observed by the former, while daily rainfall and streamflow are observed by RID. In the project area, RID's Irrigation Offices are also making observations.

1) Rainfall

   Annual rainfall varies from 1,000-1,600 mm
   90 % occurs in the wet season and the heaviest rainfall is in September

2) Temperature
   - Annual average 27.7 deg.C
   - Monthly averages differ less through year
   - Favorable for paddy cultivation even for double cropping

3) Humidity
   - Annual average 78 %
   - A slight fluctuation by month; mostly stable

4) Wind direction
   - Frequent northern or eastern winds in dry season
   - Frequent southern or western winds in wet season

5) Evaporation
   - Annual average is 4.8 mm/day or 1768 mm/year
   - Highest in March/April

(Table-2 shows meteorology in Bangkok)

3-2-2 Hydrology

Water behavior in the project area is affected by climatic factors, but even more by artificial factors to control/regulate irrigation and drainage water. The project area is in a large irrigation and drainage system wherein water is controlled at water regulators by each of the component irrigation offices, taking account of climatic conditions. Hydrology in the project area is stable due to the control of regulators along Rangsit Canal and its canal network.

3-3 Situation of the Canal

Rangsit Canal, at present, serves mainly for irrigation and drainage, and for navigation too though only a 10 km-section from the Chao Phraya River. There are various sections such as those with dense concentration of houses, floating waterweeds which cover the entire water surface, bank failure which narrows the canal, and concrete/steel/wooden bridges, etc.; 49 those bridges are installed.

The latest dredging of the canal was performed during 1981-1983 for 60 % of the canal length; however, the work volume was not sufficient and the canal is again rapidly deteriorating by sedimentation and the growth of floating waterweeds. The situation of the canal is as follows.

3-3-1 Houses along the canal

From the west end to the center of Khlong 1 and 2, residential houses are built along the canal, especially between Chulalongkorn Regulator and Route No. 1, along which houses are built in the canal land on both sides. In the section between Khlong 2 and the east end, only farmers houses are scattered along the course.

3-3-2 Floating Waterweeds

In sections east from Khlong 2, floating waterweeds are found everywhere. Sedimentation occurs mostly at bridge piers and where has narrowed the water surface. The 20 km section east from the Center Regulator has completely weed-coveredsections with lengths of several hundred meters to 2 km every several km. Waterweeds from the Chao Phraya River are massively accumulated in front of Chulalongkorn Regulator and removal of them is done by use of cutter boats.

3-3-3 Bridges

There are 49 bridges across the 54 km of the canal; 31 are concrete bridges, 16 are wooden, 1 is a temporary one and 1 is a steel raiway bridge. Spans of bridge piers are over 8.0 m, which is more than the 6 m width of the navigation lock gate. The height of bridge beams is between 3.1 and 4.5 m over the FWL of the canal. Locations and their dimensions are presented in Table-5. In addition a large number of small bamboo bridges for private farmers are also installed.

3-3-4 Other Crossing Structures

Between Khlong 8 and Khlong 9, there exist the Center Regulator equipped with a 7 m-wide removable gate. Khlong 13 crosses the canal underneath by siphon.

3-3-5 Canal Cross-section

Side slopes of the canal along the entire 54 km area eroded/failed, and sedimentation in the canal is 1.50 m on the average.

3-3-6 Navigation

Navigation between the Nakhon Nayok River and Saowapha Phongsri Navigation Locks is not possible at present due to the growth of floating waterweeds. Meanwhile, navigation from the Chao Phraya

River through Chulalongkorn Navigation Locks to Khlong 2 is frequently done for the transportation of farm products, daily commodities and other various goods. Only 10 km out of the 54 km is navigable at present.

3-4 Irrigation and Drainage System

In the Rangsit Nua and Rangsit Tai Project areas, so-called water conservation irrigation is practiced to cause shallow flooding over paddy fields in the wet season and to conserve water in the canal network by closure of water gates and catching of drained or excessive irrigation water from adjacent areas to allow farmers pumping irrigation in the dry season. Accordingly, most of the canals in the area are for both irrigation and drainage, except those specified, and function in various ways such as for equitable water distribution, catching of reusable water, water storage and water conveyance.

3-5 O&M of Irrigation and Drainage Facilities

The O&M of all irrigation and drainage facilities constructed by RID under its large-scale irrigation projects are carried out by RID except those at the on-farm level. The O&M of Rangsit Canal is done by Rangsit Tai Irrigation Office which belongs to RID Regional Office No. 8. In case a large work volume of repair or rehabilitation becomes necessary, the work is programed by the regional office or the central office depending on the required budget scale.

3-6 Agriculture and Economy

Cultivation of wet season paddy is dominant in the area. In current years, however, conversion to urban agriculture has been accelerated to produce vegetables, fruits and other upland crops. These crops require a reliable year-round water supply and improved drainage. Farmers are therefore growing them on elevated ridges and

irrigating by privately-owned portable pumps. Below is an outline of the two irrigation project areas.

Name	Area	Population	Farm Popu.	Household	Farm Hous.
	ha	pers.	pers.		
Rangsit Nua	74,000	226,000	71,000	36,000	12,700
Rangsit Tai	92,500	1,358,000	118,000	229,000	21,100
Total	166,500	1,584,000	189,000	265,000	33,800

Along with the rapid development of the Thai economy in recent years, the concentration of population and industries into the urban area has greatly accelerated. Farmlands are quickly changing to residential and industrial lands in a west-to-east direction in the Rangsit Tai Project area. The same may occur in Rangsit Nua Project area in the near future.

3-7 Land Use

The project area comprises mostly farmland and the dominant form of agriculture is paddy cultivation. Due to new government policy, conversion from paddy to upland crops and fruit is going on. Upland crops and fruit plantations are frequently observed along Raphiphatana South Branch Canal/Khlong 13. Earthwork to change paddy fields into those for other crops or into fish ponds is in progress

Upland crops are grown on elevated ridges for drainage reasons in the wet season and are irrigated by pumping into ditches along them in the dry season. There are various crops such as Chinese cabbage, beans, cucumbers, tomatoes, onions, oranges, mangos, etc. Conventional crops such as cassava, sugercane and mung beans have been changed into other crops due to low market prices. Table-3 shows the production of paddy and other crops in 1981 and 1986 for comparison.

3-8 Navigation

Rangsit Canal was primarily constructed as a canal to connect the Chao Phraya River and the Nakhon Nayok River by vessel and is also used for irrigation, drainage, navigation and domestic water use. However due to floods in the wet season, the canal bed became sedimented which has caused shallow water depths. Slopes of canal banks are also eroded/failed. In addition, dense growths of floating waterweeds impede not only irrigation and drainage but also navigation to a great extent.

About 10 km of the canal from the Chao Phraya River is rather well maintained and floating waterweeds are removed to allow navigation at the rate of as many as 4,000-6,000 boats/year through the lock gates. Navigation after the said 10 km is for the transportation of farm inputs/outputs to and from Rangsit in the wet season but becomes impossible during dry season due to shallow water depth and dense weed growth.

3-9 Water Quality

Rangsit Canal functions to catch excessive irrigation water and received drainage and sewage water from the Rangsit Nua Project area. Wastewater from industries and residential areas is diluted and washed away in the wet season to show no water pollution. However, in the dry season, due to the limited irrigation water supply and little water flow in the canal, wastewater remains to result in water quality deterioration.

Some pollutants were found to exceed the allowable standard but, generally speaking, the concentration is not such to require some treatment. BOD shows only 1/5 of the allowable level due possibly to the oxygen supplied by water weeds. Removal of the weeds may cause a lower oxygen supply but, by dredging, water flows away smoothly to prevent concentrations of pollutants in the canal.