

the entire project service area in the rainy season and service area in the dry season. The bodies of fresh water to be created through the construction of reservoirs and village ponds will be fully utilized for fisheries by residents in and around the project area for their own needs or for sale.

(2) Other Benefits

In addition to the above-mentioned benefits expressed in monetary terms, the following benefits are expected to be realized with the project.

- With the project, for making good use of irrigation water in the service area, it will be necessary to establish the water user's associations by all the beneficiary farmers. These cooperative systems will certainly improve communication among farmers influencing the technical up-grading of crop cultivation and farm management of the farmers.
- The project implementation will increase the farmer's consumption and saving through an increase in the agricultural income. The magnifying of the farm family economy will improve the farmers living standard in terms of quantity and quality (nutrition, education, health and others).
- The new village ponds to be constructed at each village in the project area shall have multiple functions not only for fish culture but also for miscellaneous farming works, domestic use and etc. The year-round use of the water in village ponds shall be made by not only farmers but whole villagers, and the village ponds will play a role to develop the attractive villages to live in as well as to give a lesson on vitally important works for collective use of water resources.
- Many villagers will have employment opportunity not only in the construction and O & M of the project but also in the farming work.

9-1-3. Economic Indicators of the Projects

(1) Internal Rate of Return

The economic profitability of the Sebai-Sebok irrigation project from the standpoint of the national economy was measured by the Economic Internal Rate of Return (EIRR). EIRR is a discount rate at which the difference between the present worth of benefits and the present worth of costs is zero.

EIRR of the package of five projects has been estimated at 8.6 percent with the project life of 50 years, which does not always seem to be high as the economic indicator of a development project in Thailand. Under the circumstances that agriculture is one of the main industries in spite of comparatively low productivity, however, the Sebai-Sebok irrigation project will be justified as the project has been planned to give the agriculture in the area a better chance of taking part in the economic growth of the Northeast, the poorest region, and will play an important role in rectification of income disparity among regions in Thailand.

Economic Internal Rate of Return

Project	EIRR(%)
1. Lam Se	8.0
2. Huai Khum Kham	8.5
3. Huai Kham Phak Wan	8.9
4. Huai Na Khai	9.7
5. Huai Soob	7.4
Package of the Five Projects	8.6

(2) Sensitivity Test

The sensitivity analysis has been done to test the sensitivity of calculations by using other parameters than those considered probable in the initial calculation. The project has been tested for its sensitivity to increase in capital cost, reduction in benefit, extension of construction period, delay in achievement of target crop yield and combination of these four parameters..

Sensitivity Test

Alternative	EIRR(%)
1. Proto-type	8.6
2. 10 % increase in capital cost	7.9
3. 2 years overdue in the construction completion	7.9
4. Combination of 2 and 3	7.3
5. 10 % reduction in benefit	7.7
6. Combination of 2 and 5	7.0
7. 3 years delay in target yield achievement	7.9
8. Combination of 5 and 7	7.0
9. Combination of 2,5 and 7	6.5
10. Combination of 3 and 7	7.3
11. Combination of 2,3,5 and 7	5.9

9-2. Farm Income Analysis

In order to consider the profitability of the farms concerned in the project area, two types of representative farms were chosen on the basis of farm size; owner farms of 3.2 ha (20 rai), which is close to the average farm size in the project area, and owner farms of 1.6 ha (10 rai). With the implementation of the project, for the representative farms of the average size, the increase in agricultural income from crop production only would be over 39,000 Baht per annum, owing to increase in paddy yield and land use intensity, being about five times of crop income in the situation "without project".

Items	<u>Improvement of Farm Income</u>					
	<u>1.6 ha (10rai) Farm</u>			<u>3.2 ha (20rai) Farm</u>		
	<u>Without Project</u>	<u>With Project</u>		<u>Without Project</u>	<u>With Project</u>	
	<u>Paddy Farm</u>	<u>Paddy + Dry Season Crops</u>		<u>Paddy Farm</u>	<u>Paddy + Dry Season Crops</u>	
1. Operated Area (ha)	1.60	1.54	1.54	3.20	3.07	3.07
2. Total of Harvested Area (ha)	1.12	1.54	1.85	2.24	3.07	3.68
3. Agricultural Income (฿)						
- Crops	3,819	10,723	19,586	7,638	21,376	39,038
- Livestocks	3,433	3,433	3,433	3,433	3,433	3,433
- Fishes	-	6,614	6,614	-	6,614	6,614
Total	7,252	20,770	29,633	11,071	31,423	49,085
4. Non Agricultural Income (฿)	8,871	8,871	8,871	8,871	8,871	8,871
5. Total Farm Income (฿)	16,123	29,641	38,504	19,942	40,294	57,956
6. Income per Capita (฿)						
- Agricultural Income	1,189	3,405	4,858	1,815	5,151	8,047
- Farm Income	2,643	4,859	6,312	3,269	6,606	9,501

TABLE 9-1. FINANCIAL AND ECONOMIC PROJECT COST BY PROJECTS

(unit: million ฿)

Year	Lam Se	Huai Khum Kham	Huai Kham Phak Wan	Huai Na Khai	Huai Soob	Total
1. Capital Cost						
1-1. Financial						
1990	1.92	2.32	1.76	2.66	1.97	10.63
1991	3.61	6.44	3.33	5.92	3.43	22.73
1992	2.40	5.72	2.31	4.59	2.31	17.33
1993	17.16	22.42	15.82	23.90	17.35	96.65
1994	58.11	114.53	80.40	43.85	71.68	368.57
1995	75.11	171.52	71.05	91.87	64.53	474.08
1996	16.38	47.80	15.02	124.02	66.97	270.19
1997	1.74	4.18	1.66	28.17	20.30	56.05
<u>Total</u>	<u>176.43</u>	<u>374.93</u>	<u>191.35</u>	<u>324.98</u>	<u>248.54</u>	<u>1,316.23</u>
1-2. Economic						
1990	1.50	1.84	1.38	2.10	1.56	8.38
1991	2.99	5.46	2.77	4.97	2.84	19.02
1992	2.11	5.03	2.03	4.04	2.03	15.25
1993	9.24	12.82	10.17	14.07	11.44	57.73
1994	35.70	72.78	51.25	27.14	46.03	232.90
1995	50.25	115.68	47.40	57.62	40.70	311.65
1996	11.72	33.70	10.75	83.53	45.51	185.20
1997	1.44	3.46	1.38	19.73	13.99	40.00
<u>Total</u>	<u>114.95</u>	<u>250.77</u>	<u>127.13</u>	<u>213.20</u>	<u>164.10</u>	<u>870.13</u>
2. O & M Cost						
2-1. Financial						
	1.39	3.28	1.20	2.65	1.16	9.68
2-2. Economic						
	1.00	2.26	0.80	1.80	0.80	6.66

TABLE 9-2. PROJECT BENEFITS

Items	Lam Se	Huai Khum Kham	Huai Kham Phak Wan	Huai Na Khai	Huai Soob	Total
<u>1. Crop Production Benefits</u>						
a. Cultivated Area (ha)	1,100	2,600	950	2,100	920	7,670
b. Harvested Area (ha)						
- Without Project	806	1,894	696	1,515	671	5,582
- With Project	1,320	3,120	1,140	2,520	1,100	9,200
c. Production ('000 ₭)						
- Net Production						
Without Project	1,648	3,687	1,258	2,801	933	10,327
With Project	12,282	29,712	15,340	28,776	16,802	102,912
- <u>Benefit</u>	<u>10,634</u>	<u>26,025</u>	<u>14,082</u>	<u>25,975</u>	<u>15,869</u>	<u>92,585</u>
<u>2. Fish Production Benefits</u>						
a. Area of Fishery (ha)						
- Reservoir	279	454	238	559	191	1,721
- Muban Pond	5.0	7.4	2.7	5.1	3.5	23.7
b. Net Production with Project ('000 ₭)						
- Reservoir	2,271	3,706	1,931	4,567	1,566	14,041
- Muban Pond	261	386	141	266	183	1,237
<u>Total Benefit</u>	<u>2,532</u>	<u>4,092</u>	<u>2,072</u>	<u>4,833</u>	<u>1,749</u>	<u>15,278</u>
<u>3. Total of Benefits ('000 ₭)</u>	<u>13,166</u>	<u>30,117</u>	<u>16,154</u>	<u>30,808</u>	<u>17,618</u>	<u>107,863</u>

ANNEX 1. LIST OF MEMBER OF JICA TEAM AND RID

ANNEX 1. List of Member of JICA Team and RID

(1) JICA Advisory Committee

Mr. Kazuo Kimura	Leader Deputy Director, Construction Department, Kinki Regional Agricultural Administration Office, Ministry of Agriculture, Forest and Fisheries (MAFF)
Dr. Teruyuki Nishijima	Geology and Groundwater Senior Geologist, Resources Division, Planning Department, Chugoku and Shikoku Regional Agricultural Administration Office, MAFF
Mr. Shigeaki Uchimura	Irrigation and Drainage (Phase I) Deputy Director, Regional Planning Division, Planning Department, Agricultural Structure Improvement Bureau, MAFF
Mr. Yoshimasa Kishi	Irrigation and Drainage (Phase II) Deputy Director, Development Division, Construction Department Agricultural Structure Improvement Bureau, MAFF
Mr. Masami Mizuno	Project Evaluation Director, Development Economy Second Division, Foreign Agriculture Department, National Research Institute of Agricultural Economics, MAFF
Mr. Tadayoshi Tokoh	Agriculture (Phase I) Director, Office of Pollution Control and Environmental Protection, Administration Division, MAFF
Mr. Taiji Nakagawa	Agriculture (Phase II) Director, Fruit Tree and Flower Culture Division, Sericulture and Horticulture Department, MAFF

(2) JICA Study Team

Mr. Kunio Ohta	Leader
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Mr. Yoshiteru Tsunoda	Co-Leader cum Water Resources Development Planning
Mr. Toyataka Niwa	Meteorology and Hydrology
Mr. Akira Yamazaki	Groundwater, Geology/Soil Engineering
Mr. Daizo Iseno	Irrigation and Drainage
Mr. Jun-ichiro Kawakami	Agriculture
Mr. Hiromi Nakamura	Soil and Land Use
Mr. Takao Kume	Structure Planning and Cost Estimate
Dr. Masayuki Imai	Agro-economy and Project Evaluation

(3) RID Counterpart Personnel

Dr. Boonyok Vadhanaphuti	Leader Senior Expert for Water Resources Planning and Development
Mr. Maitri Poolsup	Assistant Leader Director, Project Planning Division (PPD)
Mr. Chat Sarikaphuti	Assistant Leader Director, Regional Irrigation Office V (Region V)
Mr. Suthi Songvoravit	Secretary, PPD
Mr. Somphorn Thapthong	Topographical Survey Division (TSD)
Mr. Samran Phiwphong	TSD (Region V)
Mr. Danai Triyadhen	Geo-Technical Division (GTD)
Mr. Somkiat Subhadhadaphong	GTD
Ms. Aramsri Phathanasobhon	Research and Laboratory Division (RLD)
Mr. Phaibun Siridamrong	RLD
Mr. Arthorn Chatchawansaisin	Hydrology Division (HD)
Mr. Osot Chanvej	Operation and Maintenance Division
Mr. Surakarn Asavavallobh	Design and Drawing Division
Mr. Surapong Chuiglom	Medium Scale Project Construction Division
Mr. Supot Phronmanaret	Data Processing Division
Mr. Manus Kumnoetmanee	Program and Budget Division
Mr. Anan Phoonthawee	PPD

Ms. Chawee Wongprasitioporn	PPD
Mr. Charoon Roo-Kheb	PPD
Mr. Tosapol Wongwan	PPD
Mr. Prasert Lakshanasomya	PPD
Ms. Kuakul Thummaphut	PPD
Mr. Suwan Suebjarkdee	Region V
Mr. Somnek Pattanasing	Region V, Ubon Ratchathani
Mr. Benja Kiatkong	Region V, Yasothon
Mr. Suppakiat Oransathien	Region V

(4) RID Officials Concerned

Mr. Thada Saisa-Nguan	Director, Topographical Survey Division (GTD)
Mr. Prasert Milintangul	Director, Hydrology Division (HD)
Mr. Niphond Saihom	Director, Geo-Technical Division (GTD)
Mr. Thonglow Charoenrat	Director, Research and Laboratory Division (RLD)
Mr. Nukool Thongtawee	Director, Operation and Maintenance Division
Mr. Sawet Yasaravana	Director, Design Division (DD)
Mr. Sompote Sukhumparnich	Director, Data Processing Division (DPD)
Mr. Arom Khumkomgool	Director, Program and Budget Division (PBD)
Mr. Silpachai Niyomsilpa	Director, Medium Scale Project Construction Division (MCD)
Mr. Kitla Thepalaglekha	PPD
Mr. Vudhichai Chullakesa	PPD
Ms. Supha Sing-Intara	PPD
Mr. Traibhun Mekjaroon	PPD
Mr. Prasong Chitseri	HD
Mr. Amnuey Somsin	HD
Ms. La-Ong Rojarasoonthon	DPD
Mr. Jumroen Panitying	PBD

Mr. Wichit Sriwisead	GTD
Ms. Premrudee Saelee	GTD
Ms. Wannarattana Janyarungruang	GTD
Mr. Surachit Forpimai	GTD
Mr. Pol Rakthong	TSD
Mr. Somboon Mankwamde	RLD
Mr. Phoovanet Thongrungrroj	MCD
Mr. Nuttha Chaksudee	PBD
Ms. Janya Petijaveeporndej	PPD
Ms. Apiradee Udoonpong	PPD
Mr. Darong Hutajuta	PPD
Ms. Phattaporn Mekpruksawong	PPD
Mr. Somkiat Prachamwong	Region V
Mr. Wattara Na Nakhon	Region V
Mr. Penta Gaithigong	Region V

ANNEX 2. LIST OF REFERENCES AND DATA

ANNEX 2. List of References and Data

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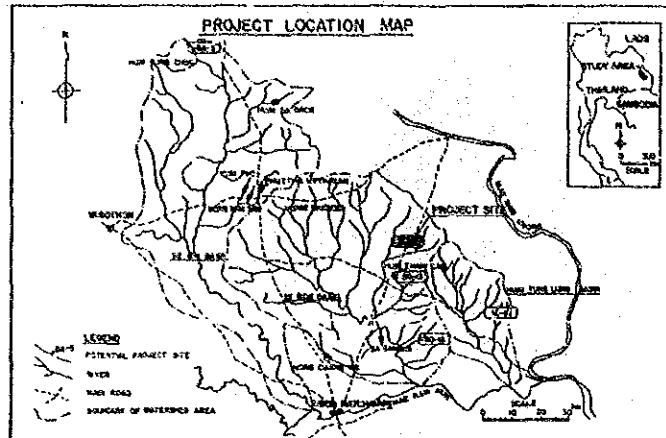
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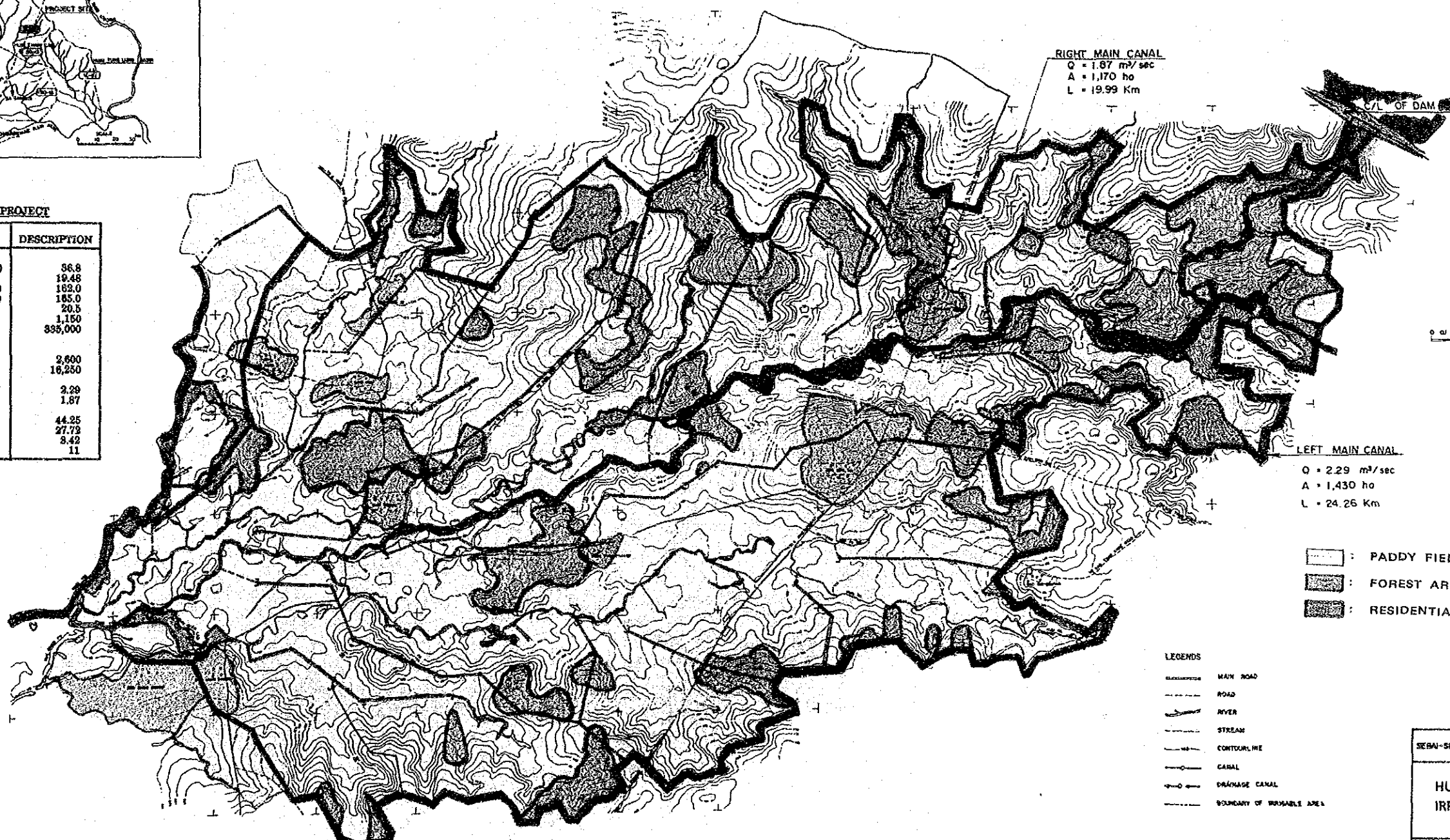
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ANNEX 3. PROJECT MAPS



MAJOR FEATURES OF THE PROJECT

ITEM	DESCRIPTION
(1) RESERVOIR	
a) WATERSHED (Km ²)	36.8
b) EFFECTIVE STORAGE (MCM)	19.48
c) NWL (MSL)	183.0
d) DAM CREST EL (MSL)	185.0
e) DAM HEIGHT (m)	20.5
f) CREST LENGTH (m)	1,150
g) EMBANKMENT (m)	335,000
(2) SERVICE AREA	
a) IRRIGABLE AREA (ha)	2,600
b) MAX DISCHARGE (cms)	16,250
- LEFT MAIN CANAL	2.29
- RIGHT MAIN CANAL	1.87
c) CANAL LENGTH (Km)	
- MAIN CANAL	44.25
- LATERAL CANAL	27.73
- DRAINAGE CANAL	3.42
d) VILLAGE POND (No)	11



RIGHT MAIN CANAL
 Q = 1.87 m³/sec
 A = 1,170 ha
 L = 19.99 Km

LEFT MAIN CANAL
 Q = 2.29 m³/sec
 A = 1,430 ha
 L = 24.26 Km

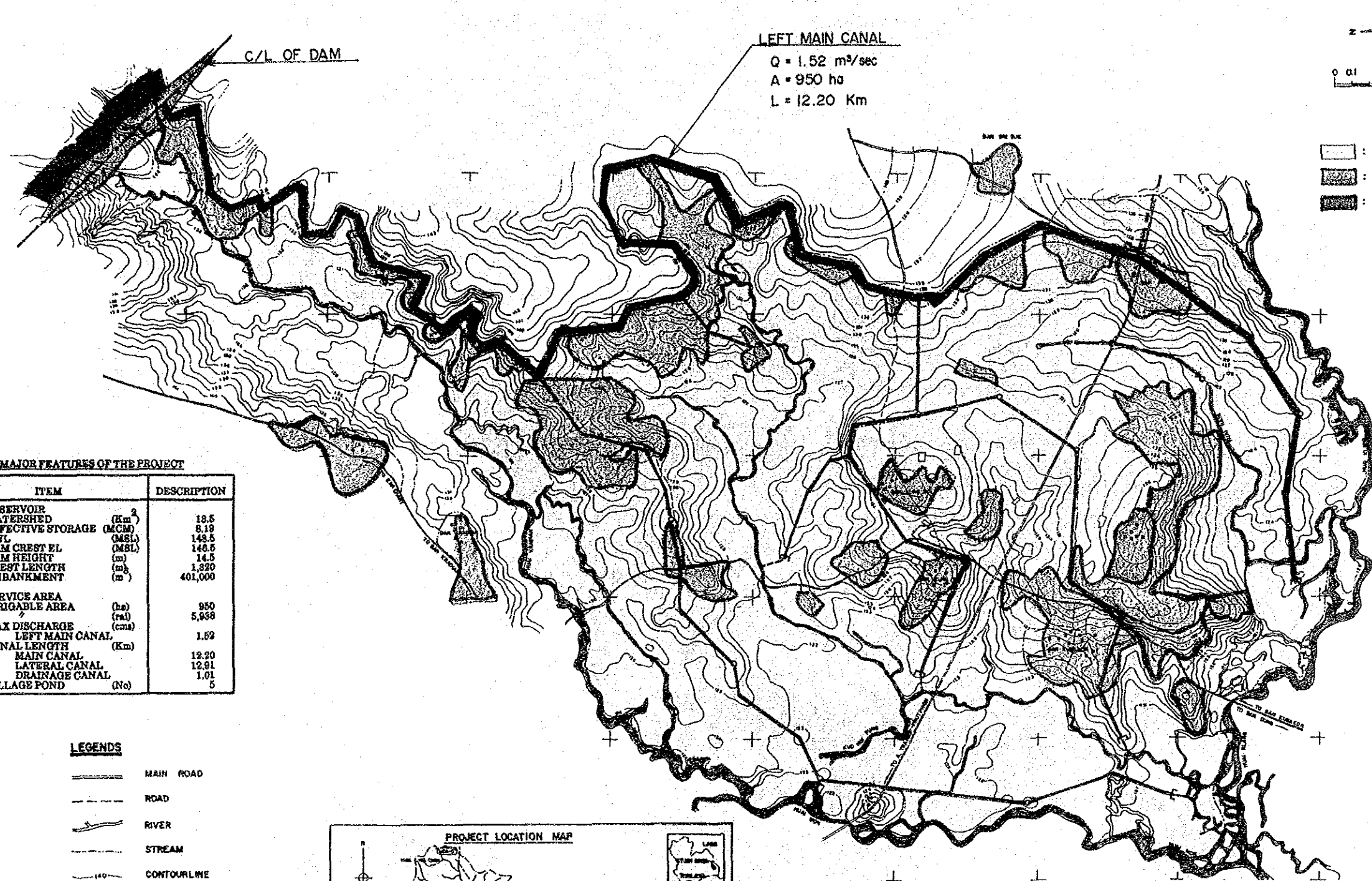
- : PADDY FIELD
- : FOREST AREA & OTHERS
- : RESIDENTIAL AREA

- LEGENDS**
- MAIN ROAD
 - ROAD
 - RIVER
 - STREAM
 - CONTOUR LINE
 - CANAL
 - DRAINAGE CANAL
 - BOUNDARY OF IRRIGABLE AREA

THE FEASIBILITY STUDY OF
 SEBAI-SEBOK BASIN DEVELOPMENT PROJECT
 IN THE NORTHEAST REGION (R.D. 1)

**HUAI KHUM KHAM
 IRRIGATION PROJECT**

NO. 2 JAPAN INTERNATIONAL COOPERATION AGENCY



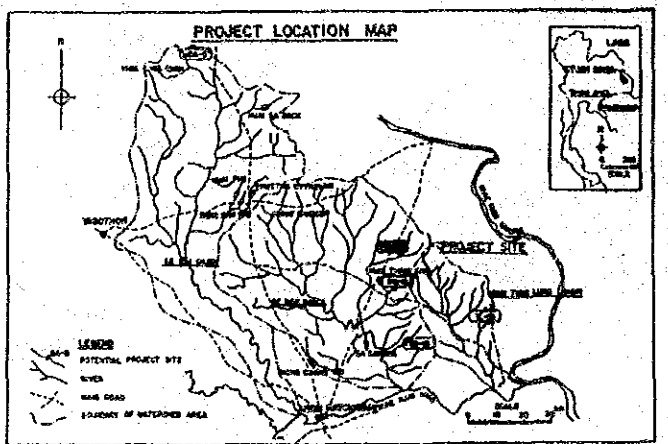
- : PADDY FIELD
- : FOREST AREA & OTHERS
- : RESIDENTIAL AREA

MAJOR FEATURES OF THE PROJECT

ITEM	DESCRIPTION
(1) RESERVOIR	
a) WATERSHED STORAGE (Kcm ³)	18.5
b) EFFECTIVE STORAGE (MCM)	8.19
c) NWL (MSL)	148.5
d) DAM CREST EL (MSL)	146.5
e) DAM HEIGHT (m)	14.5
f) CREST LENGTH (m)	1,320
g) EMBANKMENT (m)	401,000
(2) SERVICE AREA	
a) IRRIGABLE AREA (ha)	950
b) MAX DISCHARGE (cms)	5,938
c) CANAL LENGTH (Km)	
LEFT MAIN CANAL	1.62
MAIN CANAL	12.20
LATERAL CANAL	12.91
DRAINAGE CANAL	1.01
d) VILLAGE POND (No)	5

LEGENDS

- MAIN ROAD
- ROAD
- RIVER
- STREAM
- CONTOURLINE
- CANAL
- DRAINAGE CANAL
- BOUNDARY OF IRRIGABLE AREA



THE FEASIBILITY STUDY OF
SEBAI-SEBOK BASIN DEVELOPMENT PROJECT
IN THE NORTHEAST REGION (IRD)

**HUAI KHAM PHAK WAN
IRRIGATION PROJECT**

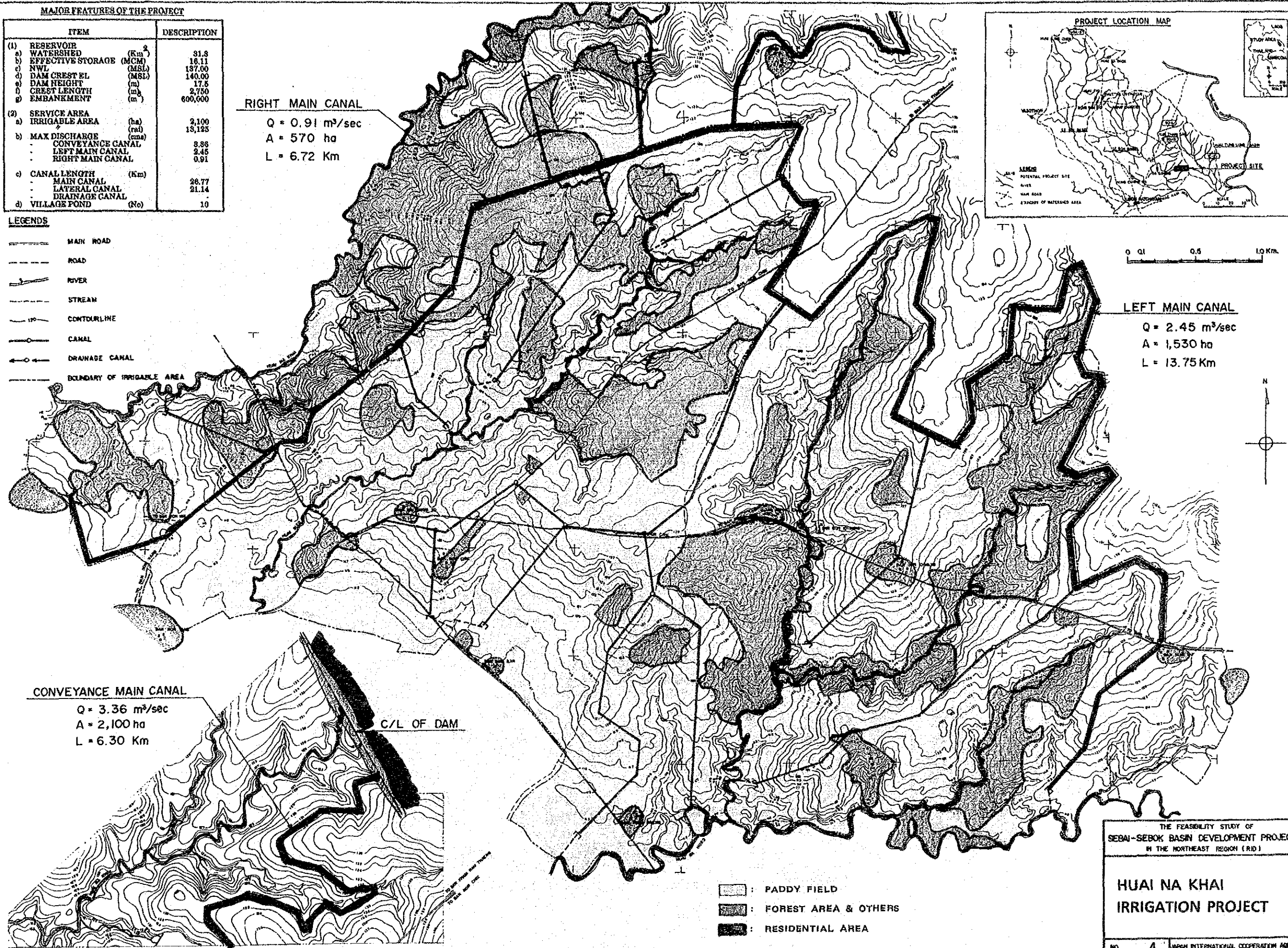
NO 3 JAPAN INTERNATIONAL COOPERATION AGENCY

MAJOR FEATURES OF THE PROJECT

ITEM	DESCRIPTION	
(1) RESERVOIR		
a) WATERSHED (Km ²)		31.8
b) EFFECTIVE STORAGE (MCM)		16.11
c) NWL (MSL)		137.00
d) DAM CREST EL (MSL)		140.00
e) DAM HEIGHT (m)		17.5
f) CREST LENGTH (m)		2,780
g) EMBANKMENT (m)		600,600
(2) SERVICE AREA		
a) IRRIGABLE AREA (ha)		2,100
b) MAX DISCHARGE (cms)		13,125
CONVEYANCE CANAL		8.88
LEFT MAIN CANAL		2.45
RIGHT MAIN CANAL		0.91
(3) CANAL LENGTH (Km)		
MAIN CANAL		26.77
LATERAL CANAL		21.14
DRAINAGE CANAL		
d) VILLAGE POND (No)		10

LEGENDS

- MAIN ROAD
- - - ROAD
- ROVER
- - - STREAM
- CONTOURLINE
- CANAL
- DRAINAGE CANAL
- - - BOUNDARY OF IRRIGABLE AREA



RIGHT MAIN CANAL

Q = 0.91 m³/sec
 A = 570 ha
 L = 6.72 Km

LEFT MAIN CANAL

Q = 2.45 m³/sec
 A = 1,530 ha
 L = 13.75 Km

CONVEYANCE MAIN CANAL

Q = 3.36 m³/sec
 A = 2,100 ha
 L = 6.30 Km

C/L OF DAM

- : PADDY FIELD
- : FOREST AREA & OTHERS
- : RESIDENTIAL AREA

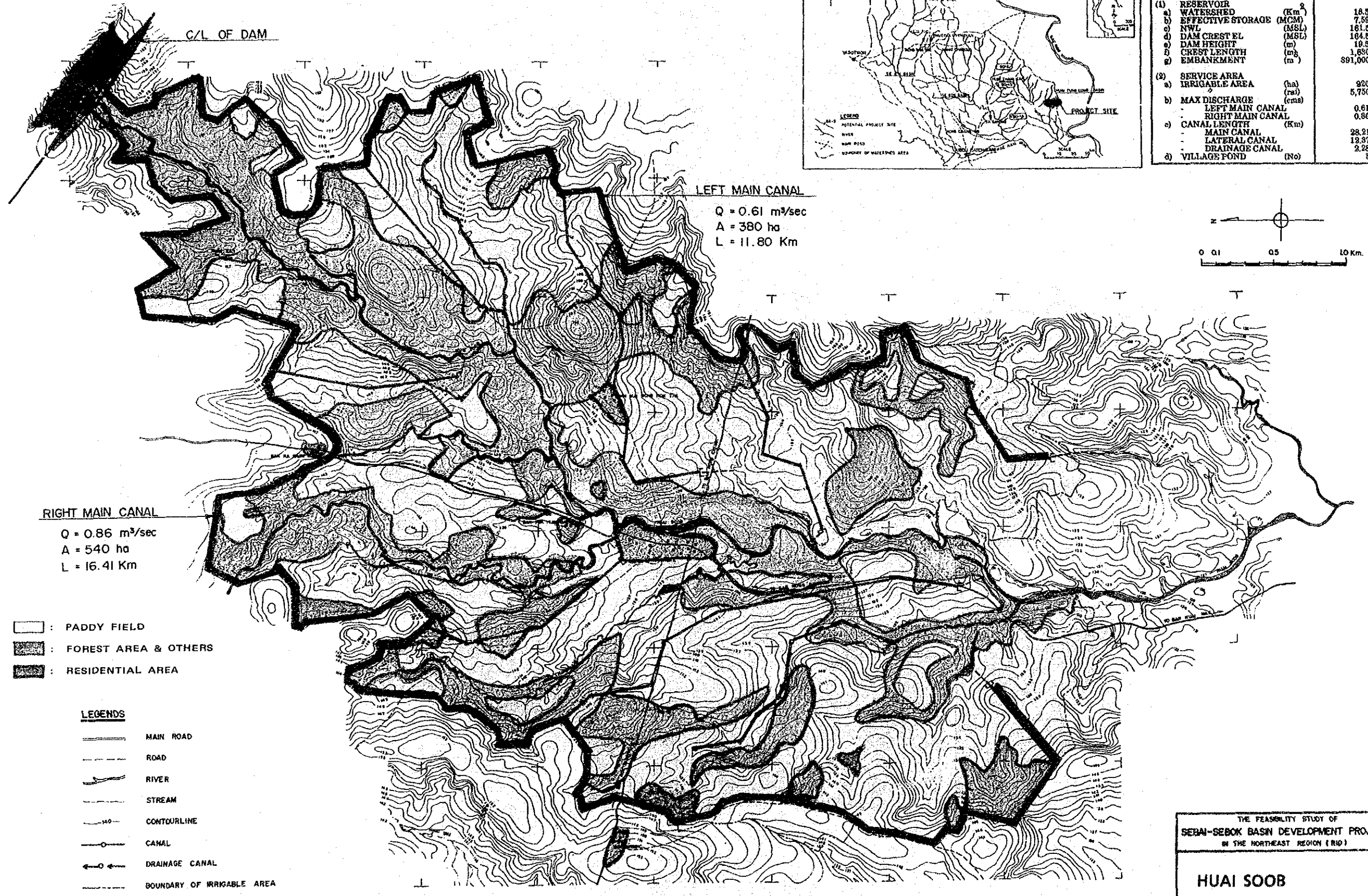
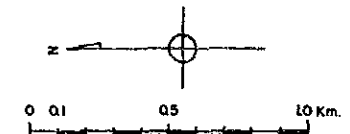
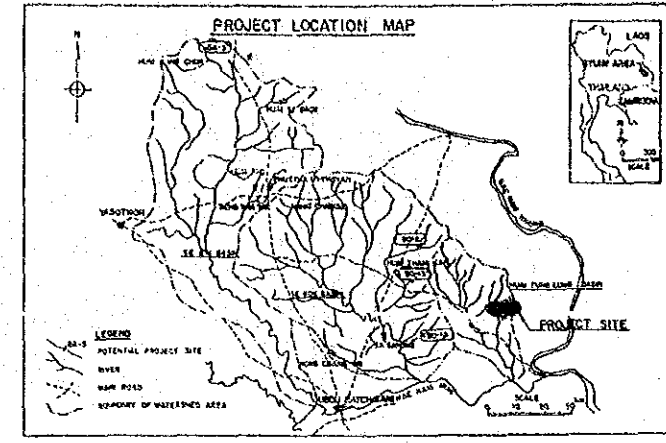
THE FEASIBILITY STUDY OF
 SEBAI-SEBOK BASIN DEVELOPMENT PROJECT
 IN THE NORTHEAST REGION (RID)

HUAI NA KHAI
 IRRIGATION PROJECT

NO. 4 JAPAN INTERNATIONAL COOPERATION AGENCY

MAJOR FEATURES OF THE PROJECT

ITEM	DESCRIPTION
(1) RESERVOIR	
a) WATERSHED (Km ²)	18.5
b) EFFECTIVE STORAGE (MCM)	7.59
c) NWL (MSL)	161.5
d) DAM CREST EL (MSL)	164.5
e) DAM HEIGHT (m)	10.5
f) CREST LENGTH (m)	1,850
g) EMBANKMENT (m ³)	891,000
(2) SERVICE AREA	
a) IRRIGABLE AREA (ha)	920
b) MAX DISCHARGE (cms)	5,750
- LEFT MAIN CANAL	0.61
- RIGHT MAIN CANAL	0.86
c) CANAL LENGTH (Km)	
- MAIN CANAL	28.21
- LATERAL CANAL	12.87
- DRAINAGE CANAL	2.28
d) VILLAGE POND (No)	5



RIGHT MAIN CANAL
 Q = 0.86 m³/sec
 A = 540 ha
 L = 16.41 Km

LEFT MAIN CANAL
 Q = 0.61 m³/sec
 A = 380 ha
 L = 11.80 Km

- : PADDY FIELD
- ▨ : FOREST AREA & OTHERS
- ▩ : RESIDENTIAL AREA

- LEGENDS
- MAIN ROAD
 - - - ROAD
 - RIVER
 - - - STREAM
 - CONTOURLINE
 - CANAL
 - ← - - - DRAINAGE CANAL
 - - - BOUNDARY OF IRRIGABLE AREA

THE FEASIBILITY STUDY OF
 SEBAI-SEBOK BASIN DEVELOPMENT PROJECT
 IN THE NORTHEAST REGION (RIU)

**HUAI SOOB
 IRRIGATION PROJECT**

NO. 5 JAPAN INTERNATIONAL COOPERATION AGENCY

JICA