

CHAPTER 4 OUTLINE OF THE PROJECT



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### 4-1 Objective

Objective of this project is to furnish appropriate dredging equipment necessary for improvement and recovery of functions of Rangsit Canal as it had been equipped with. By the project, functions such as equitable distribution of irrigation water, effective catching of and conservation of reusable water, redistribution of excessive water, smooth conveyance of drainage water to shorten flood duration and to prevent/minimize damages on upland crops and orchards, are accordingly restored so as to result in contribution to the local economic development.

### 4-2 Study and Examination on the Request

As the Thai economy steadily develops, the project area will be increasingly playing important roles as a model area for modern and intensive urban agriculture around Bangkok. Intensive urban agriculture requires precise control of irrigation water and heavy demand. Rangsit Canal however is heavily sedimented and suffers from floating waterweeds so that it is facing difficulties in satisfying the requirements. At present, additional irrigation water is taken or pumped from the Chao Phraya River but the narrowed canal cross-section limits its water reaches and makes water management quite ineffective.

This being the situation, RID is dredging the canal by use of its own equipment. However, because of 1) overly large equipment for Rangsit Canal, 2) poor work efficiency due to old-fashioned equipment, and 3) many work obstacles of canal structures, satisfactory dredging is hardly performed. This situation is accordingly blocking development of urban agriculture. Prompt furnishment of dredging equipment designed for operation in Rangsit Canal and the similar canals.

#### 4-3 Project Description

##### 4-3-1 Project Plan

Upon receipt of the equipment and materials for the project, RID formulates a long-term dredging plan for efficient use of the RID-owned equipment and those provided under the project by taking into account implementation priority among the canals, and subsequently execute the dredging accordingly.

- 1) Improvement of Rangsit canal.  
Dredging of Rangsit Canal entire 54 km, which is urgently required. For early achievement of beneficial effects, some of the RID-owned equipment applicable to Rangsit Canal is mobilized to dredge the east part of the canal. Dredged soils and weeds are hauled to a spoil bank by barge and dump truck.
- 2) Improvement of branch canals.  
In order to extend the benefits of canal improvement throughout the Rangsit Nua and Rangsit Tai Project areas, improvement of canals connected thereto are to be performed in due order.

##### 4-3-2 Location of Project Area and Conditions

Rangsit Canal is located along both the Rangsit Nua and Rangsit Tai Project areas with a length of 54 km to connect the Chao Phraya River and the Nakhon Nayok River. The canal is crossed by 15 branch canals and a siphon. The canal is equipped with two navigation locks at the both ends to the rivers, two regulators at the west end

and the center and a two-way pumping station (bore 1,000 mm x 6 units) for both irrigation and drainage at the west regulator. As the area becomes urbanized, a large number of bridges (49 in total including one railway bridge) have been constructed across the canal.

The design cross-section of Rangsit Canal is as seen in Figure-3. However, the actual one is afflicted with sedimentation, eroded/failed side slopes and floating waterweeds to deteriorate its functions. Sedimentation differs from place to place and is found less at the center and more at the slope ends, including failed bank soil. About 10 km from the Chao Phraya River suffers little sedimentations

#### 4-3-3 Outline of Equipment and Materials to be Provided

The following equipment and materials are required.

##### 1) Dredging equipment

- Dredging	Backhoe dredger boat (bucket 0.6 cu.m.)	2 units
- Hauling on water	Barge (capacity 20 cu.m.)	6
	Tugboat (150 PS)	2
- Reloading	Clamshell (bucket 0.6 cu.m)	2
- Hauling on land	Dump truck (11 ton)	6

##### 2) Materials for reloading platform

No land is available for a spoil bank along the canal, and therefore swamps scattered in the south of the canal are used for the spoil banks. For unloading dredged soil from barges and loading to dump trucks for hauling, construction of reloading platforms is necessary. They are to be constructed by RID (one in every 6 km along the road) by the use of steel sheet piles.

Steel sheet pile	256 ton
(10 m-long, 0.4 m-wide, 60 kg/m)	



CHAPTER 5 BASIC DESIGN





## CHAPTER 5 BASIC DESIGN

### 5-1 Design Policy

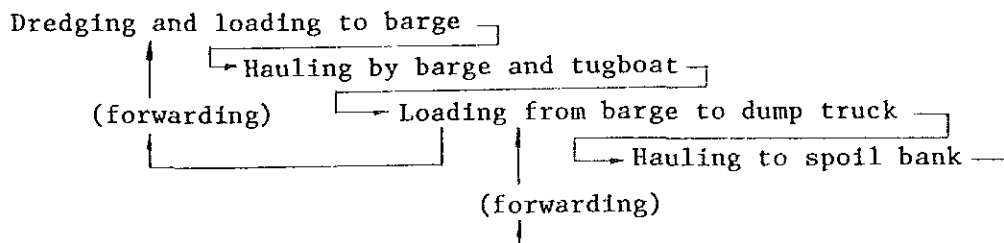
The basic design of the project is made taking the following into consideration.

- Equipment and materials necessary for dredging are determined based on the most appropriate dredging method. Sizes of the equipment are examined to fit the canal conditions.
- Determination of equipment by taking into account engineering capacity of the Drainage Machinery Branch of the Mechanical Engineering Division.
- Due consideration of request of RID in examination of type and size of equipment.

### 5-2 Design Conditions

#### 5-2-1 Method of Dredging

Along the north bank of the canal runs a paved road and there are buildings and temples along the canal. Placing of dredged soil on canal banks or slopes cannot be done. Dredged soil is planned to be hauled to a spoil bank. Dredging procedures are therefore as follows.



## 5-2-2 Selection of Equipment and Materials

### 1) Dredger

Backhoe dredger boat is employed due to following reasons.

- Better work efficiency than clamshell, bucket and shovel types.
- Rather narrow canal width and shallow water depth to allow short arm length.
- Due to silty sediment, mechanical force required for dredging.
- RID staff experienced in this type.

### 2) Hauling in the canal

- Hauling by barge and tugboat by taking water depth and canal width into consideration. Barges are not engine-propelled.

### 3) Loading

- Loading from barge to dump truck by clamshell

### 4) Hauling to spoil bank

- Hauling to spoil bank by dump truck

### 5) Reloading platform

- Temporary platform located at every 6 km along the length of the canal

## 5-3 Equipment and Materials

### 5-3-1 Dimensions of the Equipment requested for the Project

Rangsit Canal is equipped with bridges, regulators, navigation locks, etc. The equipment are therefore required to pass through them and to be workable without hindrance to satisfy the following constraints.

Width : not more than 6.0 m  
 Height : not more than 3.5 m above water surface (2.0 m MSL)  
 Draft : approx. 1.5 m

### 5-3-2 Backhoe Dredger Boat

A Backhoe dredger boat is a boat with a built-on hydraulic backhoe. its bucket capacity is the largest one that conditions allow. The boat has to be efficiently workable and able to easily travel without being blocked by canal structures. The size becomes therefore 12-13 m long, 5.5 m wide and 1.0 m draft. For the safety and stability of the boat, the backhoe on which is built may be of a 0.6 cu.m bucket.

#### Production per Hour

$$Q = 3600 \times q \times f \times E / C_m$$

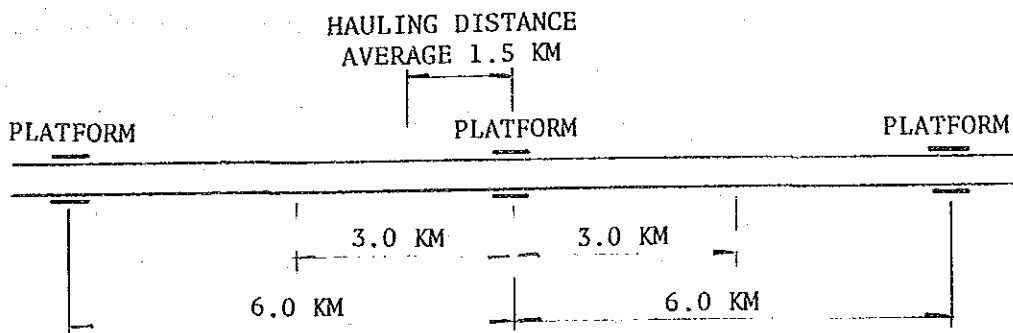
where,

Q for hourly production (cu.m/hr),  
 q for production per cycle ( $0.6 \times 0.9 = 0.54$  cu.m),  
 f for earth volume conversion coefficient (=1.0),  
 E for work efficiency (=0.6),  
 C<sub>m</sub> for cycle time (=28 sec), and  
 0.9 for bucket coefficient, then

$$Q = 3600 \times 0.54 \times 1.0 \times 0.6 / 28 = 41.7 = 40 \text{ cu.m/hr}$$

### 5-3-3 Barge

A loading platform is planned at each 6 km along the canal by taking account of loading time and hauling time. The average hauling distance for barges is 1.5 km.



Navigation speed in the canal is planned to be 4 knots (7.4 km/hr), and it will take 24 minutes net time for a round trip.

$$(1.5 \text{ km} / 7.4) \times 2 = 0.4 \text{ hr (24 min.)}$$

By counting time for preparation and mooring, gross travel time is taken as 30 min. Barge capacity then becomes 20 cu.m as,

$$40 \text{ cu.m /hr} / 2 = 20 \text{ cu. m}$$

then, the cycle time becomes,

30 min. for loading,

30 min. for hauling, and

30 min. for unloading,

to result in 90 min. The number of barges for a dredger boat becomes,

$$90 \text{ min.} / 30 \text{ min.} = 3 \text{ units}$$

#### 5-3-4 Tugboat

Tugboat to tow the 20 cu.m. barge at 4 knot. One tugboat for three barges.

#### 5-3-5 Cramshell

In meeting with the production of the dredger boat, that for the cramshell is 40 cu.m/hr with a 0.6 cu.m bucket.

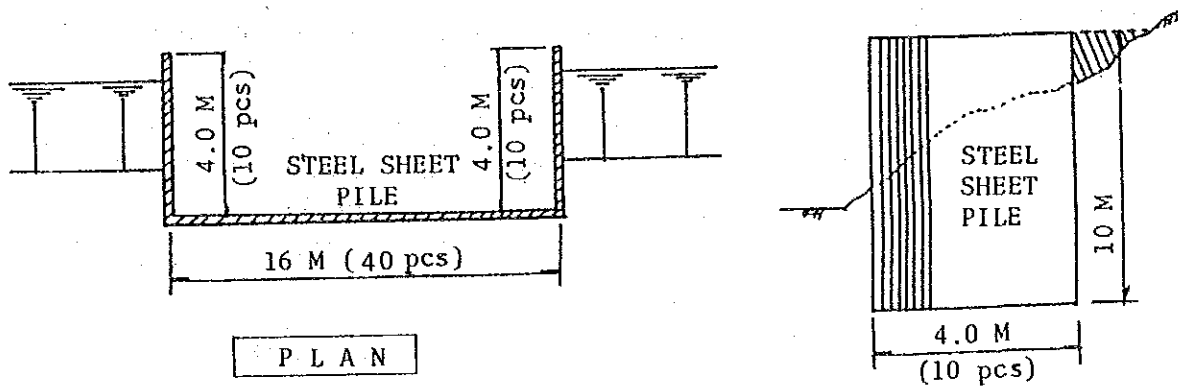
#### 5-3-4 Dump Truck

For continuous and efficient work, the size and number of units are examined in the following way.

Loading by clamshell	40 cu.m/hr
Dump truck (6.5 cu.m)	11 ton
Travelling speed of truck	20 km/hr
Hauling distance	3 km
Loading time $(6.5 / 40) \times 60 =$	10 min.
Travel time $(3 \times 2 / 20) \times 60 =$	18 min.
Cycle time $(10 + 18 + \text{loading time}) =$	30 min.
Production per hour $(60 / 30) \times 6.5 =$	13 cu.m/hr
Number of units $(40 / 13) =$	3 units

### 5-3-7 Steel Sheet Pile

Dimensions of reloading platform are determined by taking account of size of barges, work space of clamshell and standby space for dump trucks. Dimensions of the platform are 16 m long and 4 m long requiring 60 pieces of sheet pile.



The aforementioned equipment in Section 5-3 may be summarized as follows:

1) Backhoe dredger boat	1 unit
2) Barge	3
3) Tugboat	1
4) Clamshell	1
5) Dump truck	3
6) Steel sheet pile	60 pieces

#### 5-4. Implementation Plan

Dredging of Rangsit Canal is performed by RID by use of the equipment and materials granted under the following implementation plan.

##### 5-4-1 Work Conditions

- Canal length 54 km
- Dredging volume approx. 1,300,000 cu.m
- Equipment those granted and RID-owned
- Work time 8 hrs daily (2-3 shifts)
- Work day 23 days monthly
- Work month 10 months yearly (2 months for repair of equipment)
- Completion in 3 years due to urgency

##### 5-4-1 Work Volume

1) By granted equipment:

$$40 \text{ cu.m} \times 8 \text{ hr} \times 2.5 \text{ shifts} = 800 \text{ cu.m/day}$$
$$800 \times 23 = 18,400 \text{ cu.m}$$

2) By RID-owned equipment

Those applicable to Rangsit Canal are used to the full extent to dredge the east part of the canal which has fewer canal structures. The location interval of platforms and combination of equipment are similar to the granted ones.

- Dredger boat (bucket 0.7 cu.m)  
 $45 \text{ cu.m/hr} \times 8 \text{ hr} \times 2.5 \text{ shifts} = 900 \text{ cu.m/day}$
- Barge (capacity 17 cu.m)  
 $17 \text{ cu.m} \times (8 \text{ hr} / 1.5 \text{ hr/cycle}) \times 3 = 630 \text{ cu.m/day}$

- Tugboat (120 PS)
- Crane
- 35 cu.m/hr x 8 hr x 2.5 shift = 700 cu.m/day
- Dump truck (6 ton, 4 cu.m)

In the above combination of equipment, production of the barges governs the overall production so that 630 cu.m/day is employed for work planning.

$$\text{Monthly production} = 630 \times 23 = 14,500 \text{ cu.m/month}$$

#### 5-4-3 Completion Period

Considering the urgency and dredging work volume, work completion is planned in three years. Canal sections for dredging by RID-owned equipment are planned in 2 places; 8 km from the Nakhon Nayok River and another 6 km between KM 8 and KM 14. Remaining sections are dredged by the granted equipment.

##### 1) Sections by RID-owned equipment

- 8 km section:  $24 \text{ cu.m/m} \times 8,000 \text{ m} = 192,000 \text{ cu.m}$   
 $192,000 \text{ cu.m} / 14,500 \text{ cu.m/mon.} = 14 \text{ mon. in net}$
- 6 km section;  $24 \times 6,000 = 144,000 \text{ cu.m}$   
 $144,000 / 14,500 = 10 \text{ mon. in net}$

In order to complete dredging in three years, one fleet of the equipment is mobilized.

##### 2) Sections by the granted equipment

$$1,300,000 - (192,000 + 144,000) = 964,000 \text{ cu.m}$$

$$964,000 / 18,400 = 53 \text{ months in net}$$

$$53 / 30 \text{ months} = 1.8, \text{ then } 2 \text{ fleets}$$

By use of 2 fleets, it requires 26 net months for completion as,

$$964,000 / (18,400 \times 2) = 26 \text{ net months}$$

WORK SCHEDULE

Equip. Fleet	Work Vol. cu.m	Month													
		2	4	6	8	10	12	14	16	18	20	22	24	26	28
Grt'd Fleet-1	964,000						(repair)						(repair)		
Grt'd Fleet-2															
RID's Fleet		336,000													
Total	1,300,000														

5-4-4 Number of Equipment

1) Granted Equipment

- Backhoe dredger boat (bucket 0.6 cu.m)	1 unit	} 2 fleets
- Barge (20 cu.m)	3	
- Tugboat (150 PS)	1	
- Cramshell (bucket 0.6 cu.m)	1	
- Dump truck (11 ton)	3	

2) RID-owned Equipment

- Shovel dredger boat (bucket 0.7 cu.m)	1 unit	} 1 fleet
- Barge (17 cu.m)	3	
- Tugboat (120 PS)	1	
- Cramshell (bucket 0.6 cu.m)	1	
- Dump truck (6 ton)	5	

5-5 Equipment and Material Lists

- 1) Backhoe dredger boat 2 units  
(assembled from 2 or 3 parts at site)
- Length approx. 12.0 m
  - Width 5.6 m or less
  - Depth approx. 1.8 m
  - Draft 1.5 m or less
  - Height above water 3.3 m or less
  - Spud hydraulic



- Dredging depth 5.5 m or more
  - Bucket capacity approx. 0.6 cu.m
- 2) Barge (assembled from two halves) 6 units
- Length 12 - 13 m
  - Width 5.6 m or less
  - Depth approx. 1.8 m
  - Draft 1.5 m or less
  - Capacity 20 cu.m or more
- 3) Tugboat (for barge) 2 units
- Length 7.5 - 9 m
  - Width 2.5 - 3 m
  - Depth 1.0 - 1.2 m
  - Draft 1.5 m or less
  - Height above water 3.3 m or less
  - Tug speed for barge 7 km/hr or more
  - Steering manual hydraulic
- 4) Cramshell 2 units
- Bucket approx. 0.6 cu.m
  - Boom length approx. 6.0 m
  - Crawler type
- 5) Dump truck 6 units
- Payload approx. 11 ton
  - Engine output approx. 280 PS/2200 rpm
  - Drive 6x4
  - Bed capacity approx. 7 cu.m rear-open
- 6) Steel sheet pile (standard type) 256 ton
- Width x height x thickness x length  
= 400 mm x 125 mm x 13 mm x 10 m
  - Unit weight 60 kg/m



CHAPTER 6 PROJECT IMPLEMENTATION PLAN



## CHAPTER 6 PROJECT IMPLEMENTATION PLAN

### 6-1 Implementation System

The project, as a grant aid project of the Government of Japan, is implemented under the following system.

#### 6-1-1 Executing Body

The executing body of the project is the Mechanical Engineering Division of the Royal Irrigation Department, and a new organization in charge of operation and management for the dredging of Rangsit Canal is set up therein as shown in Figure-6.

#### 6-1-2 Consultants

For provision of equipment and materials under the grant aid project, a contract on consulting services is concluded between the Government of Thailand and Japanese consultants. The consultants carry out detailed design of the required equipment, prepare bidding documents and assist the executing body in bidding procedures.

#### 6-1-3 Executing Agency

The executing body of this project is the Mechanical Engineering Division of RID headed by the Chief Mechanical Engineer, who gives instructions and coordinates with parties concerned for implementation of the project.

Equipment and materials provided under the project are to be maintained and repaired by the Section of Improvement on Rangsit Canal newly established in MED. After completion of the dredging, will be applied to the branch canals. The Section is staffed by 104 personnel consisting of 90 technical and 14 non technical staff.

## 6-2 Undertakings by the respective Governments

Undertakings by the Japanese and Thai Governments for the project are as follows.

### 6-2-1 Undertakings by the Government of Japan

- 1) Provision of equipment and materials
  - Backhoe dredger boat
  - Barges
  - Tugboats
  - Cramshells
  - Dump trucks
  - Steel sheet piles
- 2) Relevant services
  - Transportation of the equipment and materials from Japan to Thailand
  - Transportation from the port of disembarkation to the delivery spot

### 6-2-2 Undertakings by the Government of Thailand

- 1) Regarding equipment and materials,
  - Preparation of equipment, materials and labor to assemble vessels
  - Preparation for mobilization of RID-owned machineries for dredging
  - Acquisition of spoil banks
- 2) Relevant procedures and cost undertakings

## 6-3 Procurement

Dredger boats, barges, tugboats, cramshells, dump trucks and sheet piles are procured in Japan because of difficulties in local procurement and technical and delivery-term reasons. Among these, the

dredger boats and barges are order made and therefore time for design and ship building has to be considered in procurement scheduling. For easy handling in transportation, they may be made from two parts or three. Therefore, engineers are dispatched to the site for assembling the boats and for staff training for equipment operation and systematic dredging practices.

#### 6-4 Implementation Schedule

Subsequent to the Exchange of Notes (E/N) between the two governments, preparation of the detail design, preparation of bidding documents, bidding and execution of contract, and equipment manufacturing are carried out. The Department of Technical and Economic Cooperation is the Thai counterpart for the Exchange of Notes.

##### 1) Detailed Design

Based on the Basic Design, bidding documents are prepared consisting of detailed design drawings, technical specifications and cost appraisals. Minute exchange of opinions with the Thai counterparts is programed at the beginning and the middle of the design period, and the finalized detailed design is subject to approval thereby.

2) Subsequent to completion of the detailed design, prequalification is done in Japan through advertisement. The executing body, after qualification, invites qualified prospective bidders and executes biddings in witness of the concerned. Bidder of the lowest fair offer becomes supplier and conclude the contract with the executing body.

3) After execution of the contract and subsequent to the approval by the Government of Japan, the supplier start manufacturing and/or acquisition of equipment and materials for delivery. Judging from the nature and number of the equipment, a total of 13 months are required for delivery, after the Exchange of Notes, consisting of 2.8 months for detailed design, 2.7 months for bidding and

contracting and 7.5 months for acquisition/manufacturing, transportation and delivery.

#### 6-5 Project Cost

Project costs are composed of those borne by the two governments, and are estimated as follows.

##### 1) Conditions for cost estimation

- Price level; March, 1989
- Currency exchange rate;
  - US\$ 1.00 = Japanese Yen 127.90
  - US\$ 1.00 = Thai Baht 25.280
- Supplier; Japanese national or juridical person
- Others; Exemption of customs duties and other taxes on imported materials and on Japanese nationals or juridical persons involved in works for the grant aid project.

##### 2) Thai Government allocates a budget of about 32 million Baht for improvement of Rangsit Canal (54 km) by dredging by use of the granted and existing equipment fleets. The budget requirement is estimated as follows:

Dredging	4.5 Baht/cu.m
Hauling on water	7.2 -do-
Reloading	2.9 -do-
Hauling on land	7.4 -do-
Sub-total	22.0 -do-
Overhead (10%)	2.2 -do-
<u>Total</u>	<u>24.2 Baht/cu.m</u>

Dredging  $24.2 \times 1,300,000 = 31.46$  million Baht

Platform 8 ples  $\times 50,000$  Baht = 400,000 Baht

then,

Total 31.86 million Baht



CHAPTER 7 O&M PLAN



## CHAPTER 7 O&M PLAN

### 7-1 O&M Management

Equipment and materials provided to the Government of Thailand are to be used together with RID-owned equipment for improvement of Rangsit Canal for three years. During that period, RID will set up a new section for the improvement of Rangsit Canal to maintain them.

Minor repairs of equipment are undertaken by the maintenance staff of the new section. Large-scale repairs are undertaken by the Workshop Division of RID. Acquisition of ordinary spare parts is locally made.

### 7-2 Estimated O&M Cost

O&M cost to be secured by the Government of Thailand for implementation of the dredging is estimated as follows.

#### 1) Personnel cost

Based on staffing plan (1989) of RID, personnel costs are estimated as follows. Estimated mean annual cost includes a 10 % annual pay hike.

Manager	1 pers.	165,000	Baht/year
Section Chief	2	264,000	-do-
Branch Chief	6	570,000	-do-
Senior staff	10	766,000	-do-
Middle staff	25	1,551,000	-do-
Junior staff	61	2,818,000	-do-
<u>Total</u>	<u>105</u>	<u>6,134,000</u>	<u>Baht/year</u>

#### 2) O&M Cost

The granted equipment are to be used for dredging of other canals after Rangsit Canal. In this case, the O&M cost is divided into operation cost and maintenance cost.

-	Operation cost	
	Annual work volume per fleet	180,000 cu.m
	Unit operation cost	22 Baht/cu.m
	then, operation cost for 2 fleets is,	
	180,000 x 22 x 2 =	7,920,000 Baht
	Maintenance cost	
	Maintenance cost varies depending on work frequency and aging, 2 % of procurement cost is employed.	
	57,500,000 x 0.02 =	1,150,000 Baht
	<u>Sub-total</u>	<u>9,070,000 Baht</u>
-	Consumables and miscellaneous	
	10 % of personnel cost is employed.	
	6,134,000 x 0.10 =	613,400 Baht
	<u>Grand Total</u>	<u>15,817,400 Baht</u>

Annual O&M cost is, consequently, estimated to be 15.8 million Baht, equivalent to 60.5 million Yen. The amount is so small as to be equivalent to 0.14 % of the total budget of RID and 3.6 % of that of the Mechanical Engineering Division in FY 1989 so that allocation of the amount can be reasonably made.

<u>Budget Scale of RID (unit:Mill.Baht)</u>			
<u>Year</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>
R I D	8,392	9,181	11,177
Mech.Eng.Div.	326	357	435

CHAPTER 8 PROJECT EVALUATION



## CHAPTER 8 PROJECT EVALUATION

### 8-1 Project Benefit

The following benefits are expected through implementation of the grant aid project for the provision of required equipment and materials and subsequent execution of the canal improvement in accordance with the project plan.

#### 8-1-1 Efficient operation of canal dredging

Equipment presently available to RID are, due to their sizes and types, not efficiently applied for dredging Rangsit Canal. The project area is located in the most important urban area of Bangkok. However, because of this, dissemination of new agriculture patterns in conformity with the government policy meets difficulties in supplying irrigation water to upland crops and fruit plantations and satisfactory drainage.

After provision of the equipment designed for the canal and application of efficient dredging methods, dredging will be smoothly performed and the methodology will then be applied to other canals to produce the same benefits.

#### 8-1-2 Increase in Agricultural Production

Water is conserved in the canal network and is used for irrigation in the dry season. Dredging of a canal enables, in this sense, more storage in the canal. The increased storage is estimated to be 1.3 million cu.m. Increased gross production of additional crops by use of the additional water volume is estimated to be 9.78 mill. Baht for paddy and 54.6 mill. Baht for upland crops and fruits to indicate 64.38 mill. Baht in total. Net income of the total is estimated to be 28.7 mill. Baht.

### 8-1-3 Drainage Benefits

When drainage is required in the project area, operation of Chulalongkorn Regulator or Chulalongkorn Pumping Station (6 x bore 1,000 m/m) is carried out. In the case of pumping drainage, due to the narrowed canal cross-section, water is not able to be sufficiently drawn to the pumping station to work at its full capacity and efficiency.

By recovering sufficiently deep canal cross-sections through dredging, the work efficiency of pumps is much improved and then inundation damages on upland crops and fruit plantations and its duration are decreased.

### 8-1-4 Navigation

Rangsit Canal was constructed for navigation as well as for irrigation and drainage. Because of sedimentation and the growth of floating waterweeds, the canal, except for a 10 km section from the Chao Phraya River, is only used for the transportation of farm products and inputs in the wet season and not used in the dry season. At present, the number of vessels passing through Chulalongkorn Navigation Locks is 4,000-6,000 per year and, by dredging of the canal, an increase in navigation not only in the wet season but also in the dry season along the whole canal reach are promised.

### 8-2 Project Evaluation

A series of examinations and studies have been made on components of the requests made by the Government of Thailand, and it is concluded that the project plan and provision of the required equipment and materials are highly viable and feasible in view of the dissemination of modern agriculture and direct and indirect benefits produced therefrom.



## 1) Evaluation

Development of the Thai economy and the simultaneous increase of the population in Bangkok caused a big change for the farmers around Bangkok. In addition, the new agricultural policy under the Sixth 5-year Plan for export-oriented agriculture and the development of domestic demand has pushed farmers in the project area to intensive urban agriculture. Paddy fields are steadily being changed into lands for highly profitable vegetables and fruits or into fish ponds. Different from paddy farming, these crops or ponds require much precise control of water supply and drainage, reliable water sources and prompt flood drainage.

The project area is thus playing important roles as a model area for disseminating modern and intensive urban agriculture, and, in the scope of the new government policy, dredging of Rangsit Canal functions to upgrade water control for irrigation and drainage and to contribute to improved navigation convenience for transportation and communications.

Meanwhile, as Rangsit Canal functions to catch drained and/or excessive irrigation water from the Rangsit Nua Project area, wastewater from factories and houses is also caught. However, BOD indicates satisfactory value while COD is slightly over the BOD. Canal dredging smoothens water flow to supply more oxygen into water and to replace water frequently without standing-still so as not to concentrate pollutants, and will thus prevent water pollution.

## 2) Indirect Effects

The equipment and materials to be furnished under the project are advantaged by high work efficiency and in application to canals with various structures therein. They will accordingly be applied not only to Rangsit Canal but also to canals in the wider extent, and subsequently bring up significant indirect effects therefrom.



CHAPTER 9 CONCLUSION AND RECOMMENDATION



## CHAPTER 9 CONCLUSION AND RECOMMENDATION

### 9-1 Conclusion

The Government of Thailand commenced the Sixth National Economic and Social Development Five-year Plan in 1987 to increase employment, to diversify production, to industrialize the nation by use of locally available resources and to promote economic activities of private sectors in order to solve problems remaining from the development plans of the past. Particularly in the agricultural sector, which suffers from low prices of major crops in the world market, the plan pushes policies for diversified crop production in meeting with world demand, quality control to compete in the world market, low production cost and financial support.

Accelerated by the economic development in the later half of the 1970's, rapid population increase and industrialization occurred in Bangkok and the adjacent area, and this brought increased domestic demand for daily commodities. Furthermore, the new policy to promote production of world competitive crops pushed the project area into that for vegetables and fruits and other highly profitable upland crops.

Rangsit Irrigation Project areas are most appropriate for application of the policy and accordingly being changed from the conventional irrigated agriculture pattern for paddy into modern and intensive urban agriculture. Such changes require more precise 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 and to boost navigation convenience will contribute to the economic development of Thailand. Consequently, benefits to be generated by the grant aid project to provide the equipment and subsequent canal dredging are judged to be remarkable and the project plan is therefore justifiable.

## 9-2 Recommendations

### 1) Operation planning

In order to make efficient use of the equipment for other canals after Rangsit Canal, formulation of a long-term operation plan for the equipment mobilization, including the RID's own ones, is required taking account of priority order to the component canals.

### 2) Equipment maintenance

For effective use of equipment, appointment of RID staff experienced in mechanical maintenance and establishment of an organization are required in order to maintain the equipment continuously functionable.

### 3) Budgeting

For use of the equipment furnished under the project to other canals after Rangsit Canal, appropriation of budget for the dredging is absolutely necessary.

### 4) Preparation of spoil banks

In advance to the dredging, spoil banks to dispose dredged soils and weeds have to be prepared.