

No. 2

LAO PEOPLE'S
DEMOCRATIC REPUBLIC
MASTER PLAN
AND
FEASIBILITY STUDY
ON

THE INTEGRATED AGRICULTURAL
RURAL DEVELOPMENT PROJECT

IN
SAVANNAKHET PROVINCE

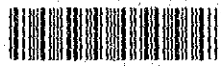
MAIN REPORT

JUNE 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

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国際協力事業団

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P R E F A C E

In response to a request for the Government of Lao People's Democratic Republic(Lao PDR), the Government of Japan decided to conduct a Master Plan Study on the Integrated Agricultural Rural Development Project in Savannakhet Province and a Feasibility Study on the top priority project and entrusted the study to the Japan International Cooperation Agency(JICA).

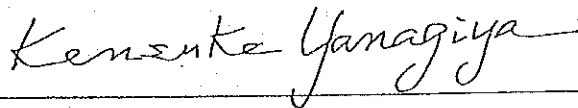
JICA sent to Lao PDR a study team, headed by Mr. Narumi Yamada of Kokusai Kogyo Co. Ltd, twice between November 1990 to November 1991.

The team held discussions with the officials concerned of the Government of Lao PDR, and conducted field survey at the Study Area. After the team returned to Japan, further studies were made and the present report was prepared.

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

I wish to express my sincere appreciation to the officials concerned of the Government of Lao PDR for the close cooperation they extended to the team.

June, 1992



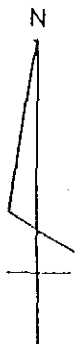
Kensuke Yanagiya

President

Japan International Cooperation Agency

PROJECT LOCATION MAP

TOTAL STUDY AREA : 12,001 km²



KHAMMOUANG PROVINCE

D. NONGBOK
1381 km²

HONGSOK

D. SAYBOULY
1016 km²

SAVANNAKHET PROVINCE

D. ATSAPHANTONG
3074 km²

KENGKABAO

D. OUTHOMPONE
1114 km²

DONGHEN

XENO

SAVANNAKHET

D. CHAMPHONE
1251 km²

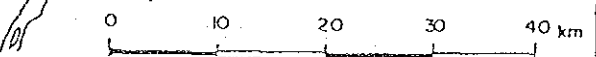
KENGGOK

D. KHANTHABOULY
1278 km²

D. SONBOULY
1240 km²

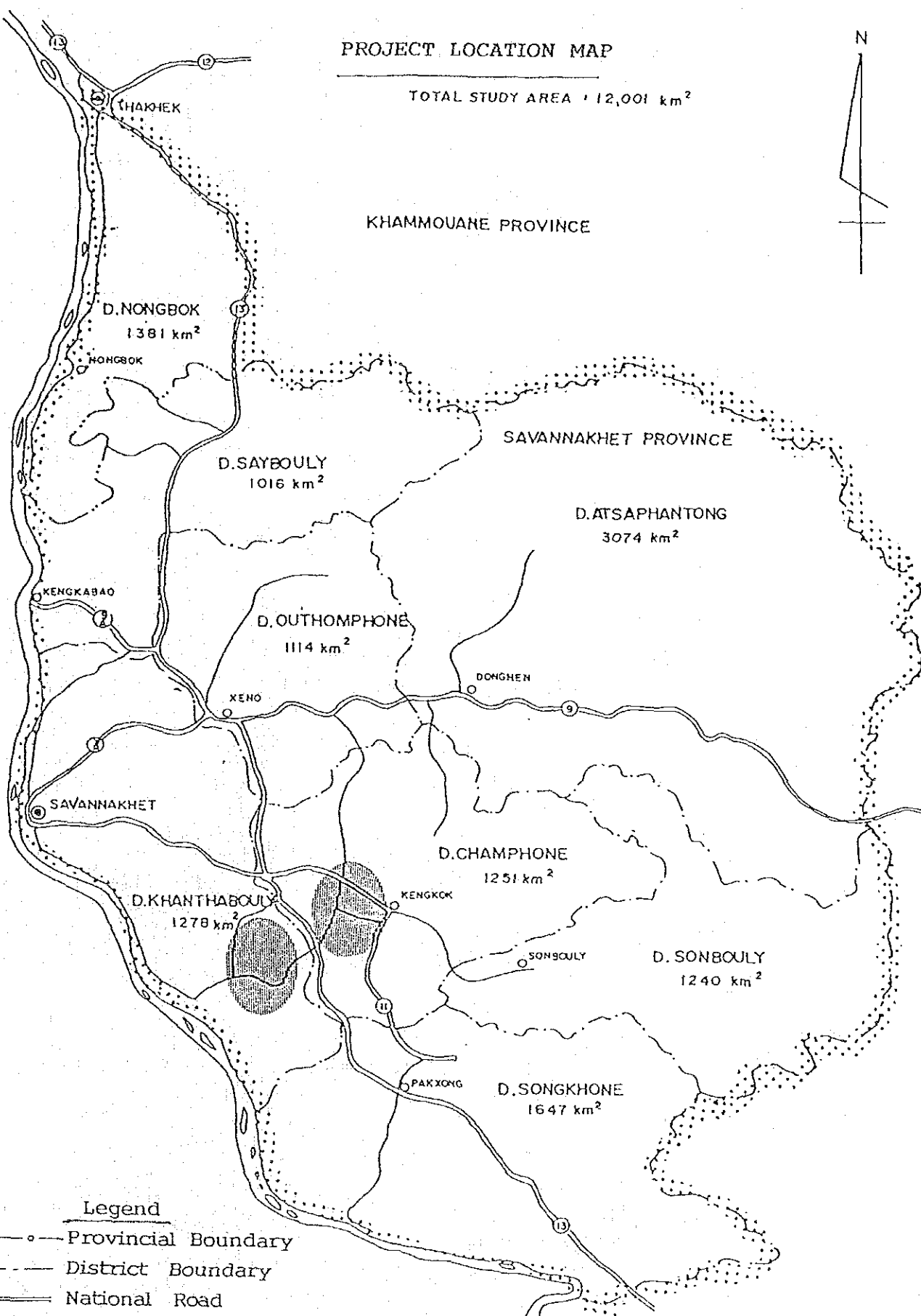
D. SONGKHONE
1647 km²

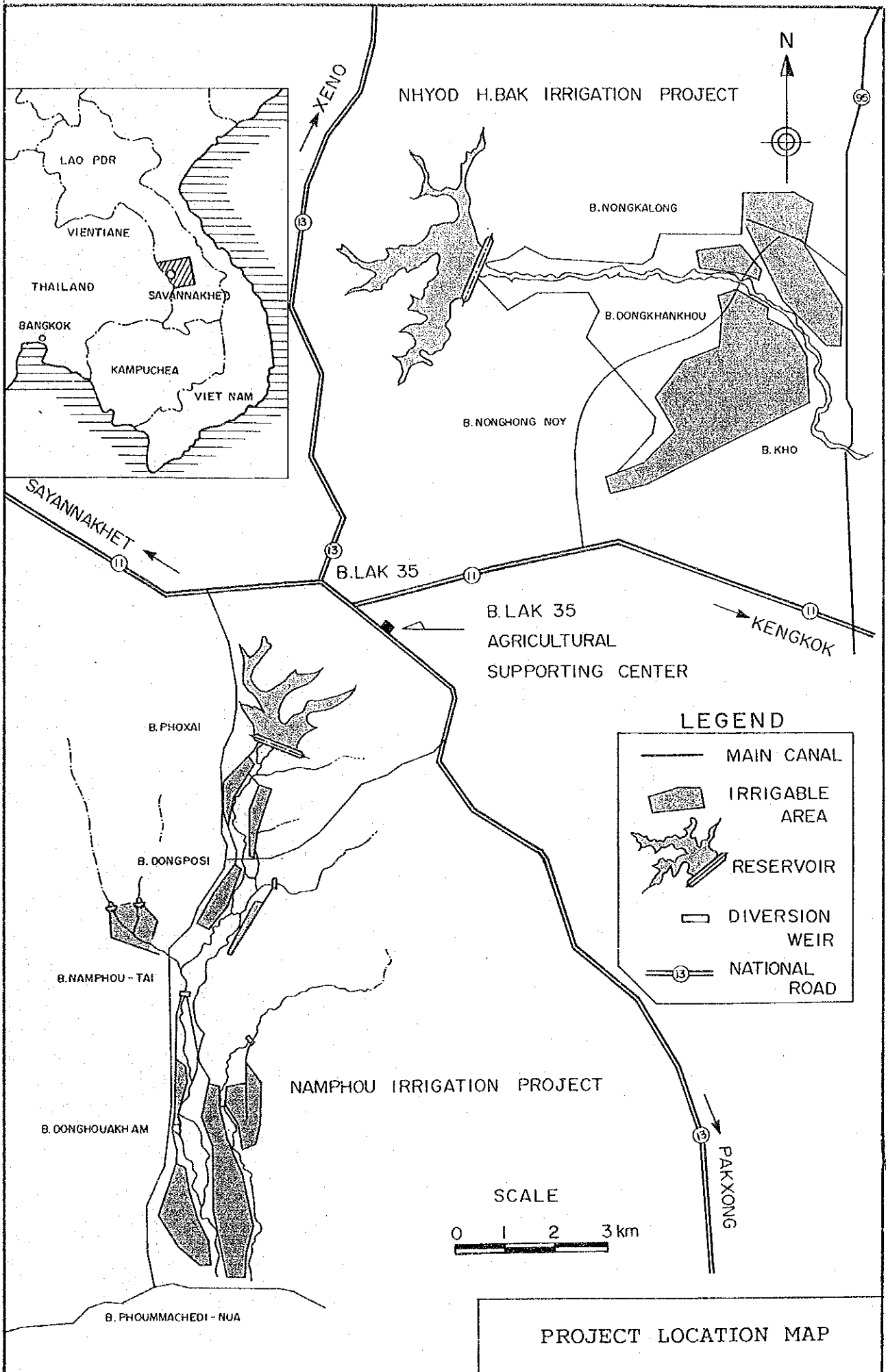
PAKXONG

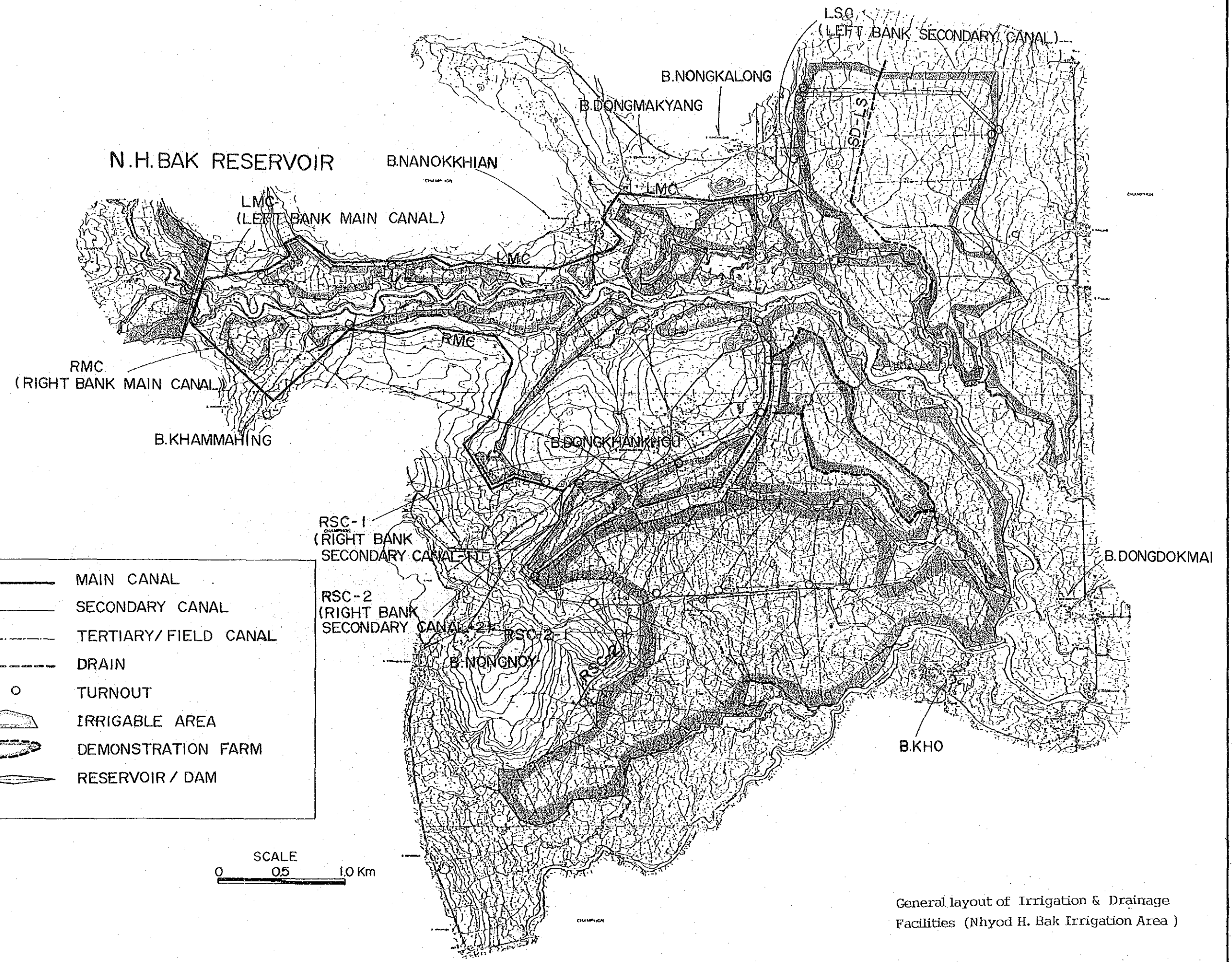
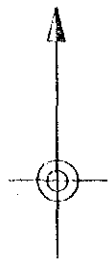









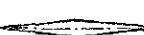
Legend

- Provincial Boundary
- District Boundary
- National Road
- Rural Road
- Top Priority Project Area



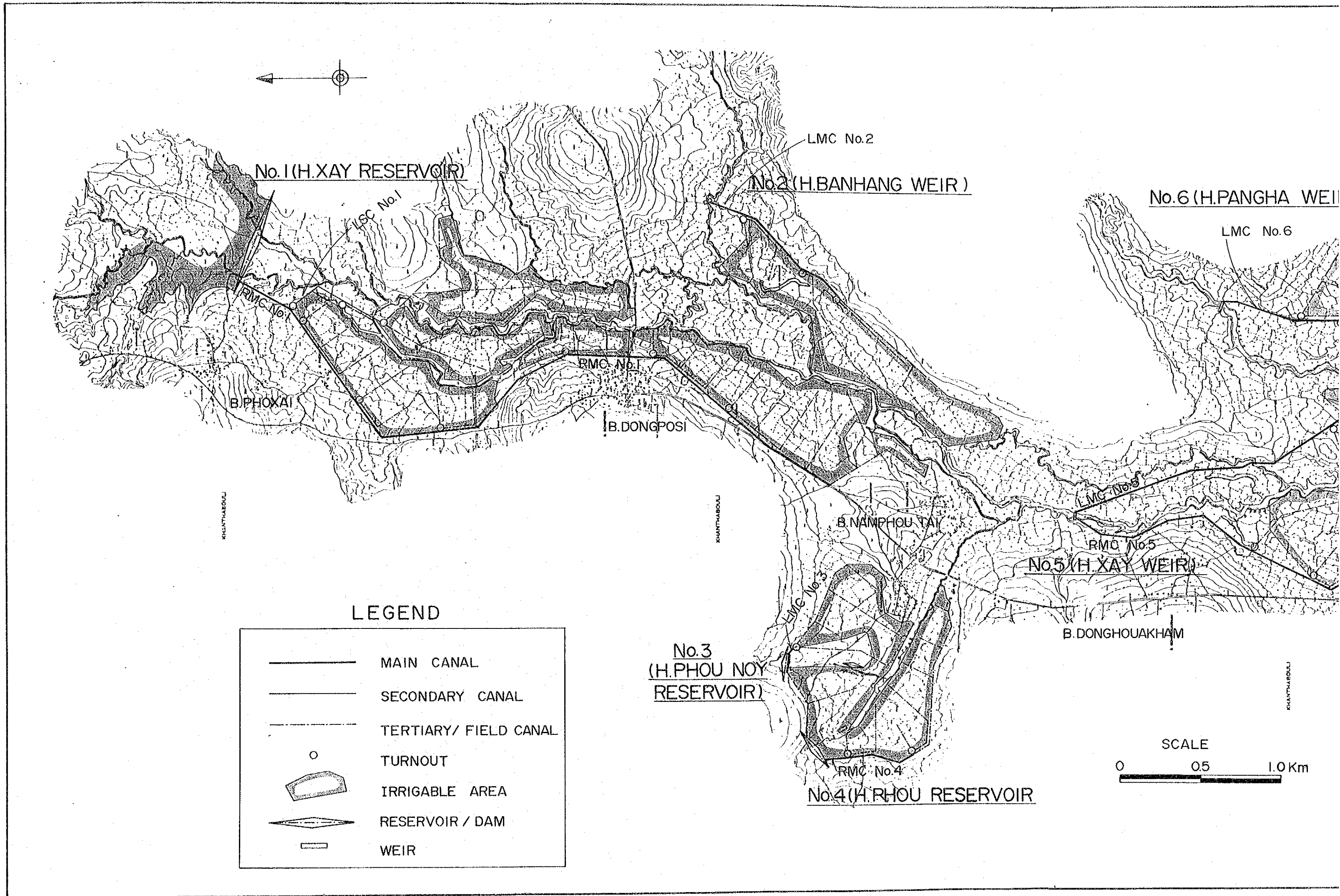




-  MAIN CANAL
-  SECONDARY CANAL
-  TERTIARY/ FIELD CANAL
-  DRAIN
-  TURNOUT
-  IRRIGABLE AREA
-  DEMONSTRATION FARM
-  RESERVOIR / DAM

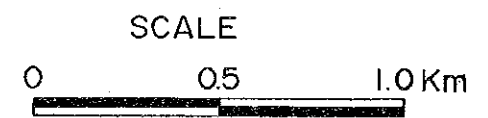
SCALE
0 0.5 1.0 Km

General layout of Irrigation & Drainage Facilities (Nhyod H. Bak Irrigation Area)



LEGEND

	MAIN CANAL
	SECONDARY CANAL
	TERTIARY/ FIELD CANAL
	TURNOUT
	IRRIGABLE AREA
	RESERVOIR / DAM
	WEIR



LMC No.2
No.2 (H.BANHANG WEIR)

No.6 (H.PANGHA WEIR)

LMC No.6

B.DONTOUM

LMC No.5

RMC No.5
No.5 (H.XAY WEIR)

B.NAMPHOU TAI

B.DONGHOUAKHAM

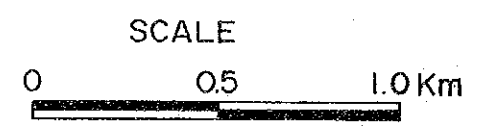
B.MOUANGKHAI

B.PHOUMMACHEDI-NUA

LMC No.3

RMC No.4

No.4 (H.RHOU RESERVOIR)



General layout of Irrigation & Drainage
Facilities (Namphou Irrigation Area)

SUMMARY

I Preface

This Report is prepared based on the 「SCOPE OF WORK FOR THE MASTER PLAN STUDY ON THE INTEGRATED AGRICULTURAL RURAL DEVELOPMENT PROJECT IN SAVANNAKHET PROVINCE 」 (S/W) agreed upon between the Ministry of Agriculture and Forestry (MAF) of Lao People's Democratic Republic (Lao PDR) and the Japan International Cooperation Agency (JICA) on August 15, 1990.

The outline of the S/W above mentioned is as follows;

(1) Objective of the Study

The objective of the Study is to formulate a master plan of the Integrated Agricultural Rural Development Project in the Savannakhet Province, in which comprehensive water resources development programs are to be reviewed and developed with possible agricultural rural development projects be identified and evaluated.

(2) Study Area

The study area covers a part of the Savannakhet Province, which consists of Khantabuli, Champhone, Songhone, Outhoumphone, Xaybouli, Atsaphanthong districts, the right bank of the Xe Banghiang which is located to the west of the village, Ban Douangmala in the Sone Bouli district, and the catchment area on the right bank of the Xe Bangfai, which is located to the west of route 13.

(3) Scope of the Study

The study is composed of two (2) phases.

(i) Phase I

A master plan of the Integrated Agricultural Rural Development Project is formulated, which comprises a study on the agricultural development plan consisting of such items as irrigation, drainage and social infrastructure.

(ii) Phase II

A feasibility study on the top priority project area which is selected in the first phase is conducted.

Background of the study

The area of Lao PDR is 236,800. It is an inland country bordered by 5 countries. The population in 1990 was estimated at 4,170,000 persons and the population density was 17.6 persons/km².

Lao PDR established a social democracy system in December 1975, but recently it tries to keep friendly relations with western developed countries and ASEAN countries, in order to recover the economic situation.

The economic policy has been reformed to the western system, based on the NEM. For example, centralization, subsidy system and bureaucracy are being excluded from the state enterprises, while independence and activation are being promoted. Every economic sector is being developed according to the methods of national capitalism, in order to improve production. As a result, training and the introduction of foreign techniques are being promoted, private ownership of agricultural lands is being permitted according to the farmer's ability and, the liberation of the rice market in order to increase productivity, policies preferring cooperative systems are being revised to consider individual rights, and the market shall determine production.

The GDP per capita of Lao PDR is extremely low at about 180 US\$ (1988). Agriculture covers 60% of the GDP. According to the FAO estimation, it also employs 72% of the population in 1989. According to the above statements, agriculture and forestry are the main industries. However, their development is extremely slow.

In the 1980's, rice production in Lao P.D.R. exceeded one million tons. It reached 1.44 million tons in 1986 and self-sufficiency in rice production was declared. Severe drought and flood in 1987 and 1988, however, caused continuous decrease in rice production. In spite of the Government's efforts to recover rice production conditions, considerable damages are further which occurred again in 1991.

From these conditions, the Government of Lao strived to improve the agricultural structure so as to increase and stabilize rice production commensurate with population increase. In the 2nd Five-Year Plan (1986-1990), 34.7% of the investment plan is allocated to agriculture, and 19 % of this was distributed to irrigation.

In spite of its ideal location and rice production conditions, Savannakhet Province is still underdeveloped. The exploitation of savannakhet as a food supplying base is, therefore, an important policy for the improvement of Lao's economic situation.

Approach to the study.

(1) A development harmonized in all fields

A marketable agricultural structure will be established instead of the traditional self-supplying agricultural one which depends on natural conditions.

Therefore, a study will be carried out so as to implement harmonious development in all fields (increase in land productivity, improvement of marketing systems and farmers' organizations, etc.)

(2) Formulation of a feasible plan

A feasible plan will be formulated taking into consideration the scale of the local budget and the actual results of the foreign aids.

A study will be made to enable the effective implementation of the plan on a wide area with small investment.

(3) Understanding the rural socio-structure

It is important to study and understand the rural socio-structure, government policy, farmers' needs and the past agricultural systems, and to establish a plan which is familiar to the farmers.

(4) Irrigation

Many of the irrigation facilities in the study area are used to supply water during the dry season in a small scale. Therefore, irrigation for a

stabilized production during the rainy season, effective use of water resources, and easy O/M will be studied as well.

II Master plan

1. Outline of the Study Area

Topography and Soils

The study area is a plain with an elevation of about 200 m stretching between the south-west foot of the Annang Ranges and the Mekong River, and it is 120 km from east to west and 150 km from north to south.

The Xe Bangfai River, Xe Banghiang River, the medium or small rivers meandering in the area, several basins and the valleys complicate the topography of the study area.

The clay in the soils are identified as kaolinite. Its movement is physically affected by rain and generally, only few are included in the surface soil layers with medium and high elevation. On the contrary, accumulation of clay is remarkable in areas with low elevation. Humus and organic matters are also in the same situation.

Thus, it is generally difficult to say that the soils in the study area are fertile excluding the lowly elevated area. However they are physically cultivable, and through adequate soil management, it is possible to raise its productivity.

Land Use

The study area is traditionally an agricultural area mainly involved in rainfed paddy farming during the rainy season. The elevation of the cultivated rainfed paddy fields in the river fans and basins ranges from 140 ~ 170 m. The paddy is planted in the shallow areas of the existing reservoirs and ponds by decreasing water level planting during the dry season. Double cropping paddy is planted on low lands blessed with water by pumping irrigation. In the fields where water can be easily used, upland crops are planted in a small scale during the dry season.

There are forests and villages with orchards and vegetable gardens on the upper land next to the rainfed paddy fields. Slash-and-burn fields are comparatively few.

Meteorology and Hydrology

The study area has a tropical climate which is dominated by the southwest monsoon. The monsoon, carrying moisture from the Indian Ocean, brings heavy rainfall between mid-May and mid-October. The northeast monsoon, between November and mid-February, brings cool air from Siberia and mainland China.

The average annual rainfall in Savannakhet is about 1,400 mm, and 1,700 mm in Xeno. The annual average temperature is about 26°C and the monthly temperature ranges from 21°C to 30°C.

Xe Bangfai and Xe Banghiang, the tributaries of the Mekong river, are the largest rivers in the study area.

Xe Banghiang basin has a catchment area of 19,600 km² and covers most of Savannakhet Province. Champhone River and Xe Xanxoy are the large tributaries of Xe Banghiang. The back-water of Mekong River reaches the middle Champhone river which has an elevation of 130 ~ 135 m.

Xe Bangfai has a catchment area of 9,470 km². From route no. 13, the downstream area of Xe Bangfai lower basin is subject to overflow during the flood season.

Society

The population of Savannakhet Province in 1990 is 611,461, and 91% (566,645) of the population belongs to the agricultural population.

The number of schools per capita in the province is a little less than the national average of the primary school, and is almost the same with the secondary and higher secondary schools.

The medical facilities are insufficient, and the total number of facilities per capita is extremely less than the national average.

The Ministry of Agriculture and Forestry, and the Provincial Department of Agriculture and Forestry provide agricultural support, but

due to insufficient budget, facilities and staffs, their efforts are mainly concentrated in some model projects.

The lands are owned by the Government. A permission is necessary for the use of these lands. Cultivating rights, however, are tradable. Taxes are imposed according to the amount of production. A courteous treatment is given to those experiencing decrease in production.

There are traditionally firm village organizations. These organizations carry out labor assignments for public work and social events.

Agro-economy

The economy of the study area depends mostly on agriculture, focusing mainly in rice production which is controlled by natural conditions. There were 87,121 ha of paddy fields in 1990 with a paddy production of 236 thousand tons, 15.6% of the total national production.

The farm size per farm-house in the study area ranges from 0.6 to 1.7 ha, that is 1.0 ha in average. The GDP per capita is 178 US\$ and agriculture covers 87% of the GDP. The cropping section covers 39% of the agricultural section, and livestock covers 57% and forestry does 4%.

Due to the self-sufficient agricultural system and socialistic economic system, the rural marketing structure is under-developed.

Agriculture

Paddy production is damaged by flood or drought almost every year. The yield of the upland paddy or the floating paddy planted on some fields is low. High yield varieties are produced and sold at Thasano Seed Farm, but they are not popular. Inputs such as chemical fertilizers and agricultural chemicals are expensive because they are imported and their use is limited.

Fruit trees, such as banana and coconuts are planted on 150 m elevation and litchi, sugar apple and jujube tree on 150 ~ 200 m elevation.

They are, however, planted on an area of less than 10 ha. Vegetable is an important cash crop. There are no farmers' marketing organizations except for watermelon. Although cotton, tobacco, sesame, etc. are also planted, their scale equals only that of a family garden.

Animals are not only used in farming, but are also exchanged for cash during emergencies. After large floods or severe droughts, the number of animals decreases. The animals are left in the fields to graze all throughout the year, but due to insufficient feed during the dry season, their number scarcely increases and the death rate of young animals is high. The efforts of the Provincial governments to prevent epidemic indicate effective results.

Fish is sold, and they are accorded good prices since they are important sources of protein. However, only a few area raised.

Irrigation and Drainage

The government has made efforts for ① paddy farming during the dry season by pump irrigation, ② paddy irrigation and water preservation for everyday living and animals during the dry season through reservoirs, ③ dissolution of inundation damages during the rainy season, and use of stored water in the river basins during the dry season through the gates.

There are only few canals for the distribution system, except for large pump irrigation systems constructed along the Mekong river and Xe Bangfai river. Supplementary irrigation during the rainy season is not implemented.

The existing irrigation systems and the irrigated area are as follows:

Type	Number (no.)	Irrigated area (rainy season)	Flood control area	Irrigated area (dry season)
Reservoir	17	563	—	1,410
Weir	12	510		108
Pump	7	1,310		1,000
Gate	13		1,000	4,520
Total	49	2,383	1,000	2,938

Drainage depends on natural rivers. There are no drainage systems.

The O/M of the irrigation systems are transferred to the districts. The O/M of small scale irrigation systems are carried out by the farmers, and the district staffs carry out patrol guidance.

Socio-infrastructure

Route No. 13 is the only road that runs across the country from north to south. It was constructed in the 1930's, and is being widened to 10 m for simple asphalt pavement.

Route No. 9 is an international road connecting Savannakhet and Vietnam. The construction commenced in 1979 and was completed in 1985 with simple asphalt pavement, and the road width is 15 m.

Route No. 11 is 85 km in length and connects Savannakhet city to B. Lahanam through B. Kengkok. Although it is partially under improvement, the condition of the road is poor.

The rural roads in the study area are under provincial control and has a total length of 520 km. Due to insufficient funds and the negligence of the users, 80% are impassable during the rainy season. The main carts of the farmers are usually pulled by cows.

Electricity is imported from Thailand across the Mekong river since 1973. It is wired to the districts of Khanthabouly, Champhone, Outhomphone and Atsaphanthong. The majority of the municipalities are not electrified except Savannakhet City where the electrification ratio is 95%. Electricity is wired from Thakhek city to the pump stations in Nongbok for the construction of the pump irrigation facilities in lower Xe Bangfai.

Savannakhet Water Supply Enterprise supplies water to Xeno, Donghen, Pakxong, Phine and Sepon. Rural areas depend on shallow wells, springs, rivers and ponds for their domestic water supply.

The Savannakhet Riverport and Kengkabao Riverport in Savannakhet Province, and Thakhek Riverport in Khammouane Province contribute to international and domestic transportation. However, due to Mekong River's low water level, traffic is slow or closed during the dry season.

There are 2 airports, one in Savannakhet and the other in Thakhek.

There are bus transportations that travel to Vientiane, Pakes, and Vietnam and local lines too.

2. The Basic Policy of Development Planning

Factors that Impede Development

The study area is still under-developed in spite of high agricultural potential, ideal location and natural resources. The factors that impede development are ① insufficient investment (for development of water resources, irrigation, agricultural production inputs, roads, post-harvest facilities, etc.), ② insufficient marketing system, and ③ insufficient extension system.

Basic Policy of Development Planning

- (1) Target year: Considering Lao PDR's present economic situation, an urgent development plan will not materialize. The year 2010 is determined as the target year for the middle term implementation of the master plan.
- (2) Stabilization and increase in rice production which will correspond with the increasing population.
- (3) Improvement of agricultural structure: Establishment of diversified agriculture (formulation of chief producing districts) and the improvement of marketing and service system following the shift from a self-sufficient agriculture to marketing.
- (4) Harmonized integrated development
- (5) Development of irrigation and drainage, and the reinforcement of their O/M
- (6) Development of road networks and the reinforcement of their O/M
- (7) Improvement of the living environment
- (8) To propagate the project by the construction of the pilot project

Agro-economic Development Concept

The annual national consumption of paddy is estimated at approximately two million tons in 2010. Assuming that the study area will produce 20% of the national consumption rate, paddy production target will be 412 thousand tons.

This project aims to triple the present agricultural production rate. In order to increase cash crops, agricultural fields for upland crops and fruit trees will be extended up to more than 5,000 ha, and 10,000 ha of irrigated upland fields will be prepared for the second crops of the paddy fields. The plan aims to increase the number of livestock 2.5 times more than its present number. Fishery, through the use of reservoirs, is also included in the plan.

Land Use Development Concept

The soils in the study area have effective layers more than 1 m thick. These soils do not include gravels and hard pans which interfere with cultivation. Vegetation in this area is normal, and the lands are cultivable.

However, areas with an elevation of more than 200 m are steep and unsuitable for cultivation. As sandy soils on the medium and high elevation areas have low moisture holding capacity and are apt to be eroded, they are unsuitable for upland fields. According to the classification for soil productivity, there are 640,000 ha of arable lands in the hilly areas of the study area and 240 thousand ha on the basins which are suitable for paddy fields and orchards. Furthermore, 210 thousand ha in the alluvia areas are suitable for paddy fields, while 110 thousand ha of land in the mountainous areas are unsuitable for cultivation.

The land use concept is as follows;

- ① Paddy Field: Using alluvia lands, basins and parts of the hilly areas, double cropping paddy fields that correspond with the water resources are developed.
- ② Orchard: hilly areas, basins and alluvia areas are used.
- ③ Upland field: suitable topographic hilly areas are used, and planting on the paddy fields during the dry season for the second crops is planned.
- ④ The afforestation of mountainous areas is planned.

Agricultural Development Concept

(1) Agricultural Supporting Organization

Organizations that will enable the smooth implementation of the formulation of the production plan, construction of infrastructure and its O/M, supply of agricultural inputs, marketing of products, collection and analysis of marketing information, rice polishing, storage, livestock, processing, trust and credit, extension, and improvement of living environment shall be formulated. The project intends that these organizations will easily adapt to rural customs and traditions, will be established and managed democratically and strengthened by substantial equity capital and the farmers' participation in the project.

(2) Rice Production

Increase in seed production, especially high-yielding varieties, expansion of paddy fields, consolidation of irrigation, increase of use of fertilizer are planned.

(3) Upland crops and fruit trees

The project intends to conduct a stable supply of saplings and seeds, stable price of products, improvement of quality, development of marketing, consolidation of irrigation during the dry season, and the introduction of cash crops. In order to achieve these plans on the establishment of farm seeds and plants, chief productive districts are formulated and irrigation during the dry season is implemented.

(4) Livestock

The main purpose of the project is to elevate technology in the area. Animals will be left to graze in the forests. Feeds and water will be kept for the dry season. Pasture farms and poultry farms with small artificial insemination center and a training center for the prevention of epidemic attached to it will be established for technological developments.

(5) Fishery

The price of fresh-water fish is stable. Cheap fries will be produced there and stocked in the newly constructed large reservoirs.

Irrigation and Drainage

(1) The Basic Policy for the Development of Irrigation

The basic policies for the development of irrigation throughout the year are ① stabilization of rice production (subsidiary irrigation during the rainy season) ② expansion of cultivated areas through double cropping (irrigation during the dry season) ③ introduction of cash crops for the second crops.

(2) Scale of Development

Regarding the formulation of irrigation development projects, medium and small scale projects will be studied in consideration of ① limited funds ② technological level ③ easiness of O/M ④ wide distribution of budgets ⑤ topography of the study area. Realizable large scale projects will be included, however, in the long term plan for the year 2010.

(3) Types of Irrigation

Water intake is classified into 4 types ① reservoir, ② weir, ③ pumping and ④ gate. In this study, gravity irrigation is considered preferentially because of the easiness of O/M.

Large scale projects such as Xe Bangfai Project will also be considered. However, an F/S with alternative study for medium and small scale projects is necessary.

(4) Water requirement

The water requirement in the study for the formulation of the master plan is estimated at 600 mm for the rainy season and 1,600 mm for the dry season. The water requirement for upland crops is approximately 75% of that of the paddy.

Agro-infrastructure Development Concept

(1) Rural roads

An improvement plan will be established on the rural roads to make traffic possible even during the rainy season.

The O/M of the roads is very important to keep them in favorable conditions. DCTPC, the kernel of Road O/M, and the O/M of the users' organizations will be, therefore, strengthened.

(2) Post-harvest

In order to improve the marketing of rice post-harvest facilities such as vehicles, storehouses, rice-cleaning machines will be installed, and loss, price stabilization, and smooth collection and shipment will be considered.

(3) Water Supply

Wells will be mainly developed for rural water supply.

Approach to Realization of the Concept

Approach to realization of the development concept is as follows;

(1) Increase of land productivity

The plan will strengthen the investment for the development of water resources and irrigation, extension of agricultural lands through the formulation of chief producing districts, supply of agricultural production inputs, strengthening extension work and improvement of roads.

(2) Establishment of agricultural supporting center

An agricultural supporting center system will be established as an organization which will promote marketing systems, farmers' organization, technology, and improvement of farmers' living.

(3) Construction of pilot projects

Pilot projects concerning the increasement of land productivity and the construction of an agricultural supporting center for the integrated agricultural development shall be made. This pilot projects will have an effective influence on the development of wider areas.

(4) Zone development

In order to achieve the development policy, zone division in consideration with the characteristics of the areas shall be carried out. Each center will command a suitable zone.

There are 6 plains important to agricultural development in the study area. Considering the plains, administrative boundaries, transportation, farming and water resources, the area is divided into the following 6 zones.

(i) Xe Bangfai Zone

District : Thakhek, Nongbok (Khammouane Province), Saybouly
Plain : Lower Xe Bangfai Plain
Characteristics : fertile soils, abundant water resources, rice producing area, floody area, poor traffic conditions, (includes two provinces).

(ii) Xeno Zone

District : Outhomphone
Characteristics : hilly area, key point of traffic, few water resources high potential for agro-industrial and livestock development.

(iii) Savannakhet Zone

District : northern part of Khanthabouly
Plain : Sompoy River Plain
Characteristics : center of administration and trade, large consumptive area, water is collected from Somphoi River and by pumping up water from the Mekong River.

(iv) B. Lak 35 Zone

District : southern part of Khanthabouly, Champhone, Songbouly
Plain : Middle Xe Champhone Plain, Phoummachedy Plain
Characteristics : abundant water resources, rice producing area, upland crops area, high-yielding area, floody area, good transportation.

(v) Pakxong Zone

District : Songkhone

Plain : Lower Xe Xangxoy Plain

Characteristics : floody area (in the Plains), upland crops area, hilly area, abundant forest

(vi) Donghen Zone

District : Atsphanthong

Plain : Upper Xe Champhone Plain

Characteristics : abundant water resources, hilly area, abundant forest, poor traffic conditions

3. Agricultural Development Plan

Agricultural supporting Center

The main factors that impede agricultural development are low productivity, poor road conditions and poor marketing structure. Agricultural supporting centers will be established at places with favorable traffic conditions. Their functions are ① post-harvest treatment such as collection and shipment of the products, rice polishing, processing, storage and rice bank, ② collection, analysis and transmission of marketing informations, ③ training and organization of farmers, ④ improvement of living environment (information exchange, activities for women, preservation of health), ⑤ mutual aid (trust, finance) and so on. The farmers will be managing these centers in the future with their own investments. They will be managed by the Government at first, however, because of inadequate financial and managing abilities.

The centers will be located in Thakhek, Nongbok, Nadeng, Xeno, Savannakhet, B. Lak 35, Pakxong and Donghen with due consideration to topographic features and favorable traffic conditions. Savannakhet Center, as the headquarters, will have the following divisions.

- | | |
|---|---|
| Administrative Division | : general affairs. planning operations |
| Production and Marketing Division | : collection and analysis of marketing information, supply of agricultural inputs, post-harvest treatment, fishery, sales |
| Credit Division | : credit, finance, investment of farmers |
| Improvement of Living Conditions Division | : improvement of the farmers' living conditions |
| Zone Development Division | : development of zones, training, organization of the farmers' requests |

Land Use Plan

The land use plan was constructed based on the development concept and is shown in the table below. The paddy field reclamation area is 13,050 ha, the field reclamation area is 5,000 ha (upland 2,000 ha, orchard

3,000 ha), and paddy field area with rotation of paddy and other crops is 10,000 ha.

	Present	Plan
Paddy field		
Rainfed	87,751	33,948
Irrigated (rainy season)	0	66,853
(dry season)	1,679	33,388
Upland field		
Rainfed (throughout year)	1,750	3,893
Irrigated (dry season)	427	10,000
Orchard	600	3,600
(Arable land)	90,244	108,294
Others	1,109,856	1,091,806
Total	1,200,100	1,200,100

Agricultural Development Plan

(1) Rice production plan

Rice production for the target year is estimated at 452 thousand tons based on the land use plan and irrigation plan, and approximately 10% of the produced rice will be stored.

(2) Agricultural gross earnings

The estimated agricultural gross earnings for the target year will be 3.2 times more than the present one.

Item	Present			Target Year		
	Production (10 ³ t)	Unit Price (10 ³ kip)	Output (10 ⁶ kip)	Production (10 ³ t)	Unit Price (10 ³ kip)	Output (10 ⁶ kip)
Paddy (rainy Season)	17.5	70	12,285	318.9	90	28,697
(Dry Season)	5.5	100	546	133.6	110	14,690
(Upland Paddy)	0.3	65	17	-	-	-
Upland Crops	3.5	100	350	7.8	120	931
Vegetable	1.1	80	85	30.0	90	2,700
Fruit	3.6	50	180	25.2	55	1,386
Livestock	(10 ³ Head)			(10 ³ Head)		
Buffalo	36.8	164.5	6,048	91.9	164.5	15,121
Cattle	45.6	122.5	5,588	114.0	122.5	13,970
Pig	16.3	35	570	40.7	35	1,424
Poultry	13.7	0.7	10	68.7	0.7	48
Fishery			-	13,685	0.2	2,737
Total (10 ⁶ kip)			25,679			81,708
(10 ⁶ US\$)			36.7			116.7

(3) Seed production plan

It is necessary to have 100 ha of irrigated paddy fields for seed production. The Thasano Seed Farm will be extended up to 50 ha, and other 50 ha of seed farms will be constructed in Donghen Zone and Xe Bangfai Zone where water resources are abundant.

Assuming that the seeds of the upland crops will be renewed every two years, 80 ha of seed farms will be necessary. They will be constructed in Donghen Zone, Pakxong Zone, and B. Lak 35 Zone.

(4) Production of organic fertilizer

A lot of chaffs are produced in the centers. These chaffs will be mixed with straws and compost of animals and will be used as basal fertilizers. The production cost is estimated at 2 US\$ per 100 kg. The necessary volume of fertilizer is about 2,000 kg per hectare.

(5) Recomendable main upland crops for each zone

Xe Bangfai Zone	: mongo beans, condiment
Xeno Zone	: feeds such as maize, sorghum
Savannakhet Zone	: vegetables, fruits
B. Lak 35 Zone	: watermelon, melon, peanuts, fruits
Pakxong Zone	: sesame, peanuts tobacco, fruits, condiment
Donghen Zone	: cotton, sesame, peanuts, citrus fruits

(6) Livestock development plan

In order to disperse technology, pasture farms will be established in Champhone District and Atsaphanthong District. The fertility rate will be improved from 21% to 50% and the death rate will be reduced from 9% to 3%.

Poultry farms will be established in Xe Bangfai Zone and B. Lak 35 Zone.

(7) Development plan for inland fishery

An incubatory pond will be established at the reservoir and fries will be stocked in reservoirs with suitable scale. Fishing rights will be issued and centers will buy and sell them.

Irrigation Development Plan

The irrigated area for the target year will be 66,853 ha of paddy fields for the rainy season, 33,388 ha for the dry season, and 10,000 ha of upland fields for the dry season.

The number of irrigation projects and irrigable areas are summarized as follows.

Number of Irrigation Project

Project Type Zone	Total	Xe Banghai	Xeno	Savanna- khat	B. Lak 35	Pakxong	Donghen
Medium, Small Scale Reservoir	38	3	6	2	15	1	11
Weir	16	1	1	2	7	3	2
Pump	14	*9	0	2	2	0	1
Gate	15	*15	0	0	0	0	0
Large Scale	8	2	0	1	2	0	3
Total	91	30	7	7	26	4	17

Irrigable Area

Type	Number	Irrigable Area (ha)	
		Rainy Season	Dry Season
Medium, Small Scale Reservoir	38	13,010	6,880
Weir	16	680	240
Pump	14	9,010	8,990
Gate	15	1,420	720
Large Scale	8	50,770 (overlapped area is 9,420 ha)	31,100 (overlapped area is 9,420 ha)
Total	91	65,470	39,210

Agro-infrastructure Development Plan

The rural roads will be improved by conducting 4~6 m wide lateritic pavements. The existing rural roads of 255 km will be improved and 10 km will be newly constructed.

One water supplying well will be constructed per 60~100 houses. The total number of wells to be newly constructed will be 250.

Length of road improvement and number of proposed wells are summarized as follows.

Construction of Agro-infrastructure

Item	Zone	Total	Xe Banghai	Xeno	Savanna-khet	B. Lak 35	Pakxong	Donghen
Road (km)	Improvement	280	45	14	43	65	61	52
	Construction	10	10					
Number of Well Construction		250	40	30	30	70	40	40

Construction Cost Estimation

The estimated construction cost of the zones, excluding costs for reclamation, tertiary canals and farm facilities, are as follows.

(unit: 1,000US\$)

Zone/Project Type	Irrigation		Roads	Center	Well	Total
	Small, Medium	Large				
Xe Bangfai	11,827	28,920	5,480	1,046	800	48,073
Xeno	6,120	-	1,750	475	600	8,945
Savannakhet	1,843	4,020	3,840	225	600	10,528
B. Lak 35	19,284	7,260	7,520	550	1,400	36,014
Pakxong	1,843	-	6,050	445	800	9,138
Donghen	7,681	15,170	6,950	460	800	31,061
Total	48,598	55,370	31,590	3,201	5,000	143,759

4. Project Evaluation

Impact of the Project

This project has the following impacts.

(1) Impacts on agricultural production

- (i) Impacts of irrigation development and expansion of arable lands:
 - ① expansion of irrigable area ② increase in production ③ increase in upland crops area ④ implementation of planned farming
 - (ii) Strengthening livestock
 - (iii) Increase on fishery production
 - (iv) Impact on gross agricultural production
- (2) Promotion of seeds production and expansion of new varieties
 - (3) Impact of agricultural support and improvement of living conditions

Impact of agricultural supporting centers: ① protection from deterioration of rice quality ② stabilization of producers' price ③ promotion of improvement of agricultural structure ④ self-supply of fertilizer ⑤ increase in employment opportunities ⑥ improvement of women's position ⑦ improvement of communication among the farmers ⑧ increase in training opportunities ⑨ promotion of local talent, rural development

- (4) Impacts of the improvement of the rural roads

① promotion of communication among the farmers by conducting visits among the villages, exchange of technology and agricultural informations ② promotion of supply of inputs, production and marketing activities ③ economize working time ④ promotion of machines and easiness of O/M.

- (5) Impacts of improvement of living environment

(i) Impacts of improvement of water supply: ① surplus labor ② Elimination of infectious diseases and reduction of death rate ③ easy supply of water for animals

(ii) Impacts of preservation of pasture and forest: ① preservation of living environment ② protection from erosion ③ preservation of water resources

(6) Priority of the Zones

Each zone is evaluated by its impacts, and they are as follows:

Items/Zone	Xe Bangfai	Xeno	Savanna khet	B. Lak 35	Pakxong Donghen	
Existing Irrigation	○	×	×	○	×	×
Water Resources	○	×	○	○	×	○
Marketing	△	○	○	○	×	×
Diversification	×	×	○	△	○	×
Scale and Easiness of Construction	○	△	△	△	×	×
Productivity	○	×	△	△	×	○
Flood Damage	×	○	×	△	△	○
Marks (○ = 3, △ = 2, × = 1)	16	12	15	17	10	13
Priority	2	5	3	1	6	4

5. Implementation Plan of the Project

(1) Promotion of the construction of pilot projects

The implementation of the master plan will be promoted by the construction of a pilot project formulated so as to promote balanced development between increase of land productivity and marketing system. The pilot project shall entail the construction of a center and superior irrigation projects located near the center.

(2) Implementation Plan of Each Zone

(i) B. Lak 35 Zone

Location of center : B. Lak 35

Irrigation projects which will be carried out by using the local budget in 1991 : H. Kalong (1), Thongkun, Thongbak

Priority projects : Nyod H. Bak, Namphou, H. Louang, H. Xiangxoum, H. Taking, H. Taleo, Phoumachedy

(ii) Xe Bangfai Zone

It is especially necessary to conduct an F/S for the Phoummachedy Project and Koutapao Project.

Irrigation projects which will be carried out by using the local budget in 1991 : H. Xay, nam Phou, Hatxiande, H. Phiphut, H. Sada, H. Bangkak, H. Sokbo

Xe Bangfai Project covers almost all of Lower Xe Bangfai Plain and this project is considered to be economical. The urgent implementation of a F/S with alternative study, therefore, is recommendable.

(iii) Savannakhet Zone

Location of center : Savannakhet City (Head Office)

Irrigation projects which will be carried out by using the local budget in 1991 : Phakkaha, Thapho

Priority projects : H. Nambo, H. Kasen, H. Sompoy

H. Sompoy project is large and has geological and hydrological problems. F/S is, therefore, necessary.

(iv) Donghen Zone

Location of center : Donghen Town
Irrigation projects which will be carried out by using the local budget in 1991 : H. Kasine
Priority projects : H. Tabonghak, H. Ngut, Vang Khonh, H. Nalai

(v) Xeno Zone

Location of center : Xeno Town
Irrigation projects which will be carried out by using the local budget in 1991 : H. Thahao (2)
Priority projects : H. Xeno, H. Hinelat, H. Kipma

(vi) Pakxong Zone

Cash crops and fruits will be increased, and the establishment of a center (Pakxong Town) as a core for marketing development and a seed and plant farm will be effective for zone development.

6. Selection of the Top Priority Project

The top priority project should be ① a project with a harmonized integrated development ② a project with a suitable scale and one in need of high technology ③ easy construction of access roads ④ a project in which diversification of farming is highly possible ⑤ highly marketable (near consumptive cities and in good road conditions) ⑥ urgently effective (possibility of double cropping, less flood damages and easiness of O/M) and ⑦ effective for demonstration (traffic conditions, type of irrigation). A gravity irrigation project with reservoirs and with possible double cropping is desirable. The Top Priority Project is selected from the top priority zone,

B. Lak 35 Zone, and irrigation projects are selected near the center and from two important plains for agricultural development.

III. Outline of the Top Priority Project Area

Location

Agricultural supporting Center is located at B. Lak 35 which is located at the cross point of Route 11 and Route 13. Nhyod H. Bak Irrigation Project Area is located 8km north-east of B. Lak 35 at the western end of middle Xe Camphon Plain, and the Namphou Irrigation Project Area is located 8km south-west of B. Lak 35 at the northern end of Phoummachedy Plain.

Water resources

The following table shows the annual runoff of each dam site estimated based on the 6 year probable rainfall, 1985.

Dam site	Nhyod H. Bak	No.1	No.2	No.3+No.4	No.5	No.6
Annual runoff (10 ³ m ³)	17,068	7,005	1,897	7,375	22,384	6,519

Soils

The project area is geologically composed of ancient alluvial deposits and dilluvial soils, mainly consisting of sandstone shale and siltstone. In the lowland areas, there are fertile soils such as Fluvisols, but almost all areas are covered by Acrisols which are poor in fertility and water holding capacity. However, the study did not indicate factors which may impede soil improvement.

According to the system of FAO/UNESCO, the soils in the project area are classified into 4 types such as Acrisols, Fluvisols, Gleysols and Cambisols. The areas by the soil types are as follows:

Soil Type	Unit : ha		
	Nhyod H. Bak Area	Nampou Area	Total
Gleysols	252	307	559
Acrisols	489	470	959
Cambisols	220	569	789
Fluvisols	-	236	236
Total	961	1,582	2,543

Soil classification

Land classification is made in accordance with the land classification system formulated by the National Institute of Agricultural Science. the results of the land classification are as follows:

Class	Unit : ha		
	Nhyod H. Bak Area	Nampou Area	Total
Paddy field Upland			
III IV	1,183	834	2,017
IV IV	399	127	526
Total	1,582	961	2,543
Village, pond, river	43	39	82

According to the results of the land classification, 2,017 ha has been evaluated as suitable for paddy cultivation. For cultivation of upland crops, all the lands are unsuitable under the present condition. However, since the main evaluated factors are wetness and erosion, there will be no problems in cultivation after irrigation and drainage development.

Land use

The project area has been developed and used as rainfed paddy fields for a long time. Double cropping fields are for spring water or manual irrigation in an extremely small scale. Early maturing varieties, medium maturing varieties and late maturing varieties are planted according to the water resources and flood conditions.

The upland crop fields are classified into normal upland fields and burn fields, however, there are only few burn-fields. Home gardens are cultivated in some parts of the residential area and fruit trees, vegetables, spices and fiber crops are planted in a small scale.

Paddy field during the dry season, and a part of the forest area are used as pasture for buffaloes and cattles.

Rural Society

(1) Beneficiary villages and population

The beneficiary villages of the project are the 14 villages of Champhon District for the Nhyod H. Bak Project and the 9 villages of Kanthabouly District for Namphou Project.

As of 1990, the total population of the beneficiary villages is 7,049 for the Nhyod H. Bak and 6,480 for the Namphou Area. The average population increase rate for the past 5 years is 3.2%.

(2) Rural life

(i) Administrative structures of village

The general structure of the village is centered on the village chief who is assisted by 2 or 3 persons. The village is divided into a "Chu", a "Nouy" and a "Kum".

The women's association, the senior association, youth association and the garrison of the village are mobilized in different occasions, varying from ceremonial occasions to restoration works of damages caused by calamities.

(ii) Farm size and yield

The average farm size is 1.09 ha for paddy field only and 1.16 ha for the total cultivated land area.

The average yield of paddy is estimated as 1.47t/ha in Nhyod H. Bak Area and 1.40 t/ha in Namphou Area.

The balance of the demand and production of paddy indicates a shortage of 95 tons, as Nhyod H. Bak Area indicates a surplus of 669 tons and Namphou area a shortage of 764 tons.

(iii) Farmers' household economy

Approximately 57% of the total income and 51% of the total expenditure are covered by self-consumptive paddy production. The most part of the

cash income is contributed by livestock, approximately 22% of the total income, and wage income. Medical expenses surpass the production cost in Namphou Area, while production cost is only second to paddy consumption in Nhyod H. Bak area.

(iv) Medical care and education

The medical care condition in the project area is extremely poor, and there are only 3 medical clinics all without permanent doctors.

There is one elementary school in every village, the educational system, however, faces problems such as lack of teaching materials, teaching staff and well qualified teachers.

(v) Domestic water

The area's source of domestic water is mostly well water.

The number of families commanded by one well ranges from 13 to 115 families, 52 families and 289 persons in average.

(3) Agriculture

(i) Paddy production

Almost all paddy fields are used as rainfed, nursery beds from May to June. Transplanting takes place in June to July, and the harvest season is in October to December. Most of the planted paddies are glutinous rice, and 20% of the early maturing varieties, 30% of the medium maturing varieties and 50% of the late maturing varieties are planted.

(ii) Upland crops

Upland rice and peanuts are mainly planted in the hilly areas during the rainy season, and vegetable are planted at fields where water resources are easily obtained during the dry season. The rate of paddy fields used during the dry season is 2%.

(iii) Fruit trees

There are no systematically large scale orchard in the project area. Mangoes, coconuts, bananas, etc. are planted around the resident areas in small scales.

(iv) Fertilizers and chemicals

Buffaloes and cattles are lot to graze in the paddy fields during the dry season, and their dungs are used as organic fertilizer. Recently, famers intend to use chemical inputs, but only a little is supplid due to its expensiveness.

(v) Irrigation

There are reservoirs ,H. Bak Reservoir constructed in 1989 and Kouthapho Reservoir constructed in 1988 near the project area. There is Phou Noy Reservoir in the project area and it irrigates 3-5ha during the dry season.

IV Basic Development Approach

Constraints against agricultural development

The factors which impede agricultural development are ① shortage of irrigation facilities, ② shortage of fertilizer, ③ poor road conditions and ④ insufficient marketing system are planned.

Approach to development

(1) Land use plan

The land use plan will be formulated based on the results of land classification considering topography, farming conditions and type of irrigation.

(2) Irrigation

The purposes of the irrigation development are increase of productivity and the possibility of a diversified agriculture. Gravity irrigation systems with reservoir, and with easy O/M measures.

(3) Agriculture

With regard to traditional farming, cropping pattern is formulated as paddies will be planted in all fields during the rainy season, and 50% of the irrigable areas will be planted with paddy. The remaining 50% will be planted with upland crops. For easy extension work, a demonstration farm will be constructed.

(4) Agricultural supporting center

An agricultural supporting center will be established as the farmers' autonomous marketing organization.

(5) Rural infrastructure

Roads connecting the irrigation area to the center and domestic water supply in the project area will be improved.

V. Agricultural Development Plan

Land Use Plan

As a result of land capability classification, an area of 2,017 ha is classified as a suitable land for cultivation. The land use plan is determined taking the present land use and topographic conditions for irrigation into consideration in addition to the result of land classification.

For the area where the soil is composed of Gleysols, Acrisols and Cambisols, rotational cropping of rice and upland crops are proposed considering the suitability of soils, soil improvement and necessity of crop diversification.

The proposed land use is summarized as follows:

	Present Land Use						Proposed Land Use					
	H. Bak		Namphou		Total		H. Bak		Namphou		Total	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
Rainfed Paddy Field	1,170	72	835	83	2,005	76	100	83	45	5	155	6
Irrigated Paddy Field	-	-	-	-	-	-	-	-	45	4	45	2
Paddy/Upland Crop Field	-	-	-	-	-	-	950	58	660	66	1,610	61
Upland Crop Field	12	1	3	-	15	1	12	1	3	-	15	1
Grassland	230	14	59	6	289	11	200	12	52	5	252	9
Forest	102	6	18	2	120	5	89	5	16	2	105	4
Waste land	68	4	46	5	114	4	59	4	41	4	100	4
Pond and Stream	35	2	37	4	72	3	34	2	36	4	70	3
Village	8	1	2	-	10	-	8	1	2	-	10	-
Infra - Structure	-	-	-	-	-	-	163	10	100	10	263	10
Total	1,625	100	1,000	100	2,625	100	1,625	100	1,000	100	2,625	100

Rural Society, Farmers' Organization Plan

(1) Plan for medical care and education

It is desirable that a clinic with 10 beds is constructed in B. Lak 35, and that a permanent doctor and 3 nurses are employed there.

As for education, it is desirable to include junior high school classes in the existing elementary schools, and to increase teaching staff corresponding to the number of classes in order to avoid a double teaching system.

(2) Domestic water supply plan

10 wells will be constructed so that each well commands less than 60 families.

(3) Agricultural supporting center

(i) Purpose

The purpose is to increase productivity with farmers' cooperation, to improve the economic condition and to elevate farmers' social status by their efforts.

(ii) Function

The functions of the center at the first stage are ① collection, processing, storage and marketing of agricultural products in the project area, ② supply of information concerning farming and marketing, ③ information concerning O/M of the constructed facilities, ④ training and ⑤ management of fishery.

(iii) Organization

The center is composed of a Board of Directors (11), Chief (1), General Affairs Division (1), Production and Marketing Division (4), Life Improvement Division (2), Credit and Loan Division (1) and Technical Division (3).

(iv) Center management plan

The benefits of the center will be felt from the 4th year of the commencement of the business and full annual benefits of approximately 40,000 US\$ will be gained from the 8th year.

(4) O/M plan for the constructed facilities

(i) Construction Office

The construction work will be carried out under the Construction Office established by the MAF.

(ii) O/M Office

After the construction work is completed, all the facilities will be turned over to the provincial government for O/M. The Provincial Government will establish an O/M Office which will carry out ① draft of water use plan, ② hydrologic and meteorologic observations, adjustment of the record and analysis, ③ control of irrigation water, ④ maintenance and repair of the irrigation facilities, ⑤ O/M and repair of machines and implements, ⑥ training on water management techniques, ⑦ extension of improved farming, and ⑧ guidance and training on demonstration farm management.

(iii) Water users association

In order to carry out O/M of the facilities and on-farm water management, the farmers will organize a water users association. Unit organizations will be organized in every turn out. 30 unit organizations in the Nhyod H. Bak Project and 39 unit organizations in the Namphou Project will be organized, and they will be grouped to each secondary canal group, main canal group, and finally to each irrigation system.

Agricultural Development Plan

(1) Proposed crops

The irrigated areas are 1,655 ha during the rainy season and 985 ha during the dry season. Paddy will be planted in all areas irrigated during the rainy season and in 490 ha out of the irrigated areas during the dry season, and upland crops will be planted in another 495 ha during the dry season. As for the selection of the proposed upland crop, it is needless to say that feed crops, vegetables, it's will be planted as important crops, considering past experiences, soils, expensive fertilizers, water requirement, processing and storage, the formulation of a chief peanut-producing district is proposed.

(2) Farming

The nursery area is 500m²/ha, and the period is 25 days. RD6 RD8 and Sampatong (145 days) for rainy paddy and RD10 and IR789 (125 days) are proposed. Compound fertilizers and composts will be used for basal fertilization and the former will be used for additional fertilization. The animal power is used for land preparation and transportation of products. Other works will be carried out by man-power. The expected yield is 4.0t/ha for rainy paddy and 4.5t/ha for dry paddy.

The upland crop will be irrigated by furrow irrigation, and shall be planted at 16,000 hectares. The expected yield is 2.5 t/ha.

(3) Fish breeding

Fish breeding is proposed using the reservoir and hatchery newly constructed, and the benefits will be used for the management of the center.

The breeding of Tilapia Nilofica and Common Carps are proposed and they will be hatched at the hatchery in the center. 10% of fries will be sold

and another 90% will be stocked in the reservoir and raised. Taking into account natural hatching, 10t of fish and 13,000 fries will be produced from the 4th year.

(4) Increase of production

Production will gradually increase after completion of the project construction and it will reach to the rates proposed below by the 5th year.

unit : t

Crops	Without Project	With Project	Annual Increase
Rainy Paddy	3,007.5	6,852.5	3,845.0
Dry Paddy	-	2,205.0	2,205.0
Total Paddy	3,007.5	9,057.5	6,050.0
Peanuts	7.5	1,245.0	1,237.5

Irrigation and Drainage Development Plan

(1) Irrigable Area

Studying the water resources, topography and soils, the irrigable areas are 950 ha during the rainy season, 800 ha during the dry season for Nhyod H. Bak Irrigation Project, and 705 ha and 185 ha respectively for Namphou Irrigation Project.

(2) Water Requirement

The annual water requirement is estimated at 17 million m³ for Nhyod H. Bak Project and 8 million m³ for Namphou Project based on the design year 1985 which is 6 years drought probable of Seno rainfall data.

(3) Drainage Water Requirement

The drainage water requirement is estimated at 6.1 lit/ha based on the design daily rainfall of 185 mm which is 10 years probable maximum daily rainfall.

(4) Irrigation System Plan

As for Nhyod H. Bak Irrigation Project, the Nhyod H. Bak Dam will be constructed as a water resource and irrigation water will be taken from

(950 ha) the Right Bank Main Canal (RMC) at the right bank of the dam. The RMC branches off at just after the outlet to the Left Bank Main Canal (LMC) (357 ha). The LMC connects to the Left Bank Secondary Canal (LSC) (218 ha) after the outlet to the direct irrigable areas (135 ha). The RMC covering the direct irrigable areas (51 ha) branches out the Right Bank Secondary Canal-1 (RSC-1) (242 ha) and the Right Bank Secondary Canal-2 (RSC-2) (174 ha).

As for the Namphou Irrigation Project, in order to effectively use the river flow and return flow, the irrigation water shall be stored in 6 dams and weirs which will be constructed on the H. Xay and its tributaries, and distributed to the irrigable areas by main canals and/or secondary canals. The irrigation system is, therefore, composed of the following 6 irrigation systems.

Diversion Facilities	No.1	No.2	No.3	No.4	No.5	No.6
River	H. Xay	H. Banhang	H. Phou Noy	H. Phou	H. Xay	H. Pangha
Irrigable Area						
Rainy season paddy	140	45	35	25	410	50
Dry season paddy	30	0	10	10	40	0
Dry season field crops	30	0	10	5	40	10
Canals RMC	140	-	13	25	165	-
L:MC	-	45	22	-	245	50
Secondary Canal	50	-	-	-	-	-

Note 1. No. 3 is an improved existing dam.

(unit: ha)

Note 2. No. 5 intakes return flow and water from No.1 reservoir.

According to the cropping pattern plan and meteorologic data, the maximum water requirements are estimated at 1.1 lit/s/ha for rainy season paddy, 1.87 lit/s/ha for dry season paddy, and 1.53 lit/s/ha for upland crops. The design discharges of the canals are determined as follows:

① Nhyod H. Bak Project

- Main canal : 1.43 lit/s/ha water requirement for 50% of paddy and 50% of upland crops during the dry season
- Secondary canal : 1.87 lit/s/ha water requirement for 100% of paddy during the dry season

② Namphou Project

- Main canal : 1.1 lit/s/ha water requirement for 100% of paddy during the rainy season
- Secondary canal : 1.87 lit/s/ha water requirement for 100% of paddy during the dry season

For easy transportation and O/M of facilities, roads will be constructed along the canals.

(5) Drainage System Plan

The project area does not usually get inundated and has a lot of natural drains (streams and rivers), and only field drainage facilities with the exception of a part of the Nhyod Area are proposed.

(6) Demonstration Farm

In order to carry out technical guidance concerning the improved farming practice, water management practice, training and extension work, effectively and smoothly, a demonstration farm will be constructed at B. Donghankhou which is located almost at the center of Nhyod H. Bak Irrigation Area and has favorable traffic condition.

In the demonstration farm, ① land consolidation (0.3 ha of farm plot size), ② introduction of small farm tractors, and ③ construction of a meteorological station are proposed.

Rural Infrastructure Plan

(1) Improvement of Roads

The following rural roads which connect the project areas with the national roads will be improved.

- | | |
|-----------------------------|---------|
| ① B. Mai ~ B. Kokleng | 10.4 km |
| ② B. Phonkho ~ Route No. 13 | 14.2 km |
| ③ B. Phonkho ~ Route No. 13 | 5.0 km |

(2) Domestic Water Supply

Considering the population of villages concerned, wells with manual type line shaft pumps in 10 villages are proposed.

VI Outline of Main Works

1. Nhyod H. Bak Irrigation Project

Nhyod H. Bak Reservoir

Catchment area :	31.0 km ²	Reservoir area :	430 ha
Total capacity :	11.9×10 ⁶ m ³	Effective capacity :	8.9×10 ⁶ m ³
Dam	Dam crest elevation : EL 171.0 m		
	Design flood level : EL 169.1 m		
	Normal full water level : EL 167.1 m		
	Lowest water level : EL 161.0 m		
	Dam type : Homogeneous earth dam		
	Dam height : 21 m	Dam length :	965 m
	Slope Upstream : 1:3.0	Downstream :	1:2.5
	Dam volume : 320×10 ³ m ³		
	Spill way : Side ditch type	Design discharge :	211 m ³ /s
	Outlet : Intake tower type	Maximum discharge :	1,36 m ³ /s
Canal	RMC	4,684 m	Maximum discharge : 1.36-0.78 m ³ /s
	LMC	5,705 m	Maximum discharge : 0.51-0.44 m ³ /s
	RSC-1	2,568 m	Maximum discharge : 0.45-0.21 m ³ /s
	RSC-2	2,418 m	Maximum discharge : 0.56-0.14 m ³ /s
	RSC-2-1	1,812 m	Maximum discharge : 0.33-0.17 m ³ /s
	LSC	4,126 m	Maximum discharge : 0.41-0.12 m ³ /s
	Tertiary canal	31,830 m	Field canal 76,000 m
	Secondary drain	2,110 m	Tertiary drain 15,760 m
	Field drain	62,000 m	

Demonstration farm : 58 ha 1 Farm tractor (35HP, with attachments),
1 Motor cycle (100cc), 1 meteorological station

2. Namphou Irrigation Project

(1) H. Xay (No. 1) Irrigation System

H. Xay Reservoir

Catchment area :	152.8 km ²	Reservoir area :	95 ha
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Total capacity : $1.6 \times 10^6 \text{ m}^3$ Effective capacity : $0.98 \times 10^6 \text{ m}^3$

Dam Dam crest elevation : EL 172.5 m
Design flood level : EL 170.8 m
Normal full water level : EL 169.3 m
Lowest water level : EL 167.0 m
Dam type : Homogeneous earth dam
Dam height : 10.5 m Dam length : 730 m
slope Upstream : 1:2.5 Downstream : 1:2.5
Dam volume : $83 \times 10^3 \text{ m}^3$
Spill way : Overflow type Design discharge : 88 m^3/s
Outlet : Gate type Maximum discharge : 0.6 m^3/s

Main canal : 3,742 m Maximum discharge : 0.154 - 0.090 m^3/s

Secondary canal : 660 m Maximum discharge : 0.087 - 0.084 m^3/s

Tertiary canal : 4,490 m Field canal : 8,650 m

Field drain : 5,420 m

(2) H. Banhang (No. 2) Irrigation System

Weir Catchment area : 4.3 km^2
Weir type : Gate type 2 Slide gates (H: 1.0 m \times 1.5 m)
 1 Stop log gate (L: 1.5 m)

Length : 9.4 m Height : 3.5 m

Main canal : 1,014 m Maximum discharge : 0.050-0.022 m^3/s

Tertiary canal : 1,930 m Field canal : 3,190 m

Field drain : 1,970 m

(3) H. Phou Noy (No. 3) Irrigation System

Dam Catchment area : 9.2 km^2 Effective capacity : 8,000 m^3

Dam type : Homogeneous earth dam (1m increase in height of
existing dam)

Dam crest elevation : EL 162.5 m
Length : 142 m
Spill way : Overflow type (10m)

Main canal : 160 m Maximum discharge : 0.025 m³/s

Tertiary canal : 1,780 m Field canal : 2,260 m
Field drain : 2,910 m

(4) H. Phou (No. 4) Irrigation System

Dam Catchment area : 5.9 km² Reservoir area : 2.0 ha

Effective capacity : 9,000 m³

Dam type : Homogeneous earth dam

Dam crest elevation : EL 163.5 m

Lowest water level : EL 161.0 m

Dam length : 307 m Dam height : 5.8 m

Dam volume : 9.3 × 10³ m³

Spillway : Overflow type (18 m)

Main canal : 590 m Maximum discharge : 0.028-0.027 m³/s

Tertiary canal : 1,340 m Field canal : 1,790 m

Field drain : 1,420 m

(5) H. Xay (No. 5) Irrigation System

Weir Catchment area : 51.4 km²

Design flood discharge : 135 m³/s

Weir type : Gate type 12 Slide gates (H:1.5m × L:1.5m)

Fixed weir 8m

Length : 32.6 m Height : 4.8 m

Main canal : LMC 3,855 m Maximum discharge : 0.270-0.148 m³/s

RMC 4,344 m Maximum discharge : 0.182-0.104 m³/s

Tertiary canal : 10,080 m Field canal : 25,130 m

Tertiary field drain : 4,350 m Field drain : 18,730 m

(6) H. Pangha (No. 6) Irrigation System

Weir Catchment area : 15.4 km²
Design flood discharge : 53.6 m³/s
Weir type : Gate type 6 Slide gates (H:1.5m×L:1.0m)
Fixed weir 43 m
Length : 52 m Height : 5.4 m

Main canal : 740 m Maximum discharge : 0.017 m³/s

Tertiary canal : 1,910 m Field canal : 2,490 m

Field drain : 2,900 m

3. Improvement of rural roads

- (1) Route-A : Length 10.4 km 1 Bridge (construction)
- (2) Route-B : Length 14.2 km 3 Bridges (improvement)
- (3) Route-C : Length 5.0 km 3 Bridges (improvement)
2 Bridges (construction)

4. Agricultural Supporting Center

Total area : 2.25 ha (150m×150m)
Office : 250 m² wooden building
Garage : 150 m² wooden building
Storage : 475 m² wooden building, ventilation
Multi purposes building : 875 m² slate roof only
Rice mill : 100 m² wooden building, ventilation rice
milling 1.5 t/h
Fish farm : 120 m² wooden building
Water supply : well
Generator : 45 KVA 1 unit, 15KVA 1 unit
Truck : 8t-3unit

- Vehicles : 1 pick-up, 2 motor bike
5. Domestic Water Supply
- Wells : 10 shallow wells with line shaft hand pump
6. Equipment for O/M Office
- Bachhoe 0.4 m³ : 1 unit
- Motorgrader 135 HP : 1 unit
- Dump truck 8 t : 1 unit
- Radio station : 4 stations (O/M Office, Center, Nhyod H. Bak Area, Namphou Are)
- Vehicle : 1 pickup
- Work-shop car : 1 unit
- Training equipment : 1 set
7. O/M Equipment for Road Improvement
- Bulldozer D6 130 HP : 1 unit
- Wheel loader 110 HP : 1 unit
- Backhoe 1.4 m³ : 1 unit
- Motor grader 135 HP : 1 unit
- Road roller 70 HP : 1 unit
- Dump truck 8 t : 2 unit
- Water tank 10 t : 1 unit
- Spare parts : 1 sum

VII Construction Cost

The construction cost of the project is as follows.

(Unit: '000\$)			
Items	Foreign Currency	Local Currency	Total Cost
1. Land acquisition	0	226	226
2. Preparatory work	139	24	163
3. Irrigation and drainage facilities			
(1) N. H. Bak			
a. N. H. Bak Reservoir			
- Dam	1,823	250	2,073
- Intake/Spillway	320	88	408
b. Main Canals	1,058	106	1,164
c. Secondary Canals	1,071	95	1,166
d. Tertiary Canals	203	83	286
e. Field Canals	108	45	153
f. Secondary Drain	48	11	59
g. Tertiary Drains	95	18	113
h. Field Drains	7	1	8
i. Demonstration Farm	36	3	39
Sub-total	4,769	700	5,469
(2) Namphu			
a. No.1 (H. Xay Reservoir)			
- Dam	522	103	625
- Intake/Spillway	145	33	178
b. No.2 (Banhang Weir)	131	31	162
c. No.3 (Phou Noy Reservoir)	12	1	13
d. No.4 (Phou Reservoir)	86	18	104
e. No.5 (Xay Weir)	371	68	439
f. No.6 (Pangha Weir)	238	61	299
g. Main Canals	480	71	551
h. Secondary Canal	32	5	37
i. Tertiary Canals	95	31	126
j. Field Canals	64	28	92
k. Tertiary Drains	25	16	41
j. Field Drains	3	1	4
Sub-total	2,204	467	2,671
4. Rural infrastructures			
(1) Rehabilitation of village road	846	466	1,312
(2) Rural water supply	110	58	168
Sub-total	956	524	1,480
5. Project office/Supporting center			
(1) B. Lak 35 center office	504	228	732
(2) Demonstration farm office	61	31	92
Sub-total	565	259	824
6. Equipment			
(1) O & M equipment	1,288	0	1,288
(2) Equipment for center office	190	0	190
(3) Equipment for demonstration farm	206	0	206
Sub-total	1,684	0	1,684
7. Engineering services	1,123	177	1,300
8. Contingencies			
(1) Physical contingency	863	220	1,083
(2) price contingency	114	24	138
Sub-total	977	244	1,221
Total	12,417	2,621	15,038

The annual O/M cost is estimated at 33,800 US\$, and the replacement cost of machines and facilities is estimated at 44,200 US\$ annually. The total cost is 78,000 US\$.

The project implementation schedule is shown at F-28.

VIII Project Evaluation

The economic internal rate of return (EIRR) and the net present value (NPV) are estimated at 8.05 % and 1,622,172 US\$ respectively.

The results of the sensitivity analysis are as follows:

Case	EIRR (%)	NPV
10 % increase of the project cost	7.45	699,335
10 % decrease of the project cost	7.38	533,117

The project is economically feasible and further, it is desirable to the local farmers from the economic point of view as the disposable income of the farmers, with 1.5 ha of farm, will increase to about 86 times compared with the present one. Therefore, the project is extremely effective for the improvement of the farmers' economy.

In addition to the direct benefits due to the increase in agricultural production, the following various favorable but intangible benefits are envisioned from the implementation of the project.

- (1) Elevation of farmers' technology and knowledge and their extension
- (2) Increase of employment opportunities
- (3) Promotion of farmers' organization
- (4) Activation of the rural economy
- (5) Improvement of the living environment
- (6) Improvement of farmers' and women's status
- (7) Planned farming by improvement of quantitative and qualitative marketing information

- (8) Expansion of the farmers' activities by the accumulation of funds
- (9) Creation of fishery and resort area by the construction of reservoirs
- (10) Supply of return flow to the downstream areas by irrigation during the dry season.

IX Recommendations

The Project is technically sound and economically viable. Further, the implementation of the Project will increase farmers' income, and the establishment of the Center will enforce the farmers' activities, raise their volition for agricultural structure, crops, a method of marketing development. Extension effect on other districts is also expected.

It is desirable to implement the Project and to reach its goal as quickly as possible as it will promote agricultural development in other wide areas.

The following recommendations are, therefore, made to the Government of Lao PDR.

- (1) A study for the financial plan for the project implementation should be made taking into consideration of the foreign aids.
- (2) An organization which has functions of the project implementation should be prepared.
- (3) In order to carry out a smooth implementation and O/M of the project, it is essential to train engineers. Participation in the foreign training programs, etc. should be studied.
- (4) In order to raise the level of farmers' living, the quality and quantity of health and education system should be improved.
- (5) In order to preserve watershed areas of the reservoir, promotion of afforestation in the watershed areas with useful trees or fruit trees are commendable.
- (6) Promotion of electrification for the project are is commendable.
- (7) As for the management of the Agricultural Supporting Center, Special Measures shall be taken regarding the Government assistance, credit and taxes, until the center will be normally operational.

