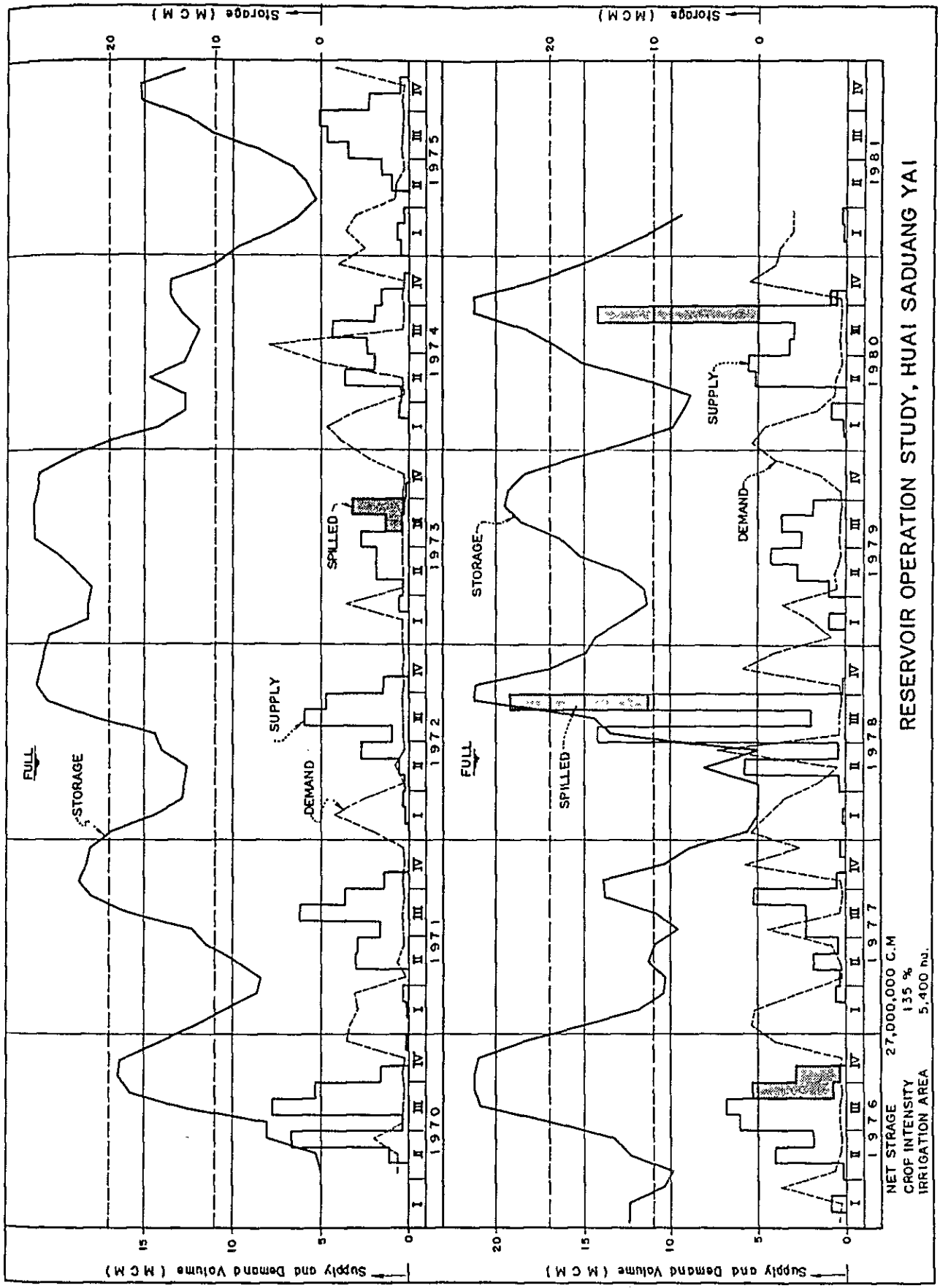
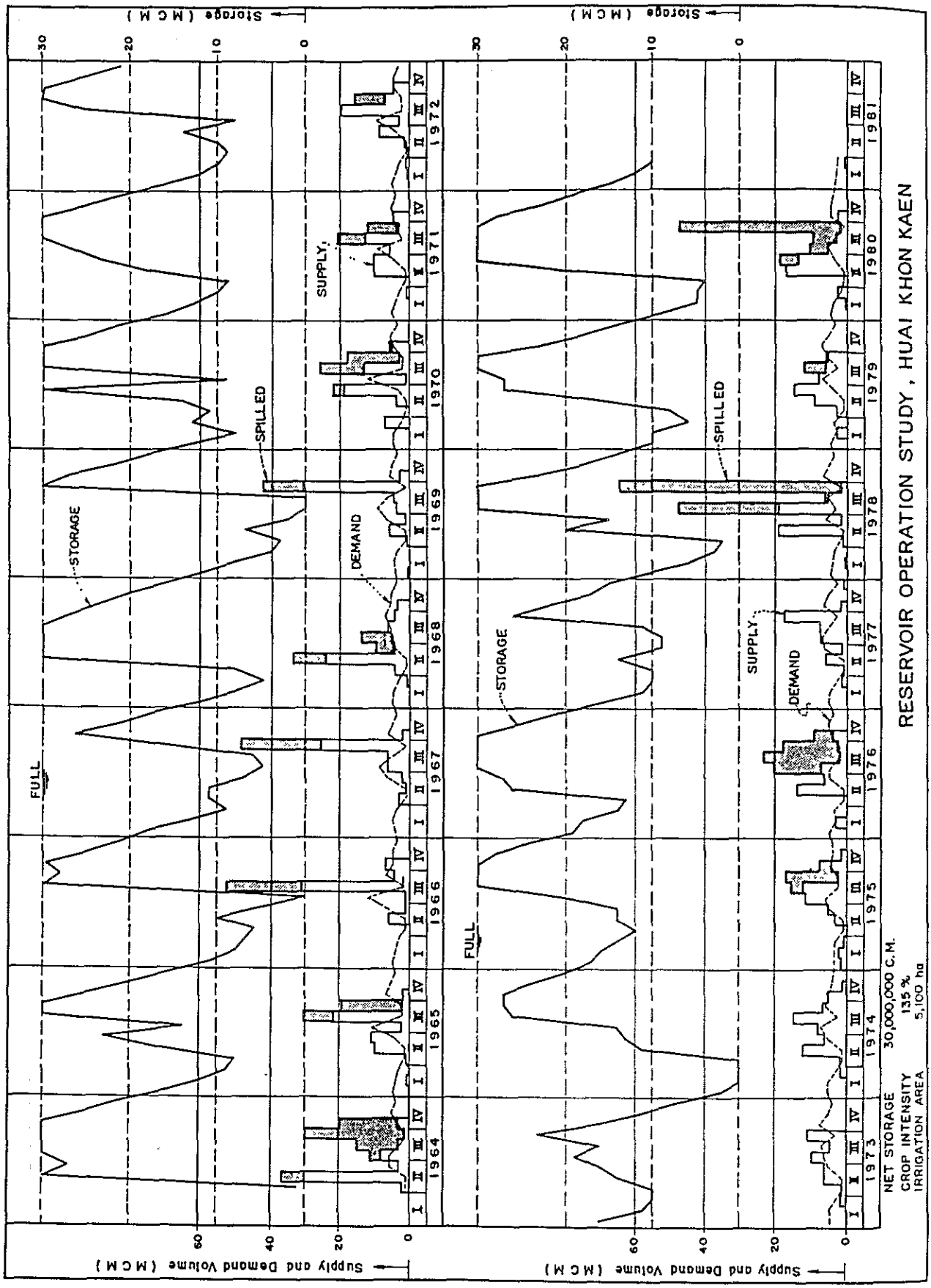
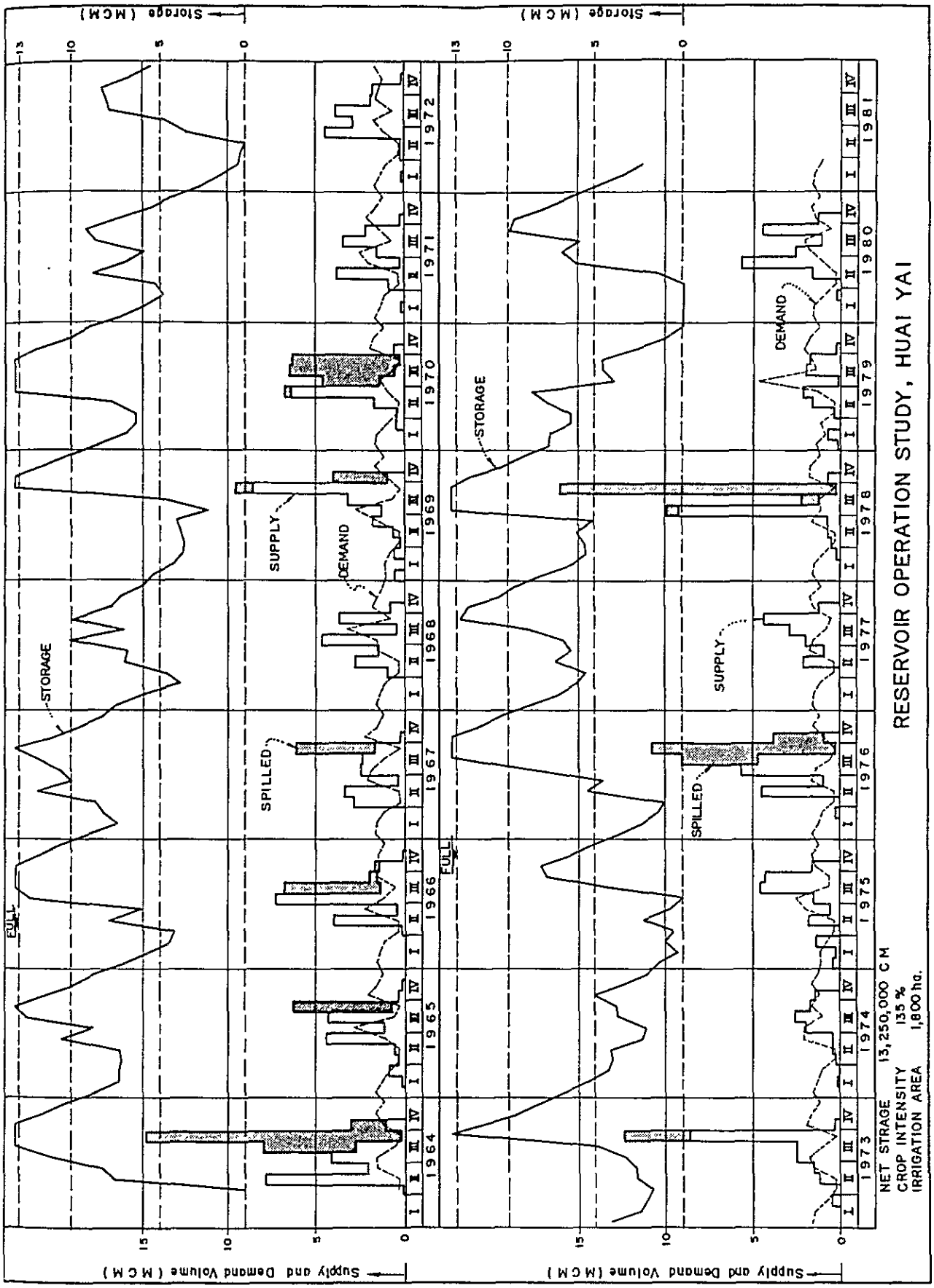
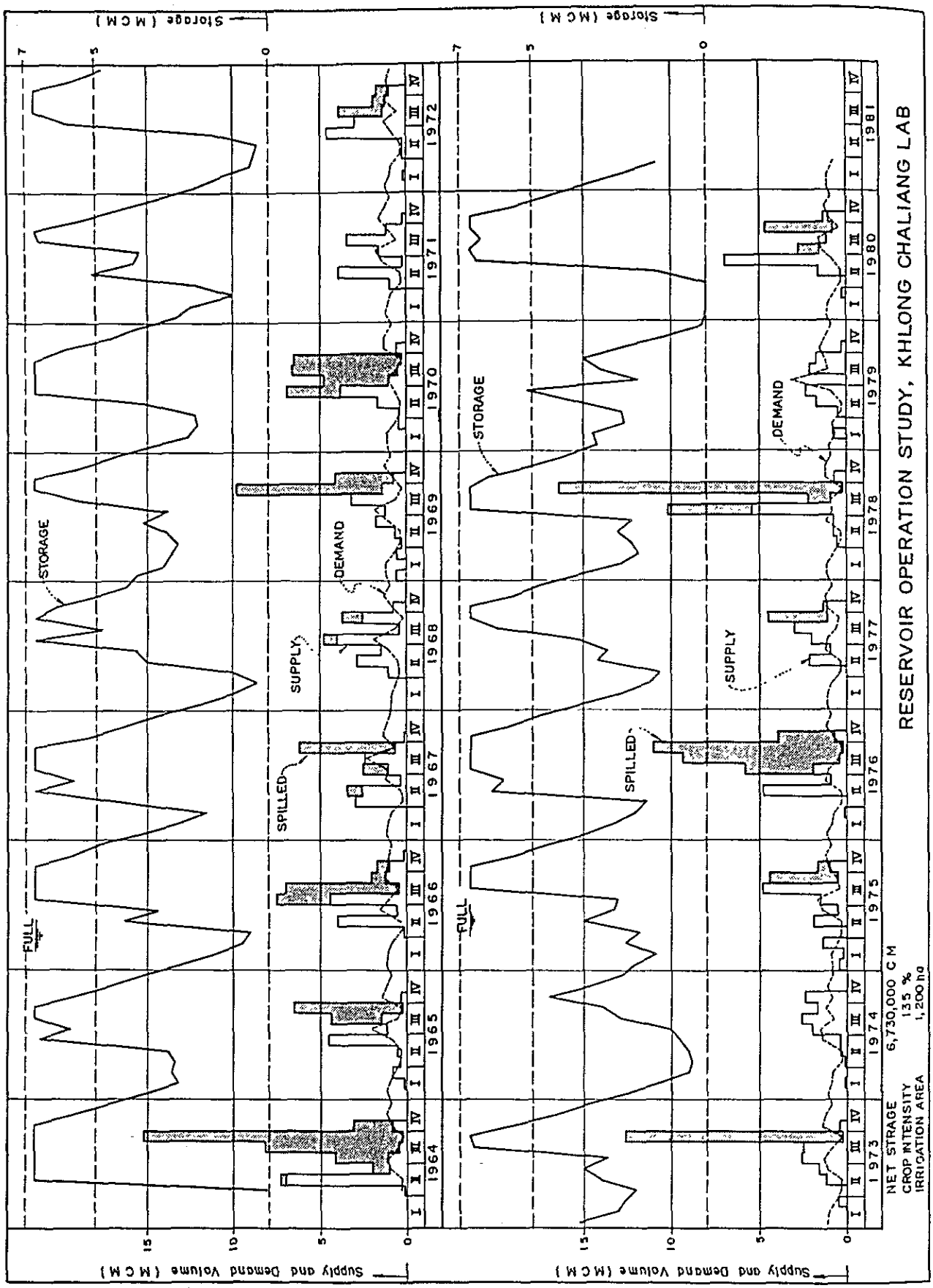
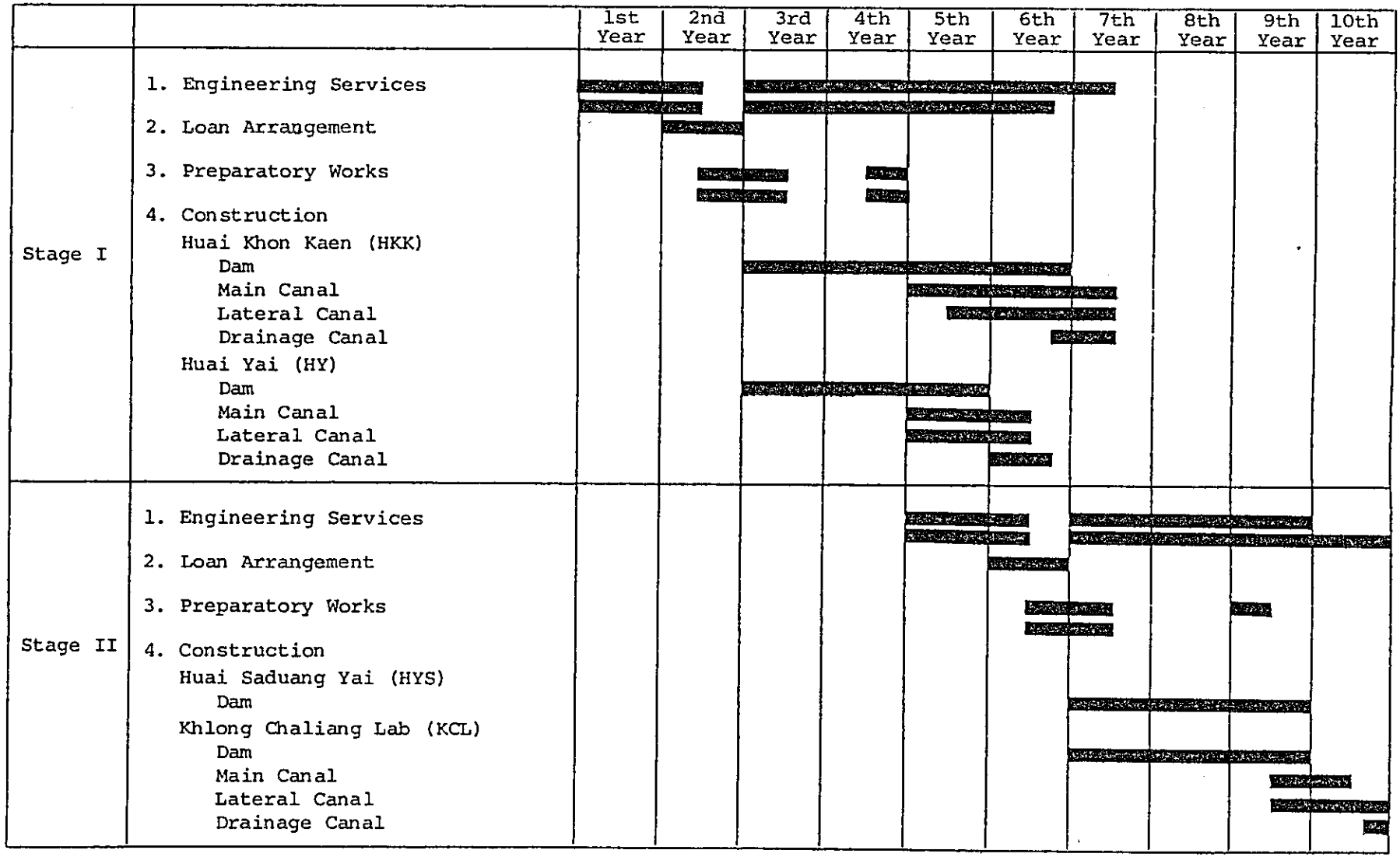
FIG. 7.2
(1)


RESERVOIR OPERATION STUDY, HUAI SADUANG YAI
Storage (M C M)
Supply and Demand Volume (M C M)
FULL
STORAGE
SUPPLY
DEMAND
SPILLED
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
NET STRAGE 27,000,000 C.M
CROP INTENSITY 135 %
IRRIGATION AREA 5,400 ha.


RESERVOIR OPERATION STUDY, HUAI KHON KAEN
NET STORAGE 30,000,000 C.M.
CROP INTENSITY 135 %
IRRIGATION AREA 5,100 ha
Storage (M C M)
Supply and Demand Volume (M C M)
STORAGE
SUPPLY
DEMAND
SPILLED
FULL
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981

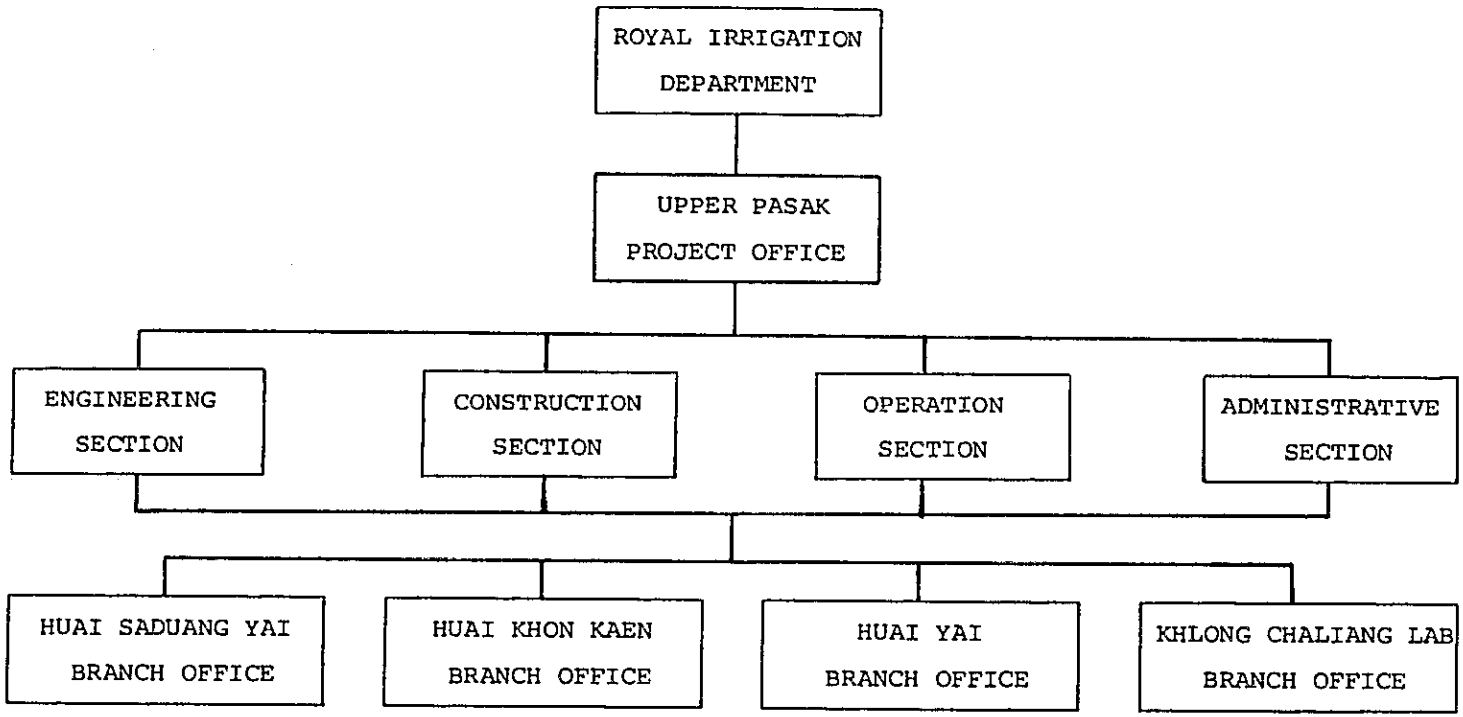

RESERVOIR OPERATION STUDY, HUAI YAI
NET STRAGE 13,250,000 C M
CROP INTENSITY 135 %
IRRIGATION AREA 1,800 ha.
Storage (M C M)
Supply and Demand Volume (M C M)
STORAGE
SUPPLY
DEMAND
SPILLED
FULL
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981


RESERVOIR OPERATION STUDY, KHLONG CHALIANG LAB
Storage (M C M)
Supply and Demand Volume (M C M)
STORAGE
DEMAND
SUPPLY
SPILLED
FULL
NET STRAGE 6,730,000 C M
CROP INTENSITY 135 %
IRRIGATION AREA 1,200 ha
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981



PROJECT IMPLEMENTATION SCHEDULE

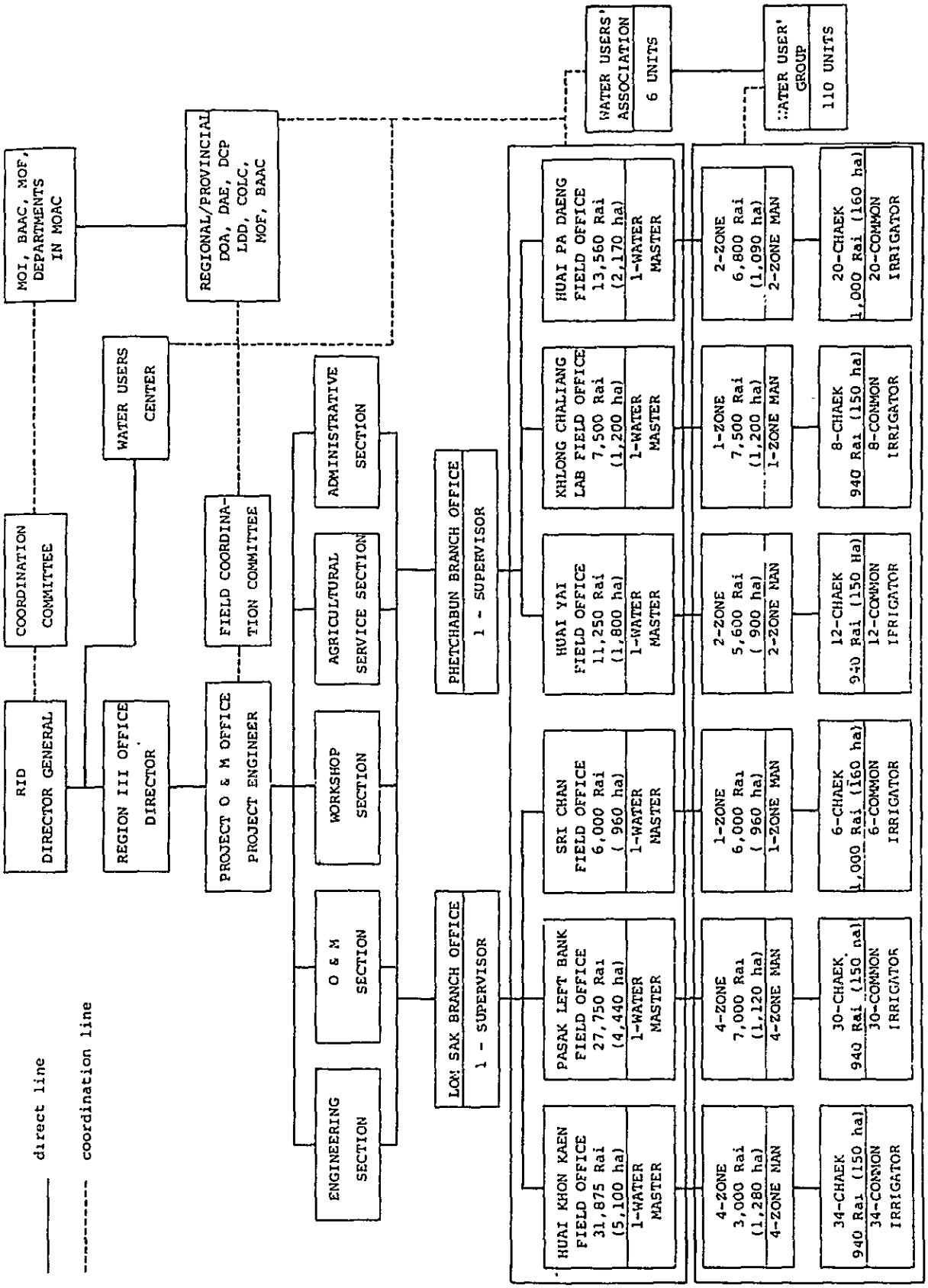
FIG. 7.3



PROPOSED ORGANIZATION FOR PROJECT CONSTRUCTION OFFICE

FIG. 8.1

FIG. 8.2



PROPOSED ORGANIZATION FOR O & M OFFICE

PLATES

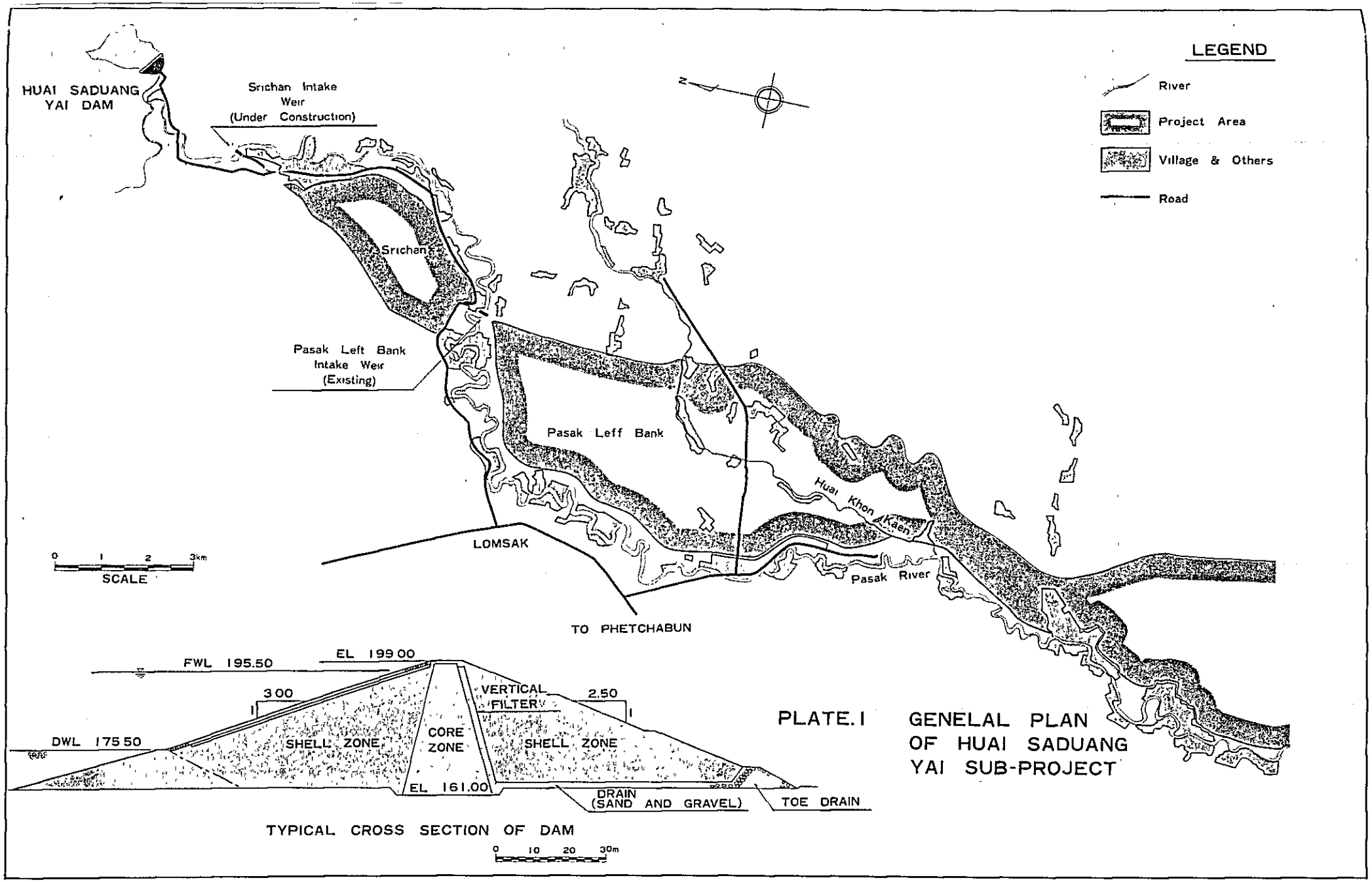


PLATE. I GENELAL PLAN OF HUAI SADUANG YAI SUB-PROJECT

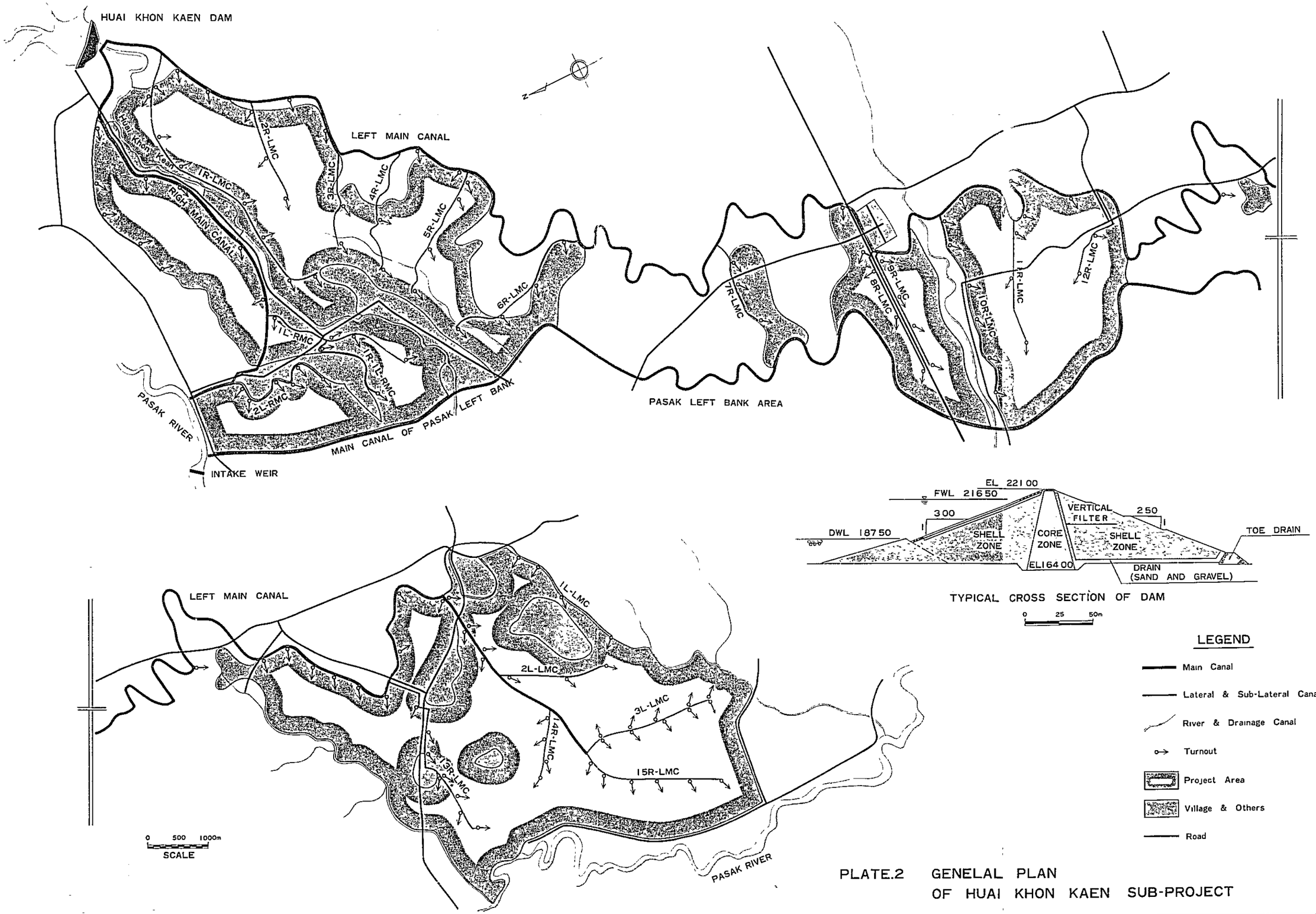


PLATE.2 GENELAL PLAN OF HUAI KHON KAEN SUB-PROJECT

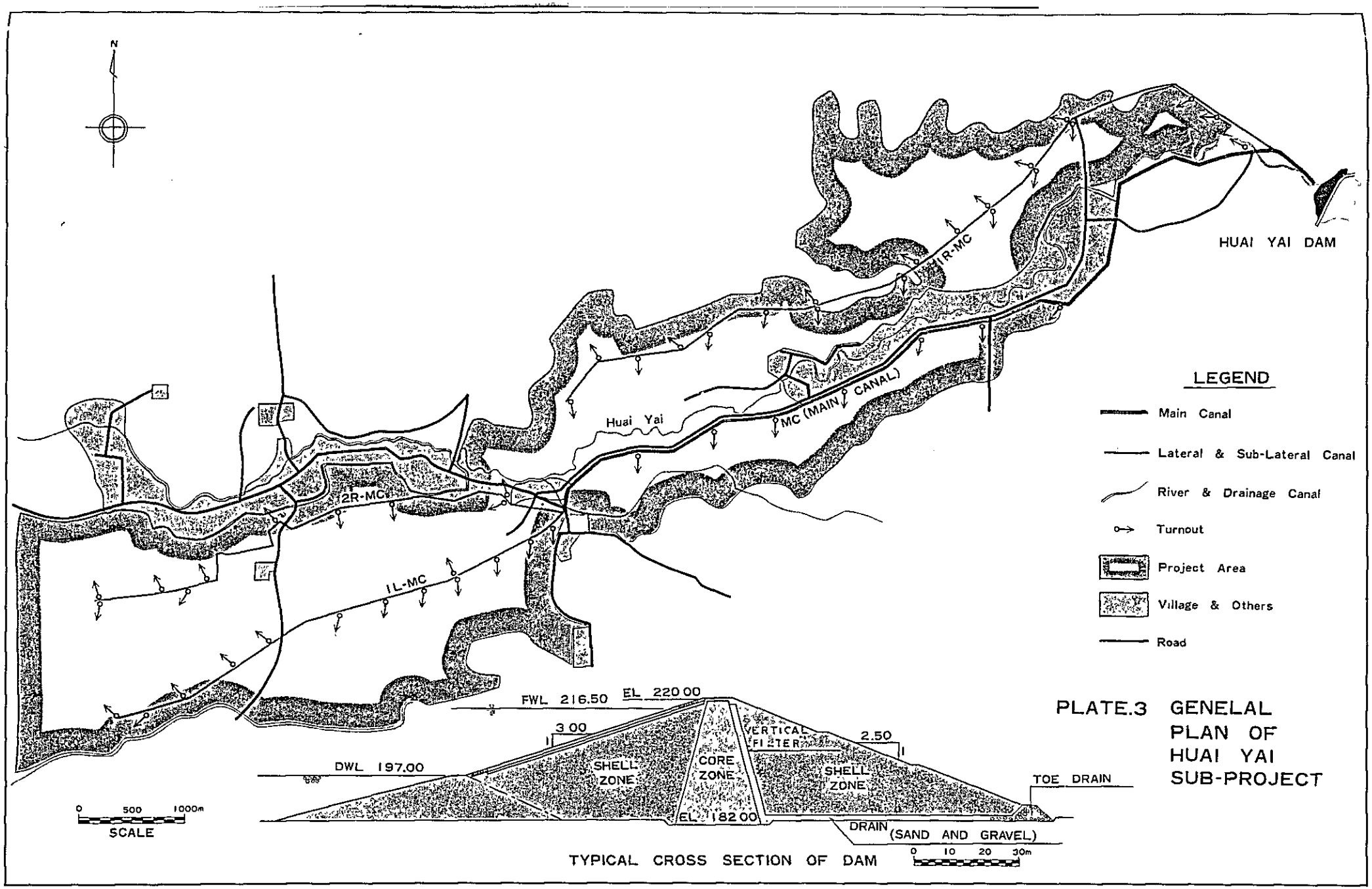
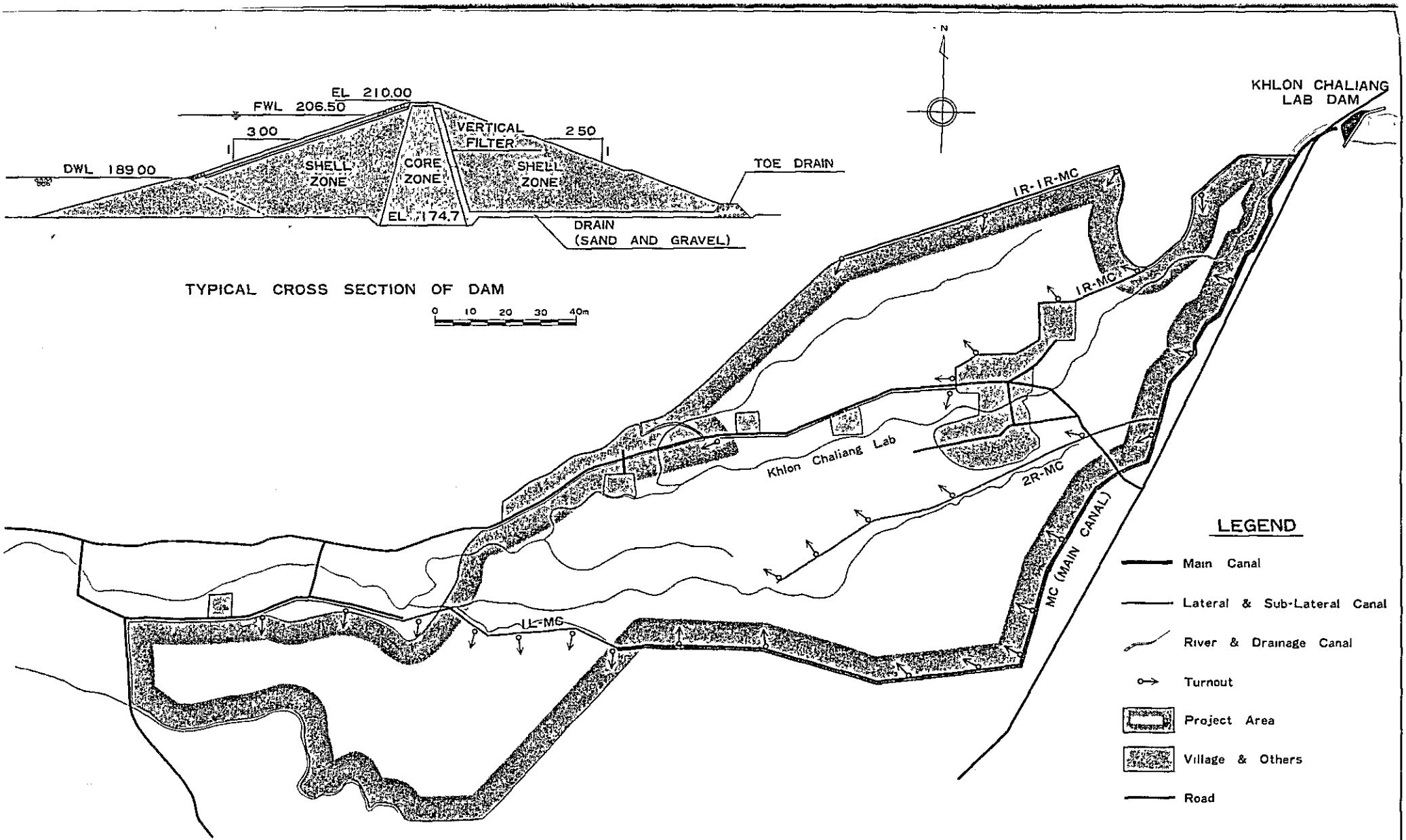


PLATE.3 GENELAL PLAN OF HUAI YAI SUB-PROJECT

TYPICAL CROSS SECTION OF DAM

0 10 20 30 40m



0 500 1000m
SCALE

PLATE.4 GENELAL PLAN OF KHLON CHALIANG LAB SUB-PROJECT

ATTACHMENTS

ATTACHMENT 1

SCOPE OF WORKS

FOR

PRE-FEASIBILITY STUDY AND FEASIBILITY STUDY

ON

THE UPPER PASAK MEDIUM SCALE IRRIGATION PROJECT

IN

THE KINGDOM OF THAILAND

The Japanese Scope of Works Mission (Japanese side), headed by Mr. AKIRA KAZAMA, Civil Engineer, Construction Department, Agricultural Improvement Bureau, Ministry of Agriculture, Forestry and Fisheries and the Thai Government (Thai side), headed by Mr. SUNTHORN RUANGLEK, Director General of the Royal Irrigation Department, Ministry of Agriculture and Cooperatives agreed the Scope of Works for Pre-Feasibility Study and Feasibility Study on the Upper Pasak Medium Scale Irrigation Project.

Signed in Bangkok

on 22nd April 1981

Mr. AKIRA KAZAMA
Leader of the Scope of Works
Mission for the Upper Pasak
Medium Scale Irrigation Project

Mr. SUNTHORN RUANGLEK
Director General
Royal Irrigation Department
Ministry of Agriculture and
Cooperatives

1. INTRODUCTION

In response to the request of the Government of Thailand (hereinafter referred to as "the Government"), the Government of Japan has decided to undertake the pre-feasibility study (A), and the feasibility study (B) on the Upper Pasak Medium Scale Irrigation Projects (hereinafter referred to as "the Project") as a part of the technical cooperation programme of the Government of Japan.

Accordingly, Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of the Government of Japan's technical cooperation programme will be the executing agency, and carry out the survey under the cooperation with the Royal Irrigation Department, Ministry of Agriculture and Cooperatives and other authorities concerned.

The Scope of Works for the Projects is prepared on the basis of the results obtained from the Preliminary Survey for the Project, describing the items to be studied, implementation schedule, and services and facilities to be provided by the Government for the smooth execution of the study.

This indicates the outline of essential features of the (A) and (B) which is to be carried out in close cooperation with the Government and its authorities concerned. The area for the irrigated agricultural development in the proposed project would be as follows.

Study (A)	1)	Huai Yai	About 1,900 ha
	2)	Huai Khon Kaen	" 4,700 ha
	3)	Khlong Chaliang Lab	" 1,200 ha
	4)	Huai Saduang Yai	" 440 ha

There is a possibility of changing the benefit area from the points of view of hydrological study and the effective use of the existing facilities.

Study (B) The area for (B) would be fixed after finishing (A)

2. OBJECTIVES OF THE STUDY

The objectives of the Study will be

1) to identify the order of priority (A)
2) to formulate an irrigated agricultural development project and identify the feasibility of the Project (B)
3) to determine the optimum water resources plan, and (B)
4) to undertake on-the-job training of the Government's officials in the course of the survey and study (A and B).

3. OUTLINE OF THE STUDY

The activities to be undertaken by the Study team will be divided into two stages.

(1) Field Works in Thailand (A and B)

(2) Home Office Works in Japan (A and B)

1) Field Works

The field works will cover the following items.

(1) to collect and review the relevant existing data and information including.

a. Meteorology and hydrology (A and B)
b. Topographic map (A and B)
c. Soil (B)
d. Geology and geohydrology (A and B)
e. Irrigation and drainage (A and B)
f. Agriculture (A and B)
g. Agro and regional economy and agricultural institution, etc. (A and B)
h. Flood control (A and B)
i. Others (A and B)

(2) to select and delineate the Project Area on the basis of review of data and information and reconnaissance survey (A and B)

(3) to carry out field surveys in the Project Area including the following items.

a. Meteological and hydrological survey (A and B)
b. Topographical Survey at proposed site (A)
c. Soil survey with test pits and laboratory analysis (B)
d. Geology and geohydrology survey (A and B)
e. Irrigation and drainage survey (A and B)
f. Land use survey (B)
g. Agro-economic survey (A and B)
h. Agricultural survey (A and B)
i. Regional economic and agro-institutional survey (A and B)
j. Construction material and cost survey (A and B)
k. Flood control survey (A and B)

(4) to determine the basic items for the project planning including (B)

a. Project boundary acreage
b. Outline of the land use and cropping pattern
c. Water requirement
d. Irrigation and drainage canal networks
e. Estimation of yield
f. Agro-institutional Plan
g. Dam planning and design in view of irrigation, flood control
h. Alternative study

2) Home Office Works

Based on the results of the field works, the home offices works will be carried out for the Study of the following items.

(1) to give a priority order to the proposed projects (A)

(2) to formulate an overall irrigated agricultural development plan including alternative plan for the Project Area (B)

(3) to prepare preliminary design of the major structures for the Project (B)

(4) to estimate the costs and benefits of the Project (A and B)

(5) to make economic evaluation for the Project (B)

(6) to prepare the implementation schedule of the Project (B)

(7) to make recommendations (A and B)

4. WORK SCHEDULE

The work schedule is shown in the attached sheet.

To carry out the Study, JICA will provide the required experts of the survey team in accordance with the work schedule attached herewith.

5. REPORTS

The following reports will be prepared and submitted to the Government.

(1) Plain of Operation (A and B)

Thirty (30) copies in English at the commencement of the field survey.

(2) Interim Report (A and B)

Thirty (30) copies in English at the end of the field survey.

(3) Draft Report (A and B)

Thirty (30) copies in English within one (1) months after the end of the home office work.

(4) Final Report (A and B)

Fifty (50) copies in English within two (2) months after receiving the comments of the Government on Draft Report.

6. UNDERTAKING OF THE GOVERNMENT

To facilitate smooth performance of the field works, the Government is requested.

(1) to provide the data and information necessary for the study (A and B)

(2) to arrange for the quick and smooth customs clearance of the survey equipment and materials required for the field works (A and B)

(3) to exempt from any taxes and duties imposed by the Government on the goods brought by the team members into Thailand for the purpose of the study (A and B)

(4) to make arrangement of exemption of taxes, duties and levies incurred during the survey by the team (A and B)

(5) to request the ministries and other governmental organizations concerned to cooperate with the team in smooth execution of the survey (A and B)

(6) to provide the necessary computer facilities free of charge, other equipments, etc. (A and B)

(7) to designate the counterpart personnel to cooperate with the team in conducting the Study effectively in the following field.

a. General Planning Engineer (A and B)
b. Irrigation and Drainage Engineer (A and B)
c. Foundation Engineer (B)
d. Dam Engineer (A and B)
e. Hydrologist (A and B)
f. Geologist (A)
g. Soil Experts (A)
h. Agronomist (B)
i. Agro-economist (A and B)
j. Agro-institutional Expert (B)
k. Survey Engineer (A and B)

The number of counterpart personnel and their respective assignment periods should be decided by consultation of the team with Thai Authorities concerned prior to conducting the survey.

(8) to provide the office space for the team (A and B)

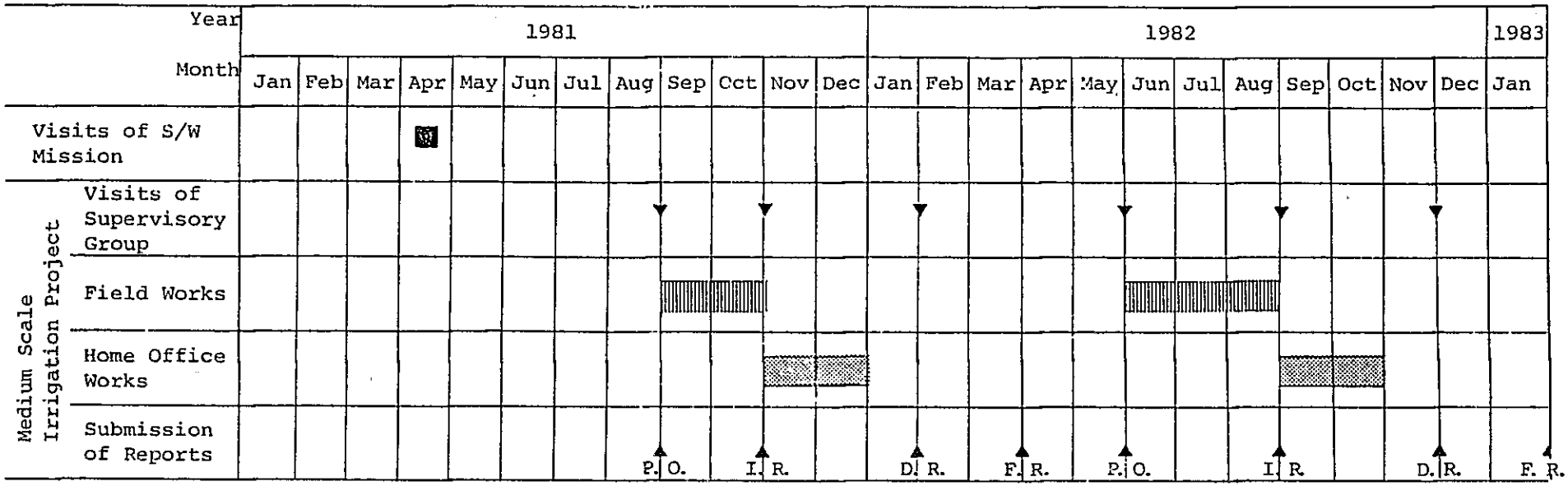
(9) to make the necessary arrangement to obtain the permission of the Authorities concerned for the team to conduct the survey in the objective area (A and B)

(10) to guarantee the security of the team members during the surveying period (A and B)

(11) to make arrangement for dispatching a few counterpart personnel to Japan in the course of the home office works (A and B)

(12) to extend close cooperation to the team in every respect for smooth execution of the Study (A and B)

WORK SCHEDULE FOR THE MEDIUM SCALE IRRIGATION PROJECTS



P.O. : Plan of Operation

I.R. : Interim Report

D.R. : Draft Report

F.R. : Final Report

ATTACHMENT 2

RID OFFICIALS CONCERNED, MEMBERS OF SUPERVISORY COMMITTEE AND STUDY TEAM OF THE PROJECT

A. RID Officials Concerned

(1)	Boonthai Otaganonta	Chief Engineer for Civil Engineer
(2)	Suthep Tingsabhat	Director, Program & Budget Division
(3)	Boonyok Vadhanadhuji	Director, Project Planning
(4)	Chari Tulayawong	Director, Medium Scale Construction
(5)	Chareuk Nonthathum	Director, Large Project Construction Division
(6)	Jumsak Tejasen	Director, Laboratory and Research Division
(7)	Shoombhol Chaveesuk	Director, Design Division
(8)	Damrong Saraswathana	Director, Hydrology Division
(9)	Phyool Chamtasiro	Director, Survey Division
(10)	Nukool Thongtawee	Director, Operation & Maintenance Division
(11)	Silpachai Niyomsilpa	Director, Irrigation Regional Office III
(12)	Charnchai Klinhom	Chief, Small Scale Project Planning Section
(13)	Supha Singintara	Chief, Economic Branch
(14)	Chaleo Niyomthai	Project Manager of Medium Scale
(15)	Arom Khumkongool	Program and Budget Division
(16)	Suphon Chirapuntu	Head, Soil Investigation Section
(17)	Obe-Ua Varatorn	Chief, Dam Design Section
(18)	Sanit Pitak	For Director, Low and Land Division
(19)	Somphorn Thapthong	Chief, Survey Region III
(20)	Sirirat Temiyanond	Planning System Coordinator
(21)	Supojana Rujirakul	Project Planning Engineer
(22)	Danai Triyadhen	Chief, Land Classification Branch
(23)	Osot Charnvej	Chief, Cropping Pattern Planning
(24)	Prasong Jitseri	Hydrology Division
(25)	Somkiat Subhadhadaphongs	Geology Survey Branch
(26)	Soonthon Cheenchavean	Phetchabun Provincial Engineer
(27)	Dhongchart Chullasuk	Economic Branch
(28)	Taweechai Mackaman	Project Planning Division
(29)	Apichai Watanayomanaporn	Operation & Maintenance Division

(30)	Nibondh Saihom	Design Division
(31)	K. Kimura	Senior Colombo Plan Expert
(32)	K. Uno	Colombo Plan Expert
(33)	T. Miyazaki	Colombo Plan Expert

B. Supervisory Committee

(1)	Y. Suematsu	Leader	Agricultural Structure Improvement Bureau, Ministry of Agriculture, Forestry and Fisheries
(2)	H. Kawanishi	Agriculture	Agricultural Structure Improvement Bureau, Ministry of Agriculture, Forestry and Fisheries
(3)	A. Kazama	Irrigation/ Drainage	Agricultural Structure Improvement Bureau, Ministry of Agriculture, Forestry and Fisheries
(4)	Y. Sakamoto	Irrigation/ Drainage	Kinki Regional Administration Office, Ministry of Agriculture, Forestry and Fisheries
(5)	H. Aoki	Agro-Economy	Tohoku Regional Administration Office, Ministry of Agriculture, Forestry and Fisheries
(6)	K. Hibino	Economy	Loan Department II, The Overseas Economic Cooperation Fund (Japan)

C. Study Team

(1)	H. Yamamoto	Team Leader
(2)	A. Honda	Dam Engineer
(3)	T. Tomita	Irrigation and Drainage Engineer
(4)	T. Niwa	Hydrologist
(5)	A. Oshika	Soil Mechanical Engineer
(6)	N. Ariga	Pedologist
(7)	I. Koshino	Agronomist/Agro-Economist
(8)	M. Ishizuka	Institutional Expert
(9)	Y. Yukawa	Construction Planning Engineer
(10)	T. Seki	Design and Survey Engineer
(11)	T. Ishihara	Design and Survey Engineer
(12)	K. Sasabe	Design and Survey Engineer
(13)	E. Takemori	Design and Survey Engineer

ATTACHMENT 3

MICRO HYDROPOWER DEVELOPMENT

1. General

The proposed storage dams will provide a possibility of micro hydropower development, if the water head to be created between the surface water level of reservoir and the tail water level of the outlet work of the dam can effectively be harnessed. This possibility is assessed for each storage dam as below. Since the assessment is on the preliminary basis, further detailed study is needed before start of the implementation.

2. Available Water Head

A micro hydropower station is proposed immediately downstream of the outlet work of the dam. The available water head for power generation varies throughout the year according to the fluctuation of the reservoir water level. The following table shows the available water head at each storage dam.

Dam	High Water Level of Reservoir	Low Water Level of Reservoir	Tail Water Level of Outlet	Available Water Head
Huai Saduang Yai	EL.195.5 m	EL.174.5 m	EL.173.0 m	22.5 - 1.5 m
Huai Khon Kaen	EL.216.5 m	EL.206.8 m	EL.174.0 m	42.5 - 32.8 m
Huai Yai	EL.216.5 m	EL.197.0 m	EL.187.0 m	29.5 - 10.0 m
Khlong Chaliang Lab	EL.206.5 m	EL.189.0 m	EL.180.0 m	26.5 - 9.0 m

3. Available Discharge

The water requirements for irrigation use, downstream use and municipal use (only for the Khon Kaen reservoir), all of which will be released through the outlet work, are taken into account as available discharge for power generation, and any particular operation rule is not prepared for the power generation purpose.

4. Assessment of Development Possibility

Judging from the above-mentioned available water heads and the discharge, the cross-flow type turbine is selected for all the dams (Fig. 1). In the selection of the cross-flow type turbine, furthermore, the fluctuation of available water head has to be taken into consideration, because it is specified that the lowering of water head should be less than 20% of the maximum water head. Following this specification, the lowering rate of the water head from the high water level to low water level is checked as follows:

Dam	Lowering Rate (%)
Huai Saduang Yai	93
Huai Khon Kaen	23
Huai Yai	66
Khlong Chaliang Lab	66

From the above table, it is understood that only the Huai Khon Kaen dam can provide the possibility of hydropower development.

5. Development Plan of the Huai Khon Kaen Hydropower Scheme

In order to assess the optimum installed capacity of the generating plant for the Huai Khon Kaen hydropower scheme, a comparative study is made by calculating the annual energy outputs for the various installed capacities which are obtained by multiplying the rated water head of 37.7 m by discharges with certain probability of exceedance (Fig. 2). The result of comparative study is shown in Fig. 3. From this figure, it may be concluded that the installed capacity is 450 kW, for which the maximum discharge is 1.46 m^3/sec, corresponding to about 72%.

The general features of the proposed development plan are summarized as follows:

- Type of hydraulic turbine : cross-flow
- Maximum discharge : 1.46 m^3/sec
- Minimum discharge : 0.29 m^3/sec
- Maximum water head : 42.8 m
- Minimum water head : 32.8 m
- Rated water head : 37.7 m
- Installed capacity : 450 kW
- Average annual energy production (10^6 kWh) : 2.8

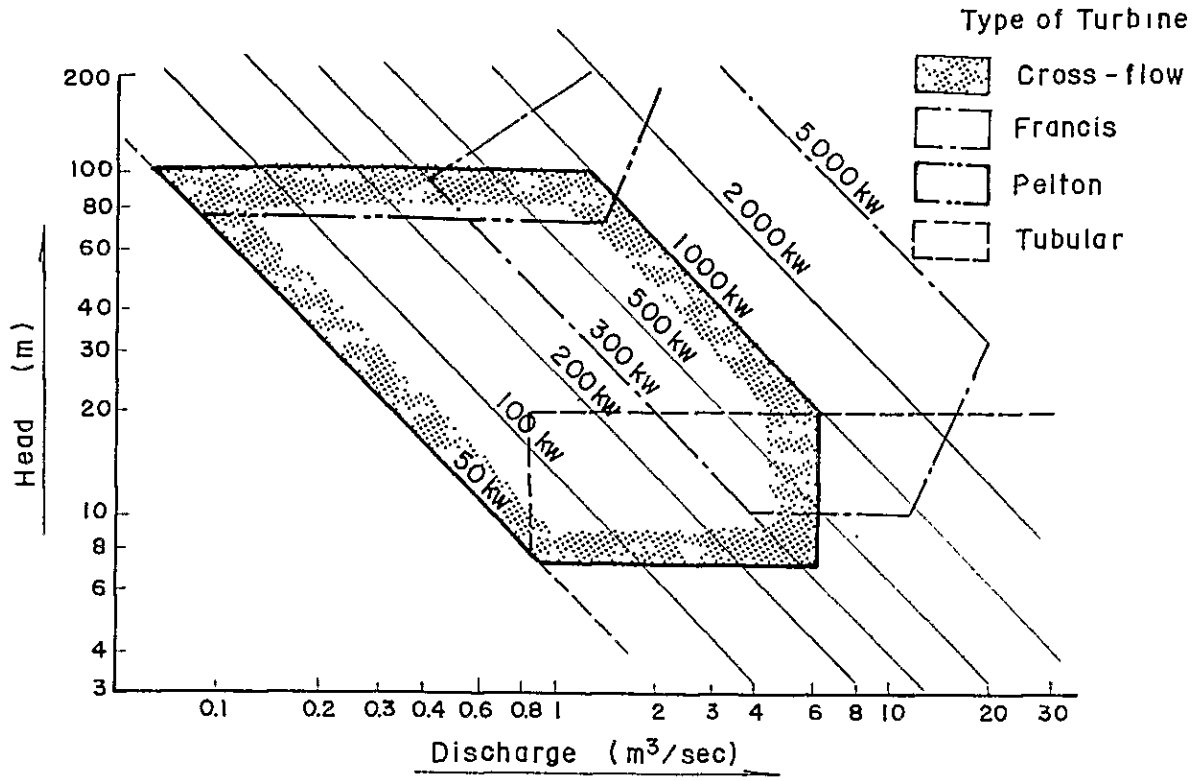


FIG.1 CHARACTERISTIC CHART OF HYDRAULIC TURBINE

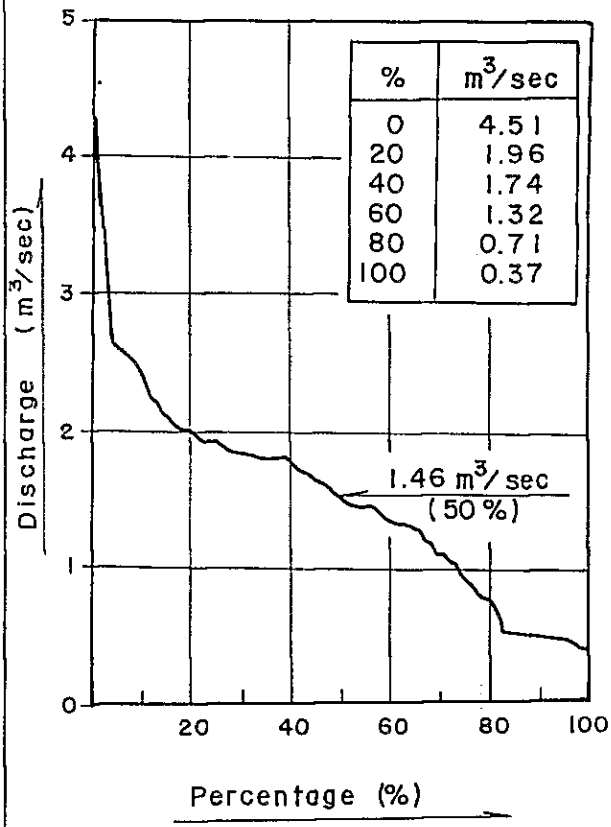


FIG.2 DURATION CURVE

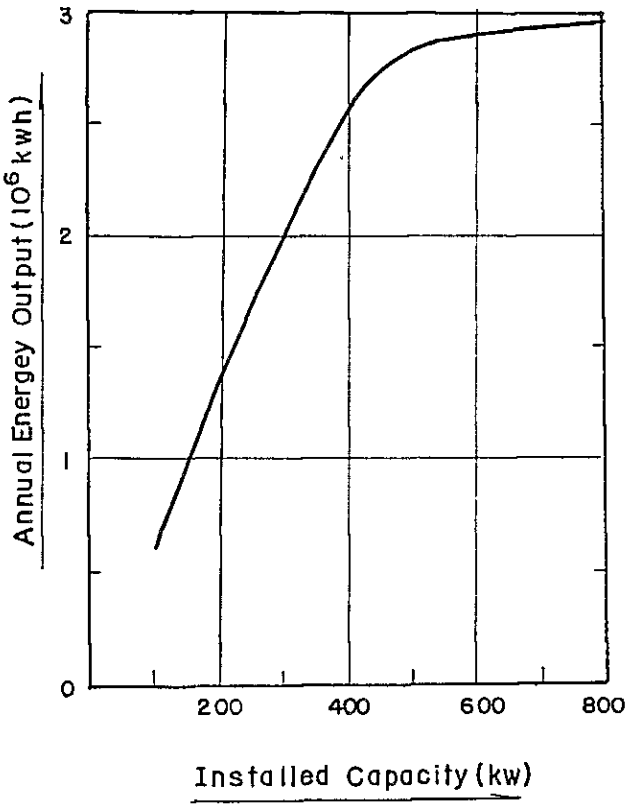


FIG. 3
INSTALLED CAPACITY-ENERGY OUTPUT CURVE

ATTACHMENT 4

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