THE FEASIBILITY STUDY
ON
THE LOWER NORTHEAST MEDIUM SCALE IRRIGATION PACKAGE PROJECT
IN
THE KINGDOM OF THAILAND

EXECUTIVE SUMMARY REPORT

July 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

THE FEASIBILITY STUDY

ON

THE LOWER NORTHEAST MEDIUM SCALE

IRRIGATION PACKAGE PROJECT

IN

THE KINGDOM OF THAILAND

EXECUTIVE SUMMARY REPORT

July 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

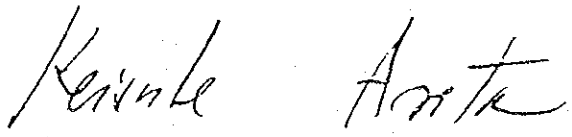
In response to the request of the Government of the Kingdom of Thailand, the Japanese Government decided to conduct a Feasibility Study on the Lower Northeast Medium Scale Irrigation Package Project and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA sent to Thailand a survey team headed by Mr. Shoichiro Higuchi from February 1983 to March 1984.

The team exchanged views on the Project with the officials concerned of the Government of Thailand and conducted a field survey. After the team returned to Japan, further studies were made and the present report has been prepared.

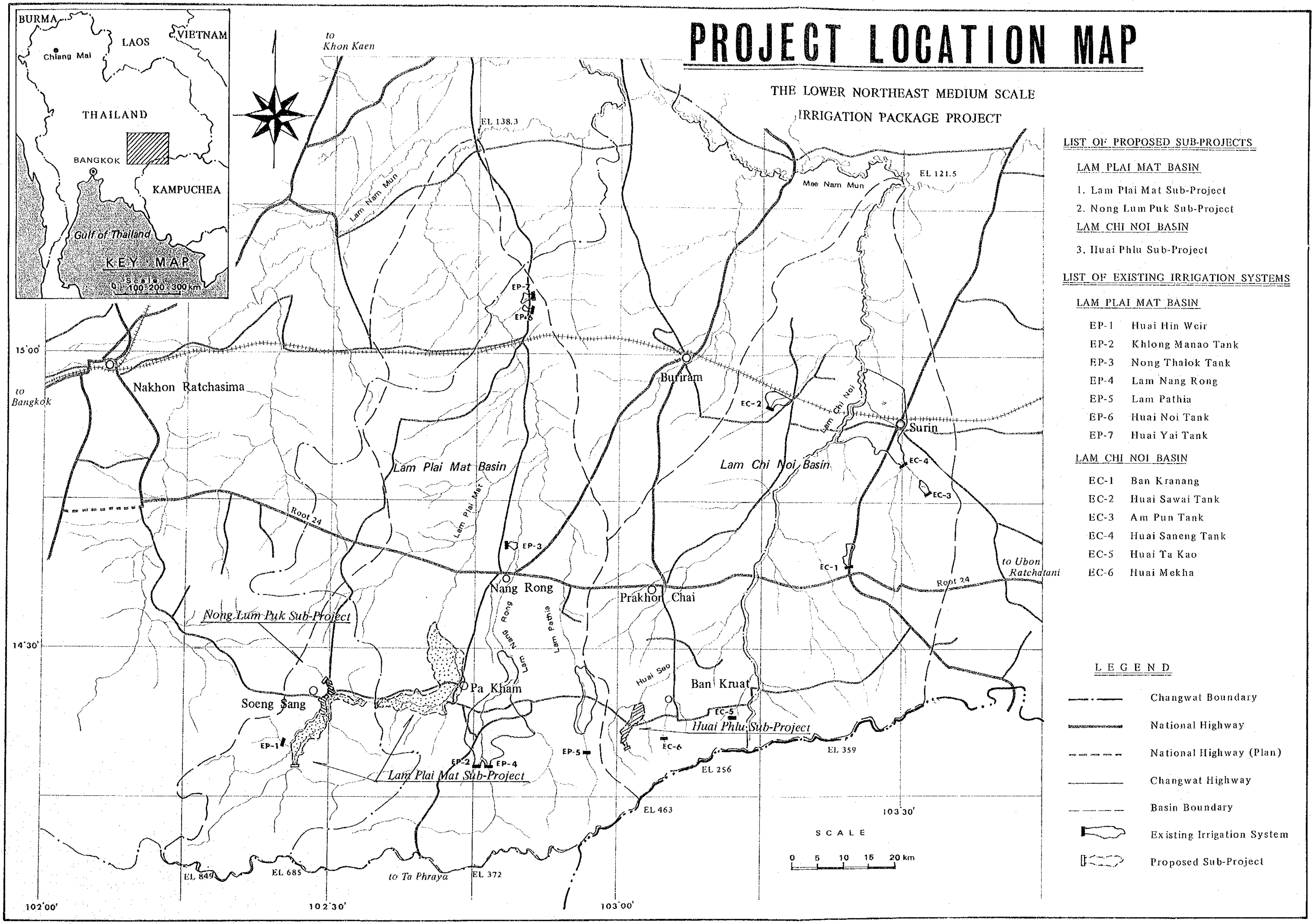
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

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.

July, 1984

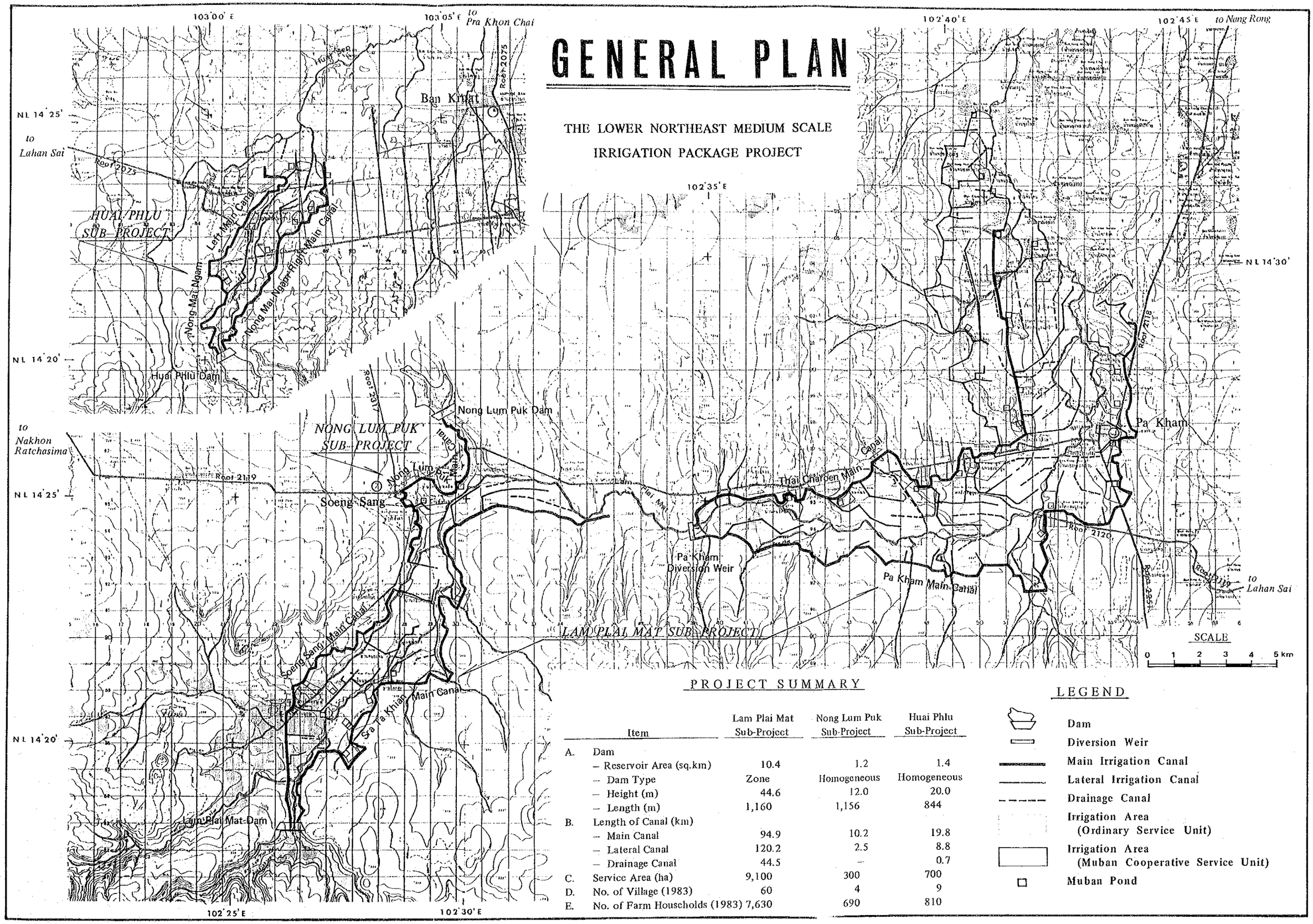


Keisuke Arita
President
Japan International Cooperation Agency


PROJECT LOCATION MAP
THE LOWER NORTHEAST MEDIUM SCALE
IRRIGATION PACKAGE PROJECT
LIST OF PROPOSED SUB-PROJECTS
LAM PLAI MAT BASIN
1. Lam Plai Mat Sub-Project
2. Nong Lum Puk Sub-Project
LAM CHI NOI BASIN
3. Huai Phlu Sub-Project
LIST OF EXISTING IRRIGATION SYSTEMS
LAM PLAI MAT BASIN
EP-1 Huai Hin Weir
EP-2 Khlong Manao Tank
EP-3 Nong Thalok Tank
EP-4 Lam Nang Rong
EP-5 Lam Pathia
EP-6 Huai Noi Tank
EP-7 Huai Yai Tank
LAM CHI NOI BASIN
EC-1 Ban Kranang
EC-2 Huai Sawai Tank
EC-3 Am Pun Tank
EC-4 Huai Saneng Tank
EC-5 Huai Ta Kao
EC-6 Huai Mekha
LEGEND
Changwat Boundary
National Highway
National Highway (Plan)
Changwat Highway
Basin Boundary
Existing Irrigation System
Proposed Sub-Project
SCALE
0 5 10 15 20 km
BURMA
LAOS
VIETNAM
Chiang Mai
THAILAND
BANGKOK
KAMPUCHEA
Gulf of Thailand
KEY MAP
Scale
0 100 200 300 km
to Khon Kaen
EL 138.3
Lam Nam Mun
Mae Nam Mun
EL 121.5
15°00'
Nakhon Ratchasima
to Bangkok
Buriram
EC-2
Lam Chi Noi
Surin
EC-4
EC-3
Lam Plai Mat Basin
Lam Chi Noi Basin
Lam Plai Mat
Root 24
EP-7
EP-6
EP-3
Nang Rong
Prakhon Chai
EC-1
to Ubon Ratchatani
Nang Rong
Lam Pathia
Nong Lum Puk Sub-Project
14°30'
Pa Kham
Soeng Sang
Huai Seo
Ban Kruat
EC-5
Huai Phlu Sub-Project
EC-6
EP-1
EP-2
EP-4
EP-5
Lam Plai Mat Sub-Project
EL 256
EL 359
EL 463
103°30'
EL 849
EL 685
to Ta Phraya
EL 372
102°00'
102°30'
103°00'

GENERAL PLAN

THE LOWER NORTHEAST MEDIUM SCALE
IRRIGATION PACKAGE PROJECT



PROJECT SUMMARY

Item		Lam Plai Mat Sub-Project	Nong Lum Puk Sub-Project	Huai Phlu Sub-Project
A.	Dam			
	– Reservoir Area (sq.km)	10.4	1.2	1.4
	– Dam Type	Zone	Homogeneous	Homogeneous
	– Height (m)	44.6	12.0	20.0
	– Length (m)	1,160	1,156	844
B.	Length of Canal (km)			
	– Main Canal	94.9	10.2	19.8
	– Lateral Canal	120.2	2.5	8.8
	– Drainage Canal	44.5	–	0.7
C.	Service Area (ha)	9,100	300	700
D.	No. of Village (1983)	60	4	9
E.	No. of Farm Households (1983)	7,630	690	810

LEGEND

- Dam
- Diversion Weir
- Main Irrigation Canal
- Lateral Irrigation Canal
- Drainage Canal
- Irrigation Area (Ordinary Service Unit)
- Irrigation Area (Muban Cooperative Service Unit)
- Muban Pond

CONTENTS

SUMMARY

SUMMARY

1. Introduction

The Project Area, comprising three sub-project areas of Lam Plai Mat, Nong Lum Puk and Huai Phlu, is located in the Lower Northeast Region of Thailand which has long been the problem area with a backward economy, low per capita income, limited water resources and other constraints such as poor soils, unfavorable weather, etc.

The Fifth National Economic and Social Development Plan (1982-1986) explains that the development of the Lower Northeast region is intended primarily to provide the more efficient utilization and rehabilitation of land, water and forestry resources in order to increase agricultural output and alleviate poverty problems along the border area. The Project Area extends parallel to the Highway No.24 along the border with the Democratic Republic of Kampuchea and is nominated as one of the urgent development areas in the Fifth Plan.

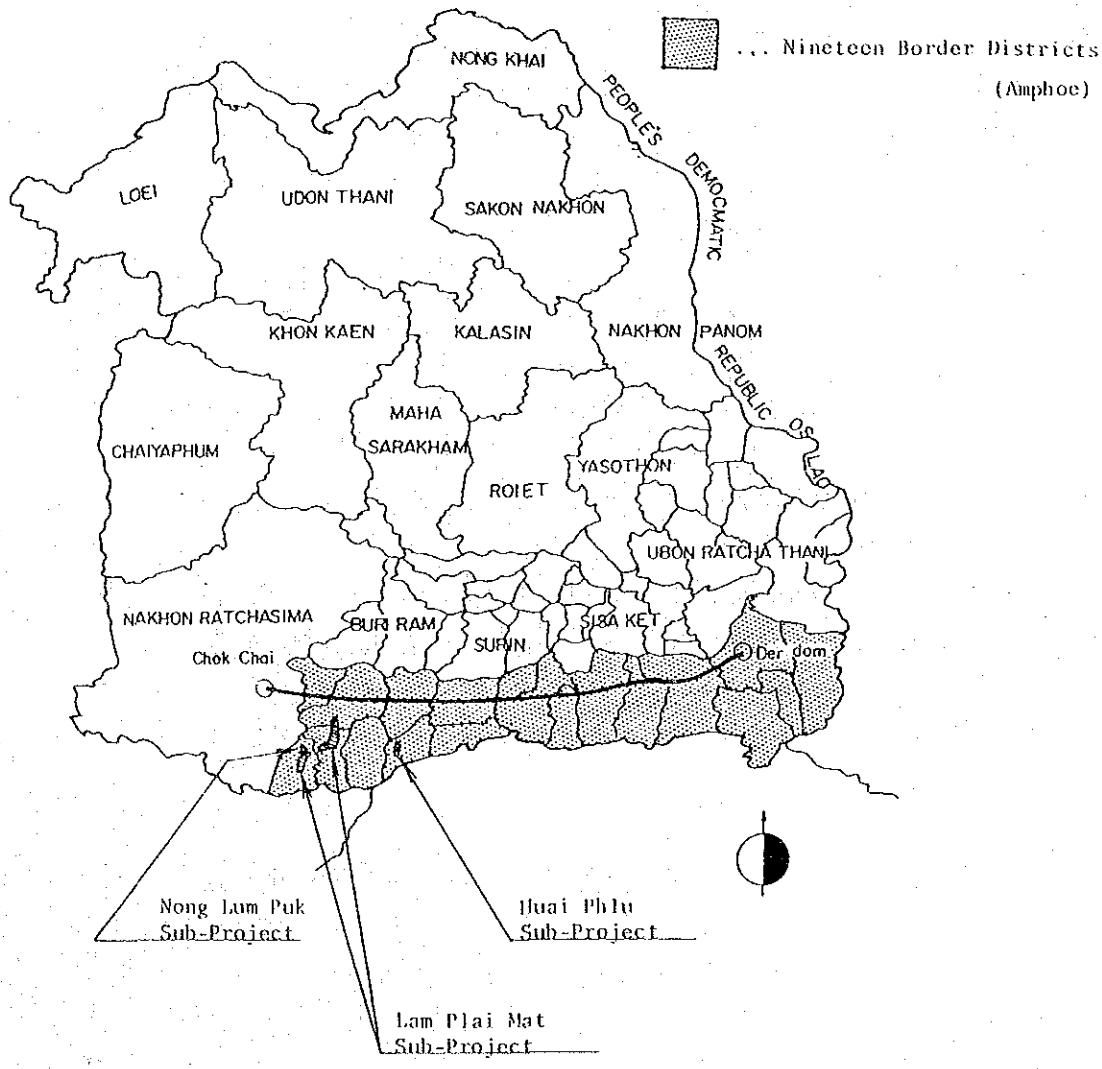
The Project service areas are presently plagued with the fluctuations in wet season paddy yields as a result of insufficient supplementary irrigation during drought period and no opportunity to cultivate any crops during the dry season. Furthermore, the water is insufficient in meeting the minimum requirement of domestic supply for people and animals, subsistence agriculture and related activities.

Under these circumstances, the Thai government has made a great effort in the water resources development in the SSIP, and the projects implemented by the SSIP reaches 129 in number in these two basins. It would be, however, rather impossible to alleviate the poverty of the majority of the farmers by the SSIP which is characterized by the limited scale and budget. Implementation of

the medium scale irrigation projects would be an urgent prerequisite to solving the poverty problem.

In order to promote the development of the medium scale project for the water resources and irrigated agriculture in the Lower Northeast Region, RID has selected the Lam Plai Mat and Lam Chi Noi basins as the Project Area at the first stage.

Nineteen Border Districts in the Lower Northeast



The government of Thailand requested the government of Japan to extend technical aid for the formulation of the development plan in this Project Area. In response to the request of the government of Thailand, the government of Japan decided to undertake the Feasibility Study on the Lower Northeast Medium Scale Irrigation Package Project (hereinafter referred to as "the Study"), within the general framework of technical cooperation between Thailand and Japan which was set forth in the Agreement of Technical Cooperation, signed on 5 November 1981 between the two governments. The Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of technical cooperation programs of the government of Japan, commenced the Study in close cooperation with Royal Irrigation Department, Ministry of Agriculture and Cooperatives, and other authorities concerned.

The Overall Basin Study (Study A) was made at first from February to June 1983 in order to grasp the present conditions of water resources, agriculture and socio-economy in the Study basin area and to select the first priority sub-projects for which the Feasibility Study (Study B) was carried out. As a result of the Overall Basin Study, three sub-projects of Lam Plai Mat, Nong Lum Puk and Huai Phlu were selected as the first priority package project.

This Feasibility Report has been prepared for the package project consisting of three sub-projects based on the result of field works from September to December 1983 and the home office work from January to March 1984.

In addition, the recommendation on "Criteria and Guideline for Preparing the Feasibility Study on Small-Medium Irrigation Project, in the Northeast Region" has been prepared from the result of Feasibility Study (Study B). This recommendation is submitted in separate volume.

2. Objectives of the Project

The medium scale irrigation project in the Lower Northeast Region has a particular purpose to alleviate the poverty and the income disparity of the farmers and to stabilize the rural area from socio-economic viewpoint. The objectives of the Project, therefore, consists of the following items:

(1) To develop the limited water resources by constructing the storage reservoir and to supply the adequate water through the irrigation system for a large number of farmers engaged in the cultivation of wet season rainfed paddy in the Project Area.

(2) To increase the agricultural productivity and farmer's income by introducing the stabilized irrigation water supply and the modernized agricultural technology.

(3) To introduce also the field crops to a limited extent in the dry season for farmer's self-consumption and marketing near the Project Area.

(4) To achieve the water-based integrated muban development through domestic water supply and fish breeding.

3. The Project Area

3.1. Topography and River Basin

The Project Area is located on the southern part of Khorat Plateau. The altitude of the Plateau ranges from 150 to 250 meters above mean sea level and the Project Area is bounded on the south by cuesta ridges of the San Kamphaeng Range, with elevation from EL 300 m to EL 800 m.

Two river systems are developed in the Project Area. One is the Lam Plai Mat running out of Mt. Khao Rai (EL 849 m) in the San Kampheang Range. The other is the Lam Chi Noi river originating in the cuesta ridges of the same range on the border of Kampuchea.

Lam Plai Mat and Nong Lum Puk sub-project areas are located in the Upper Lam Plai Mat basin while Huai Phlu sub-project area is located in the Upper Lam Chi Noi.

3.2. Water Resources

The annual average rainfall is as scarce as 1,065 mm in the Lam Plai Mat basin and 1,312 mm in the Lam Chi Noi basin, and the rainfall of about 900 mm is concentrated in the wet season of May to October. The rainfall has a big seasonal and annual fluctuation which brings about a water shortage problem for the cultivation of wet season rainfed paddy, especially for the nursery plantation season of paddy.

Since the rainfall between April and July is mostly absorbed into the ground of the drainage area which consists of sandy pervious soils and completely dried up during dry season from November to March, the river runoff is very scarce at the beginning of wet season from April to July and appears from August and October after saturating the ground by rainfall. Therefore, the river

runoff is also rather difficult to use for the irrigation purpose without being controlled by storage reservoir.

The summary of the river runoff at the damsite of three sub-projects is as follows:

	Lam Plai Mat	Nong Lum Puk	Huai Phlu
Drainage Area (sq. km)	485	25	21
Ave. Annual Runoff (MCM)	77.4	4.4	4.6
Runoff Coefficient (%)	15.0	16.4	16.7
Annual Runoff in Dry Year (MCM)	38.7	0.2	1.7
Annual Runoff in Wet Year (MCM)	205.8	12.6	7.9

3.3. Sub-Project Area

(1) Lam Plai Mat Sub-Project

Lam Plai Mat Sub-Project area is located in the Lam Plai Mat basin belonging to changwat Nakhon Ratchasima and Buriram.

The Lam Plai Mat damsite is proposed at a confluence of two rivers of the Lam Plai Mat and the Huai Sai Kong in the Upper Lam Plai Mat basin. The site has a drainage area of 485 sq.km with gentle topography and dense forest, and there will be no land acquisition and compensation problems involved in the reservoir area.

The proposed irrigation service area extends along the both banks of the Lam Plai Mat forming a strip of about 60 km long nad 1 to 2 km wide. The service area belongs to changwat Nakhon Ratchasima and Buriram including 8 tambon and 60 muban in three amphoe of Soeng Sang, Pa Kham and Nang Rong.

The farm households of 7,630 are presently engaged in the cultivation of wet season paddy throughout the service area under the rainfed condition with introduction of a little streamflow. No crops are planted in the dry season. The farmers living in the service area always suffer from water shortage for irrigation in paddy field and domestic needs.

(2) Nong Lum Puk Sub-Project

Nong Lum Puk Sub-Project area covers a central part of amphoe Soeng Sang of changwat Nakhon Ratchasima being located in the Upper Lam Plai Mat basin.

The damsite is placed at the Huai Nong Lum Puk, a tributary of the Lam Plai Mat. The site has a drainage area of 25 sq.km with a very flat topography and thin forest. There are paddy cultivation fields of about 20 ha in the proposed reservoir area and cassava fields around damsite.

The proposed irrigation service area extends immediate downstream of the damsite and belongs to amphoe Soeng Sang including two tambon and four muban.

The farm households of 690 are cultivating the wet season paddy and cassava in the Project service area and are comparatively better off as compared with those in major part of the Lam Plai Mat sub-project service area, because they have an opportunity to cultivate cassava in a large hilly area around the reservoir site.

(3) Huai Phlu Sub-Project

The Huai Phlu Sub-Project area is located closely to amphoe Ban Kruat in the Huai Seo sub-basin of the Lam Chi Noi basin.

The damsite is proposed at the Huai Phlu emptying itself into the Huai Seo near the Kampuchea border. The damsite has a drainage area of 21 sq.km with gentle topography and thin forest. There is no paddy field in the reservoir area but some cassava cultivation is practiced.

The irrigation service area extends along the both banks of the river immediately downstream the damsite. The service area is also under cultivation with the wet season paddy, although the problem of water shortage exists. The service area includes two tambon and nine muban in amphoe Bank Kruat, changwat Buriram. The farm households of 810 are engaged in the agriculture.

3.4. Agriculture and Socio-Economic Conditions

(1) Land Use and Agriculture

The arable land in each sub-project area has been considerably increased from 1977 to 1982 as follows, because many farmers overpopulated in the other regions of the Northeast Thailand have migranted into the Project area to seek water and cultivation land.

	Lam Plai Mat			Nong Lum Puk			Huai Phlu		
	1977 (Ha)	1982 (Ha)	Ratio (Ha)	1977 (Ha)	1982 (Ha)	Ratio (Ha)	1977 (Ha)	1982 (Ha)	Ratio (Ha)
Paddy Field	8,523	12,000	1.4	565	690	1.2	267	996	3.7
Upland Crops	6,657	12,920	1.9	1,092	1,714	1.6	658	2,685	4.1
Others	1,757	3,420	2.0	196	69	0.4	16	127	7.9
Total	16,937	28,340	1.7	1,853	2,473	1.3	941	3,808	4.1

The arable area was located originally along the main river course but is presently expanded along the small streams and in the hilly forest area. The migrant farmers have engaged in the cultivation of wet season paddy under the rainfed condition at the area along small streams and in the cassava plantation in the hilly forest area.

The average farm size per household is about 1.4 to 2.4 ha for paddy field and 2.7 to 3.4 ha for upland field. However, the harvested area of paddy field is only 60 to 70 percent against the total arable paddy area due to water shortage and its productivity is also as low as 1.2 to 1.3 ton per ha. There is no cultivation of upland crops such as vegetable and industrial crop in the dry season due to no rainfall and no available stream runoff.

The only cassava plantation is prevailing in the project area as the upland crops.

(2) Population and Households

The population and households at present in the Project Area is summarized as follows:

Sub-Project Area	Total Households	Population	Persons Per Household	Farm Households
Lam Plai Mat	8,730	49,390	5.6	7,630
Nong Lum Puk	770	4,260	5.5	690
Huai Phlu	960	5,390	5.6	810
Total	10,460	59,040	5.6	9,130

The population growth rate in the Project Area between 1970 and 1980 is remarkably high as 6.0 to 7.0 percent compared with that of 2.9 percent in the Northeast and whole Thailand.

(3) Income Growth and Distribution

Special effort has been made to clarify the income level and its distribution of the farm households in the Project area based on the farm household sample survey conducted during the field survey of the Feasibility Study. This income distribution has been grouped into four classes, viz. (1) Poor (2) Marginal, (3) Better-off, (4) Wealthy in accordance with the criteria employed in the NESDB.

As shown in the following table, the present farm income (1982/1983 price level) of the Project Area is very low and many farmers are poor as compared with the average income farmers of the Northeast Thailand.

Income Class Per Capita	Poor ฿3,500	Marginal ฿3,500-4,670	Better-Off ฿4,670-7,000	Wealthy ฿7,000	Overall
1. Northeast Thailand Average:					
Income (฿)	2,580	4,200	6,970	16,550	4,630
Distribution (%)	43.3	27.1	22.3	7.3	100
2. Sample Farm in the Project Area					
a. Lam Plai Mat Sub-Project:					
Income (฿)	2,140	4,050	5,870	13,200	3,580
Distribution (%)	63	15	15	7	100
b. Nong Lum Puk Sub-Project:					
Income (฿)	2,250	4,290	5,400	16,520	8,320
Distribution (%)	31	14	16	39	100
c. Huai Phlu Sub-Project:					
Income (฿)	2,060	4,170	5,740	12,210	4,450
Distribution (%	56	10	20	14	100

The farmer's income in the Nong Lum Puk is higher than that of the Northeast Thailand, because the farmers in this Project Area has an opportunity to cultivate cassava in the hilly area.

4. Project Formulation

(1) Water Resources Development

Since the water resources such as rainfall and river runoff in the Project area are considerably scarce and have a large seasonal and annual fluctuation as compared with those of other regions in Thailand, the water resources development in the Project Area is planned to provide the reservoir to store rich runoff in the wet season or wet year and to use it together with the rainfall for the irrigated agriculture.

The water resources development in this Project also purposes to allocate equally the developed water to a large number of farmers in the Project Area, because the water resources are not always sufficient to respond to the water demand of all farmers in the Project Area.

The optimum reservoir capacity has been studied based on the possible extent of service area by available developed water and construction cost of the Project facilities, and the following effective capacity is proposed for three sub-projects.

Sub-Project	Lam Plai Mat	Nong Lum Puk	Huai Phlu
i) Annual Mean Runoff (MCM)	77.4	4.37	4.61
ii) Effective Reservoir Capacity (MCM)	90.0	4.0	6.0
iii) Irrigation Service Area (ha)	9,100	300	700

In the Lam Plai Mat Project, the Lam Plai Mat reservoir water is used together with the run of the river flow in the drainage area of 465 sq.km. between the Lam Plai Mat damsite and the Pa Kham Weir site. Therefore, the effective reservoir capacity of the Lam

Plai Mat is planned with a slightly large capacity as compared with the annual runoff in order to use effectively the run of the river flow at the Pa Kham Weir site.

In the Huai Phlu Project, the rainfall in the Project Area is larger than that of the Lam Plai Mat Project Area. The effective reservoir capacity is planned also slightly larger than the annual runoff amount in order to use rainfall effectively together with the reservoir water for the irrigation.

This effective reservoir capacity is determined on the basis of several reservoir operation results with the combination of different reservoir capacity and irrigation area.

A diversion weir is proposed for the Lam Plai Mat Sub-Project in order to use the run-of-river flow at the drainage area between the dam and diversion weir in addition to the reservoir water of the Lam Plai Mat dam, taking into consideration the full utilization of the river water in the Project area.

(2) Irrigated Agriculture Plan

Since the Project aims to supply the developed water to stabilize the irrigated agriculture in the Project Area and to alleviate the poverty of farmers by increasing the agriculture productivity, the irrigated agriculture plan is made so as to supply the supplemental irrigation water mainly for the wet season rainfed paddy fields to the largest possible extent in the Project Area.

The following concepts are introduced in the irrigated agriculture plan:

- The existing paddy fields are selected as the proposed service area.

- The cropping intensity in the Project is planned as 100 percent for the wet season paddy and approximately 10 percent for field crops in the dry season.

- The additional seedling plots are provided for the wet season paddy field outside the service unit, because the paddy planting under the rainfed area always awaits the rainfall, which implies that the farmers often fail to obtain the good seedling when transporting takes place.

- The rotation irrigation system is considered for the zones or the groups of service units in case the water shortage in the reservoir takes place in the dry years.

- The irrigation area is selected from the immediate upstream area of the damsite to the downstream area taking into consideration the social and political stabilization of the upstream area near the border of Democratic Republic of Kampuchea, the minimization of construction cost for irrigation canal system and the smooth and easy water management in the service area.

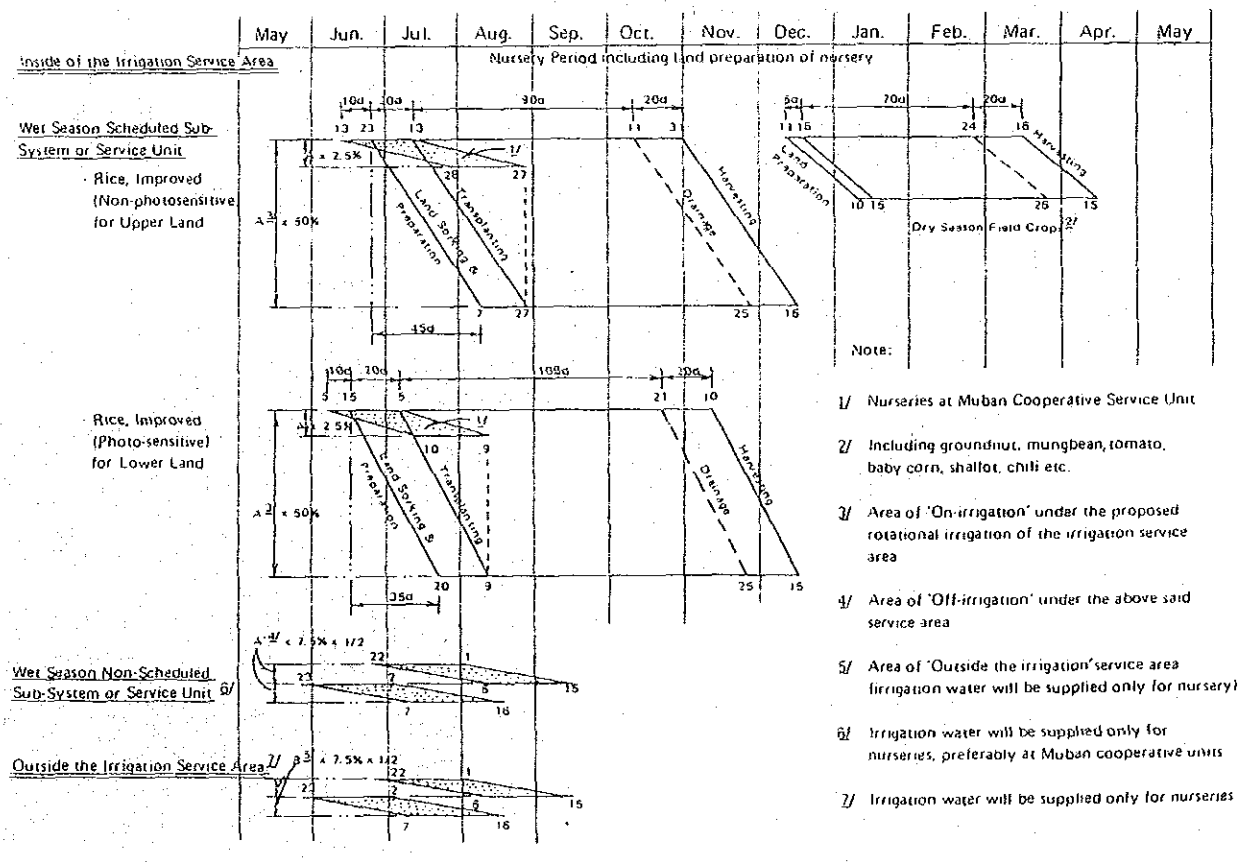
- On-farm works for the wet season paddy only are developed in more extensive mode. In view of the problems encountered by the water users' group, it is proposed to reduce the size of terminal service units to 20 to 30 ha which would contribute to better cooperation and effective management by farmers themselves. It is expected that the local people regard the facilities as their own property, if the farmers would be able to construct them by themselves. In this case, strong technical assistance and proper financial cooperation should be extended by the government agencies concerned.

- Cultivation of field crops during the dry season would motivate the villagers to make much more effort to increase their production of cash crops. Review of the present social dynamics in muban as well as of the labor problem shows that female workers of about half the farm households such as "Rice Main" and "Rice + Upland Crops" households would participate in the cultivation of groundnuts, mungbeans, tomatoes, baby corn, shallot and chili in the land of one to two rai per household. Collective cultivation of the field crops in each muban would be possibly made based upon the special land-lease arrangement. For this, the muban cooperative service unit is worked out so that water bucket irrigation is practised.

(3) Proposed Cropping Pattern

For wet season paddy, the non-photosensitive and photosensitive type is introduced with the area ratio of 50 percent each taking into consideration the farmer's consumption in the Lower Northeast Thailand and the market in Bangkok.

Proposed Cropping Pattern



For dry season crops, six crops such as groundnuts, mungbeans, tomatoes, baby corn, shallot and chili are selected taking into consideration the farmer's consumption and local market. Tomatoes would be sent to the existing Nang Rong tomato processing factory.

(4) Water-Based Integrated Muban Development Plan

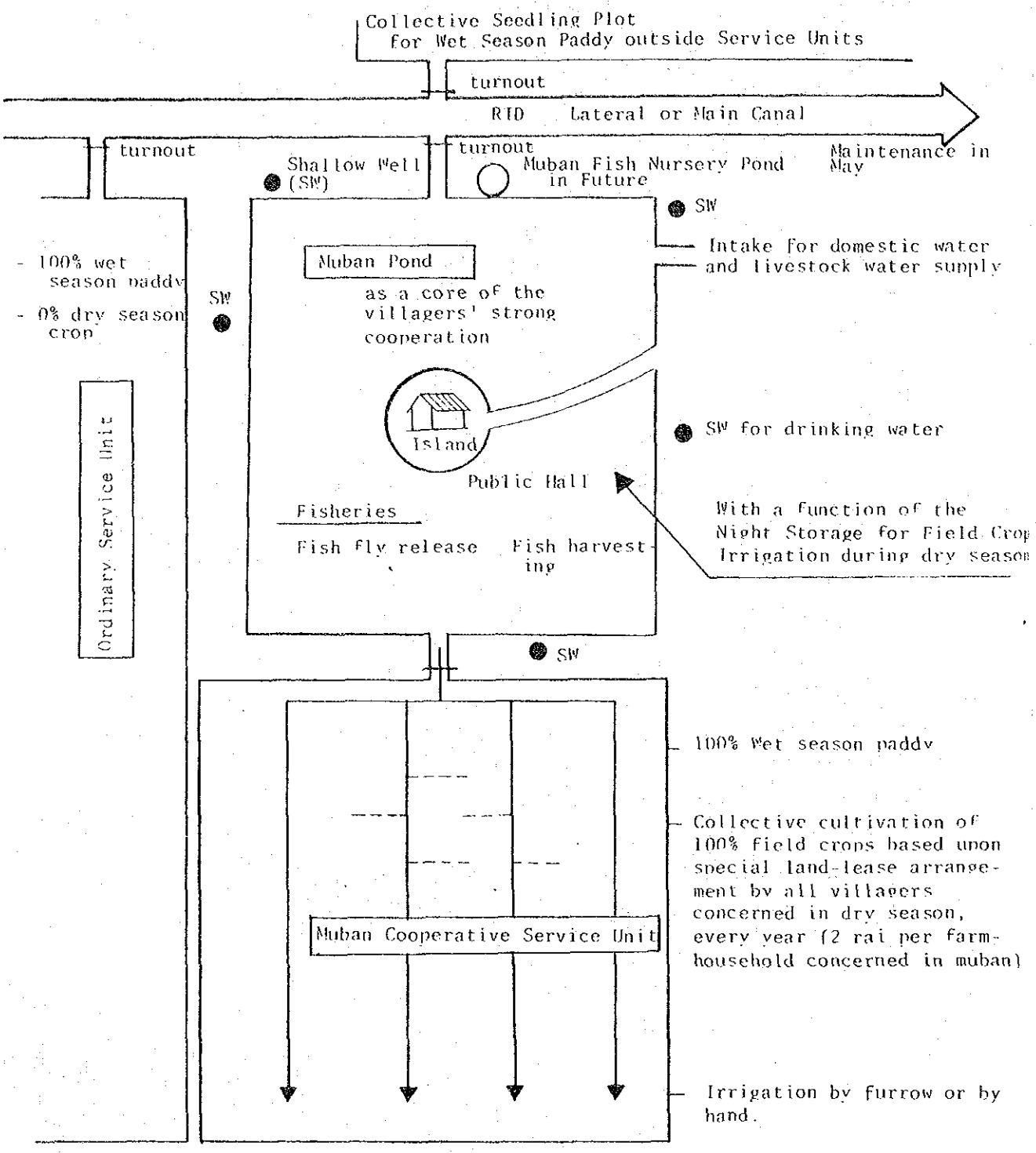
With particular emphasis upon the basic human needs (or basic minimum needs) of the poor farmers in the irrigation service area, the muban-based integrated development is envisioned to utilize a fraction of the available reservoir water and promote a strong cooperation of the muban people for successful implementation of the Project.

A muban pond as a strong core of the villagers' cooperation is a possible magnification of the night storage reservoir to be required for collective cultivation of dry season field crops and is used for the muban peoples' fishery and domestic water supply through shallow wells.

In addition, the collective nurseries for the wet season rainfed paddy outside the proposed irrigation service area within the muban concerned are introduced for contributing to stabilization of the rainfed paddy and growth of income.

The model of the Water-Based Integrated Muban Development is shown in the following Figure.

Model of the Water-Based Integrated Muban Development



5. The Proposed Project Facilities

The proposed Project facilities consist of the major works of storage dam, diversion weir and canal system to be constructed by RID and the terminal works of the on-farm and muban communal facilities to be provided by the farmer's association through proper organization established under the technical and financial assistance of the government agencies concerned.

(1) Storage Dam

The storage dam is planned with the earthfill type based on the conditions of the damsite such as topography, engineering geology, available construction material, etc.

The Lam Plai Mat dam is designed with the zone type earthfill due to a large dam scale but the Nong Lum Puk and the Huai Phlu dams are designed with the homogeneous type earthfill due to a low height of dam.

The outline of three dams are summarized in the following table and its preliminary design is shown in Drawings 1 to 6.

(2) Pa Kham Diversion Weir

The Pa Kham diversion weir is provided at the middle parts of the Lam Plai Mat in the Project area and planned with concrete ogee solid gravity type in order to supply irrigation water to the downstream service area of 7,150 ha in the Lam Plai Mat sub-project.

The outline of the diversion weir and its preliminary design is shown in the following Table and Drawing 7.

Outline of the Reservoir , Dam and Diversion Weir

Reservoir and Dam

Description	Unit	Lam Plai Mat Sub-Project	Nong Lum Puk Sub-Project	Huai Phlu Sub-Project
(i) Location				
Changwat		Nakhon Ratchasima	Nakhon Ratchasima	Buriram
Amphoe		Soeng Sang	Soeng Sang	Ban Kruat
Tambon		Nong Son Bun	Kut Bot	Nong Mai Ngam
Muban		Rat Burana	Nong Lum Puk	Nong Mai Ngam
(ii) River Basin				
Basin		Lam Plai Mat	Lam Plai Mat	Lam Chi Noi
River		Lam Plai Mat	Huai Nong Lum Puk	Huai Phlu
Drainage Area	sq.km	485	25	21
Annual Mean Rainfall	mm	1,065	1,065	1,312
Annual Mean Runoff	MCM	77.4	4.37	4.61
(iii) Reservoir				
Reservoir Area	sq.km	10.4	1.2	1.44
Total Reservoir Capacity	MCM	97.3	4.38	6.32
Effective Reservoir Capacity	MCM	90.0	4.0	6.0
Dead Water Capacity	MCM	7.3	0.38	0.32
High Water Level	EL-m	264.6	236.0	245.0
Full Water Level	EL-m	261.8	235.0	243.8
Low Water Level	EL-m	246.6	228.6	233.7
(iv) Dam				
Type		Zone	Homogeneous	Homogeneous
Height	m	44.6	12.0	20.0
Length	m	1,160	1,156	844
Crest Elevation	EL-m	266.6	237.0	247.0
Spillway Design Flood Capacity	cu.m/s	984	100	83
Intake Capacity	cu.m/s	11.83	0.39	0.91
Embankment Volume	10^3cu.m	1,656	190	275

Diversion Weir

Description	Lam Plai Mat Sub-Project
(i) Location	
Changwat	Buriram
Amphoe	Pa Kham
Tambon	Nong Bua
Muban	Khok Khao Ya Kha
(ii) River Basin	
Basin	Lam Plai Mat
River	Lam Plai Mat
Drainage Area	1,050 sq.km
Annual Mean Rainfall	1,065 mm
(iii) Weir Body	
Type	Concrete Ogee Solid Gravity
Height	2.6 m
Length	240 m
High Water Level	EL 212.0 m
Full Water Level	EL 209.5 m
(iv) Scouring Sluiceway	
Sluiceway Length	20 m
Radial Gate	(6 m x 2.25 m) x 3 sets
(v) Intake Facilities	
Intake Capacity	9.29 cu.m/s
Intake Width	13.2 m
Sluice Gate	(2.2 m x 2.0 m) x 3 sets
	(1.8 m x 2.0 m) x 3 sets

(3) Canal System

Since the service area lies on a flat topography with strip shape along the river course in three sub-projects, the alignment of irrigation main canal is placed along the both banks of the river course.

The canal alignment is selected based on the following considerations:

- To place canal alignment so as to be designed by gravity flows.

- To place the canal alignment nearby the muban to introduce the irrigation water into the muban ponds in order to establish the water based muban development consisting of the domestic water and village fishery development.

- To extend the lateral canal alignment to cover the terminal service area of 20 to 30 ha for the purpose of easy construction of the on-farm development works and simple water management by farmer's association.

The following concept is adopted for the preliminary design of irrigation canal in accordance with the service area conditions and the criteria prevailing in RID.

- Irrigation canal with a bottom width of more than 0.5 m is designed with concrete lining taking into consideration that the soil in service area consists of pervious sandy materials.

- Peak diversion requirement of canal is 1.3 liter/sec/ha based on the water operation study in the Project Area.

The outline of the canal system and its preliminary design is shown in the following Table and Drawings 8 to 10.

Outline of the Canal System

(i) Lam Plai Mat Sub-Project

Description	Unit	Sub-Systems				Total
		Sra Ta Khian	Soeng Sang	Pa Kham	Thai Charoen	
Intake Point		Dam	Dam	Weir	Weir	
Service Area	ha	940	1,010	2,000	5,150	9,100
Discharge Capacity	cu.m/s	1.22	1.31	2.60	6.69	11.82
Length of Main Canal	km	25.8	12.3	30.4	26.4	94.9
No. of Lateral Canals		9	7	19	32	67
Length of Lateral Canal	km	9.6	17.4	20.9	72.3	120.2
Length of Drainage Canal	km	5.9	5.3	5.9	27.4	44.5

(ii) Nong Lum Puk and Huai Phlu Sub-Projects

Description	Unit	Nong Lum Puk	Huai Phlu
Intake Point		Dam	Dam
Service Area	ha	300	700
Discharge Capacity	cu.m/s	0.39	0.91
Length of Main Canal	km	10.2	19.8
No. of Lateral Canals		3	10
Length of Lateral Canal	km	2.5	8.8
Length of Drainage Channel	km	-	0.7

(4) On-Farm Work and Muban Communal Facilities

The on-farm work work consists of simple earthworks for the farm ditches and roads in fields of 20 to 30 ha, and could be easily constructed with the manpower from the farmer's association.

The farm pond, fish pond, well for domestic water supply, etc. will be constructed as the muban communal ficilities together with the on-farm work by the farmer's association.

The muban cooperative ponds for the water based integrated muban development are constructed nearby muban. The water surface area of pond will be 0.8, 1.6 and 2.4 ha and its depth is approximately 1.5 to 2.0 m.

The preliminary design of muban cooperative pond is shown in Drawing 11.

Outline of the On-farm Work and Muban Communal Facilities

	Irrigation Service							
	Ordinary Service Unit		Muban Cooperative Service Unit		Collective Seedling Unit		Muban Pond	
	No.	Ave.Size (ha)	No.	Ave.Size (ha)	No.	Ave.Size (ha)	No.	Ave.Size (ha)
Lam Plai Mat Sub-Project	336	27	55	14.5	63	2.4	31	1.4
Sra Ta Khian	37	25	8	11.3	11	2.9	5	1.1
Soeng Sang	39	26	6	13.3	8	5.5	5	1.2
Pa Kham	76	26	13	16.9	13	0.9	6	1.9
Thai Charoen	184	28	28	14.6	31	2.1	15	1.5
Nong Lum Puk Sub-Project	15	20	4	7.5	4	2.3	2	2.4
Huai Phlu Sub-Project	37	19	7	5.7	9	0.3	7	0.9

6. Cost Estimate

The construction cost of the major works for dam, weir and canal system is estimated on the basis of an international tendering.

The terminal facilities such as on-farm and muban communal facilities will be constructed by water users group under the technical and financial assistance by the agencies concerned.

Miscellaneous costs including those of O & M equipment, right-of-way, survey and investigation, administration and consulting services are estimated on the basis of the prevailing procedures and rates. Physical contingencies of 10 percent are added to the base cost.

The estimated project cost consisting of the base cost and physical contingencies is shown in the following page and summarized as follows:

(Unit: 10^3 ฿)

Sub-Project	Base Cost	Physical Contingency	Total	Cost Per Hectare
1) Lam Plai Mat(9,100 ha)	698,723	69,873	768,596	84.5
2) Nong Lum Puk(300 ha)	38,968	3,897	42,865	142.9
3) Huai Phlu(700 ha)	74,949	7,495	82,444	117.8
4) Total(10,100 ha)	812,640	81,265	893,905	97.2

Project Cost

(Unit: 10^3B)

	Foreign Currency	Local Currency	Total
(1) Lam Plai Mat Sub-Project (9,100 ha)			
1. Civil Works			
- Dam	184,011	109,026	293,037 (38.1)
- Canal Systems	97,433	148,043	245,476 (31.9)
- On-Farm and Communal Facilities	14,470	16,330	30,800 (4.1)
2. Miscellaneous	82,914	46,496	129,410 (16.8)
Base Cost (1 + 2)	378,828	319,895	698,723 (90.9)
Physical Contigencies	37,883	31,990	69,873 (9.1)
Sub-Total	416,711 (54.2%)	351,885 (45.8%)	768,596 (100.0) (100.0%)
Price Contigencies	191,263	204,540	395,803 (51.5)
Total	607,974 (52.2%)	556,425 (47.8%)	1,164,399 (151.5) (100.0%)
(2) Nong Lum Puk Sub-Project (300 ha)			
1. Civil Works			
- Dam	15,364	9,269	24,633 (57.5)
- Canal Systems	2,718	5,227	7,945 (18.5)
- On-Farm and Communal Facilities	856	854	1,710 (4.0)
2. Miscellaneous	2,870	1,810	4,680 (10.9)
Base Cost (1 + 2)	21,808	17,160	38,968 (90.9)
Physical Contigencies	2,181	1,716	3,897 (9.1)
Sub-Total	23,989 (66.0%)	18,876 (44.0%)	42,865 (100.0) (100.0%)
Price Contigencies	9,471	9,246	18,717 (43.7)
Total	33,460 (54.3%)	28,122 (45.7%)	61,582 (143.7) (100.0%)
(3) Hnai Phlu Sub-Project (700 ha)			
1. Civil Works			
- Dam	25,411	17,742	43,153 (52.3)
- Canal Systems	5,778	11,358	17,136 (20.8)
- On-Farm and Communal Facilities	2,333	2,227	4,560 (5.5)
2. Miscellaneous	6,536	3,564	10,100 (12.3)
Base Cost (1 + 2)	40,058	34,891	74,949 (90.9)
Physical Contigencies	4,006	3,439	7,495 (9.1)
Sub-Total	44,064 (53.4%)	38,380 (46.6%)	82,444 (100.0) (100.0%)
Price Contigencies	21,588	24,092	45,680 (55.4)
Total	65,652 (51.2%)	62,472 (48.8%)	128,124 (155.4) (100.0%)
(4) Overall			
1. Civil Works			
- Dam	224,786	136,037	360,823 (40.4)
- Canal Systems	105,929	164,628	270,557 (30.3)
- On-Farm and Communal Facilities	17,659	19,411	37,070 (4.1)
2. Miscellaneous	92,320	51,870	144,190 (16.1)
Base Cost (1 + 2)	440,694	371,946	812,640 (90.9)
Physical Contingencies	44,070	37,195	81,265 (9.1)
Sub-Total	484,764 (54.2%)	409,141 (45.8%)	893,905 (100.0) (100.0%)
Price Contigencies	222,322	237,878	460,200 (51.5)
Total	707,086 (52.2%)	647,019 (47.8%)	1,354,105 (151.5) (100.0%)

The cost per unit area of the Lam Plai Mat sub-project is ฿84,500 per ha (about ฿14,000/Rai) and seems to be reasonable for the investment of the project implementation. However, the costs of unit area for two sub-projects of Nong Lum Puk and Huai Phlu are ฿142,900 per ha (฿23,800/Rai) and ฿117,800 per ha (฿19,600/Rai), which becomes rather high investment cost for the project implementation, because the dam cost of two sub-projects is increased due to the long dam crest length of 1,156 m in the Nong Lum Puk dam and the pervious dam foundation in the Huai Phlu dam.

Price escalation rates applied for estimating Price Contingencies are as follows:

	1983 (%)	1984 (%)	1985 (%)	1986 (%)
Domestic	12	10	9	8
Foreign	7.5	7.5	7.5	6.0

7. Project Implementation Program

(1) Organization and Management

The major facilities such as dam and irrigation system will be implemented by RID, and the on-farm work and the muban communal facilities will be implemented by the farmer's association newly established in the Project Area.

In order to succeed the implementation as well as the operation and maintenance of the Project, RID and other agencies concerned should coordinate each other and help the farmer's association.

It is assumed that eight government agencies centering RID would be responsible for implementing the Project in the works of design, construction and O/M together with proper assistance to the villages in technical, organizational, promotive and financial terms. Such agencies would be as follows:

- Ministry of Agriculture and Agricultural Cooperative
  - Royal Irrigation Department (RID)
  - Department of Agricultural Extension (DOAE)
  - Department of Fisheries (DOF)
  - Department of Livestock Development (DOLD)
  - Department of Cooperatives Promotion (DOCP)

- Ministry of Interior
  - Department of Local Administration (DOLA)
  - Community Development Department (CDD)
  - Office of Accelerated Rural Development (ARD)

- Bank for Agriculture and Agricultural Cooperatives (BAAC)

Implementation Schedule for the Project

Description	1983	1984	1985	1986	1987	1988	1989	1990	1991
A. Construction Schedule									
1. Feasibility Study									
2. Loan Procedures									
– Engineering Service Loan									
– Construction Loan									
3. Construction for Major Works									
– Preparation									
– Consultant Recruitment									
– Detailed Design									
– Project Administration									
– Right-of-Way									
– Tender for Construction									
– Construction – Lam Plai Mat Sub-Project									
– Nong Lum Puk Sub-Project									
– Huai Phlu Sub-Project									
– Maintenance by Contractor									
4. Construction by Farmer's Association									
– Detailed Design									
– On-farm Work – Lam Plai Mat Sub-Project									
– Nong Lum Puk Sub-Project									
– Huai Phlu Sub-Project									
– Muban Communal Facilities – Lam Plai Mat Sub-Project									
– Nong Lum Phuk Sub-Project									
– Huai Phlu Sub-Project									
B. Action Program by Executing Agencies Concerned									
1. Royal Irrigation Department (RID), MOAC									
– Detailed Design and Construction of Dams, Irrigation Canal and Drainage Canal									
– O & M of the Lam Plai Mat Sub-Project									
– Assistance in Organizing Water User's Groups									
– Technical Assistance in Construction and O & M of the Irrigation Service Units									
– Technical Assistance to the Water User's Association in O & M of the RID-constructed Major Works (Nong Lum Puk and Huai Phlu Sub-Project)									
2. Department of Agricultural Extension (DOAE), MOAC									
– Extension Services to Farmers in Agricultural Production Technique and etc.									
3. Department of Fisheries (DOF), MOAC									
– Supplying Fish Fry to the Muban Pond and RID-constructed Reservoir									
– Extension Services to the Villagers in Fish Production Technique and etc.									
4. Department of Livestock Development (DOLD), MOAC									
– Extension Services for Livestock Development through Water Use from the Muban Pond									
5. Department of Cooperatives Promotion (DOCP), MOAC									
– Promotion of Cooperation Activities in Fisheries, Livestock production, Supply of Credit, Purchase of Production Inputs and Marketing of Agricultural Products									
6. Department of Local Administration (DOLA), MOI									
– Overall Coordination of Development for the Project									
– Coordination of the Various Agencies at the Local Level									
– Special Coordination of Water-based Integrated Muban Development									
7. Community Development Department (CDD), MOI									
– Assistance to the Villagers Organizing Themselves for Self-help, Self-rliance and Active Participation in Planning and Construction of the Various Terminal Facilities and Subsequent O & M.									
8. Office of Accelerated Rural Development (ARD), MOI									
– Technical Assistance to Tambon or Muban Development Committee with Respect to Planning, Construction and O & M of Village Communal Facilities									
9. Bank for Agriculture and Agricultural Cooperative									
– Provision of Institutional Credits in the Form (BAAC) of Production Loans for Agricultural Purposes and of Investment Loans for On-farm Development and Agricultural Assets.									

(2) Project Construction

The Project would be constructed over a period of seven years, taking one and half year for implementation arrangement including the loan procedures to the international financing agency, one and half year for the detail design of the Project facilities, a half year for international tendering and three years for construction.

The Lam Plai Mat and Huai Phlu sub-projects would be completed in the middle of 1990, while the Nong Lum Puk sub-project at the end of 1988, assuming that Huai Phlu sub-project will be commenced after the completion of Nong Lum Puk sub-project due to their project scale.

RID will be fully responsible for design and construction of major works including dam, weir, canal system up to outlet of the service units and drainage channels for the three sub-projects. RID will provide a project construction office at the Lam Plai Mat damsite under the Region VI. RID will also be responsible for technical assistance for the design and construction of the on-farm works which should be carried out by the farmer's association.

ARD will be responsible for technical and financial assistance for the design and construction of the muban communal facilities which should be also made by the farmer's association.

The great emphasis should be placed upon the farmer's participation in initiating the Project in contributing labour for construction and in cost sharing.

(3) Operation and Maintenance of the Project

RID will be responsible for future O & M of the major works in the Lam Plai Mat sub-project under the present procedures and arrangement. O & M for major work in other two small-medium

sub-projects of Nong Lum Puk and Huai Phlu that are on the extension line of the RID-SSIP will be entrusted to the water users' associations under the RID's intensive technical assistance in training local full-time operators and monitoring their O & M.

On-farm and muban communal facilities will be operated and maintained by the water users' groups and the muban development committees with the technical assistance of RID, DOAE, DOF, DOLA and ARD.

(4) Consulting Service

The consultants will be employed to assist RID in the detailed design, preparation of the contract documents and the construction, and also provide guidance on establishing operation and maintenance procedures.

The estimated total input is 414 man-months including 198 man-months for local experts and is divided into 170 man-months for the detailed design and 244 man-months for the construction, supervision and guidance.

8. Project Evaluation

(1) General

The proposed Project intends to deliver adequate water to the largest number of the farmers for meeting the minimum requirements for subsistence agriculture, domestic use and animal breeding and related activities through implementation of the three selected sub-projects in the Lower Northeast Thailand which remains the poorest region in country. It is commonly interpreted that the lower level of traditional subsistence cultivation of paddy would be closely related with the incidence of rural poverty.

Evaluation of the Project has been carried out from two aspects, viz. (1) poverty alleviation effect on the basis of income growth and distribution and (2) IRR from the national economic viewpoint.

(2) Poverty Alleviation Effect: Income Growth and Distribution

On the basis of the farm household sample survey during the Study, the present income level and distribution among the farmers in the Project area have been clarified. It is assumed that the incremental income will be derived from the Project on the same household pattern and price level as those at present. Income and distribution with and without the Project have been compared with particular reference to the available data for the rural Northeast:

	Lam Plai Mat	Nong Lum Puck	Huai Phlu	Rural Northeast
At present, 1982/83 level:				
Ave. Annual Per Capita Income (฿)	3,580	8,320	4,450	4,630
Ave. Household Size	6.0	6.1	6.3	6.1
Ave. Annual Household Income (฿)	21,490	50,760	28,060	28,260
Households (%) in Poverty Group */	63	31	56	44.
With the Project, 1982/83 price level:				
Ave. Annual Per Capita Income (฿)	5,470	9,170	5,410	
Ave. Household Size	6.0	6.1	6.3	
Ave. Annual Household Income (฿)	32,830	55,940	34,110	
Households (%) in Poverty Group	20	27	40	

*/... The absolute poverty below the poverty line of ฿3,500 per capita based upon the cost of a minimum diet and a minimum level of expenditures for other basic human needs.

In the Project study, Poverty Index has been developed to combine appropriately two basic factors, viz. (1) average income level and (2) its distribution particularly to the poor, which would be applicable for the Lower Northeast region.

$$\text{Poverty Index} = \frac{\text{Average Household Income in the rural Northeast}}{\text{Average Household Income in Sub-Project}} \times \text{Distribution of Households in Poverty Group in Sub-Project}$$

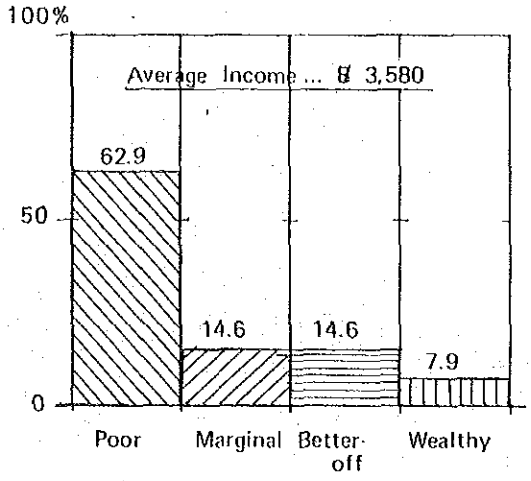
Another indicator is "Poverty Alleviation Rate" which is a difference between the Poverty Indices with and without the Project.

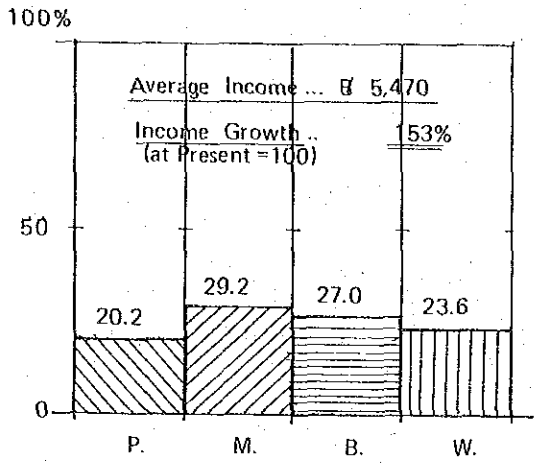
Change of Income Distribution With Project (201 Sample Farms)

A. At Present

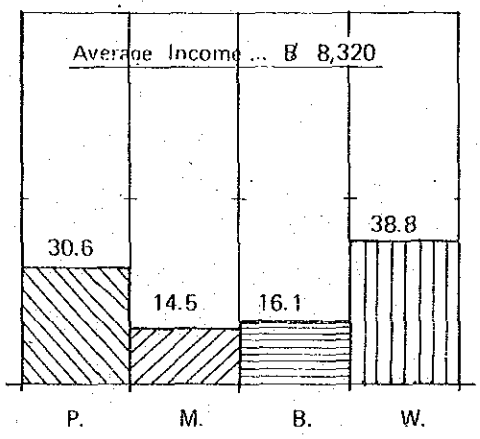
B. With Project

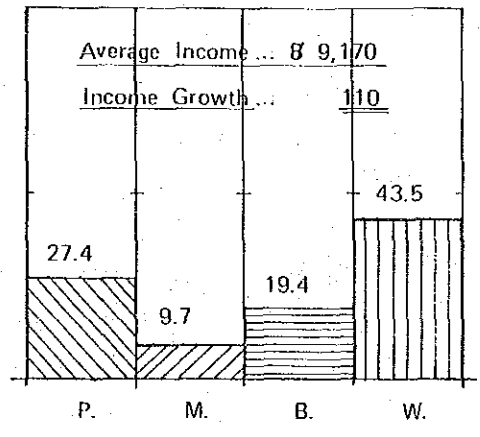
1. Lam Plai Mat Sub-Project



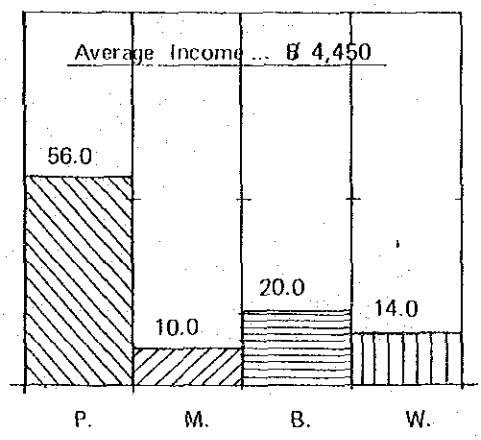


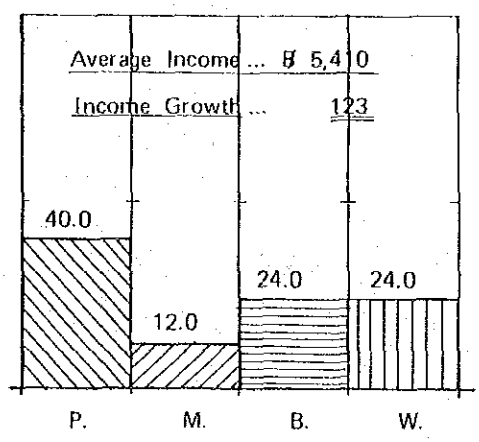
2. Nong Lum Puk Sub-Project





3. Huai Phlu Sub-Project





	Lam Plai Mat	Nong Lum Puk	Huai Phlu	Rural Northeast
(Irrigable Area)	(9,100 ha)	(300 ha)	(700 ha)	
Poverty Index at Present	0.83	0.17	0.56	0.44
Poverty Index with the Project	0.17	0.14	0.33	
Poverty Alleviation Rate	0.66	0.03	0.23	

The following findings are obtained:

- Income level in the Nong Lum Puk Sub-Project at present would be extremely high, 1.8 times as high as the average of the rural Northeast. This would originate from cassava production due to favorable transportation to Korat and also largely from the off-farm income.

- Poverty Index: the higher the income level, the lower the poverty index.

- Poverty Alleviation Rate: the higher the rate, the more significant the poverty alleviation effect.

- The poverty alleviation effect would be remarkable in the Lam Plai Mat sub-project. In the Nong Lum Puk sub-project, the Poverty Index with the Project is almost identical to that of the without case; therefore, little effect is observed in the Poverty Alleviation Rate.

- It can be considered that the Project which has the higher Poverty Index at present is qualified as the likely potential project with higher priority for earlier implementation.

- Attention should be paid to the fact that the Poverty Alleviation Rate should not contain any factor of the project cost.

(3) Evaluation through IRR

Since the common unit of account used in the economic analysis is uncommitted public income measured at border prices, specific conversion factors available in converting from domestic to the border prices for goods and services produced or consumed by the project have been used to express all values in terms of the common unit of account. Because of imperfections in the labor market, the wage rate of common or unskilled labor has been appropriately estimated with shadow price.

Nine categories of the Project economic benefits are considered such as (1) irrigation for the wet season paddy in the ordinary service units and muban cooperative service units, (2) irrigation for the dry season field crops in the muban cooperative service units, (3) irrigation for the muban collective seedling plots for the wet season rainfed paddy outside the service units, (4) irrigation for the muban collective seedling plots in the muban cooperative service units for the wet season rainfed paddy inside the service units (when the irrigation service area is decreased due to the reservoir operation rule), (5) water supply for drinking and domestic use for muban people from the muban ponds and successive communal facilities, (6) water supply for drinking and domestic use for muban buffaloes and cattle from the muban ponds and successive communal facilities, (7) fishery in the muban ponds, (8) fishery in the RID-constructed reservoirs, and (9) foreshore field crops in the RID-constructed reservoirs at lower water level (for the small-medium project).

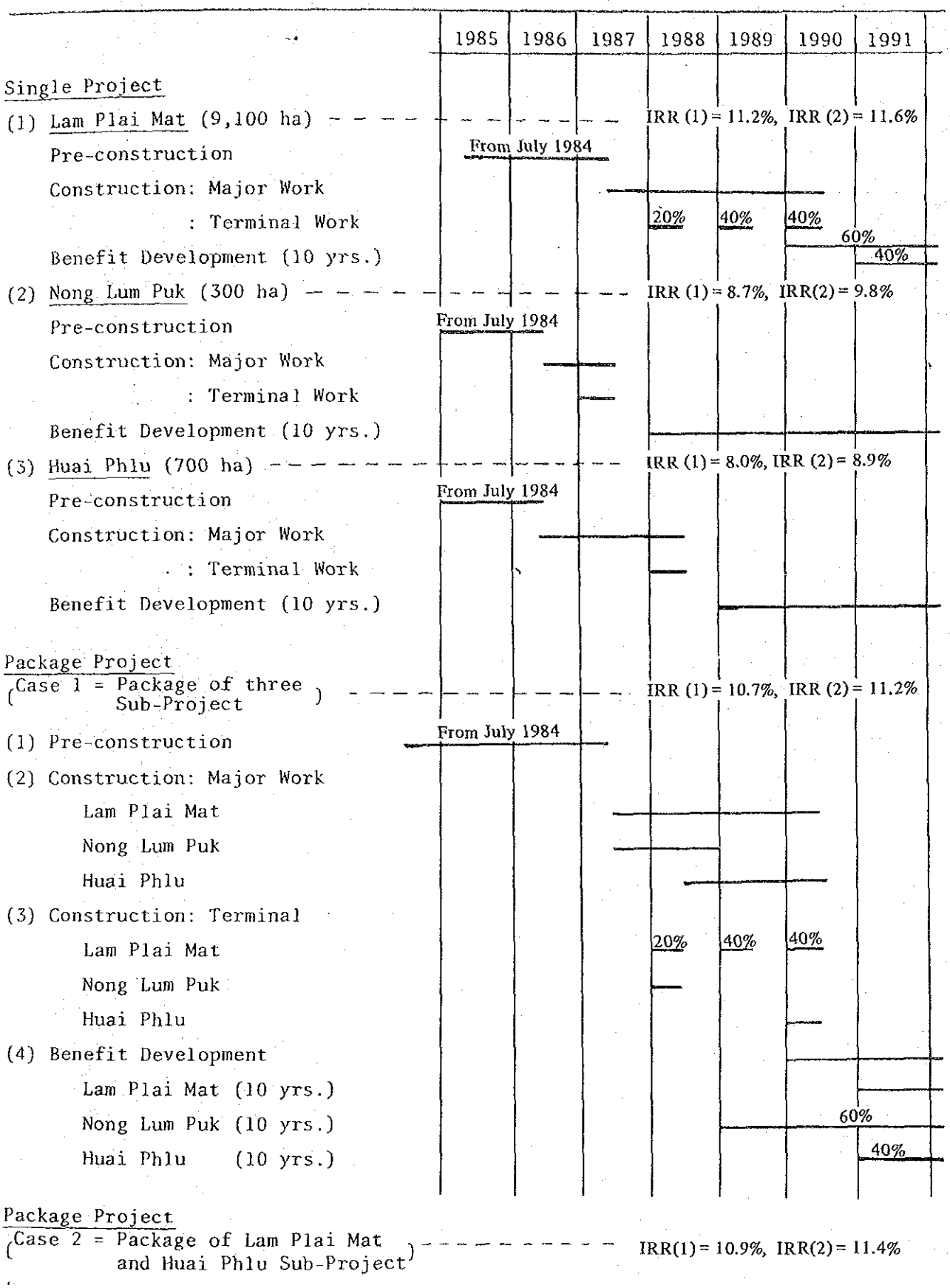
Cassava production has been identified in 936 ha, 99 ha, and 144 ha of the proposed reservoir area for the sub-projects of Lam Plai Mat, Nong Lum Puk and Huai Phlu, respectively. It has been reported that in the Lam Plai Mat case, cultivation of cassava is permitted until the 1983/84 year in connection with the Development for Defense of the Boundary between Khon Buri - Soeng Sang Project

since October 1982. In general, cassava cultivation in the proposed reservoirs is in the form of encroached public land; therefore, no compensation should be officially required. In the economic evaluation, both the IRRs with and without the reservoir cassava productions have been calculated as IRR(1) and IRR(2), respectively.

A development period for accrual of the projected full benefit has been assumed at seven years for paddy and field crops in the Lam Plai Mat sub-project and five years in the Nong Lum Puk and Huai Phlu sub-projects, while the total period is 10 years based upon fishery development in the Project reservoirs for all the sub-projects.

IRR for both the single project case and package project case has been estimated in line with the following time sequence of major factors, and is presented in the following page.

Construction Schedule and Benefit Development



RECOMMENDATION

RECOMMENDATION

1. The proposed Lam Plai Mat sub-project is technically sound and socio-economically feasible. With appropriate institutional set-up, proper operation and maintenance, and adequate overall management and coordination among the government line agencies concerned, it should be a great and valuable asset to the Upper Lam Plai Mat basin where development has been neglected so far.

The government should, therefore, take the next procedure and necessary arrangements for immediate implementation of the Lam Plai Mat Sub-Project that would contribute greatly towards significant poverty redressing of the farm households covering the proposed irrigable area of 9,100 ha or 56,900 rai.

2. The proposed Nong Lum Puk Sub-Project which is engineeringly feasible has, aside from irrigation development, an important function providing potable water supply for amphoe Soeng Sang, changwat Nakhon Ratchasima which has been designated as a government's strategic location for a leading access to the border areas with the Democratic Republic of Kampuchea. This leads to a reason why this sub-project has been selected in the Overall Basin Study.

It has been, however, pointed out in the Feasibility Study that the present income level of the farm households in this sub-project is considerably higher than the average of the rural Northeast and the degree of absolute poverty alleviation with the Project would not be so significant. It is suggested that further discussion within the government agencies should be made on the possible implementation of this Nong Lum Puk sub-project from the public investment point of view.

3. The Huai Phlu sub-project that is categorized "Small-Medium" is situated in proximity of the border with Kampuchea covering two tambon in amphoe Ban Kruat, changwat Buriram designated as the Target Areas for Rural Development Programs under the Fifth Plan (1982 - 86) where the historical difficulties are demonstrated in the Feasibility Study.

This sub-project is socially viable from the viewpoint of income level and poverty alleviation effect; however, this dam has a high construction cost. This damsite, without taking any alternative, is equipped with such unfavorable conditions such as removal of thick pervious overburdens at both the abutments and procurement of suitable embankment materials from a long distance, resulting in the cost increase and a low IRR of eight percent.

Generally speaking, majority of the so-called small-medium projects in the Lower Northeast region which usually have similar dam construction problems to the Huai Phlu sub-project would have the IRR below the general government criteria applicable to the large and medium sized projects. It is assumed that when appraised with such criteria, the number of the viable projects for immediate implementation should be few. Taking into account the special development concept and approach involved and particular social and political soundness to be achieved, it may be suggested to lower the standard or minimum IRR for the small-medium scale projects. This should be a matter of discussions in the government.

With the above specified careful examination of the various factors related, it is recommended that the Huai Phlu sub-project should be proceeded to the next step, ready for urgent implementation.

4. In accordance with the recommendations mentioned above, the following survey and investigation works should be carried out prior to construction.

4.1. Hydrological Observation

The meteorological and runoff observation at the Lam Plai Mat damsite was commenced in July 1983. The observations should be continued without any interruption for future detailed design, operation and maintenance.

4.2. Preparation of Topographical Map

(1) The presently available map of 1/10,000 in scale of the Lam Plai Mat damsite and its service area was prepared by different benchmark elevations which are not related between the damsite and service area. A new benchmark survey, therefore, should be made and basic benchmarks should be placed at the damsite and service area.

(2) The existing map of 1/10,000 in scale for the Lam Plai mat service area was prepared by direct ground survey and is not accurate. Aero-photo map should be prepared by newly established benchmarks before the detailed design stage.

(3) The topographical map of 1/2,000 in scale should be prepared for the design of the on-farm and muban communal works in the service area of the sub-projects before the detailed design stage.

(4) More detailed survey for the project facilities should be made during the detailed design stage for determining location and alignment of the structures.

4.3. Geological Investigation

Additional core borings with permeability and penetration tests should be carried out at damsites for the detailed design. The approximate quantity to be required is shown in ANNEX B.

Particular attention should be paid to the core drillings at the river bed in the Lam Plai Mat damsite, because the excavation depth at the cutoff trench on the riverbed could not be estimated by the core drilling carried out in the Feasibility Study.

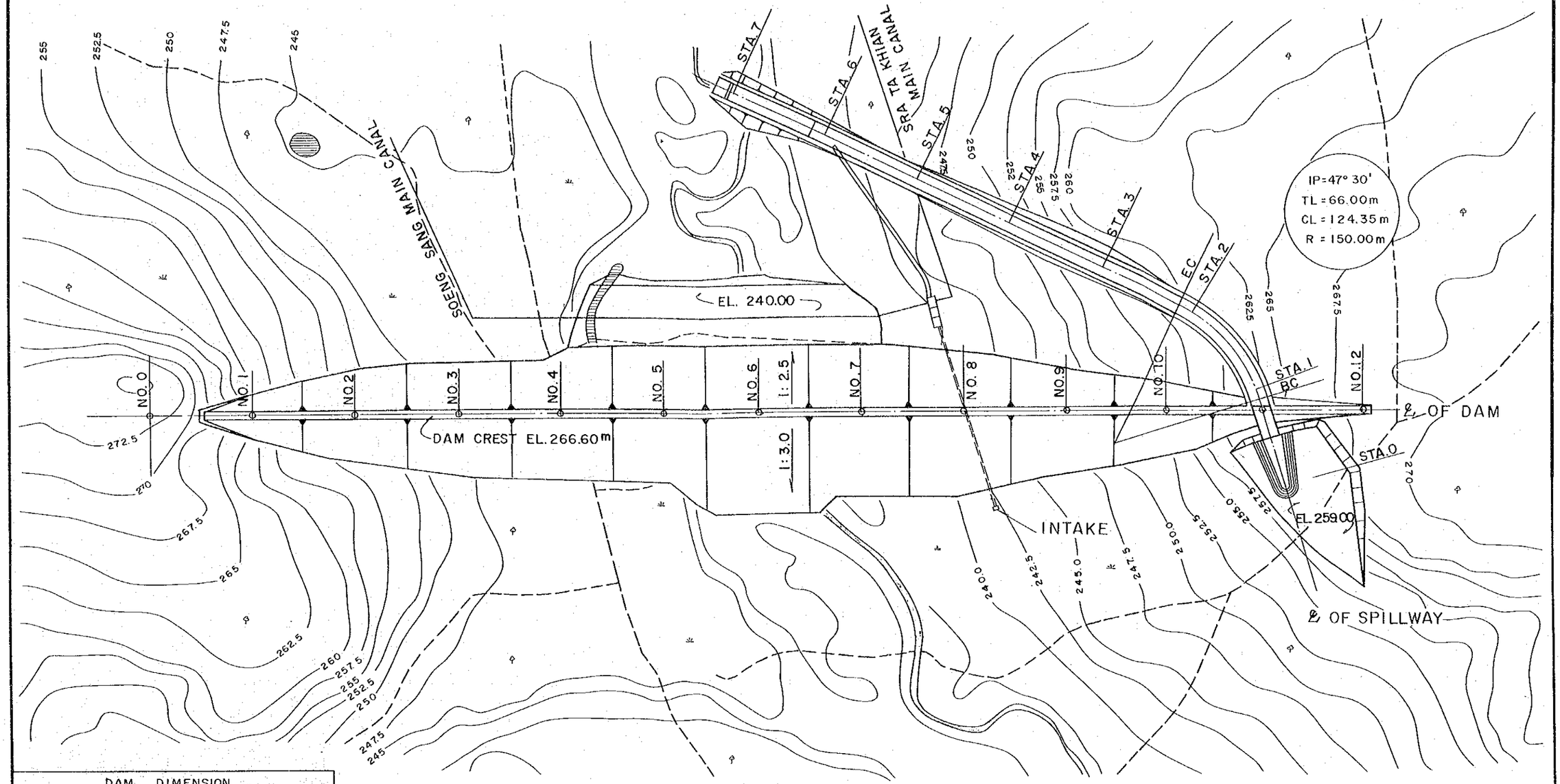
4.4. Construction Materials Survey

(1) Although the borrow area of impervious materials in the Lam Plai Mat dam has sufficient quantity and its quality is suitable for the dam impervious zone, the survey of required random materials located at both upper banks of the damsite has not been made yet in the Feasibility Study. The quality test of the random materials in a laboratory should be made in the detailed design stage.

(2) The borrow area in the Huai Phlu damsite is located a little far from the damsite and has interbedded fine sand. Additional borrow area should be surveyed in the detailed design stage to economize on the construction cost.

DRAWINGS

LIST OF DRAWINGS



DAM DIMENSION		
Catchment Area	485	km^2
Gross Reservoir Capacity	97.3	MCM
Effective Capacity	90.0	MCM
Sediment Volume	7.3	MCM
High Water Level	264.60	m
Full Water Level	261.80	m
Dead Water Level	246.00	m
Dam Type	Zone Type Fill Dam	
Dam Height	44.6	m
Dam Length	1,160	m
Dam Crest Elevation	266.60	m
Embankment Volume	1,656,000	m^3
Design Flood	1,366	m^3/sec
Spillway Capacity	984	m^3/sec
Spillway Type	Side Channel	
Overflow Depth	2.8	m
Spillway Crest Length	100	m
Intake Capacity	11.83	m^3/sec

N

SCALE

0 10 20 m

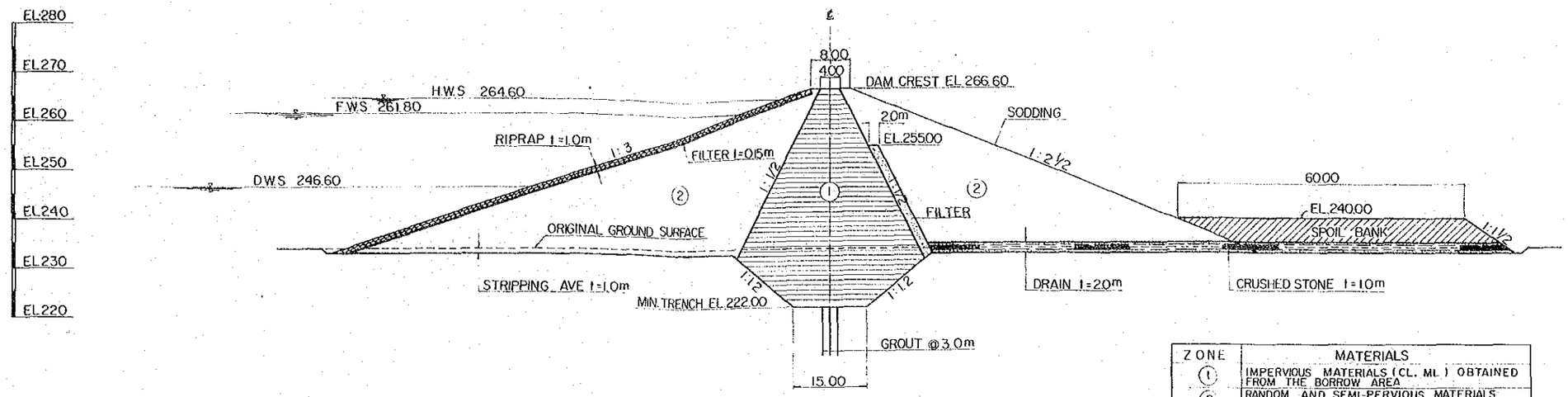
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

LOWER NORTHEAST IRRIGATION PROJECT

LAM PLAI MAT DAM (1/2)

DATE		DWG	1

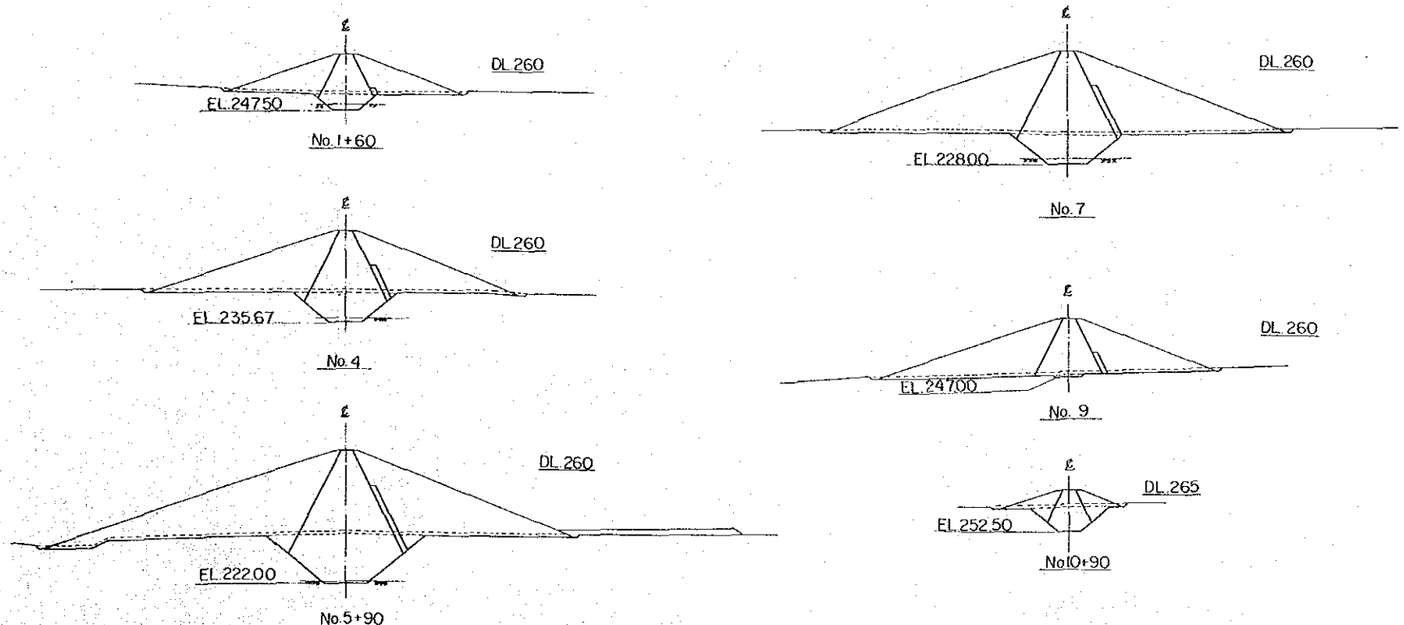
JAPAN INTERNATIONAL COOPERATION AGENCY



ZONE	MATERIALS
①	IMPERVIOUS MATERIALS (CL. ML) OBTAINED FROM THE BORROW AREA
②	RANDOM AND SEMI-PERVIOUS MATERIALS EXCAVATED AT SPILLWAY, CORE TRENCH AND OTHERS
RIPRAP	SAND STONE FROM QUARRY AND SELECTED HARD SAND STONE EXCAVATED AT SPILLWAY
FILTER	WELL-GRADED MIXTURES OF SAND AND GRAVEL OBTAINED FROM THE MUN RIVER
DRAIN	CRUSHED STONE

TYPICAL CROSS SECTION

0 10 20 30 40 50



CROSS SECTION

0 10 20 30 40 50m

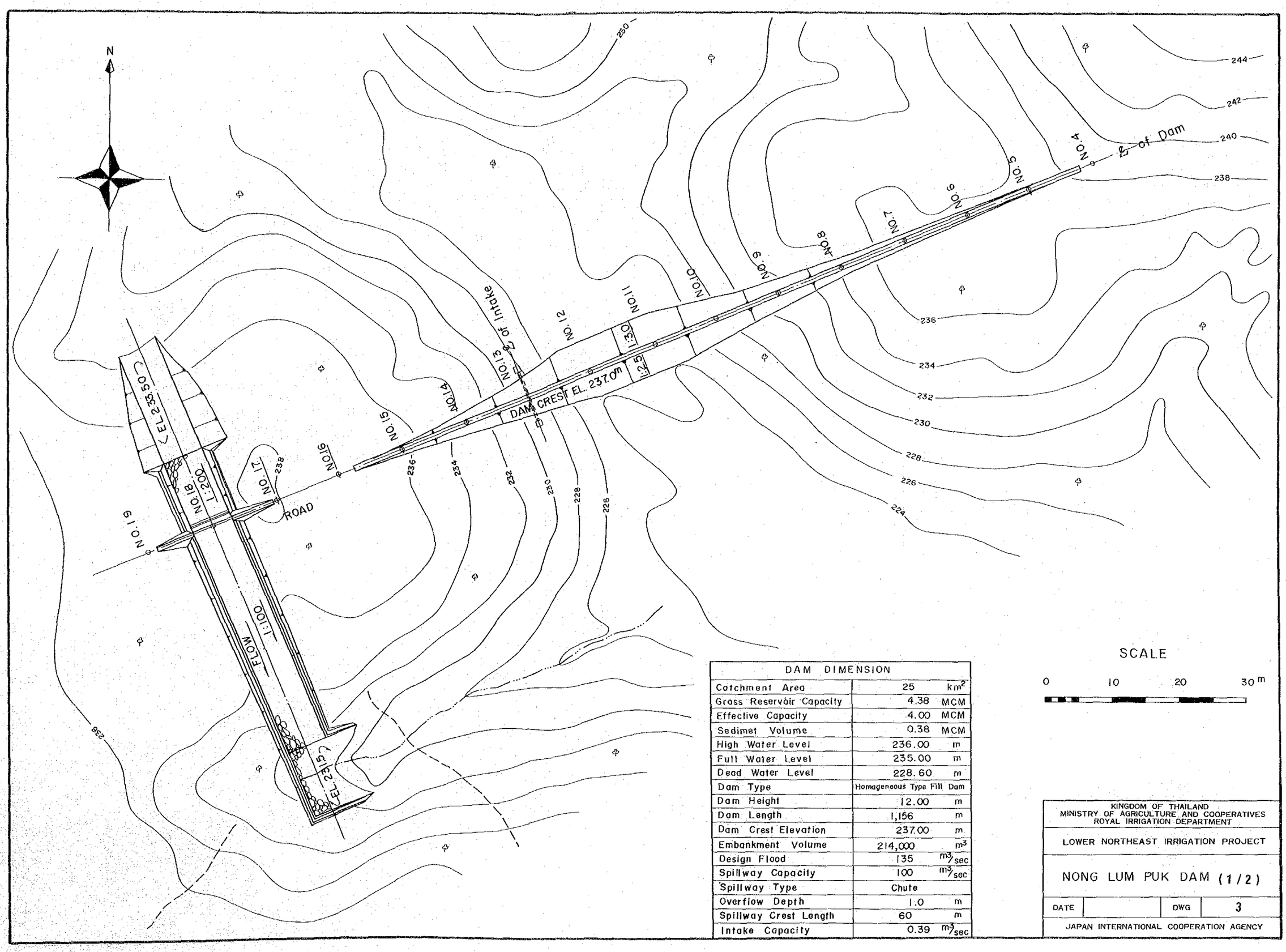
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

LOWER NORTHEAST IRRIGATION PROJECT

LAM PLAI MAT DAM (2/2)

DATE		DWG	2

JAPAN INTERNATIONAL COOPERATION AGENCY



DAM DIMENSION		
Catchment Area	25	km^2
Gross Reservoir Capacity	4.38	MCM
Effective Capacity	4.00	MCM
Sedimet Volume	0.38	MCM
High Water Level	236.00	m
Full Water Level	235.00	m
Dead Water Level	228.60	m
Dam Type	Homogeneous Type Fill Dam	
Dam Height	12.00	m
Dam Length	1,156	m
Dam Crest Elevation	237.00	m
Embankment Volume	214,000	m^3
Design Flood	135	m^3/sec
Spillway Capacity	100	m^3/sec
Spillway Type	Chute	
Overflow Depth	1.0	m
Spillway Crest Length	60	m
Intake Capacity	0.39	m^3/sec

SCALE

0 10 20 30 m

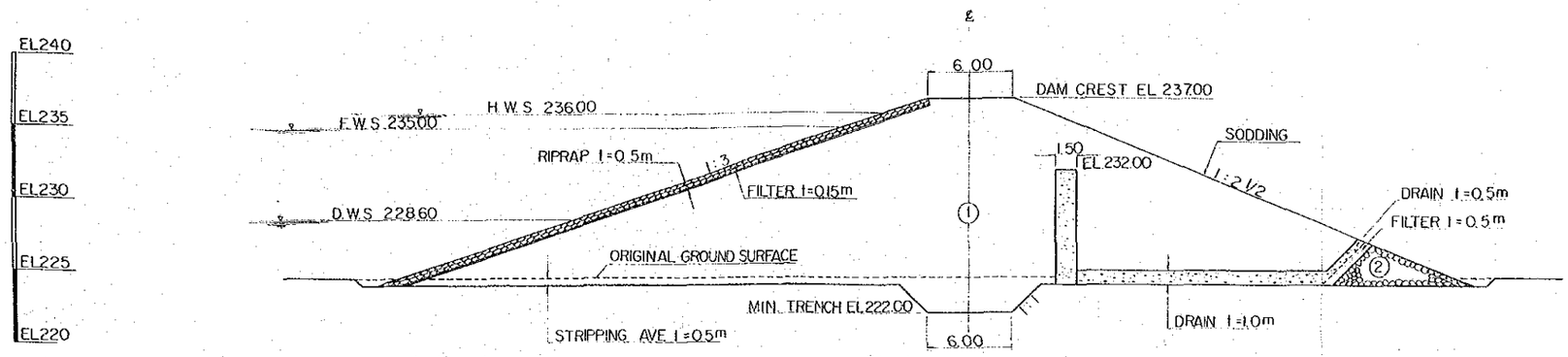
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

LOWER NORTHEAST IRRIGATION PROJECT

NONG LUM PUK DAM (1/2)

DATE		DWG	3

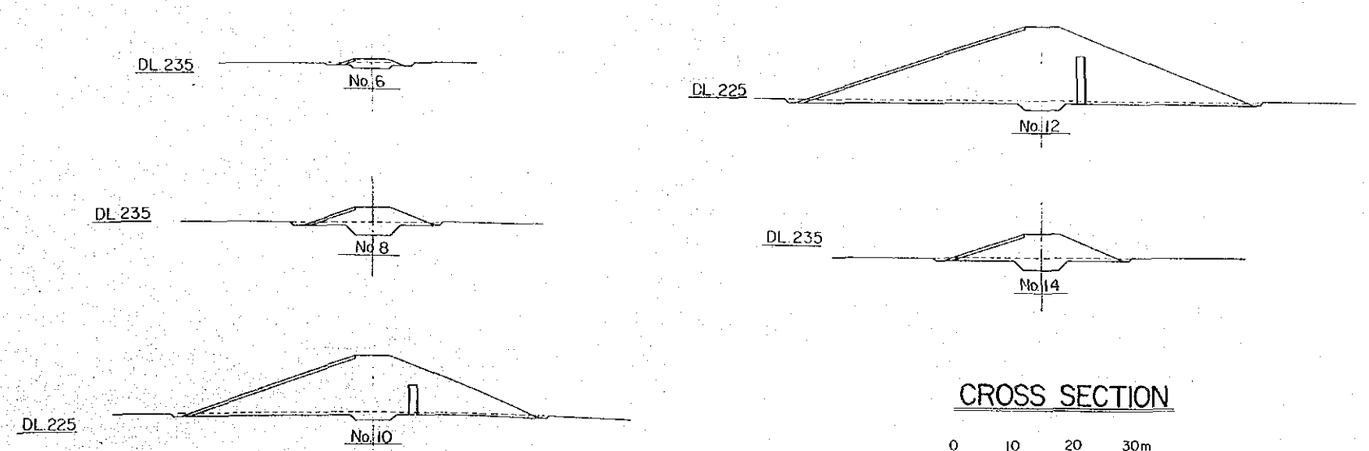
JAPAN INTERNATIONAL COOPERATION AGENCY



TYPICAL CROSS SECTION

0 5 10 15 20m

ZONE	MATERIALS
①	IMPERVIOUS MATERIALS (GM,MH) OBTAINED FROM THE BORROW AREA
②	PERVIOUS MATERIALS (ROCK), BASALT OBTAINED FROM QUARRY AND/OR EXCAVATION OF SPILLWAY
RIPRAP	BASALT FROM QUARRY AND SELECTED HARD BASALT EXCAVATED AT SPILLWAY
FILTER	WELL-GRADED MIXTURES OF SAND AND GRAVEL OBTAINED FROM THE MUN RIVER
DRAIN	CRUSHED STONE



CROSS SECTION

0 10 20 30m

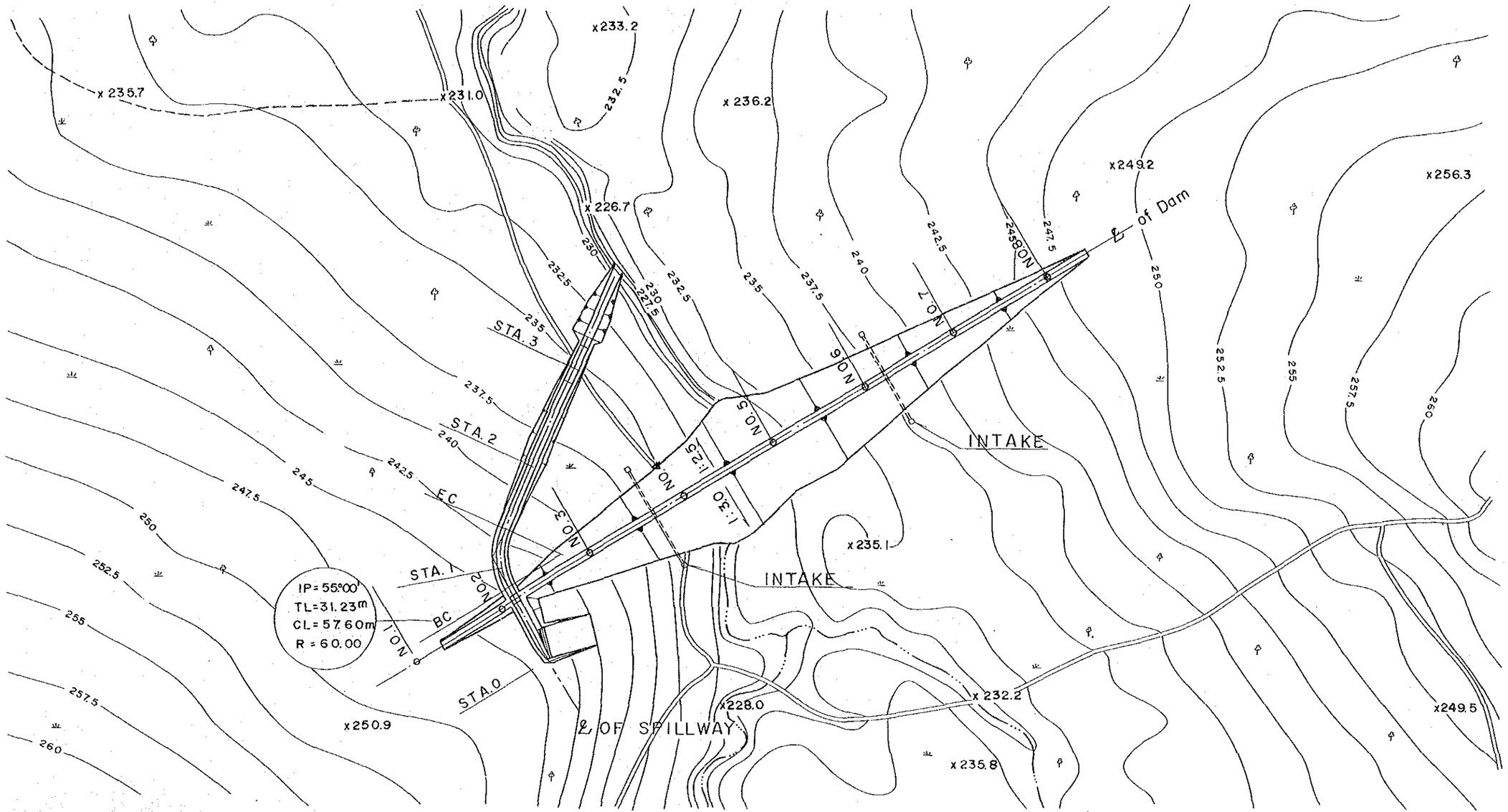
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

LOWER NORTHEAST IRRIGATION PROJECT

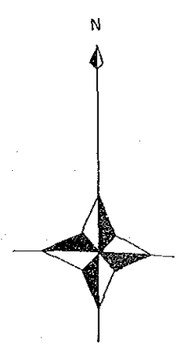
NONG LUM PUK DAM (2 / 2)

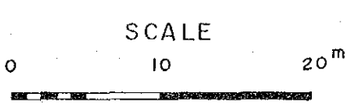
DATE		DWG	4

JAPAN INTERNATIONAL COOPERATION AGENCY



DAM DIMENSION		
Catchment Area	21	km^2
Gross Reservoir Capacity	6.32	MCM
Effective Capacity	6.00	MCM
Sediment Volume	0.32	MCM
High Water Level	245.00	m
Full Water Level	243.80	m
Dead Water Level	233.70	m
Dam Type	Homogeneous Type Fill Dam	
Dam Height	20.0	m
Dam Length	844	m
Dam Crest Elevation	247.00	m
Embankment Volume	297,000	m^3
Design Flood	140	m^3/sec
Spillway Capacity	83	m^3/sec
Spillway Type	Side Channel	
Overflow Depth	1.2	m
Spillway Crest Length	30	m
Intake Capacity	0.91	m^3/sec





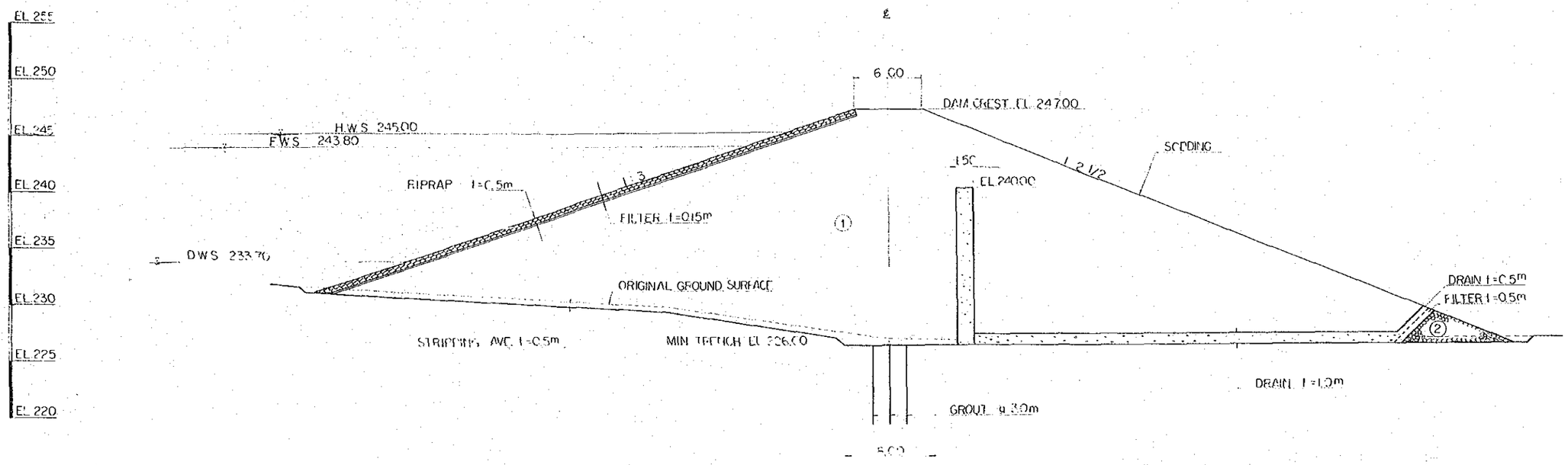
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

LOWER NORTHEAST IRRIGATION PROJECT

HUAI PHLU DAM (1/2)

DATE. | DWG 5

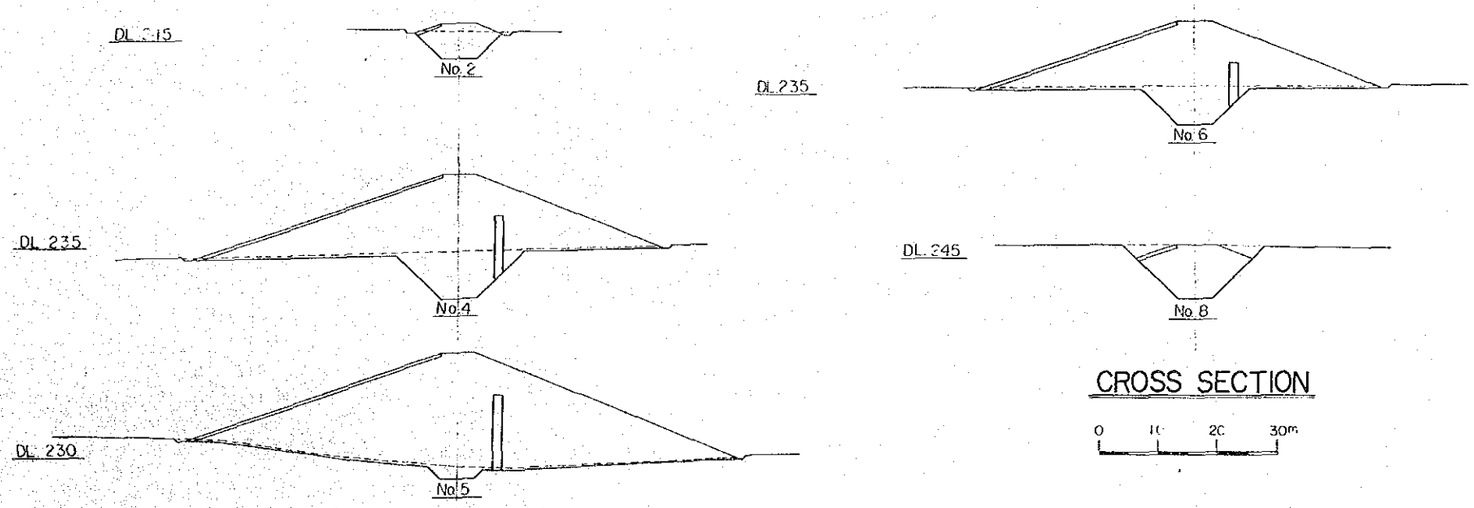
JAPAN INTERNATIONAL COOPERATION AGENCY



TYPICAL CROSS SECTION

0 5 10 15 20m

ZONE	MATERIALS
①	IMPERVIOUS MATERIALS (CL) OBTAINED FROM THE BORROW AREA
②	PERVIOUS MATERIALS(ROCK) SANDSTONE OBTAINED FROM QUARRY AND/OR EXCAVATION OF SPILLWAY
RIPRAP	SAND STONE FROM QUARRY AND SELECTED HARD SAND STONE EXCAVATED AT SPILLWAY
FILTER	WELL-GRADED MIXTURES OF SAND AND GRAVEL OBTAINED FROM THE MUN RIVER
DRAIN	CRUSHED STONE



CROSS SECTION

0 10 20 30m

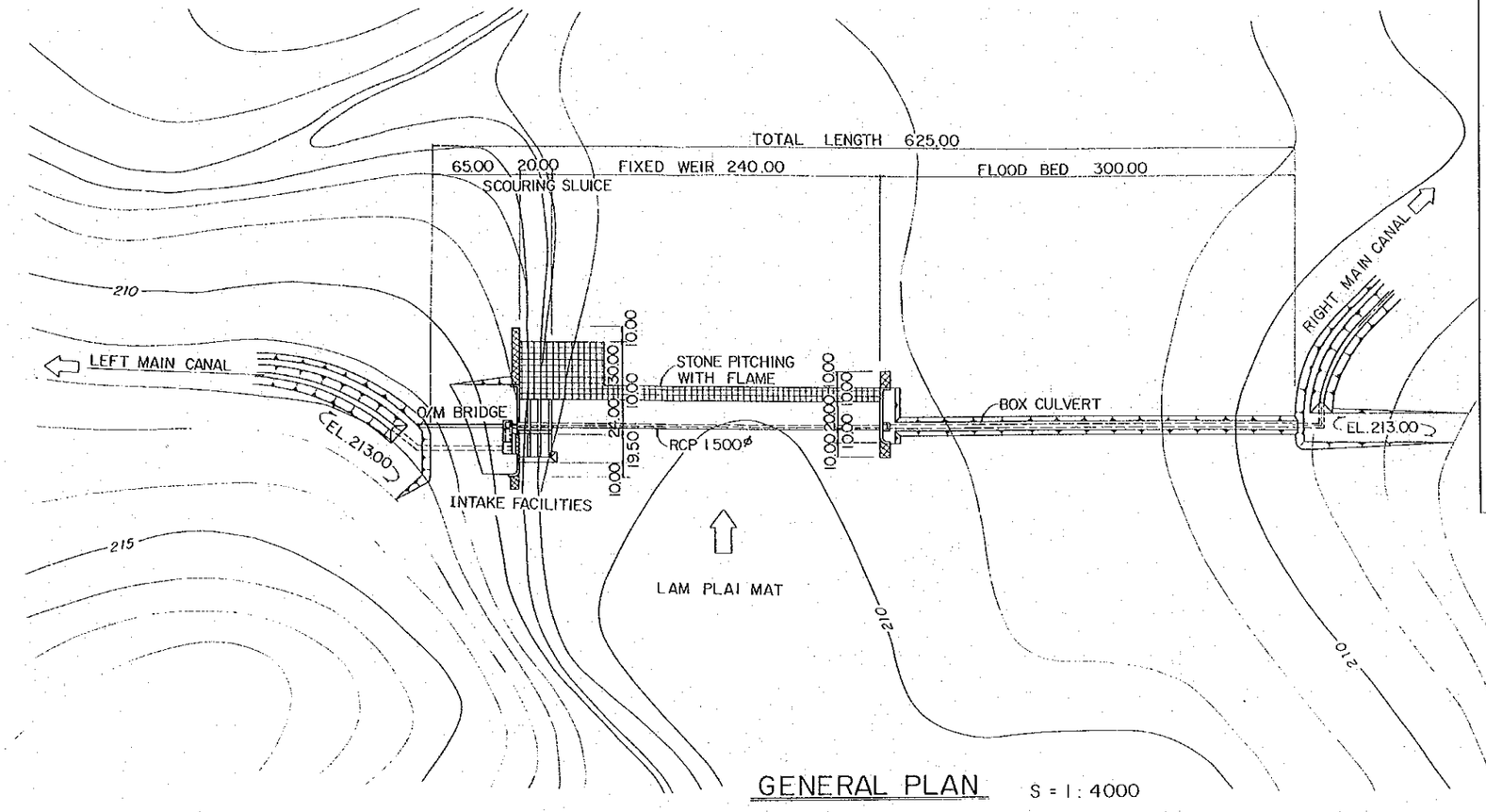
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

LOWER NORTHEAST IRRIGATION PROJECT

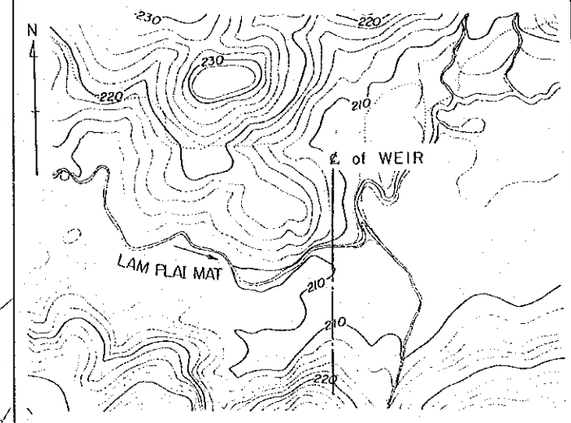
HUAI PHLU DAM (2/2)

DATE		DWG	6

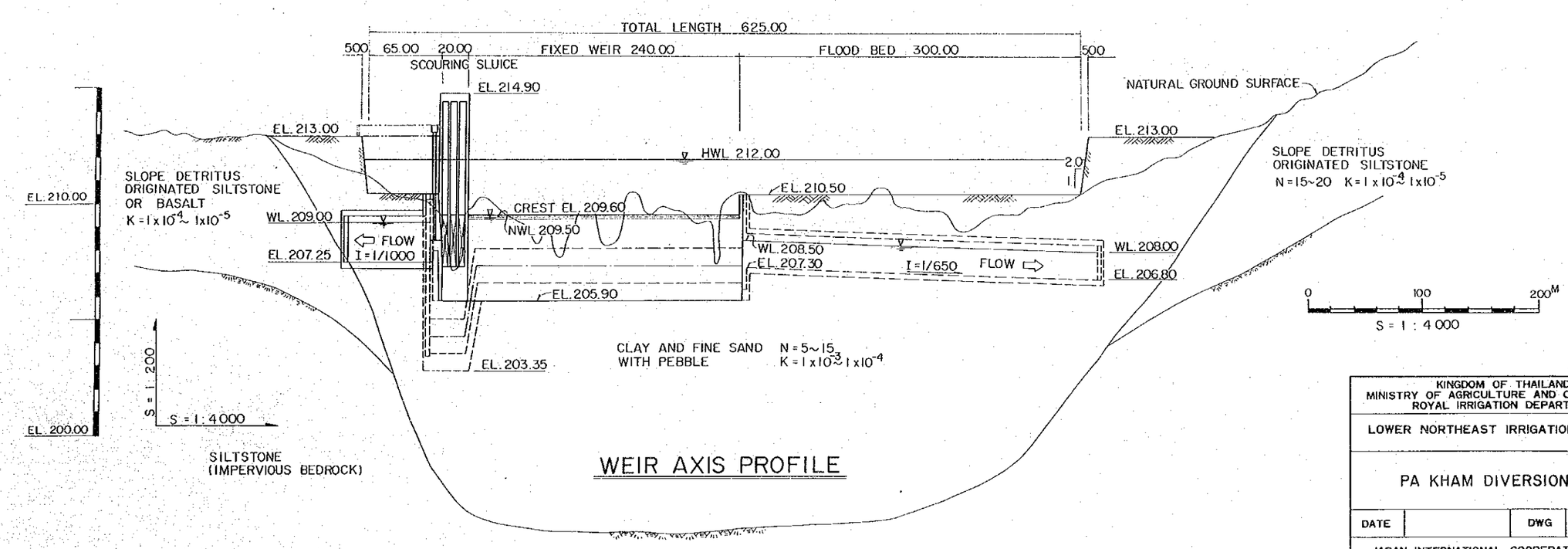
JAPAN INTERNATIONAL COOPERATION AGENCY



GENERAL PLAN S = 1 : 4000



LOCATION MAP
S = 1 : 40,000



WEIR AXIS PROFILE

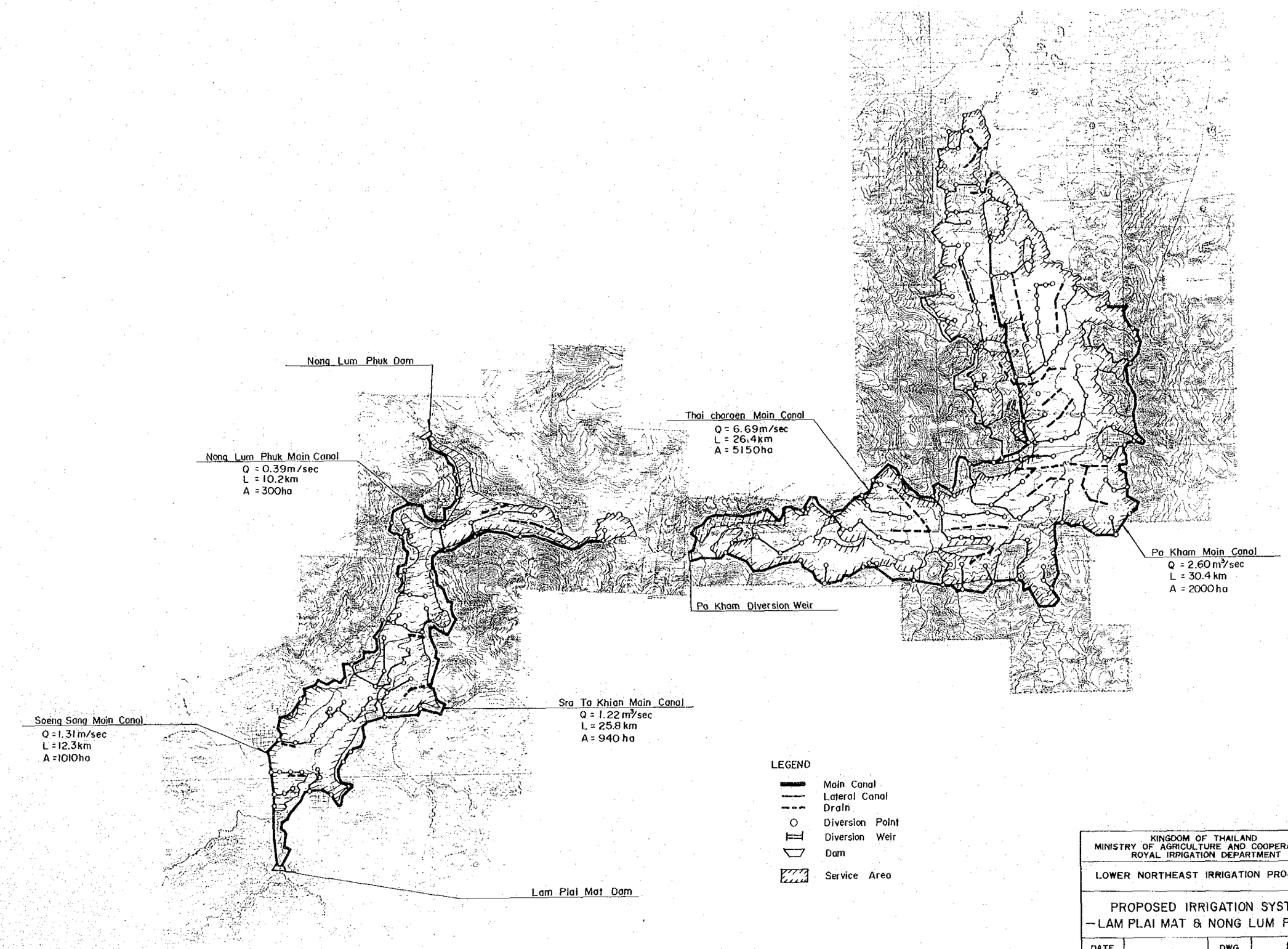
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

LOWER NORTHEAST IRRIGATION PROJECT

PA KHAM DIVERSION WEIR

DATE		DWG	7

JAPAN INTERNATIONAL COOPERATION AGENCY



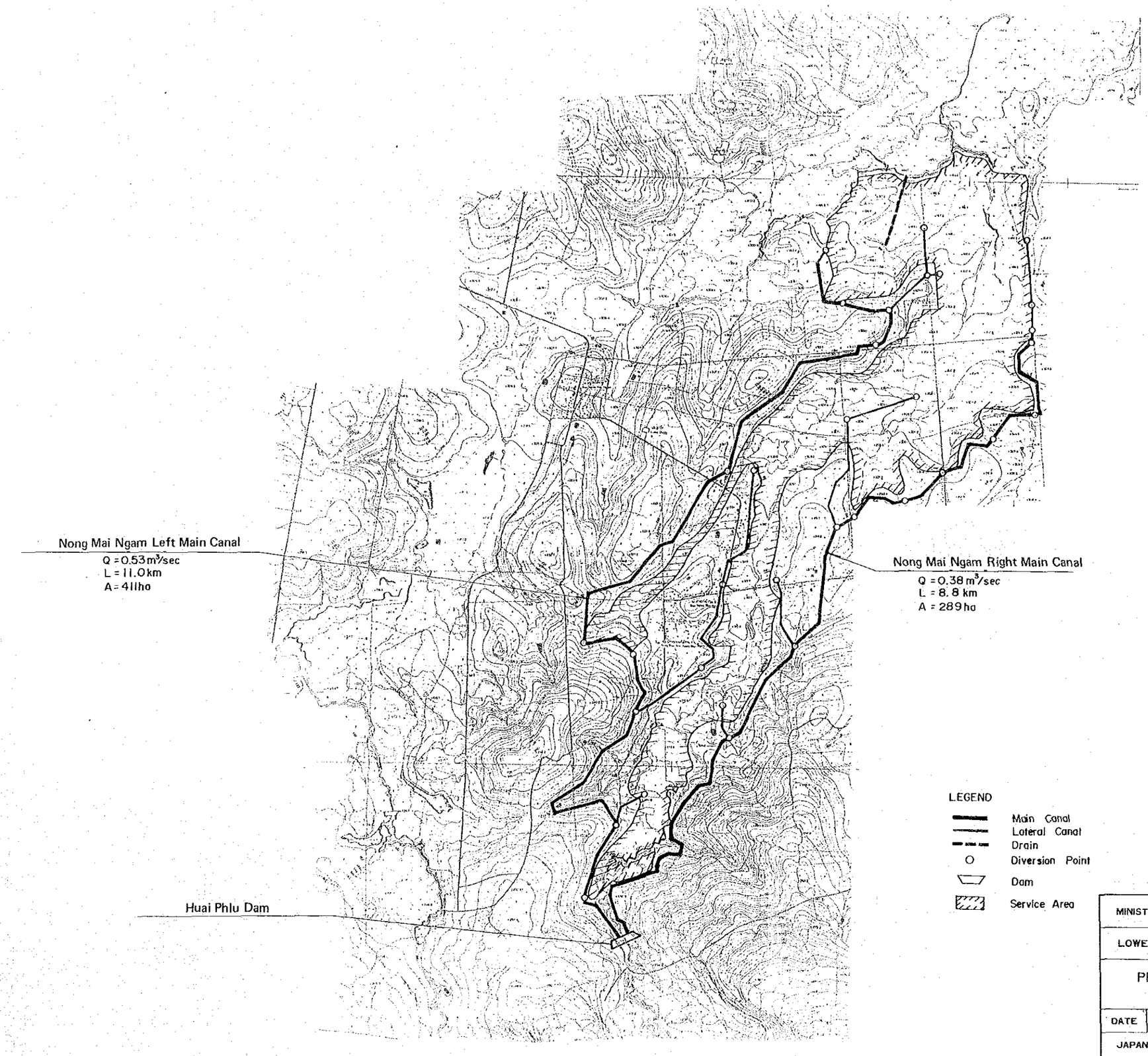
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

LOWER NORTHEAST IRRIGATION PROJECT

PROPOSED IRRIGATION SYSTEM
—LAM PLAI MAT & NONG LUM PHUK—

DATE		DWG	8

JAPAN INTERNATIONAL COOPERATION AGENCY



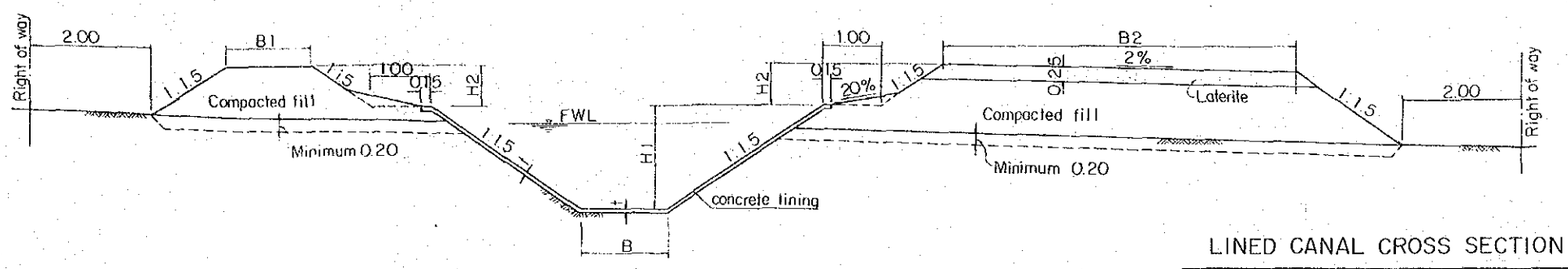
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

LOWER NORTHEAST IRRIGATION PROJECT

PROPOSED IRRIGATION SYSTEM
— HUAI PHLU —

DATE		DWG	9

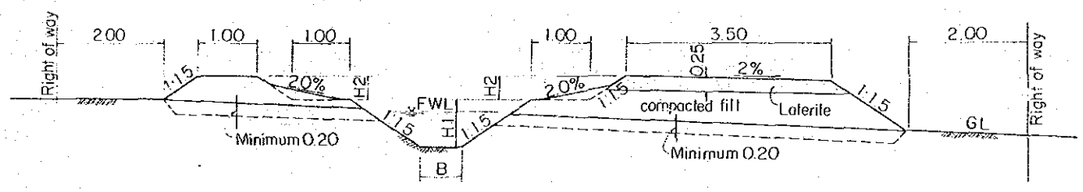
JAPAN INTERNATIONAL COOPERATION AGENCY



LINED CANAL

LINED CANAL CROSS SECTION DETAILS

TYPE	Q m^3/sec	B m	B1 m	B2 m	H1 m	H2 m	I cm
L1	6.63~6.37	1.80	1.50	6.00	2.00	0.80	7
L2	6.04~5.69	1.70	1.50	6.00	1.95	0.75	7
L3	5.59~5.02	1.60	1.50	6.00	1.90	0.75	7
L4	4.49~4.37	1.50	1.50	6.00	1.75	0.70	6
L5	2.60~2.55	1.20	1.50	6.00	1.40	0.60	6
L6	2.24~1.74	1.10	1.00	3.50	1.30	0.60	5
L7	1.89~1.46	1.00	1.00	3.50	1.25	0.55	5
L8	1.30~1.00	0.90	1.00	3.50	1.10	0.50	5
L9	1.22~0.66	0.80	1.00	3.50	1.05	0.50	5
L10	0.80~0.52	0.70	1.00	3.50	0.85	0.45	5
L11	0.60~0.32	0.60	1.00	3.50	0.80	0.45	5
L12	0.46~0.06	0.50	1.00	3.50	0.65	0.40	5



UNLINED CANAL

UNLINED CANAL CROSS SECTION DETAILS

TYPE	Q m^3/sec	B m	H1 m	H2 m
E1	0.01~0.05	0.30	0.45	0.35
E2	0.05~0.10	0.40	0.55	0.35
E3	0.10~0.20	0.50	0.65	0.35
E4	0.20~0.30	0.60	0.75	0.40
E5	0.30~0.40	0.70	0.80	0.40
E6	0.40~0.50	0.70	0.85	0.40

KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

LOWER NORTHEAST IRRIGATION PROJECT

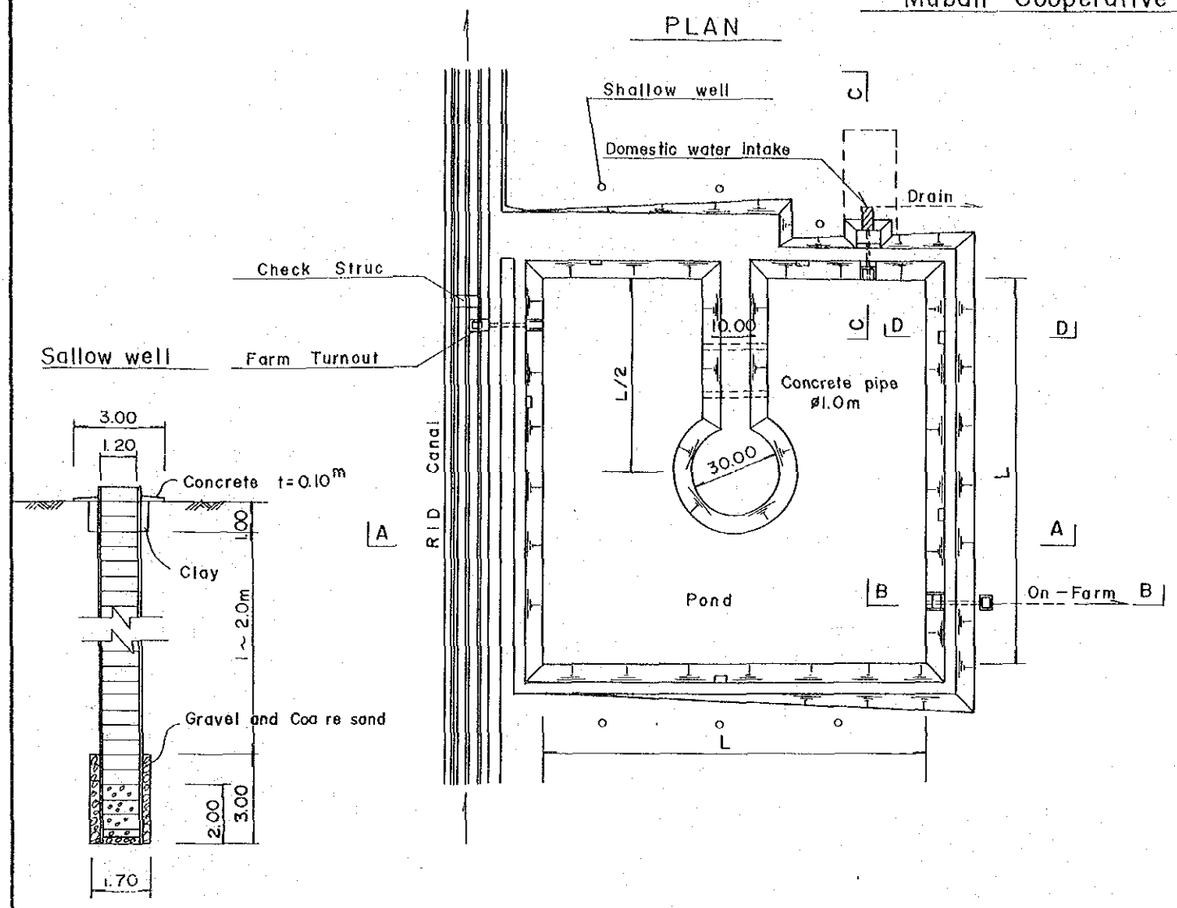
TYPICAL CANAL SECTION

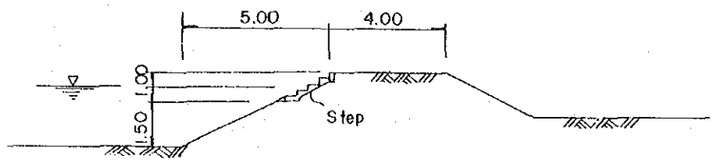
DATE | DWG 10

JAPAN INTERNATIONAL COOPERATION AGENCY

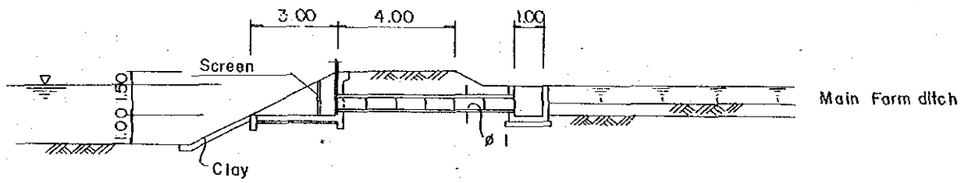
Muban Cooperative Pond

PLAN

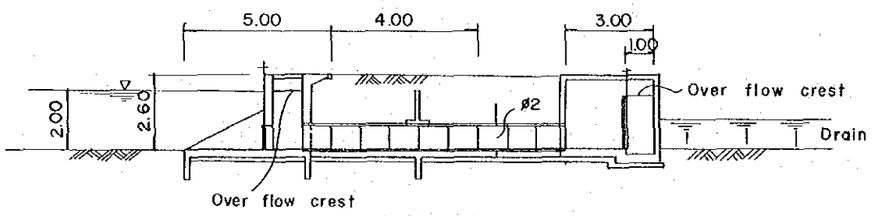




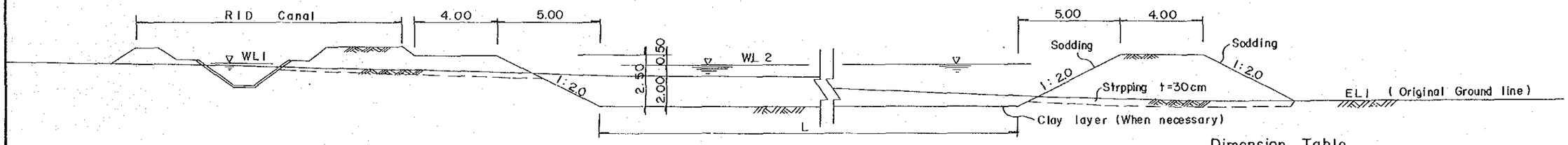
D ~ D Section



C ~ C Section



B ~ B Section



A ~ A Section

Dimension Table

TYPE	Area of Pond	L	ø 1	ø 2	WL1 – WL2	WL2 – EL 1
MP – 1	2.4 ha	160 m	0.60m	1.00 m	Minimum 0.50 m	Minimum 0.50 m
MP – 2	1.6	130	0.50	1.00		
MP – 3	0.8	100	0.30	0.60		

KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

LOWER NORTHEAST IRRIGATION PROJECT

MUBAN COOPERATIVE POND

DATE | DWG 11

JAPAN INTERNATIONAL COOPERATION AGENCY