THE ROYAL GOVERNMENT OF LAOS

THE REVISED FEASIBILITY REPORT

ON

THE THA NGON AGRICULTURAL DEVELOPMENT PROJECT

MARCH 1968

OVERSEAS TECHNICAL COOPERATION AGENCY

TOKYO

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PREFACE

In recognition of the vital importance of improving food situation of the country, the Royal Government of Laos places great emphasis on the agricultural development, particularly in the Vientiane Plain in which the capital of the kingdom situates.

As a part of the agricultural development program in the Vientiane Plain, the Royal Government requested the Government of Japan to extend technical cooperation for the development of Tha Ngon area which covers about 800 hectares of irrigable land.

In compliance with this request, the Overseas Technical Cooperation Agency, which is the executing agency of the Japanese Government for technical cooperation, dispatched a field survey mission for a period of about one month in January 1968. The team consisted of ten members and headed by Mr. Tatsuichi Fukuzawa, Senior Research Officer, Agricultural Land Bureau, Ministry of Agriculture and Forestry. The team prepared a report on the agricultural development plan based upon the technical and economic feasibility studies of the project, and submitted it to the Royal Government of Laos in March 1968.

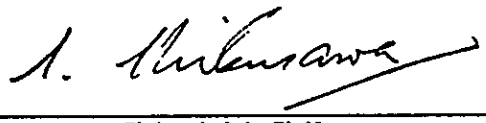
Upon receipt of the further request by the Royal Government for a more detailed study, the Detailed Design Team consisting of ten members and headed by Mr. Tatsuichi Fukuzawa was dispatched to the site for a period of about two months from November 5 to December 30, 1968. It follows from this detailed study that some revisions have been effected in the original development plan. We are confident that the materialization of this project will contribute much to the agricultural development of the Vientiane Plain and at the same time will serve as a medium for furthering the friendly relationship between the peoples of the two nations.

In submitting this report, we wish to express our deep gratitude to Mr. Tiao Somsavath Vongkoth, Director-General of Agriculture, Ministry of the National Economy, Dr. Pane Rassavong, Commissary-General for

Planning, Planning Ministry, Mr. Oukeo Souvannavong, Executive Secretary of the Laotian National Mekong Committee, as well as other officials of the Royal Government for the assistance they have so kindly extended to our team.

We are also grateful to the members of the United States Agency for International Development, the Japanese Embassy in Laos, the Japanese Overseas Cooperation Volunteers and the Japanese Cooperation Association for the Development of Laos for the valuable advices and assistance.

We also wish to record our thanks to Mr. Tatsuichi Fukuzawa, Survey Team Leader, and the members of his team, as well as to the Ministry of Foreign Affairs and Ministry of Agriculture and Forestry, and to Nippon Koei Co., Ltd., for the efforts they dedicated in the preparation of this report.



Shin-ichi Shibusawa
Director-General
Overseas Technical Cooperation Agency

March 1969

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(i) General

In Autumn 1967, the Royal Government of Laos requested the cooperation of the Government of Japan for the development of Vientiane Plain. In reply to the request, the Government of Japan decided to make available for the Royal Government the service of a team of experts for the technical survey of the Tha Ngon Agricultural Development Project in the Vientiane Plain, in January 1968 and the feasibility study report was submitted to the Royal Government in March 1968. In November 1968, the Detailed Design Team was dispatched by the Government of Japan upon further request by the Royal Government and made some revised feasibility report based on the detailed survey.

In spite of the fact that Laos is mainly an agricultural country and about 90 per cent of its working population are engaged in agriculture on land covering approximately an area of 1,800,000 hectares, i.e. 7 percent of its teritory, agriculture is not yet able to keep up with the growing domestic demand for food and a part of the demand for food has been met by increased imports. According to the Statistical Report (June 1967) prepared by U.S.A.I.D./Laos, rough and milled rice with a value of about 82,400 U.S. dollars in foreign exchange was imported during the period from January to June in 1967 among the total imports under the United States Commercial Import Program. So, the Royal Government is laying great emphasis on the agricultural development under irrigation to increase farm products for self-sufficiency in food production.

The Tha Ngon Agricultural Development project lies in the same lowland, which was considered as suitable land for paddy rice cultivation in the first stage plan contemplating the irrigation of 5,000 hectares under the Nam Ngum Multi-purpose Development Project, The project area covers a gross area of about 1,000 hectares. The soils in the project area are formed mostly of recent alluvial immature soils originated from the parent material of fluvial deposits, which was

transported rather recently by the Nam Ngum and its tributaries. These soils can be subdivided into two subgroups, i.e. the natural levee soils and the hydromorphic soils, which are suitable for paddy rice cultivation according to their chemical and physical properties.

The project area, being adjacent to the right bank of the Nam Ngum, is subject to flood by the rise of the river and the run-off from the H. Nong Sam Kha drainage area during the rainy season.

(ii) Development Plan

The project aims at the development of 800 hectares of the culturable irrigable area by the construction of irrigation and drainage facilities as well as by the introduction of improved irrigation and farming practices as a model agricultural development projects in the vast virgin lands along the Nam Ngum, thereby contributing certainly to the oversea trade balance by decreasing the import of agricultural products into Laos.

As for the prospective farming program, two types of farm, i.e. a standard farm of 2 hectares and a standard farm of 5 hectares on both of which two annual crops of paddy rice would be mainly raised, were considered. The results show that the management of a 5 hectare farm would be more profitable on the economical viewpoint, however the 2 hectare farm equipped with agricultural machinery would be recommended based upon the present agricultural and socio-economical conditions of the project area. With this program, about 400 farm households could be settled to the new land to engage in more profitable irrigation farming.

(iii) Construction Plan and Cost

For the proper development of the project area, an economical cost comparison has been made for the two following schemes for the protection of the project area against flood damages. The first scheme would involve the construction of a flood gate to prevent the back flowing of water from the Nam Ngum into the project area through

the H. Nong Sam Kha, its tributary, a closure dam and a pumping station to obstruct the flow from the Nong Sam Kha drainage area and to drain excess water resulting from heavy rainfalls in the irrigation area and the second scheme would aim at the installation of a flood gate only which will serve for preventing the back flowing of the water from the Nam Ngum as mentioned above and for letting pass the water through it. In the latter case, about 60 percent of the project area would be flooded every year during August and September.

It results that both schemes would satisfy the engineering feasibility and the economic and financial feasibility; however the stemming benefits from the second scheme based on the evaluation from both the economic and financial viewpoints are estimated to be larger than those from the first scheme. Therefore, the second scheme has been adopted.

Under this project, it is proposed to construct one irrigation pumping station with two pumps of 28.5 cubic meters per minute capacity each and irrigation canals of a total length of 19 kilometers for the pumping and conveyance of the maximum demand of 1.2 liters per second per hectare of water from the Nam Ngum, drainage canals of a total length of 9 kilometers, one flood protection embankment of 9.0 kilometers, roads of a total length of about 40 kilometers and one electric distribution line of 11 kilometers; it is estimated that the construction would require a period of 24 months and would entail a cost of at about 860,000 U.S. dollars equivalent exclusive of interest, the foreign exchange component of which would be about 650,000 U.S. dollars, and in addition to this, an initial farm investment estimated at about 300,000 U.S. dollars would be required for the new farm buildings, agricultural machinery, commercial fertilizers, agricultural chemicals, seeds, etc. to be provided for the resettlement of the farmers in the project area and also as fund necessary for the operation of standard farms in the first year of irrigation farming.

(iv) Economic evaluation

The present yield is estimated at 0.95 ton of paddy rice per hectare on average in the vicinity of the project area. The improved year-round farming coming into fulloperation is estimated to raise the yield to about 10 tons per hectare per year. The average farm receipt would be about 698 U.S.dollars equivalent per hectare with an annual capacity to pay of about 150 U.S. dollars per hectare. The resultant saving in rice import would be about 8,000 tons per year.

Based on a rate of interest assumed at 3 per cent per annum and an average life of the irrigation and drainage systems at 75 years, the annual equivalent benefits would be about 111,700 U.S.dollars, while the total cost would be 53,200 U.S. dollars consisting of the annual equivalent construction cost (30,400 U.S. dollars), and operation and maintenance cost (22,800 U.S. dollars); the resultant benefit-cost ratio would be then 2.1.

The project would therefore be technically and economically sound and the prevailing economic situation of Laos is justification for the implementation of the agricultural development project in Tha Ngon area.

(v) Conclusion

(a) Pilot farm

For the successful implementation of the agricultural development project, it is recommended that a pilot farm be established in parallel to the execution of agricultural development project, as the important method for prompting agricultural production with irrigation involves experimentation and demonstration, and it is expected that the Government of Japan would contribute in planning, constructing and operating of this farm, which would cover an area of about 100 hectares in the project area and serve as a model for operating irrigation schemes on a cooperative basis, and also in providing the services of qualified experts and procuring equipment and facilities necessary for its smooth operation.

The farm would among other objectives:

(i) select suitable crop varieties for the improved year-round paddy rice cultivation under irrigation;

(ii) set up the most profitable cropping pattern and crop rotation.

(iii) train extension workers and farmers in modern irrigation farming methods and management under the guidance of experts with long experience.

(b) Farmer's Association

For the economic and technical efficiency of the irrigation farm management, it is essential to change the present farming using mainly buffalo for field work by introducing the use of the most adequate size machinery, which will enable to save labour and increase the output.

In this connection, it is necessary to set-up a farmer's cooperative adapted to the socio-economic conditions of the project area, who will control all cultivation works, collect and ship farm products from the individual farmer, and also manage the irrigation and drainage systems under the guidance of the Laotian administrative authorities.

(c) Power Distribution Line

Although the cost for the construction of the transmission line from Vientiane to B. Tha Ngon is not considered in the proposed project which is a pumping irrigation scheme, the construction work should be undertaken in parallel with the construction of the project in view of making available the abundant and cheap power from the Nam Ngum power station which is under construction for the operation of the pumping plants and the lighting of the rural villages.

CHAPTER I INTRODUCTION

Though blessed with rich water resources and vast arable land, the agricultural production of Laos is very poor due to the shortage of irrigation facilities. In spite of the fact that more than 90 percent of the population is engaged in farming, Laos is under the obligation of importing rice and other foodstuff each year from foreign countries in large quantities. Because of this fact, the Royal Government of Laos is now promoting the agricultural development by concentrating its efforts in the development of the Vientiane Plain, where Vientiane, the Laotian Capital city is situated, for the stabilization of the national economy and for the betterment of the living standards of the nation.

The Japanese consulting engineers made already the feasibility study of the Nam-Ngum Multipurpose Development Project, which involves also the agricultural development of the Vientiane Plain, from 1959 to 1964. Furthermore, the O.T.C.A. prepared the detail design of the Nam-Ngum Dam based upon the development plan and completed it in 1966. Then, the construction of the dam started in September 1968 and it is hoped that its completion will contribute much to the promotion of the Nam Ngum Overall Development Plan. Thus, the implementation of the Tha Ngon Agricultural Development Project has been contemplated as one of the agricultural development model projects in Vientiane Plain based upon the development plan.

On the occasion of the visit made in Laos, during Autumn 1967, by Mr. Eisaku Sato, Prime Minister of the Government of Japan, H.R.H. Souvanna Phouma, Prime Minister of the Royal Government of Laos requested for the cooperation of the Government of Japan for the development of the Vientiane Plain and on other fields.

Then, the Royal Government of Laos established a list of concrete projects for which the cooperation of the Government of Japan would be requested and asked his Assistance for the development of about 2,000

hectares of land in Phon Hong area, about 70 kilometers north of Vientiane, and of about 800 hectares of land in the Tha Ngon Area along the Nam Ngum, 25 kilometers north of Vientiane, concerning the development of Vientiane Plain.

In answer to the request, the Tha Ngon area was selected as the object of the Technical Assistance by the Government of Japan for reasons which will appear hereunder and owing to the fact that the area has been preliminarily surveyed by the Japanese Consulting Engineers:

(1) The establishment of a pilot farm of an appropriated scale (about 100 hectares) is expected prior to the execution of the agricultural development of the Tha Ngon area; the records collected by the Lao-Japan Agriculture and Livestock Farming Training Center and the facilities available in the center, located near the project area, are valuable and the said center can be used as an important organization for the construction of the pilot farm under consideration.

(2) The Tha Ngon Agricultural Development Project could well serve as a model project for the development of the Vientiane Plain, notably the lowland area along the Nam Ngum.

(3) There are plans for establishing the Laos-France Agricultural vocational High School, as well as a the Lao-UK-US Soil and Plant Protection Laboratory under the assistance of the French Government for the former and the British and U.S. Governments for the latter respectively, in the vicinity of the Tha Ngon area. Thus, the Tha Ngon area will offer a great possibility for the development of an agricultural technique center in Laos.

CHAPTER II GENERAL

2.1 Situation and Relief

2.1.1 The Kingdom of Laos

The Kingdom of Laos, lying in the Northern part of the Central Indochinese Peninsula between latitudes 14° and 22° North of the equator, is surrounded by China, Viet-Nam, Cambodia, Thailand and Burma.

This country covers an area of about 236,800 square kilometers and stretches over a length of about 1,000 kilometers from north to south and a breadth of about 400 kilometers in its widest part and 150 kilometers in its narrowest part from east to west.

Laos consists mostly of mountain area lying at the elevations ranging from 1,000 to 2,000 meters above sea level and running from the northern part to the southern part of the country; the Annam Cordillera forms the boundary to Viet-Nam. The plain lies at the elevations between 100 and 180 meters above sea level and extends from the Vientiane Plain along the left bank of the Mekong River towards the Pakse Plain, on the south.

The climate of Laos is the so-called monsoon climate and is characterized by two distinct season, i.e. the dry season lasting six months from November through April and the rainy season during the remaining period. The rainfall is more than 1,500 millimeters in the plain and more than 3,000 millimeters in the mountain area.

From the viewpoint of temperature, this country belongs to the tropical zone; the average temperature ranges from 21° to 28°C, although the maximum temperature rises sometimes above the mean temperature of 32°C.

There are about 1,800,000 hectares of arable land, which is about 7 per cent of territory; on this area, about 900,000 hectares

are cultivated with paddy rice and the remaining 400,000 hectares with other crops, such as maize, potato, coffee-plants, tobacco plants, fruit trees, etc.

2.1.2 Vientiane Plain

The Vientiane Plain with an area of about 200,000 hectares is one of the largest plains of the country. The centre of the plain is drained by the Nam-Ngum, one of the major tributaries of the Mekong.

The plain is scattered over with gently undulating elevated lands with elevation of 160 to 180 meters and descends generally from north toward the Mekong, on the south, forming gentle sloping lands.

An area of 35,000 to 40,000 hectares in the lowland is utilized at present for cultivated crops, among which the paddy rice is the main crop and is grown in the rainy season under natural conditions, without artificial water application. In the upland, the agriculture is conducted in the form of shifting cultivation by slashing and burning method.

Vientiane city, the political and economic centre of Laos located on the left bank of the Mekong in the southern part of the country has a population of about 140,000, including that of its suburbs.

The Nam Ngum takes its rise in Mount Phou Kout, on the north-east of the Tran Nhin Plateau. It has a total length of about 420 kilometres and a drainage area of about 17,400 square kilometres.

The river runs nearly towards the southwest through relatively steep mountain area until it reaches the Nam-Ngum dam site, joins on to the Nam Lik, its tributary, in the Vientiane Plain and flows southwardly on extremely gentle slope through the central part of the plain

It changes its course in the vicinity of B. Tha Ngon, about 25 kilometres north of Vientiane, flowing eastwardly and drains into the Mekong on the eastern end of the plain.

As the waterway is getting narrower in the vicinity of B. Tha Ngon, the flow is delayed during the rainy season when the discharge exceeds 2,500 cubic meter per second at B. Tha Ngon and the upstream low lying marshy area is flooded each year; thus, this area forms a waste land of about 60,000 to 70,000 hectares.

However, during the dry season, i.e. from November through April, the river goes down to such an extent that the land is not cultivated owing to the lack of water. The difference of the water level in the dry season and the rainy season is about 15 metres and such natural conditions exert much influence in both agricultural and socio-economical activities of the Vientiane Plain.

2.2 Present Conditions of Agriculture in the Vientiane Plain

The Vientiane Plain, as previously mentioned, has a population of about 250,000, including that of Vientiane city; it is the most important area from the political, social and economical viewpoint as well as regarding to its population.

However, the agricultural production is not able to keep up with the growing demand for food and a part of which the demand for food has been met by imports from Thailand. So the Royal Government of Laos is making great efforts to meet the growing demand for agricultural products by promoting the agricultural development of the Vientiane Plain, which includes a part of the Nam-Ngum Multipurpose Development Plan (involving the irrigation of 5,000 hectares in the first stage and 32,000 hectares in the final stage), and undertook also the construction and operation of a pilot farm (about 300 hectares) with cooperation given by FAO.[/1]

/1: United Nations Food and Agriculture Organization

The Royal Government of Laos in 1966 has established in B. Tha Ngon the Agriculture and Livestock Farming Training Center with cooperation given by the Government of Japan, and is now promoting the training of the farmers and agricultural youths.

Moreover, USAID considering also the priority of the agricultural development of this plain to other economic development projects, has been promoting the irrigated farming in this area for several years. In 1967, a small scale 100 hectares pilot irrigation projects near B. Sithan Tay about 20 kilometers southeast of Vientiane and near B. Kok Kieng about 80 kilometers north of Vientiane involving the pumping of water from the Mekong for irrigation of paddy rice and other crops in the former and from the Nam Lik in the latter.

Farmers in the area are beginning to appreciate the advantages of the irrigated farming very quickly, and small scale irrigation is already practised by the individuals in various places.

2.3 General Economy of Laos

2.3.1 Population

According to the statistics published in 1967 by the Statistics Service of Laos,/1 the population in 1966 was 2,698,000, and the rate of population increase is about 2.3 percent./2 The density is 11.4 inhabitants per square kilometre. It is estimated that about 140,000 persons are living in Vientiane city. Although the number of inhabitants according to the industrial classification is not known some 90 percent of population are estimated to derive their living from farming. The greater part of these inhabitants are concentrated on the plains in the Basin of the Mekong, while the Thai Dam, Yao, Meo and Kku, etc., are living in the mountainous areas.

/1: Le Service de la Statistique du Laos

/2: Estimated rate of population increase for the years 1958 to 1964 (Asia Agricultural Problems Research Association)

2.3.2 Education and Religion

Education in Laos has been expanded to quite an extent due to the efforts made by the government authorities ever since the nation became independent, but it is still insufficient.

Though no special educational institutions for agriculture have been established, the FAO Pilot Farm in the southern part of Vientiane is holding a short term practical training for about 40 young farmers, each year. Buddhism is the state religion, and is most popular among the Laotian people. Education by buddhist priests is very popular.

2.3.3 Agriculture and Forestry

Agriculture in Laos is the key industry playing a role of importance in national economy of Laos. Some 90 percent of Laotian people derive their living from farming in land of about 1,300,000 hectares corresponding to about 5 percent of the territory. However, the agricultural production being very low, most of farmers are not able to make a living by agriculture alone. The main farm product is rice, followed maize. potato, coffee, tobacco, sweet potato, cotton, etc.; the sesame and poppy are grown on upland. The cultivated acreage and crop production are as given in Table 2.1.

Table 2.1 Cultivated Acreage and Crop Production[/1]

Unit: Acreage: Hectare
Yield: Ton

Product	Fiscal year 1960/61	1961/62	1962/63	1963/64	1964/65	1965/66
Rice						
Acreage	647,900	635,700	623,600	660,100	773,000	888,950
Production	530,000	520,000	510,000	540,000	632,000	727,100
Maize						
Acreage	31,400	38,500	38,500	63,200	40,000	43,200
Production	15,000	18,000	18,000	30,000	19,000	20,520

/1: Source: Le Service du l' Agriculture

- continued -

Product	1960/61	1961/62	1962/63	1963/64	1964/65	1965/66
Potato						
Acreage	3,000	2,200	2,800	2,800	3,000	3,000
Production	13,000	12,000	13,000	13,000	14,000	14,000
Coffee						
Acreage	700	1,000	2,600	3,500	6,000	6,000
Production	400	600	1,500	2,000	3,480	3,480
Tobacco						
Acreage	2,500	3,000	3,300	5,000	5,000	6,500
Production	1,500	1,800	2,000	3,000	3,000	3,900
Sweet Potato						
Acreage	800	930	1,100	1,100	1,300	1,300
Production	600	700	800	800	960	960
Cotton						
Acreage	3,700	4,800	5,500	5,500	5,500	6,050
Production	1,000	1,300	1,500	1,500	1,500	1,650

Livestock farming is one of the most promising industries in this country, but not much development is seen. The number of livestock raised according to 1960 - 1966 statistics is as given in Table 2.2. Cattle and buffaloes are mainly used for field works and for transportation purposes; the the hogs and poultry form a source of cash income for the farmers.

Table 2.2 Number of Animals Raised[/1]

Livestock Products	1960/61	1961/62	1962/63	1963/64	1964/65	1965/66
Cattle	642,900	668,600	688,700	704,900	718,900	729,800
Buffalo	344,100	357,800	386,600	460,700	469,900	477,100
Horse	19,610	20,400	21,010	21,530	22,000	22,330
Hogs	882,800	890,300	905,100	932,200	955,500	979,400
Chicken	8,453,400	8,876,000	9,142,300	9,360,800	10,077,200	10,104,200

/1: Source: Le Service Vétérinaire

Most of the territory is covered with forests, which form one of the main resources of the country. Besides timber such as teak, pine and dau, etc., the lacquer, benzoin and cardamon are the special products of Laos, but the development of these forestry resources has been restricted by the transportation system.

Table 2.3 Forestry Products[1]

Product	Unit	1960/61	1961/62	1962/63	1963/64	1964/65	1965/66
Iron wood	m^3	23,800	31,300	48,000	46,000	61,000	77,000
Firewood	m^3	52,300	85,200	40,900	72,500	65,100	63,100
Charcoal	ton	4,400	6,400	9,500	10,600	10,400	10,700
Benzoin	ton	11	5	4	18	9	13
Lacquer	ton	10	21	47	19	-	-
Cardamon	ton	7	3	6	2	4	4

2.3.4 Mining and Industry

Laos is very rich in mineral resources. In other words, the existence of resources of gold, tin, iron, copper, coal, manganese and tungsten etc. have been confirmed, but development of such resources is much behind, and only about 600 to 700 tons of tin are being mined each year in the southern part of Laos. Industries are mostly light consumption good industries such as the manufacture of tobacco, matches, rice-mill, manufacture of refreshments, methyl alcohol distilleres and saw-mills. There is a cement factory (daily production capacity is 25 to 30 tons) in the southern part of Laos, but this is far from satisfying the domestic demand.

Amount of tin mined and power consumption during the period from 1961 to 1965 are as shown in Table 2.4.

Table 2.4 Tin Production and Power Consumption[2]

		1961	1962	1963	1964	1965
Tin production	ton	674	720	663	686	578
Power consumption	10^4kWH	8	9.4	10	13.4	16.6

/1: Source: Le service des Eaux et Forets
/2: Source: Le service de le Statistique du Laos

2.3.5 Incomes and Prices

The gross income earned per inhabitant is reported to be 65.7 U.S. dollars according to J.D. Drilon Jr.[/1]

The inflationary situation in Laos was so strong that the current rate of exchange, which was 153 Kips per 1 U.S. dollar in 1963, dropped in January 1964 and was equivalent to 479 Kips per 1 U.S. dollar; this corresponds to an approximate drop three times as much as the former rate of exchange. Since then, the situation was stabilized by the use of the exchange stabilization fund.

Meanwhile, the prices of the consumption goods increased considerably, and particularly the prices of foodstuffs recorded so large increase that the prices in 1966 were as high as 7.5 times those in 1969.

2.3.6 Overseas Trade

The trade is not balanced, as Laos has a net excess of imports over exports. Importations from abroad have rapidly increased year by year and exportations in 1965 were only 3 percent of the importations.

Tin is the chief export of Laos and exportation of tin in 1965 occupies 60 percent of the total exportations, while foodstuffs are the principal imports from abroad and occupy more than 32 percent of the total importations. Exports and imports from 1962 to 1965 can be classified according to the products and values as shown in Table 2.5.

Table 2.5 Exports and Imports[/2]

A. Exports (million Kips)

Products	1962	1963	1964	1965
Tin	25.1	37.2	165.7	147
Timbers	0.9	5.0	12.7	19
Green coffee beans	11.4	5.1	15.1	11

/1: J.D. Drilon JR. "The Agricultural Development Organization", December 1965

/2: Source: Le Service de la Statistique du Laos

- continued -

Products	1962	1963	1964	1965
Cardamon	2.7	2.6	2.9	1
Lacquer	N.a.	0.9	0.4	27
Skin	2.3	1.6	1.6	1
Others	9.1	4.1	14.6	34
Total	61.9	57.2	213.3	240

B. Imports (million Kips)

Item	1962	1963	1964	1965
Animal Products	117	86	157	258
Vegetable Products	393	396	1,195	1,545
Oils and fats	4	9	17	55
Products of food industries	215	227	503	686
Mineral products	399	511	958	1,268
Chemical products	93	92	374	412
Rubber and Plastic goods	26	28	169	223
Timbers and wooden goods	14	14	19	55
Paper goods	48	86	156	269
Textile goods	221	192	599	727
Footwear and headgear	18	12	32	27
Ceramics and glassware	28	55	106	213
Jewels	1	-	48	5
Metal goods	90	215	373	434
Machinery	127	198	509	704
Vehicles	101	165	699	799
Scientific instruments	18	19	65	115
Leather goods	3	2	4	5
Others	14	14	41	93
Total	1,930	2,321	6,024	7,893

In addition to the general imports mentioned above, daily necessities worth about 8,220,000 U.S. dollars of which the farm products worth about 2,400,000 U.S. dollars comprised 29 percent were imported according to the United States Commercial Import Program in 1965.

2.3.7 Communication

Laos is an inland country without single seaport. So, there are two means of land transportation. One is from Bangkok to Vientiane and the other is from Saigon or Phnom Penh to Pakse. The Thai railway is available for transportation up to Nong Khai on the opposite bank of Vientiane and to Oubon on that of Pakse. Improvement and expansion of the roads are necessary for the development of Laos, but the road systems have been still left undeveloped due to topographical difficulties. However, the Paksane - Thakhek highway, which serves for better transportation on the banks of the Mekong, was completed in May 1965 under USAID, and the construction of the bridge which will connect Vientiane with Nong Khai in Thailand is being planned . Thus, transportation facilities in Laos are being improved gradually.

As far as the transportation by ships is concerned, the Mekong is one of the important means of navigation. But the existence of many rapids on its course prevent development of such means of navigation. However ships less than 200 tons are utilizing the river for transportation in its downstream.

2.3.8 Power supply

Main cities in Laos are being supplied with expensive electric power by the use of small scale diesel generators due to the high cost of imported fuel. In spite of expensive electric charge (about 12 US cent per KWH) in and around Vientiane, the demand of power increases rapidly, and the shortage of electric power is keenly felt. In future, the completion of the Nam Ngum Power Station will certainly promise the promotion of electrification in farming village and industrialization in and around Vientiane for rich power supply.

CHAPTER III PROJECT AREA

3.1 General

The Tha Ngon Agricultural Development Project area is situated at about 5 kilometres north-east of B. Tha Ngon, which is about 25 kilometres north of Vientiane.

The project area overlooks the Nam Ngum from north to east and is bounded from west to south by the uplands with an elevation ranging from 170 to 185 metres. The project area with an elevation between 163 and 167 metres is a flat plain covering an area of about 1,000 hectares, the most of which is grassland mixed with shrub vegetation, while the remaining is formed by forests and upland fields.

The Nam Ngum discharge fluctuates largely with season and the difference in the water level between the flood period and the dry season is about 15 metres. As 90 percent of the project area is flooded every year due to the rise of the river during the high water period, most of it is left uncultivated.

The levee area of the Nam Ngum only is cultivated with banana trees, cassava, upland rice, etc., and the remaining part is used as pasture.

3.2 Topography

As mentioned above, the Nam Ngum runs along the northern side of the project area, and the project area descends gently toward the south from this natural levee. There are several natural ponds in the central part of the project area, from which several streams run eastward and join into the H. Nong Sam Kha, which flows from west to east on the sourthern side of the project area.

The H. Nong Sam Kha has a drainage area of about 23.6 square kilometres and takes its rise in elevated land on the sourthern part of the B. Tha Ngon and flows into the Nam Ngum near B. Lat Khouei

after passing through the project area.

From the topographic point of view, the project area can widely be divided into the area above the elevation of 165 metres, which is mostly covered with forests, and the area on the lower elevation, which is mostly grassland mixed with shrub vegetation. /1

3.3 Meteorologic Data

Meteorological data available for the project area are only those obtained from the Meteorological Service in Vientiane, which is situated at Longitude 102°34' East and Latitude 17°57' North. In the Tha Ngon project area, some observations and records were recently made by such organizations as the Lao-Japan Agriculture-Livestock Farming Training Center, but the data obtained cover only a short period, which is not sufficient to serve as basic data in planning the new agricultural development under irrigation.

Therefore, the records of temperature, relative humidity, evaporation, cloudiness, sunlight hours, precipitation, number of rainy days, etc., from the Vientiane Meteorological Service covering the period from 1958 to 1967 were mainly used for the determination of the water requirements, the preparation of the cropping pattern, etc.

As far as the solar radiation is concerned, the data available cover only 2 years, e.g. 1964 and 1967, so the lacking data were supplemented by means of computation based upon an empirical formula.

As the results of analysing temperature and precipitation records of Tha Ngon and Vientiane, no significant difference was found between the figures obtained from these two places, which are about 25 kilometres distant from each other.

/1: The state of land use of the project area is given under 4.2 "Land Use" of Chapter IV.

Accordingly, it was decided that the data obtained from Vientiane could be safely used as the basic data in planning the irrigated farming in the project area.

The mean monthly values are shown in Table 3.1. The other climatological factors, which were obtained from the meteorological tables in Vientiane and are necessary for planning the irrigation network, are summarized in Table 3.2.

The mean annual precipitation is estimated at 1,717 millimetres, about 88 percent of which comes in the rainy season from May to September. However, the rainfall records frequently indicate "no drop of rain" in November, December, January and February of the dry season. It is then inevitable that supplement of water to crops by irrigation is needed during such period for profitable and economical agricultural development in this area.

This area being in the zone of the tropical monsoon, the South or South-East wind prevails from June to September in the rainy season, and the North or East wind prevails from October to April in the dry season. Wind velocity is small, and it seldom exceeds 4 metres per second.

Although the mean monthly temperature for the past 10 years varies between 21°C and 28°C in this area, which are not much different from the figures of the other areas in the zone of the tropical monsoon.

The daily mean temperature, which is about 25°C in February, drops sometimes to 20°C in the latter part of February or early March; during this period, the daily range of temperature is about 15°C, although the daily highest temperature rises to 30°C.

With the exception of 360 to 386 calories per square centimetres per day during the rainy season, the insolation is estimated at 400 calories per square centimetres per day throughout the year and this value exceeds 350 calories per square centimetres per day which is normally required for paddy rice cultivation.

Table 3.1 Meteorological Data at Vientian during Last Ten Years

	Temperature (℃)					Relative Humidity %			Evaporation (mm)		Cloud amount
	Mean	Min.		Max.		Mean	Min.	Max.	Month	Day	
		Mean	Absolu	Mean	Absolu						
Jan.	21.0	15.1	4.7	28.0	34.0	74.1	42.2	94.7	122.9	4.0	3.4
Feb.	23.3	17.8	10.5	29.8	36.0	71.9	42.7	93.2	123.9	4.4	3.4
Mar.	26.4	21.0	11.7	32.6	38.6	69.3	41.8	91.9	156.7	5.1	3.0
Apr.	28.1	23.4	18.7	34.3	40.7	69.8	43.1	91.9	178.6	6.0	4.0
May	28.0	24.3	20.0	32.9	39.0	80.2	55.4	95.4	114.3	3.7	6.2
June	27.6	24.7	21.5	32.3	36.8	84.1	62.4	96.3	97.8	3.3	7.6
July	27.3	24.5	21.0	31.0	34.8	84.5	64.1	96.2	89.2	2.9	7.5
Aug.	27.0	24.6	21.9	30.8	34.5	86.3	65.5	96.6	81.1	2.6	8.1
Sept.	26.4	23.8	21.5	30.3	34.8	86.6	65.7	96.7	85.2	2.8	8.0
Oct.	26.0	22.5	16.6	30.6	34.4	81.6	54.4	95.4	107.5	3.5	5.5
Nov.	23.7	19.7	12.0	29.9	34.8	77.4	47.8	94.9	114.2	3.8	4.5
Dec.	21.2	16.4	9.2	28.0	34.5	75.3	44.5	96.1	110.4	3.6	3.9

	Precipitation (mm)			Number of rainy day			Sun light			Solar radiaton	
	Mean	Min.	Max.	Mean	Min.	Max.	N(hr)	n(hr)	n/N (%)	Out-Terres	Cal. Value
Jan.	5.0	0.0	35.2	1.2	0	6	11.22	8.4	74.7	671.4	429.7
Feb.	10.4	0.0	29.9	2.3	0	6	11.61	7.9	67.2	754.3	452.6
Mar.	27.3	2.7	78.9	4.6	0	8	12.05	6.8	56.4	843.8	447.2
Apr.	97.2	25.3	241.5	7.6	4	13	12.53	7.0	54.8	900.0	468.0
May	247.4	97.4	407.3	16.0	9	23	12.98	6.3	49.5	918.7	441.0
June	249.0	116.4	430.7	18.0	11	26	13.17	5.1	38.7	918.7	385.9
July	269.5	137.2	487.1	18.7	11	23	13.09	5.1	39.0	916.7	385.0
Aug.	350.1	188.7	646.7	23.1	16	27	12.70	4.6	36.2	896.5	358.6
Sept.	387.5	119.5	638.7	20.2	15	25	12.24	4.9	40.0	850.0	365.5
Oct.	66.3	0.0	152.1	13.0	0	17	11.75	7.9	67.2	773.8	464.3
Nov.	6.6	0.0	21.2	2.0	0	10	11.33	8.2	72.3	683.8	430.8
Dec.	0.9	0.0	6.3	0.2	0	1	11.06	8.3	75.1	641.3	416.9

Table 3.2 Other Climatological Factors For Irrigation Scheme Planning

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Sidereal Daylight	11.22	11.61	12.05	12.53	12 98	13 17	13.09	12.70	12.24	11.75	11.33	11.06
Out-Terrestrial Solar Radiation (cal/cm/day)	671.4	754.3	843 8	900.0	918.7	918.7	916.7	896 5	850.0	773 8	683.8	641.3
Monthly % of Daylight Hours	7.88	7.26	8.40	8.46	9.02	8.99	9.02	8.81	8.29	8.24	7.67	7.89

The relative humidity is rather high, the average maximum relative humidity being never below 90 percent all round the year and the mean relative humidity being around 85 percent in the rainy season and 70 percent in the dry season. However, the relative humidity is clearly lower in the daytime during the dry season and during which the lowest value is almost 40 percent; this shows a wide variation in the mean daily relative humidity. Under such conditions, it would be necessary to regulate the relative humidity by means of irrigation for paddy rice cultivation during the dry season, as the blooming of flowers occurs during the short period of two hours between 10 and 12 in the morning.

A standardized method of measuring evaporation is being used by means of a large pan (U.S.W.B. 120 centimetre Class A Pan); however, the evaporation pan being recently installed, the observed values used for this report derived from data from small size evaporation pan (20 centimetre pan) and portable Piche evaporimetre, covering a period of 10 years. According to these records, the daily evaporation was about 4.0 millimetres in the driest period and almost 2.5 millimetres in the rainy season per day.

3.4 Soil Condition

The soils covering the survey area are broadly divided into two groups. The first group is the recent alluvial immature soils and the other group is the ancient alluvial lateritic soils.

The former or the recent alluvial immature soils are the soils originated from the parent material of fluvial deposits which was transported by the Nam Ngum and its tributaries rather recently. The soils develop along the right bank of the Nam Ngum and cover the relatively lower land with elevations ranging between 161 and 167 metres.

They occupy about 1,320 hectares with proportional extent of about 77 per cent of total survey area.

The soils of this group are subdivided into two subgroups such as the natural levee soils and the hydromorphic soils. The natural levee soils occupy the river levee of the Nam Ngum and extend over about 300 hectares with elevations of 165 to 167 metres.

In general, the soils have very thick effective solum depth of more than 1 metre and hold medium texture throughout the profiles.

As to their chemical properties, these soils have very weak active acidity of about 6.0 in pH value and slightly strong potential acidity of about 4.4 to 5.2 in pH value. Their cation exchange capacity ranges between 7 and 12 milligram equivalents per 100 grams of soil and the base saturation degree varies from 40 to 50 per cent. Although the contents of humus, available nitrogen and phosphoric acid, and exchangeable bases are slightly rich in these soils as compared with the contents in the other soil groups in the survey area, their contents are still insufficient for the sustainable performance of irrigation farming on the soils of this group. Accordingly, the proper application of optimum amount of fertilizer is necessarily required for the profitable irrigated crop culture on these soils.

As regards the hydrodynamic features of these soils, they are so blessed with favorable irrigability and drainability that they have rather high available moisture holding capacity with range between 14 and 17 per cent by volume and low basic intake rate of 0.6 millimetres per hour.

At the practice of irrigation farming, therefore, various irrigation methods including furrow irrigation, border irrigation, and sprinkler irrigation can be used for application providing that the methods are properly designed upon the base of detailed hydrodynamic survey results on irrigated fields.

The hydromorphic soils develop at the back of the aforementioned

natural levee soils and cover nearly flat lowland with elevations of 161 to 165 metres. They extend over about 1,020 hectares. They have very thick soil layer depths in common. But their effective solum depths are rather thin and less than 50 centimetres in their natural conditions as they have extremely heavy textured gley horizons at rather shallow depths under ground surface.

Their textures are clayey throughout their profiles, especially the subsoils have very heavy clayey textures.

Regarding their chemical properties, the soils have relatively high acidity as compared with the natural levee soils. Their cation exchange capacities range between 7 to 14 milligram equivalents per 100 grams of soil, and their base saturation degrees vary from 27 to 50 per cent. The contents of humus, available nitrogen and phosphoric acid, and exchangeable bases are rather few and insufficient for the vigorous growth of common crops.

In the light of these chemical properties the inherent fertilities of these soils are not so rich in common, and proper fertilization is necessitated for the profitable culture of irrigated plants on them.

In regard to their hydrodynamic features, these soils have very high available moisture holding capacities ranging from 35 to 50 per cent by volume and low basic intake rates of about 0.6 millimetres per hour. In view of these facts, these soils are considerably suitable for the culture of paddy rice plants by applying the check border irrigation method or flood irrigation method.

The latter soil group or the ancient alluvial lateritic soils develop on the gently undulating upland occupying the southern part of the survey area. These soils extend over about 400 hectares with proportional extent of about 23 per cent of total survey area.

The soils of this group have been derived from old alluvial deposits through the weathering process of laterization. Then, the

specific illuvial horizon or B horizon with accumulation of iron oxide and aluminium oxide in various forms with as pulverized dots or pisolites or iron concretions.

As to texture, the surface soils have rather coarse textures such as loamy fine sand or sandy loam, and the soils of underlying horizons have heavy textures such as silty clay or light clay with the exception of illuvial horizons consisting of pisolites or iron concretions.

Regarding chemical properties, the soils have rather strong active acidity with pH values ranging from 4.5 to 5.2 and potential acidity of 3.5 to 4.5 in pH value. Their cation exchange capacities are very low and ranging from 5.0 to 9.0 milligram equivalents per 100 grams of soil and their base saturation degrees are also very low and varying between 20 to 40 per cent. The soils contain few humus and other nutritious components. Under these circumstances, the inherent fertilities of these soils are lower than those of the other soils in the survey area, and so, relatively large amount of fertilizer should be applied for the irrigated culture of common crops on the land of this soil group.

As to their hydrodynamic features, the soils have rather low available moisture holding capacities ranging from 8 to 30 per cent by volume and relatively high basic intake rates with range between 40 to 80 millimetres per hour.

Accordingly, the contour ditch irrigation method and furrow irrigation method are adaptable for the application of irrigating water on the field of these soils.

Based upon the above mentioned survey results, the lands in the survey area are rated and separated into five classes according to the land capability in the light of the fertility, workability, conservability, irrigability, and drainability. The rating of land capability and the area of each class are tabulated as in the following.

Table 3.3 Rating of land capability and area by rating class

Rating grade	Soil grouping	Essential characteristics	Area (ha)	Proportional extent (%)
Class I.	Recent alluvial natural levee soils: Type 3: Phase C	Very deep, medium textured, high workable, high irrigable, high drainable, non-erodible, fairly rich in inherent fertility, very rarely flooded, very suitable for irrigation farming of common tropical crops.	200	11.6
Class IIA.	Recent alluvial hydromorphic soils: Type 2: Phase B	Very deep, medium to fine textured, fairly workable, slightly high irrigable, slightly low drainable, nonerodible, slightly rich in inherent fertility, annually flooded, suitable for submerged culture of paddy rice.	650	37.8
Class IIB.	Ancient alluvial lateritic soils: Type 5: Phase G	Deep, medium textured, workable, fairly irrigable, high drainable, slightly erodible, rather poor in inherent fertility, nonflooded, suitable for irrigated culture of common crops.	190	11.1
Class III.	Recent alluvial hydromorphic soils: Type 1: Phase A Recent alluvial natural levee soils: Type 3 : Phase D	Very deep, medium textured, hardly workable, high irrigable, very low drainable, non-erodible, fairly rich in inherent fertility, serious in annual flooding, suitable for submerged farming of paddy rice.	470	27.3

Rating grade	Soil grouping	Essential characteristics	Area (ha)	Proportional extent (%)
Class IV.	Ancient alluvial lateritic soils: Type 4: Phase F	Slightly shallow, fairly coarse textured, fairly workable, slightly low irrigable, high drainable, slightly erodible, poor in inherent fertility, non-flooded, suitable for contour ditch irrigation or furrow irrigation culture of dry field crops.	140	8.1
Class V.	Ancient alluvial lateritic soils: Type 4: Phase E	Very shallow, very coarse textured, hardly workable. low irrigable, high drainable, slightly erodible, poor in inherent fertility, nonflooded, hardly profitable for irrigation culture of common crops, suitable for perennial crop culture or pasture.	70	4.1
Total			1,720	100.0

3.5 Hydrology

3.5.1 Nam Ngum

The Nam Ngum is one of the main tributaries of the Mekong, and it has a total length of about 420 kilometers and a catchment area of 17,400 square kilometers. The river has many bends and flows meanderingly, especially on the downstream of B. Pa Kanioung for a distance of about 150 kilometers. The project area is situated on the right bank of the river in the middle part of the 150-kilometer course.

The river-bed gradient of the Nam Ngum is about 1/10,000 on an average beweeen B. Pa Kanioung and B. Tha Ngon, and about 1/25,000 beweeen B. Tha Ngon and B. Pak Ngum where the Nam Ngum unites with the Mekong. Concerning the course beweeen B. Tha Ngon and B. Lat Khouei, it was confirmed from the actual measurement of water level during the dry season and from the flood marks observed that there is a head of some 50 centimeters both in the dry and wet seasons, which is equivalent to a gradient of 1/20,000.

The water level and the discharge of the Nam Ngum have been observed at B. Tha Ngon and B. Pa Kanioung since 1960. The records of mean monthly discharge for 8 years (1960 - 1967) are shown in Table 3.4 for each station.

The table shows that the discharge during the 6-month dry season is only about 13 percent of the annual discharge. The ratio of each monthly discharge to the annual during the wet season (May to September) is larger for Pa Kanioung than Tha Ngon, and vice-versa in the dry season. The fact indicates clearly that the vast lowlying marshy lands beween B. Pa Kanioung and B. Tha Ngon functions as a natural retarding basin.

Table 3.4 Mean Monthly Discharge of the Nam Ngum River

Station	Tha Ngon		Pa Kanioung	
	Mean discharge (m^3/sec)	Rate (%)	Mean Discharge (m^3/sec)	Rate (%)
May	150	1.92	151	2.18
June	760	9.73	706	10.21
July	1,299	16.63	1,278	18,49
August	1,816	23.25	1,728	25.00
September	1,855	23.75	1,694	24.51
October	851	10.90	517	7.48
(Sub total for Wet season)	(6,731)	(86.18)	(6,074)	(87.87)
November	407	5.21	302	4.37
December	219	2.80	176	2.55
January	153	1.96	120	1.74
February	117	1.50	92	1.33
March	95	1.22	74	1.07
April	88	1.13	74	1.07
(Sub total for Dry season)	(1,079)	(13.82)	(838)	(12.13)
TOTAL	7,810	100.00	6,912	100.00

The water level of the Nam Ngum measured during the past 8 years and the maximum flood stage in each year at Tha Ngon are given in Fig. 3.1 and Table 3.5, respectively.

Table 3.5 Flood Stage at Tha Ngon

Year	Flood stage (El. m)
1960	165.59
1961	167.17
1962	163.90
1963	167.42
1964	165.99
1965	165.80
1966	168.50
1967	165.52
Average	166.24

The estimation of probable flood stage of the Nam Ngum at Tha Ngon was made based upon the data given in the above table, and the results are shown in Table 3.6.

Table 3.6 Probable Flood Stage at Tha Ngon

Return period (year)	Flood stage (El. m)
2	166.2
5	167.3
10	167.8
20	168.2
50	168.7

In this calculation, the flood stage at elevation of 168.50 meters, which occurred in 1966, has been excluded, as the value is considered too large as compared with others. The results show that it would correspond to a 35 year-flood stage.

The reliability of the calculation on the probable flood stage was shown by inspections which were made during the two month period from November to December 1968, and the results of which are briefly described hereunder.

i) Flood with similar magnitude as that of 1966 has never been observed in the past 40 years.

ii) Flood which overflows the natural levee along the Nam Ngum at the upstream side of the Project area occurred with a frequency of once in 4 or 5 years in the past years. In other word, flood stage with an elevation of about 167 meters will have one-in 4 or 5 years frequency.

iii) Flood in the normal year did not overflow the natural levee. The fact shows that the flood stage was less than 166.5 meters in elevation.

On the other hand, the flood discharge of the Nam Ngum is expected to be regulated to some extent by the completion of the Nam Ngum Dam. According to the Feasibility report on the Multi-purpose Nam Ngum Project, the flood stage at Tha Ngon after regulation is estimated as shown in Table 3.7. However, the figures in the table are only tentative, and will be subjected to amendment after more accurate data are collected and analysed.

Table 3.7 Assumed Flood Stage at Tha Ngon after completion of Nam Ngum Dam

Return Period (year)	Before Regulation (El. m)	After Regulation (El. m)
5	167.3	166.8
10	167.8	167.3
20	168.2	167.7
50	168.7	168.2

3.5.2 Nong Sam Kha Stream

The H. Nong Sam Kha is the only stream in the Project area which flows eastward on the southern side of the area and unites with the Nam Ngum near B. Lat Khouei. During the rainy season, the water stage of the Nam Ngum is generally higher than land elevation in the Project area. Therefore, the water of the Nam Ngum backflows from the mouth of the H. Nong Sam Kha and submerges the project area.

The drainage area of the H. Nong Sam Kha is about 23.6 square kilometers at the confluence. Even though the backflow from the mouth of the H. Nong Sam Kha is completely prevented, the project area will be still submerged by the runoff from the H. Nong Sam Kha basin to some extent during the rainy season, which occurs at the same time as the high water period of the Nam Ngum.

Flooding water level in the project area is estimated on the basis of only the runoff[/1] from the H. Nong Sam Kha for 8 years from 1960 to 1967 as given in Fig. 3.1, and the highest water level in each year is shown in Table 3.8. Probable flooding water level estimated based upon the table is shown in Table 3.9.

Table 3.8 Highest Water Level in the Project Area in Each Year

Year	Water level[/2] (El. m)	Submerged area[/2] (ha)
1960	164.94	850
1961	164.62	760
1962	163.22	300
1963	164.00	580
1964	163.60	430
1965	163.58	420
1966	165.38	940
1967	164.26	650
Average	164.20	620

/1: The runoff from the H. Nong Sam Kha is estimated from the precipitation observed in Vientiane under some assumptions.

/2: The water level and submerged area are estimated by using the elevation-volume and elevation-area curves shown in Fig. 3.2

Table 3.9 Probable Water Level in the Project Area

Return Period (year)	Water level (El. m)	Submerged area (ha)
2	164.4	700
5	165.1	870
10	165.5	920
20	165.8	950
50	166.2	960

Fig. 3.1 HYDROGRAPH OF THE NAM NGUM RIVER AND FIOODING WATER LEVEL IN THE PROJECT AREA

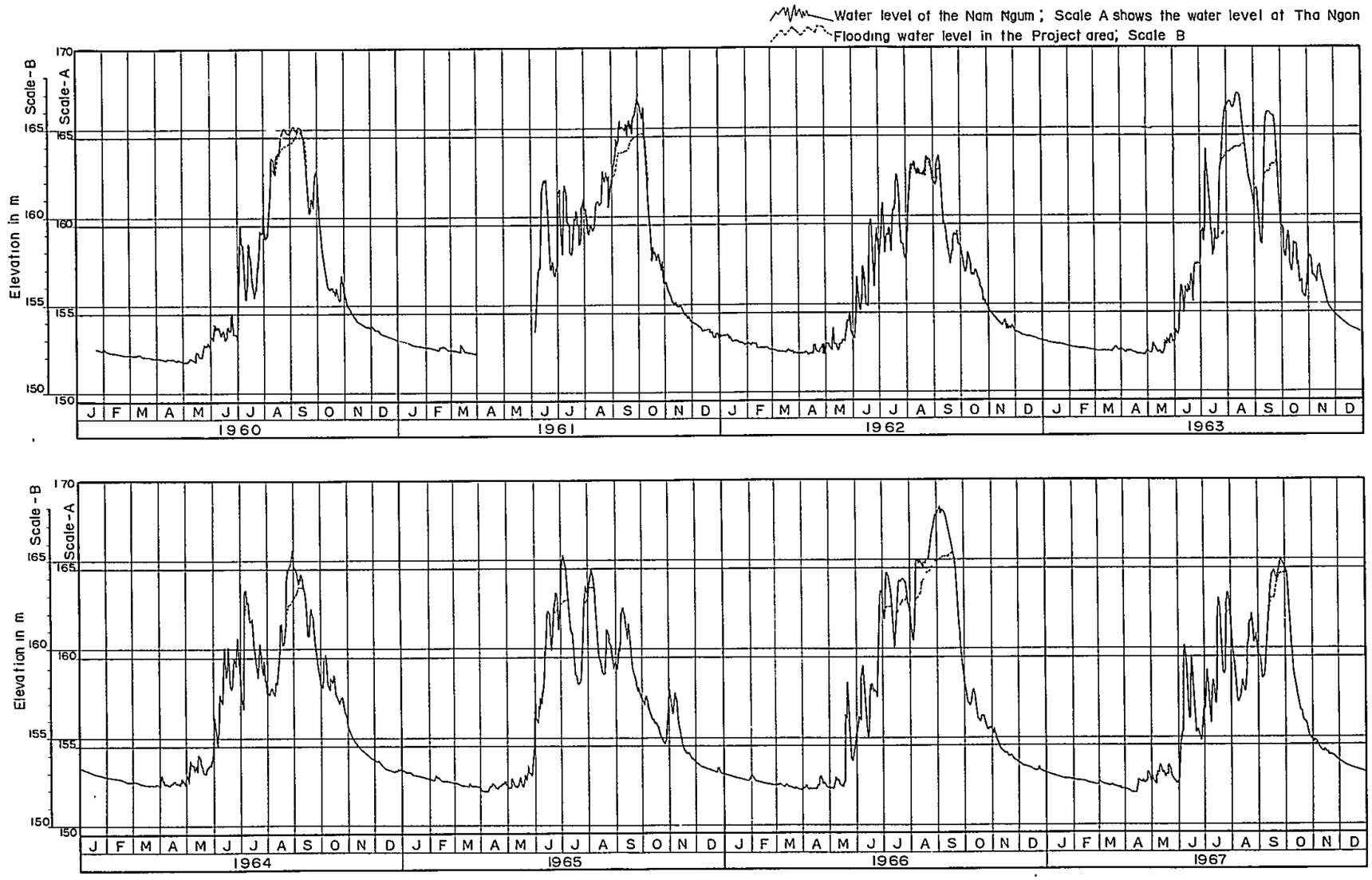
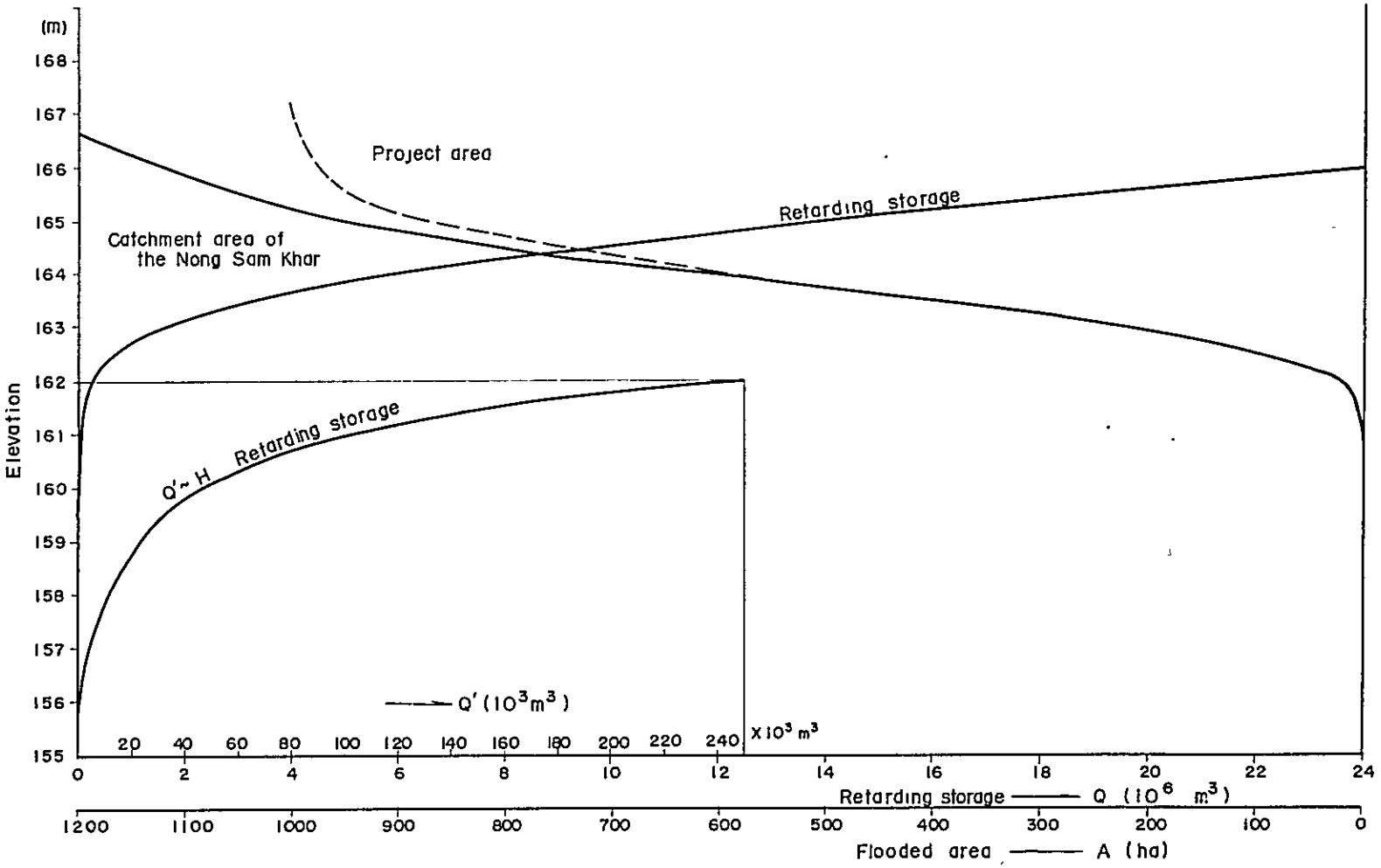


Fig. 3. 2 RETARDING STORAGE AND FLOODED AREA IN THE PROJECT AREA



CHAPTER IV PRESENT CONDITION OF AGRICULTURE

4.1 General

There are four hamlets, i.e. B. Tha Ngon, B. Tha Som Mo, and B. Lat Khouei are situated along the right bank of the Nam Ngum, and B. Nong Sam Kha is located on the some elevated land of the right bank of the Houei Nong Sam Kha. It is estimated that the total number of households in the abovementioned four hamlets is 260 with a total population of about 1,500.

Most of the inhabitants are engaged in paddy cultivation, and many of them are also occupied in fishery and forestry. They do the fishing on the Nam Ngum, other rivers and ponds. Forestry includes felling of trees for timber and charcoal.

In Ban Tha Ngon, there are two public institutions, the Crop Experimental Station of the Agriculture Service and the Lao-Japan Agriculture and Livestock Farming Training Center where the tests and training on the intensive farming including irrigation, application of fertilizers, and mechanization are being conducted.

4.2 Land-use

The project area is covered mainly with forest, grassland and shrub as shown in the following table and the land use map in and around the project area is shown in the attached Plate No.13.

Classification	Surveyed area	Project Area
a. Forest	740 ha	190 ha
b. Grassland	290	290
c. Shrub	580	500
d. Others	110	20
Total	1,720	1,000

The present land-use of the land classified by vegetation is as follows.

a) Forests: These forests exist on the natural levee on the northern side and on upland on the southern side of the project area above 165 meters in elevation, and are being used for obtaining timber and wood for making charcoal. A part of these land has been reclaimed where upland rice, banana, maize, other fruits and vegetables are being cultivated.

b) Grassland: The grassland lies in the center of the project area and is covered with cogan grass and others. This area is entirely flat and is inundated every year by flood from the Nam Ngum during the rainy season.

Consequently, only about 20 hectares of some elevated land are being used for paddy cultivation during the rainy season.

c) Shrub: Shrubs are found on the lowland along the H. Nong Sam Kha and its tributaries and shrubs, 2 to 3 meters high, are growing thick. Most of the land is not used.

On the other hand, most of the farmland surrounding the project area is being cultivated for paddy field during rainy season and wasted during the dry season due to the shortage of water. The upland rice is only cultivated on the land newly reclaimed and some upland where the rain water is extremely difficult to be held. Vegetables and fruits are cultivated on a small scale along the natural levee of the Nam Ngum.

4.3 Method of Cultivating

Paddy and upland rice, which are the main crops in the vicinity of the project area, are being cultivated in the following manner.

a) Paddy: The cultivation of paddy is proceeded by man power and domestic animal. Nursery bed is prepared from the beginning to the middle of June, transplanting from the middle of July

to the middle of August, and harvesting from the middle of November to the beginning of December. Practically no fertilizer, weeding, pest control and other control measures are applied. Rice plants harvested are dried on land, and threshing is done by man power.

b) Upland rice: Upland rice is planted after clearing the upland forest land by slashing and burning method. Planting is done in May or June in the early rainy season. Harvesting is done in October and November. The land is so exhausted that it usually left unused for 3 to 5 years after using for one season.

4.4 Yield

Data on the Yield of crops in the project area are scarce. According to the paddy yield investigation along the national road between Tha Ngon and Vientiane conducted in 1967 by the Lao-Japan Agriculture and Livestock Farming Training Center, the average yield was 1.7 tons per hectare. Our paddy yield investigation at B. Tha Ngon, B. Tha Ngon Na, B. Tha Som Mo and B. Lat Khouei showed that average yield was less than 0.95 ton per hectare.

4.5 Livestock

Stocks raised in the farms around the project area are baffaloes, cows, ducks and chickens. Baffaloes are mostly used for field works, while cows are used for transportation. These cattle are usually grazed in the forests and plains, and also on paddy field in the dry season. Straw is the only fodder given to the cattle. Cows are raised not for the purpose of selling them, they are sold only when they are to be replaced by young cows. Most of the poultry is for home consumption.

4.6 Farm Size

Most of the farmers in the project area have 2 to 3 hectares of farm land. Generally a family consists of 6 to 7 persons of which

2 to 3 are above the age of 15. Those farmers owning large farms employ hired labor, and the wages[/1] are paid either in kind or in cash.

4.7 Farm Receipts

The agriculture practised around the project area is on the subsistence level and it is very difficult to analyse the farm budget. The report[/2] prepared by J.D. Drilon Jr. indicates that the annual income of each villager in Laos is 55.43 U.S. dollars which is only 50 percent of the annual income of each person in urban districts. Our investigation has revealed that the annual farm receipts are US$100 to 200.[/3] As this amount of annual farm receipts alone is not sufficient for the farmers to make their living, they are supplementing the shortage by engaging themselves in fishery, wage labor, charcoal making, etc.

4.8 Market for Agricultural Products

Though Tha Ngon area is located only 25 kilometers away from Vientiane, its agricultural production is no better than the subsistence level, and no production aimed at the supply of agricultural products to other towns and cities is being promoted in this area.

The only market in the Tha Ngon area is located at the ferry station of the Nam Ngum River on the Vientiane to Pa Kanioung highway. The scale of this market is very small, and only the surplus vegetables and fruits left over by the farmers after reserving those for their own use are sold.

/1: The daily wage if paid in cash is 250 -- 300 Kips (equivalent to US$0.5 - 0.6)

/2: See footnote on national income and prices under Para. 2.3.5 of Chapter II.

/3: Estimated from the price of unhulled rice in B. Tha Ngon as of January 1968, which was US$75/ton.

CHAPTER V PROSPECTIVE FARMING PROGRAM

5.1 General

As described previously, the lowland in which the project area lies is the same as the one covering an area of 5,000 hectares and selected as being suitable for paddy rice culture in the First Stage Irrigation Plan of the Vientiane Plain under the Nam-Ngum Multi-purpose Development Project.

As the weather conditions of the area are favorable for raising paddy rice and the proposed area is close to the source of water and would not involve excessive pump lift, being located adjacent to the right bank of the Nam Ngum between the elevation of 163 and 167 metres and being a flat area consisting of alluvial soils with high available moisture capacity, it can be said that the project area would become one of the most suitable areas for paddy rice culture through proper installation of drainage and irrigation facilities.

However, most of the farmers around the project area possess 2 to 3 hectares of land, which is generally cultivated with paddy rice during the rainy season and used as pasture during the dry season, as previously explained in Chapter IV. Thus, the yield of crops is rather low.

In view of improving such conditions, special considerations were given to the following in preparing the prospective farming programme.

(a) Modern farming of land directly by the farm owner.

(b) Extension of improved technics to harvest two crops a year under proper management.

(c) Farm mechanization

(d) Setting-up of farmer's organization such as the farmer's association, agricultural cooperative association, etc.

5.2 Cropping Pattern

It has been assumed that the entire area would be cropped with paddy rice, which has been taken up as the main crop for the self-sufficiency of food by the farmers and the increase of food production to meet the growing demand of the country, in framing the cropping pattern.

The cropping pattern presented in Fig. 5.1 has been worked out in due consideration of the physical conditions of the project area and espècially the liability of the land within it to be submerged during the flood period.

In this connection, the following two cases have been contemplated in the preparation of the cropping pattern:

(a) the possibility of growing paddy rice in both rainy and dry seasons, which will be rotated with one green manure crop to help maintain the fertility of the soil, by constructing complete drainage and irrigation facilities;

(b) the possibility of raising paddy rice in both dry season and rainy season by reducing the scale of the drainage facilities, i.e. by laying land fallow during the flood period (August and September).

The result of the study shows that harvesting of two crops of paddy rice a year would be possible in both cases/1 Therefore, the latter case has been adopted.

As for rice varieties, the currently grown varieties are not considered to be suitable for raising two full harvests a year, owing to their photoperiodic sensitivity, their long maturation period and liability to lodging in response to the application of large amount of fertilizer in view of obtaining higher yield.

/1; In the first survey report, it was planned so that paddy rice culture would be carried out only in the rainy season and dry crops would be grown during the dry season in case of (b) owing to the fear that the fall in temperature (December to February) in the dry season would prevent the favourable growth of paddy rice. However, the results of the this survey show that rice growth and yield would hardly be affected by such fall in temperature.

The introduction of improved rice varieties with favourable characteristics has then be decided under the mechanized farming contemplated in this agricultural development plan. Among them, the IR - 5, IR - 8, Gampaihybrid and C_4 - 63 were adopted as suitable varieties taking due consideration of the desire of the Royal Government and the data from the Salakham Experimental Station.

The IR - 8, which is one of them, is already recommended and diffused in Laos for production of two crops a year and its raising has given favourable results. Other varieties among them are also expected to be recommended and diffused in the future.

5.3 Adapted Standard Farm

The general plan for management of the individual farms will depend on their area; the lack of heavy settlement and population pressure on the land of the project area leaves the way clear for farm units of the size and type needed for efficient irrigation systems, modern mechanized production, efficient storage and marketing of farm products. These conditions would permit the establishment of large scale farm units.

However, in due consideration of the farm units existing in the vicinity of the project area and the necessity of spreading the modern agricultural technics to be introduced among these farmers, the most adapted standard farm considered would be a family-sized farm with a holding of 2 hectares of land, utilizing middle scale farm machines which will be purchased and owned by a farmers' organization.

5.4 Annual Farm Budget

The annual farm budget is analysed for the purpose of evaluating the benefits in the form of profits earned on the standard farm from the construction of irrigation and drainage facilities and the supply of irrigation water.

With the advance of improved irrigation farming, the farm products will increase year by year and the farm budget until the production has attained the target in the 5th year of farming is shown in Table 5.4.

The details of the farm receipts and farm expenses, as well as the capacity to pay from the 5th year of the farming, are given below.

5.4.1 Annual Farm Receipts

The annual farm receipts are the product of the estimated price of the farm products by the anticipated annual quantity of these products and are estimated to be approximately 1,395 U.S. dollars per farm unit of 2 hectares of land as shown below.

Table 5.1 Annual Farm Receipts

Kinds of crops	Cropped area (ha)	Yield/1 (t/ha)	Production (tons)	Unit price/2 (US$/t)	Total price (US$)
Paddy rice	3.8	5.0	19.0	65	1,235
Vegetables	0.2	10.0	2.0	80	160
Total					1,395

/1: According to the result from the Salakham Experimental Station and the data from neighbouring countries, it is quite possible to have an yield of 5 tons of paddy rice per hectare and per crop from the 5th year and thereafter of the completion of the project even if the planting in August and September is avoided, as mentioned in the case (b) of Section 5.2 and by using such improved rice varieties as indicated in the said Section. In addition, an increased yield of about 10 percent, i.e. about 5.5 tons of paddy rice per hectare and per crop, could be obtained by planting green manure to help maintain the soil fertility as stated in the case (a) of Section 5.2.

/2: The prices of agricultural products have been estimated based on the domestic wholesale prices and prices of imported agricultural products in Laos.

5.4.2 Annual Farm Expenses

The farm expenses are estimated for the purpose of determining the estimated normal repayment ability of the farmers (hereinafter designated as "capacity to pay") for the irrigation water use.

However, the necessary costs involved in the construction of the irrigation and drainage facilities for this project, the supply of irrigation water to the farm units in the project area, as well as the equivalent amortization charges for the repayment of the loan obtained for the initial farm investment necessary for the farm operation are not included in these farm expenses.

In order that good farm receipts as indicated above may be derived, adapted irrigation farming practices such as efficient water use, fertilizer and agricultural chemical use, utilization of improved farm machinery, implements and tools, and introduction of utilization of improved crop varieties should be adopted by the farm operators.

The annual farm expenses required for the operation of farm units under conditions stated above would be approximately 1,096 U.S. dollars per farm unit of 2 hectares of land.

Table 5.2 Annual Farm Expenses

Expense items	Amount (U.S.$)
A. Agricultural operating costs	
1. Seeds produced and used on the farm /1	15
2. Seeds purchased /2	10
3. Commercial fertilizers purchased /3	240
4. Agricultural chemicals purchased /4	60
5. Farm tool depreciation	25
6. Payment for field works carried out with machinery on work contract /5	290

(to be continued)

Expense items	Amount (U.S.$)
7. Farm shed depreciation	18
8. Miscellaneous items/6	18
Sub-total (A)	676
B. Family living allowance	
1. Goods produced on the farm and consumed by the farmer	130
2. Consumption within the home of goods and services not produced on the farm	210
3. Public imposts and taxes/7	14
4. Insurance	8
5. Farm building depreciation	40
6. Sundry items/8	18
Sub-total (B)	420
C. Total expenses (excluding water charge)	1,096

/1: About 1 per cent of the amount of farm receipts.

/2: About 60 per cent of the seeds produced and used on the farm.

/3: Fertilizer requirement was estimated based on the data from the Salakham Experimental Station, the Lao-Japan Agriculture and Livestock Farming Training Center at Tha Ngon, the Agricultural Technical Center of the Khmero-Japanese Friendship in Battambang (Cambodia), and the International Rice Research Institute in Philippines, as follows:
- 500 kg of Ammonium sulphate per hectare of crop.
- 500 kg of Calcium superphosphate per hectare of crop.

/4: Seresan, BHC, etc., of about U.S.$ 15 per hectare of crop.

/5: Payment for field work carried out with machinery on work contract was computed based on operation and maintenance expenses of machinery met by the agricultural cooperative.

/6: About 5 per cent of the total of items (1) to (5) of the agricultural operating costs.

/7: About 1 per cent of the amount of farm receipts.

/8: About 5 per cent of the total of items (1) to (5) of the family living allowance.

5.4.3 Capacity to Pay

The annual capacity to pay, as shown in Table 5.3, is the difference between farm receipts and farm expenses.

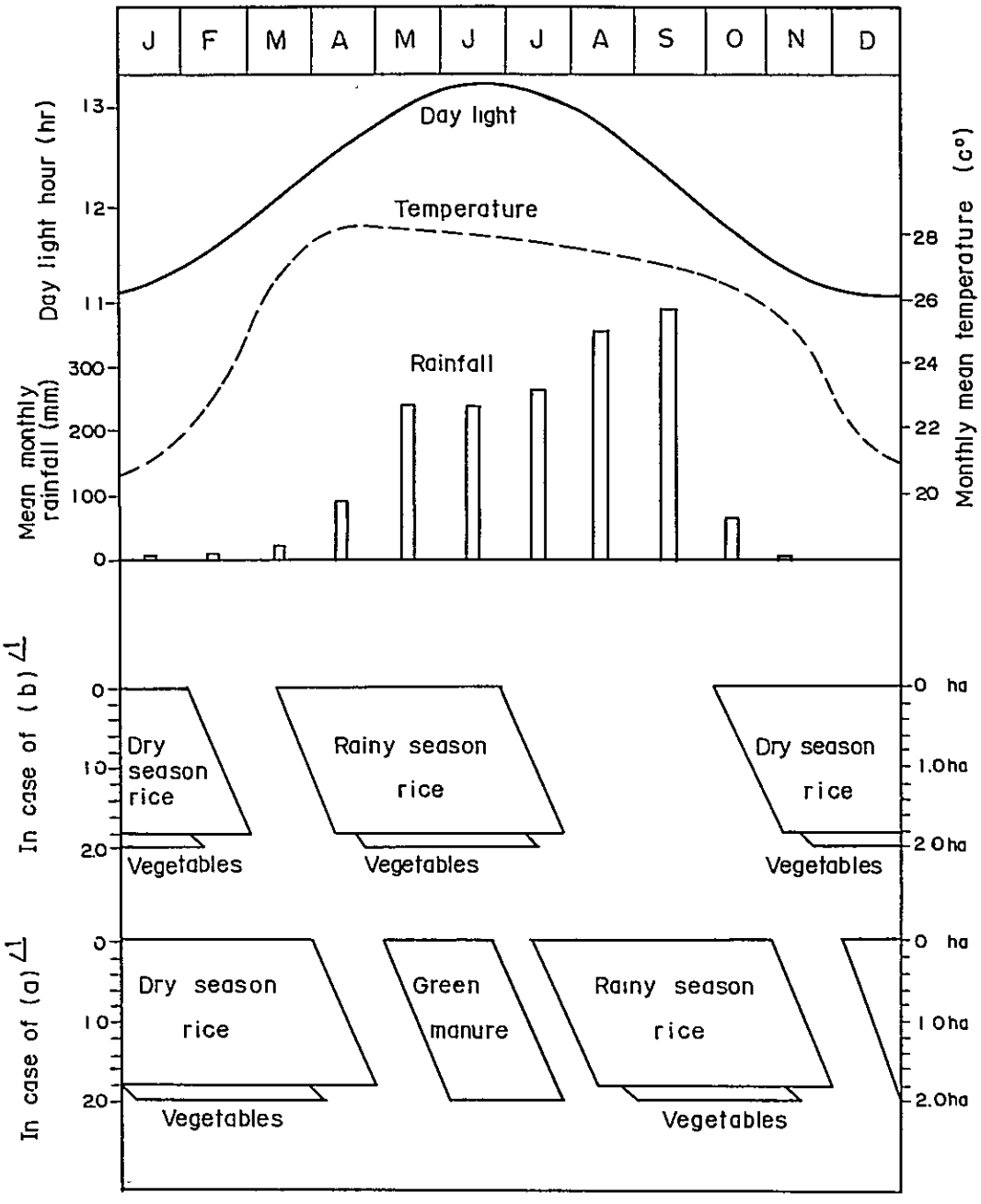
Table 5.3 Annual Capacity to Pay

Item	Amount (U.S.$)
A. Farm receipts	1,395
B. Farm expenses (exclusive of family living expense)	676
Gross farm income	719
Family living expense	420
C. Capacity to pay	299

Table 5.4 Annaul Farm Budget from 1st Year to 5th Year

	1st	2nd	3rd	4th	5th
A. Farm Receipts					
1) Paddy rice	429	898	1,063	1,175	1,235
2) Vegetables	128	160	160	160	160
Sub-total	557	1,058	1,223	1,335	1,395
B. Farm Expenses					
1) Agricultural operating costs	367	676	676	676	676
2) Family living allowance	190	290	330	390	420
Sub-total	557	966	1,006	1,066	1,096
C. Capacity to pay	0	92	217	269	299

Fig. 5.1 CROPPING PATTERN



∠1 : See page 36

5.6 Pilot Farm and Farmers' Ogranization

(1) Pilot Farm

In order to increase the agricultural production and the amount of farm receipts as contemplated in the prospective farm programme, it is necessary that all farmers in the project area become proficient in raising two crops a year by irrigation. On the Vientiane Plain at present, there are a few farmers benefited by the aid of the Royal Government, the USAID, etc., who try to put in practice irrigation farming, by applying manure, but almost all farmers have no experience in cultivating two crops a year by means of irrigation.

Therefore, it will be necessary to establish a pilot farm on an adequate scale of about 100 hectares, in parallel to the execution of agricultural development project in the Tha Ngon area. The setting up of the pilot farm would be made under the Technical Cooperation between the Royal Government and Japanese Government, and about 4 members of the Japanese agricultural specialists (rice crop, irrigation, agricultural management, extension, etc.) together with about 10 members of the Japanese Overseas Cooperation Voluteers (in rice crop, horticulture, kitchen-gardening, irrigation, stock-raising, agricultural management, farm machinery, etc.) would be sent over there for accomplishing the following items by taking into account the results from the Lao-Japan Agricultural and Livestock Parming Training Center, the Salakham Experimental Station, etc.:

1. Practical management of irrigation and drainage facilities and efficient water control.

2. Field tests on the feasibility of adopting the raising of two crops of paddy rice in a year (including the selection of crop varieties improvement of culture method, establishment of culture method standard, farming of cropping pattern and rotation, determination of proper farm scale, etc.)

3. Guidance and training of Laotian extension technicians, (including training in Japan).

4. Demonstration of the favourable results in putting in practices of improved irrigation farming to the farmers.

In addition of the role as an agricultural guidance organization to be played by the pilot farm, it is hoped that it will at the same time give guidance in the operation and maintenance of the irrigation and drainage systems and in organizing farmers' association, etc.

(2) Farmers' Organization

For the increase of agricultural production and farm receipts, the development of farmers' organization coupled with the extension of agricultural techniques would be necessary.

To achieve this aim, the setting-up of water users' association that will be in charge of efficient control of water, maintenance and operation of irrigation and drainage facilities, as well as an agricultural association in charge of the supply of agricultural implements and materials, the storage, processing and sales of farm products, repayment of loans, etc., should be contemplated. For the creation and operation of the farmers' organization, the aforesaid Japanese agricultural specialists and Japanese Overseas Cooperation Volunteers will take charge of guidance.

Almost no farmers' organization exists at present in Laos. However, ADO (Agricultural Development Organization), established in 1965 under the Lao - U.S. joint management, is attending the supply of agricultural implements and materials to farmers. As to large-sized pumps, this joint organization does not loan them direct to individual farmers, but to groups of farmers.

Such farmers' organization as recommended herein should be developed by taking into account the businees activities of ADO.

CHAPTER VI IRRIGATION AND DRAINAGE

6.1 General

Because of inundation of the area mainly caused by the Nam Ngum in the wet season and of shortage of water in the dry season, the Project area is mostly unexploited, excepting some lands used for the rainfed culture of paddy rice in the wet season. The key to development of agriculture in the area lies in controlled removal of excess water and irrigation.

The net irrigable area is decided as 800 hectares/1 due to the topographic reason. The water required for irrigation of this area will be pumped up from the Nam Ngum and conveyed to farmland through the lateral canals branching off from the two main canals running on the north and the south of the Project area, respectively. This irrigation system will make possible to cultivate the farmland even during the dry season.

While, it will be necessary to avoid flooding of the area by the Nam Ngum in the wet season. For this purpose, the construction of flood protection embankment and flood gate is contemplated on the natural levee along the Nam Ngum and at the mouth of the H. Nong Sam Kha, respectively. Even if both the flood gate and flood protection embankment are constructed, however, the lower parts of the area will be still inundated by the runoff from the catchment area of the H. Nong Sam Kha including the Project area. This problem can be solved by avoiding the cropping in August and September./2

Construction of both road system and power distribution line will also be essential items for introducing mordern agriculture into the Project area. The road system proposed consists of the main and secondary

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/1: Total area is 1,000 hectares, but since 20% of the area is estimated to be used for ridges, canals and farm roads, etc., the net area is 800 hectares.

/2: See footnote /2 in page 52.

roads. The main road is arranged to connect the farmer's residential areas to B. Tha Ngon, passing through the center of the Project area. The secondary roads are constructed, branching off from the main roads. Also, the flood protection embankment can be used as a road. The road system will secure traffic between the farmer's residential area and the farmlands as well as outside of the Project area.

Two distribution lines will be constructed for the Project, branching off from the transmission line to be installed between Vientiane and B. Tha Ngon. The distribution lines will supply not only the pumping plant, but also the farmer's residental areas, rice mills, repair shops, etc., contemplated to be provided in parallel with the construction of the Project with electric power.

The following is the outline of the main works of the Project;

(1)	Net irrigable area	800 ha
(2)	Intake structure	
	Pump:	2 units
	Type	Submersible pump, ϕ450 mm
	Head	Actual head 15.25 m
		Total head 20.00 m
	Capacity	28.5 m^3/min/unit
	Motor:	145 KW x 2
	Regulating pond:	Effective storage 10,000 m^3
		H.W.L. 168.25 m, L.W.L. 167.25 m
	Location:	About 2 Km N.N.E. of B. Tha Ngon
(3)	Irrigation canals	
	Main canal:	2 Nos.
	Total length	9.0 Km
	Discharge	790 - 200 ℓ/sec
	Type	Earth canal with trapezoidal section of 0.5 - 1.0 m depth and bottom width (A part is concrete lining canal)
	Lateral canal:	10 Nos.
	Total length	10.0 Km

Discharge	Max. 150 ℓ/sec
Type	Earth canal with trapezoidal section of 0.3 - 0.7 m depth and bottom width (A part is concrete lining canal)

(4) Flood protection embankment

Crest elevation	El. 167.0 m at the upstream end and 166.5 m at the lower end
Crest width	4.00 m
Length	9.0 Km

(5) Flood gate

Culvert	Double box type each 2.00 x 2.40 m
Gate	1-steel gate 2.00 x 5.00 m, electrically driven hoist

(6) Drainage canals

Main canal

Length	4.0 Km
Type	A large portion is the natural stream widened and reshaped

Lateral canal

Length	6.0 Km
Type	Most of the canals are natural stream widened and reshaped, and the canals to be constructed newly are of trapezoidal section with minimum depth and bottom width of 1.5 m, respectively.

(7) Road system

Main road

Length	10.0 Km
Dimension	Overall width 6.00 m, effective width 5.00 m, average height of embankment 0.50 m

Secondary road

Length	30.0 Km
Dimension	Overall width 4.00 m, average height of embankment 0.30 m

(8) Power distribution line

Length (inside project area only) 11.0 Km

6.2 Irrigation Water Requirements

In making a new irrigation project, estimation of water requirements is required for deciding appropriate water-use and for the design of canals and other structures.

Calculation of water requirements is made in the following order:

a) Calculation of consumptive use of water and determination of percolation loss.

b) Calculation of effective rainfall and determination of conveyance loss.

With regard to the consumptive use of water, no measured values are available for the Project area. Therefore, calculation of the consumptive use of water is made by using the values of evaporation, which is considered to be closely related to the consumptive use. Effective rainfall is obtained by means of the USDA Method[/1], but the effective rainfall of the month, during which the precipitation is mostly of below 5 millimetres is regarded as zero. In consideration of the nature of the soil in the project area and the length of the canals, conveyance loss is taken as 20 per cent.

The water requirements calculated in the abovementioned order for the cropping plan given in Chapter V are as shown in Table 6.1. The detailed process of calculation and the explanations are as given in the Appendix C.

Table 6.1 Water Requirements (mm)

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Total
Consumptive use of water, water for puddling. percolation	240	214	233	194	14	151	320	170	151	28	1,715
Effective precipitation	25	-	-	-	-	-	77	106	107	24	339
Net requirements	215	214	233	194	14	151	243	64	44	4	1,376
Gross requirements	269	268	291	243	17	188	304	80	55	5	1,720

/1 USDA: United States Department of Agriculture

As shown in the above table, the maximum requirement occurs in April, which is equivalent to a discharge of 1.17 (say 1.2) litters per second per hectare. This value is used as the basic value in the design of pumping stations, irrigation canals, etc. under this project.

6.3 Irrigation System

6.3.1 Pumping Station and Regulating Pond

A pumping station is required for providing irrigation water for the Project area. The location of the pumping station selected as the most favorable is 2 kilometers downstream of Ban Tha Ngon, western edge of the Project area. The river bank at the site is sloping down to the riverbed at a gradient of nearly 1:2. The elevation of the top of the embankment is about 167 meters, and the site consists mostly of clayey soil.

The design of the pumping station is made in consideration of the fluctuation of the water level of the Nam Ngum, and particularly its safety in the flood period. The sump of the pumping station will be recessed back from the river's edge to avoid damages which may be caused by driftwood etc. during the flood period. The sump will be connected with the intake by culvert about 30 meter-long. The elevation of the top of the sump is decided as 165.0 meters to avoid submersion during its operation. At the intake, one steel gate and two screens will be installed.

Two units of submersible pump each having a head of 20 meters and capacity of 28.5 cubic meters per minute will be used for pumping. Each pump will be driven by 145 kilowatt motors fed by power to be supplied from the Vientiane Sub-station, and the pumps will work continuously for 24 hours per day in maximum.

The operation of the pumps will be conducted in an operating house to be located on the natural levee about 10 meter away from the sump. For the purposes of the easy operation of the pumps and of the

efficient use of irrigation water, a regulating pond will be constructed at the outlet of discharge pipeline, about 80 meters apart from the operating house. The capacity of the pondage is determined at 10,000 cubic meters. Irrigation water pumped up will be stored in the pond and then distributed to each of the north and south main canals.

The detailes of the pumping station are as given in attached Plate No.4.

6.3.2 Irrigation Canal

(1) Main canal

Two main canals will be constructed from the topographic reason. A main canal, named the North Main Canal, will be constructed along the natural levee of the Nam Ngum on the northern edge of the Project area. This canal will supply irrigation water to about 650 hectares of land. The length of the canal will be about 6.5 kilometers. The other is the South Main Canal with a length of about 2.5 kilometers which will be constructed along the slope of the upland on the southern side of the Project area, and will irrigate the remaining area of 150 hectares.

The greater part of these main canals will be of earth canal type with trapezoidal section having inside slope of 1:1.5, exepting for some parts where the concrete lining to a thickness of 10 centimeters will be applied from the topographical viewpoint. The lined canal is estimated at about 700 meter long on the North canal and 200 meters on the South canal, respectively. The inside slope of the lined canal will be 1:1.

The longitudinal slope of the main canals will be 1/3,000 to 1/4,000, and the capacity is determined on basis of the maximum monthly water requirements (1.2 litters per second per hectare in April) for 24-hour irrigation. Profile and dimension of the main canals are as given in attached Plate No.3.

Many related structures such as turnouts, check gates, spillways and culverts, etc. will be constructed. Standard types of these related structures are given in Plates No.5 to No.8, and their locations are as indicated in Plate No.3. The number of these structures is summarized below.

	North Main canal	South Main Canal	Total
Turnout	12	3	15
Culvert	13	3	16
Checkgate	3	1	4
Spillway	3	1	4
Cross drain	-	3	3

(2) Lateral canal

Irrigation water diverted by the turnouts provided along the main canal will be conveyed to the distribution ditches through the lateral canal.

Most of the lateral canals will be also of earth canal type, but some portions are lined with concrete due to topographical conditions. The section of the earth canal will be trapezoidal with inside slope of 1:1.25, and the lined canal will have rectangular section. Longitudinal slope of the lateral canals varies between 1/200 and 1/1,000.

The number of the canals and their lengths are given below.

System	No. of canals	Total length (Km)
Canals branching off from North Main Canal	9	8.0
Canal branching off from South Main Canal	1	2.0
Total	10	10.0

(Of the above, 2.0 kilometers is concrete lined canal)

6.4 Drainage System

6.4.1 General

As mentioned proviously, the project area is affected by flooding due to backflowing the water from the Nam Ngum during the rainy season. Therefore, drainage system is one of the most important items for the development of the Project area. Based on the analysis of the hydrologic data/1 and the result of the comparative study,/2 it is envisaged to provide the following facilities.

(1) Flood gate to prevent the backflow of water from the Nam Ngum from the mouth of the H. Nong Sam Kha.

(2) Flood protection embankment to protect against the flood flow of the Nam Ngum.

(3) Drainage canals of various types within the Project area

6.4.2 Flood Gate

The Houei Nong Sam Kha is the only natural stream in the Project area. The stream flows eastward on the southern end of the Project area and joins the Nam Ngum near B. Lat Khouei.

The elevation of the riverbed of the H. Nong Sam Kha near the confluence is about 156 meters. While, the water level of the Nam Ngum rises to more than 165 meters in every wet seasons. The water of the Nam Ngum, therefore, flows into the Project area.

/1 Hydrological studies are described in Section 3.5 "Hydrology" of this report and Appendix A.

/2 Even if those facilities are constructed, however, the lower parts of the area will be still inundated by the runoff from the H. Nong Sam Kha's basin including the Project area. For agricultural utilization of this area throughout the year, it may be considered that intercepting dam and canal and pumping system to prevent and to pump out such flooding water be provided. But, those facilities may serve for drainage for only two or three months a year while they require rather a large investment. Therefore, it is advisable to take up a specific cropping schedule that the second crop is harvested before the commencement of inundation period. Thus, two crops a year are obtainable in this area under irrigation without any particular installations. Comparative study on the structures is given in Appendix D.

through the mouth of the H. Nong Sam Kha and stagnates in the area during the wet season. In order to prevent from inundating the land, a flood gate will be provided at the mouth of the H. Nong Sam Kha, and it will be so operated as to protect the inflow from the Nam Ngum and to allow the outflow from the Project area.

The flood gate consists of a 10-meter long inlet channel, 33 meter long culvert and 18 meter long chute, and its total length is about 60 meters. A steel gate with 2 meter high and 5 meter wide will be installed in the middle part of the structure. Culvert is the double box type with 2.00 meter height and 2.40 meter width. The detailes of the flood gate are given in Plate No.10.

6.4.3 Flood Protection Embankment

As mentioned previously, the water level of the Nam Ngum fluctuates largely from about 152 meters in elevation in the dry season to 164 meters or more in the wet season. For the protection of the Project area from such high water level, the flood protection embankment will be constructed along with the installation of flood gate. The embankment will be constructed on the natural levee along the Nam Ngum. The crest elevation of the embankment is determined at 167.0 and 165.5 meters at the upstream and lowerstream ends, respectively, which is sufficient to protect against flood having about a one-in-eight-years frequency after the completion of the Nam Ngum dam. Crest width of the embankment will be 4.0 meters so that it can be used as a road. A slope of 1:2.0 is adopted both for the inner and outer sides of the embankment, and the length is about 9.0 kilometers.

Profile and standard section of the flood protection embankment are shown in attached Plate No.9, and its route is given in Plate No.2.

6.4.4 Drainage Canal

Drainage canals to be constructed for the Project consists of the main, lateral and field drains. The waste water from each farm will be led to field drains and will be collected in the main drain directly or through the lateral drains, and then carried away outside the Project area through the flood gate above-mentioned.

The main drain is composed of mostly the H. Nong Sam Kha, a part of which is widened and reshaped. The length is about 4.0 kilometers. A greater part of lateral drains will be installed utilizing the small tributaries of the H. Nong Sam Kha. The laterals to be constructed newly will have 1.5 meters of minimum depth and bottom width with trapezoidal section with inside slope of 1:1.5. The total length of the lateral drains is estimated at about 6.0 kilometers. Field drains at an interval of about 400 meters. This drain will have 0.6 meter of depth and bottom width with trapezoidal section.

The drainage system is as shown in attached Plate No.2.

6.5 Road System

For performing the proper irrigation farming, operating and maintaining the irrigation system and transporting the goods and supplies into or out of the Project area, the construction of road system is contemplated for the Project.

The proposed road network consists of the main roads and secondary roads. Two main roads will be constructed with a total length of about 10.0 kilometers. One is the road running from east to west through the center of the Project area, and it will joins the national road which leads to Vientiane. The other is the road which runs from south to north in the area slightly west of the center of the Project area and connects with the above-mentioned road.

Many secondary roads running almost perpendicularly to the main roads will be constructed at an interval of about 400 meters. The number of secondary roads to be constructed will be about 20, and its total length will amount to about 30 kilometers, including the flood protection embankment which can be used as a secondary road.

The width of roads will be 6 and 4 meters for the main and secondary roads respectively. The surface of the main roads will be paved with laterite material which is available in the southern part

of the Project area. In connection with the roads, the following bridges and culverts will be required.

	Bridge	Culvert
Main road	2	14
Secondary road	3	20
Total	5	34

The layout of the road system is given in Plate No.2. Typical cross section of roads and typical structures are shown on Plate No.8.

6.6 Power Distribution Line

As mentioned before, pumps driven by electric motors will be installed for irrigation purpose. Also, the rice mills, repair shops and farmer's residential areas etc. are the essential items for the introduction and smooth management of modern irrigation farming, and they will be established in keeping pace with the construction of the Project. These facilities and equipments will require much electric power.

Two plans are envisaged for electrification of the Project area. One is to construct a distribution line to supply power from Vientiane and the other is to install the diesel generators in each consuming district. The comparative study/1 on the above two discloses the former is preferable for the reasons of low annual cost, easy operation and maintenance, and others. Furthermore, the distribution line to be constructed will promote electrification of villages scattered along the line.

In planning the distribution line, a load of 720 kilowatts for the Project area and 320 kilowatts for the villages located along the road running between Vientiane and B. Tha Ngon are estimated. Voltage is planned to be set at 22 kilovolts which will be one of the standard voltages in Laos in the future. Hard-drawn aluminum stranded conductor of 55 square millimeters is

/1 See Appendix D

chosen as a conductor in view of the tensile load, voltage regulation, power loss, construction cost, etc., and steel pipe pole is selected as supporting posts. For the easy construction works, maintenance and inspection, the line should be constructed along the national road from Vientiane to B. Tha Ngon. The 22 kilovolts power from the Vientiane Substation will be stepped down to the lower voltage at each consuming district.

500 KVA transformer (3-phase, 22KV/380-220V) with switchgear will be installed at the pumping station. For the rice mills, repair shops, farmers' residential area etc., a transformer will be installed on the pole nearby each facility.

The route of the distribution line is shown in the attached Plate No.1.

6.7 Construction Materials and Transportation

6.7.1 Construction Materials

Quantities of main construction works for the project are estimated as follows.

Construction quantities

		Unit	Quantity
1.	Excavation, common	m^3	120,000
2.	Embankment	m^3	330,000
3.	Concrete works	m^3	2,950
4.	Form	m^2	16,000
5.	Reinforcement bars	ton	130
6.	Metal works	ton	25
7.	Concrete pipe	m	1,350
8.	Corrugated metal pipe	m	830
9.	Steel tubular pole	Nos	180

The main construction materials, equipment and machineries required for such construction works are as shown below.

Materials, equipment and machinery

		Unit	Quantity
1.	Cement	ton	950
2.	Reinforcement bars	ton	155
3.	Structural steel	ton	35
4.	Pumping equipment	ton	25
5.	Construction machineries	ton	100
6.	Distribution line equipment	ton	75
7.	Fuel and oil	kℓ	70
8.	Timber	m^3	950
9.	Gravel	m^3	2,800
10.	Sand	m^3	1,500

Of these materials and equipments, cement, reinforcement bars, structural steel including steel structures such as gates, iron pipe, trash rack, shutters, etc., pumping & distribution line equipments and construction machineries will be imported from abroad. The required quantities of timber, which is mainly used in formwork, are available in and near the Project area. Sand and gravel are mainly available from the Nam Ngum near by the Tha Ngon ferry site.

6.7.2 Transportation

All of the materials, equipments and machineries imported from abroad will be transported via Thailand. They will be unloaded at Bangkok and then transported from Bangkok to Nong Khai by railway or by road.

In Laos, B. Tha Deua, where Nong Khai is located at the opposite side of the Mekong, and Vientiane, about 23 kilometers are connected by a fairly good road with four lane. Two lane road is available from Vientiane to B. Tha Ngon for a distance of about 25 kilometers. These roads are sufficient for the transportation of the construction materials.

For the transportation between B. Tha Ngon and the job sites, existing ox-cartroad of 3 kilometer long will have to be widend and improved prior to the construction of the Project.

6.8 Construction Schedule

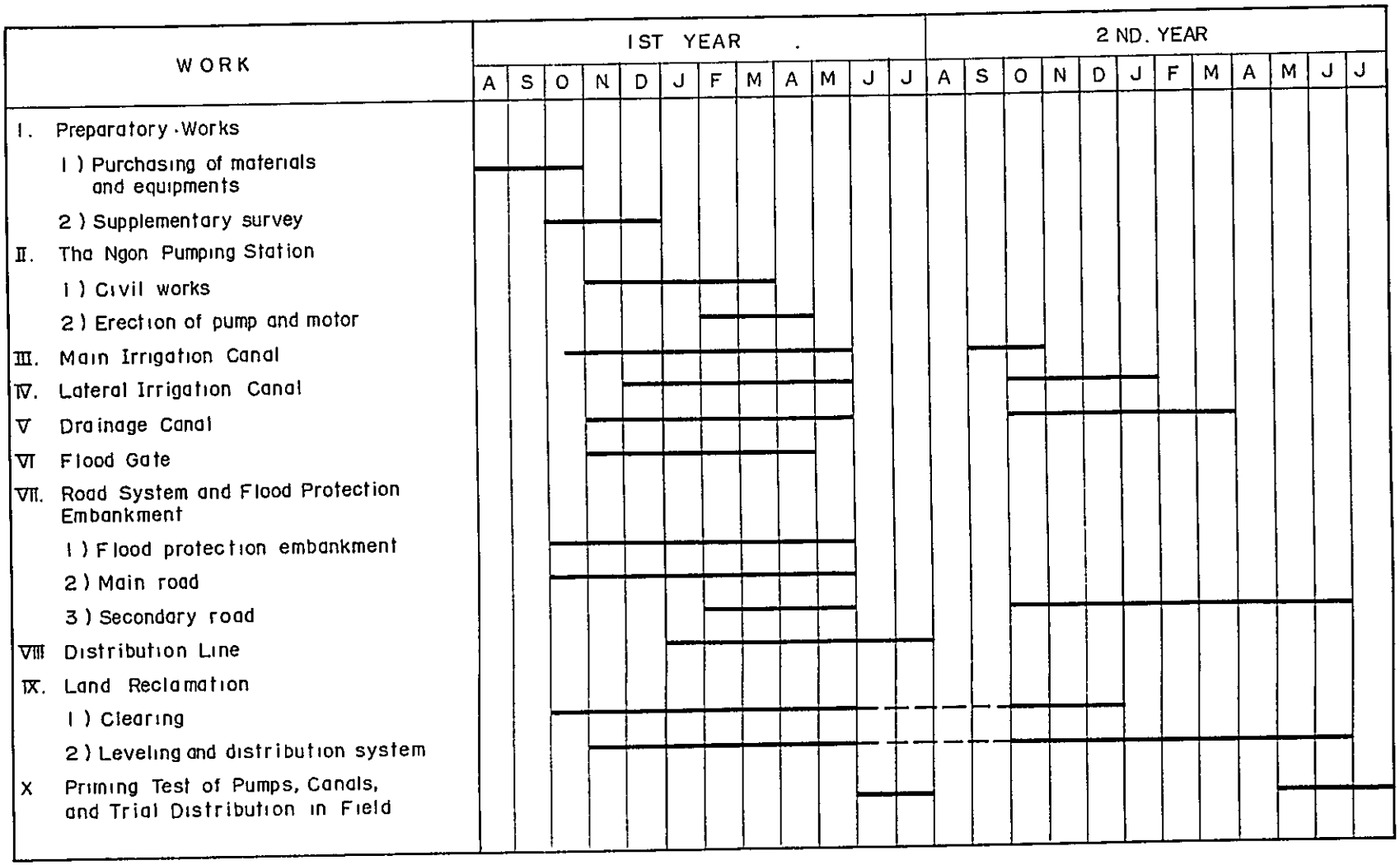
As the Project area is inundated during the wet season, the construction work will be restricted to quite an extent. Since most of the works involves earthwork such as the construction of canals, roads, land reclamation, etc., the construction works will be promoted by avoiding the wet season as much as possible.

Under such circumstances, it will be necessary to use mechanized power for the construction works, especially for the earth works, excepting for the construction of lateral canals and pumping station. The main construction machineries required will be the power shovel, bulldozer, motor grader, dump truck, road roller, etc.

The construction works will be performed in the order of the construction road between B. Tha Ngon and the Project area and flood protection embankment, then followed by the construction of flood gate, pumping station, main canal, main road etc. The land reclamation work will be commenced from the western side of the Project area and the work for 200 to 300 hectares of land will be completed in the first year so that the trial cultivation on the land will be possible.

The period required for the completion of the whole construction works is estimated at approximately 24 months inclusive of the preparatory works, and priming test and later adjustment of irrigation system. The construction schedule for the Project is tentatively illustrated in Fig. 6.1.

Fig. 6. 1 CONSTRUCTION SCHEDULE



CHAPTER VII COST ESTIMATE

7.1 Construction Cost

The construction cost of the Project is estimated at 860,000 US dollars excluding interest during construction period. Of the amount, 610,000 US dollars would be foreign exchange necessary mainly for purchase of pumps, gates, metal work, cement, construction equipment, and other material not available in Laos. The remaining 250,000 US dollars would be domestic currency necessary for purchase of materials available locally and for construction labor.

The estimated amounts do not include import duty, other taxes, and texes to be imposed on the foreign engineers. The estimated cost of each item is shown in Table 7.1.

In addition to the construction cost, about 100,000 US dollars, comprising 62,000 US dollars of foreign currency and 38,000 US dollars of domestic currency, will be required for the construction of power distribution line between Vientiane and B. Tha Ngon. The distribution line, however, is considered to justify itself in view of the electrification of the rural area. Therefore, the construction cost of the line is not included in the Project cost.

Table 7.1 Estimate of Construction Cost

(Cost in US dollars)

Item	Total amount	Foreign currency	Domestic currency	Remarks
1. Preparatory works	14,000	4,000	10,000	
2. Tha Ngon pumping station	133,000	113,000	20,000	
3. Main irrigation canal	58,000	37,000	21,000	about 9 km
4. Lateral irrigation canal	55,000	26,000	29,000	about 10 km
5. Drainage canal	23,000	17,000	6,000	about 10 km
6. Flood protection embankment	67,000	50,000	17,000	about 9 km
7. Flood gate	51,000	29,000	22,000	
8. Road system	76,000	50,000	26,000	Main road 10 km, Secondary 30 km only inside of the project area
9. Power distribution line	43,000	27,000	16,000	
10. Reclamation of land	145,000	103,000	42,000	
Sub-total	665,000	456,000	209,000	
11. General expense and engineering services	120,000	100,000	20,000	
12. Contingency and reserves	75,000	54,000	21,000	
Total	860,000	610,000	250,000	

Remarks: The rate of foreign exchange is 500 kips for one US dollar in this estimation.

7.2 Initial Farm Investment

Besides the above-mentioned construction cost of irrigation and drainage system, initial farm investment will be required for the smooth management of the Project. The initial farm investment comprises the costs for purchasing the farm implements, constructing the farm buildings, and farm operating cost in the first year. The operation, maintenance and replacement cost of irrigation system also be included in the investment, as no revenue can be expected from irrigated farmers at the beginning.

The following table shows the initial farm investment required for the Project.

Item	Cost in US$
1. Agricultural machineries	181,000
2. Farm buildings	43,000
3. Fertilizer	18,000
4. Agricultural chemicals	12,000
5. Seeds	2,000
6. Fuel and others	22,000
7. Operation, maintenance and replacement cost of irrigation system in the first year	22,000
Total	300,000

7.3 Annual Fund Requirement

In accordance with the construction schedule as stated in Chapter VI, the funds required in each year are estimated as follows.

	Foreign currency	Domestic currency	Total
1st year	430,000	170,000	500,000
2nd year	180,000	80,000	360,000
Total	US$ 610,000	US$250,000	US$ 860,000

CHAPTER VIII BENEFITS AND ECONOMIC FEASIBILITY

8.1 Direct Benefit

With the advance of improved irrigation farming in the Project area, the farm products will increase year after year. As described in Chapter V, the annual income of a standard farm with a unit area of 2 hectares will attain its possible target in the 5th year of irrigation farming. The annual budget of the standard farm in and after the 5th year is as shown below.

Item	Per farm (US$)	for 800 hectares (US$)
1) Farm receipt	1,395	555,000
2) Farming expenses	676	270,400
3) Gross farm income	719	287,600
4) Family living allowance	420	168,000
5) Farm profit (or capacity to pay)	299	119,600

As for the crops, an annual production of about 8.000 tons of unhulled rice, which corresponds to some 10 percent of the annual imported rice, can be expected from the Project. Vegetables will also be grown to some extent.

8.2 Indirect Benefit

Besides the above direct benefits, the realization of this project will bring about the so-called stemming benefits which can be taken by the shipping agents, wholesalers, retailers, process manufactures, etc. during the course in which the agricultural products are delivered to the consumers from the farm. It is also possible to expect the so-called induced benefits which can be obtained from the increase in the purchase of farm tools and materials by farmers. Meanwhile, the greater part of this project area is left unused as forests and grassland and it could be anticipated that land values will increase to several times by the realization of the Project. Furthermore, many other benefits not to be

calculated in the monetary value such as the improvement of living standard, environmental sanitation and road system can be expected.

8.3 Economic Evaluation of the Project

The procedure to evaluate the economic feasibility of the Project is mainly in accordance with the method illustrated in the "Manual of River Basin Planning" published by the United Nations Commission for Asia and the Far East.

In this evaluation, however, only the farm profit (or capacity to pay) is considered as the Project benefits for the sake of conservative evaluation. The period of economic analysis is taken as 75 years for the average useful life of irrigation facilities. The rate of interest is assumed at 3 percent per annum.

(1) Annual Benefits

As stated in Chapter V, farm income increases year after year and attains its maximum in and after the 5th year of irrigation farming. Assuming the time of completion of the project is zero point, the annual equivalent benefit will be as follows

Year	Annual Benefit US$	Present worth[/1] US$
1	0	0
2	36,800	34,700
3	86,800	79,400
4	107,600	95,600
5	119,600	)
⋮		) 3,107,600
⋮		)
75	"	)
Total		3,317,300
Annual Equivalent Benefit		111,700[/2]

/1: This value is obtained by multiplying annual benefit by Present Worth Factor $P.W.F. = \frac{1}{(1+i)^n}$

/2: Value obtained by multiplying the sum of annual benefit converted to Present Worth by Capital Recovery Factor

$C.R.F = \frac{i(1+i)^n}{(1+i)^{n-1}}$ where: n = year, i = annual rate of interest

(2) Annual cost

(a) Construction cost inclusive of the interest during construction /1 — US$901,300

Annual equivalent of construction cost

US$901,300 x 0.03367/2 = US$ 30,400 --(A)

(b) Operation, maintenance and replacement cost

i) Operation and maintenance cost

Personel expense/3	US$	7,000
Office expense (US$200 x 12 months)		2,400
Electric charge for pumping		5,000
Repairing cost (Construction costx0.6%)		5,200
Miscellaneous		1,000
Sub-total	US$	20,600 --(1)

ii) Replacement cost/4

Cost of equipments	US$	60,000
Replacement cost		
US$60,000 x 0.03722/5 =	US$	2,200 -- (2)
Total, (1) + (2)	US$	22,800 -- (B)

(c) Annual cost (A) + (B) — US$ 53,200

(3) Benefit - Cost Ratio

$$\frac{\text{Annual benefit}}{\text{Annual cost}} = \frac{\text{US\$111,700}}{\text{US\$ 53,200}} = \underline{2.1}$$

As shown by the above benefit-cost ratio, the Tha Ngon Project is economically beneficial, and the economic feasibility will increase if other direct and indirect benefits are taken into account.

/1 The interest during the construction period is estimated in accordance with the annual fund requirement given in Section 7.3.

/2 Capital recovery factor for 75 year period and annual interest rate of 3 per cent.

/3 Details of the personnel expense are shown below.

1 - Manager (Agronomist)	US$2,000
1 - Mechanical Engineer	US$1,200
2 - Irrigation Engineer	US$1,800
1 - Accountant	US$1,200
1 - Labor	US$ 800
Total	US$7,000

/4 Cost needed for the replacement of facilities and equipments which involve the irrigation pumps, steel gates, power distributing equipments, etc. The average life of these items is taken as 20 years.

/5 Sinking fund factor for 20-year period and annual interest rate of 3 per cent.

CHAPTER IX FINANCIAL EVALUATION

9.1 Financial Feasibility

9.1.1 General

As mentioned before, the initial investment needed for the Project comprises the construction cost of irrigation system and the initial farm investment necessary for the smooth management of irrigation farming, and is estimated at 1,160,000 US dollars as shown below.

Construction cost of irrigation system	US$ 860,000
Initial farm investment	US$ 300,000
Total	US$ 1,160,000

It is generally considered rather difficult to expect big returns from the anticipated benefit of the Project, especially in its earlier stage. Therefore, it would be necessary to finance this Project by a fund with low interest rate and long-term repayable period. It is also hoped that the first several years of deferred payment could be allowed until the farm management is well stabilized.

The Advisory Board of the Mekong Committee[/1] has suggested as a general principle that the financial feasibility of projects should be based on a standard loan, as may be widely agreeable to financial institutions, and that the standard loan with an annual interest rate of 3 per cent and the amortization period of 40 years may be assumed for irrigation projects.

9.1.2 Benefit-Cost Ratio

According to the above suggestion, the financial feasibility of the Project was evaluated for the following two cases. The procedure of estimation of the benefit-cost ratio is similar to that

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/1: The Committee for Coordination of Investigation of the Lower Mekong Basin

for economic evaluation, excepting that the maturity period of loan is used instead of the useful life of the irrigation and drainage facilities.

CASE I

Annual interest rate	3 per cent
Unredeemable period	first 5 years
Amortization period	6th year to 30th year
Maturity period	30 years

(1) Annual benefit

Year	Annual benefit US$	Present worth US$
1	0	0
2	36,800	34,700
3	86,800	79,400
4	107,600	95,600
5	119,600	
'	"	
'	"	1,899,700
'	"	
30		
	Total	2,109,400

Annual equivalent benefit

US$2,109,400 x 0.05102 = US$107,600

(2) Annual cost

(a) Construction cost inclusive of the interest during construction US$901,300

Initial Farm Investment US$300,000

Total (Initial investment) US$1,201,300

Annual equivalent of initial investment

US$1,201,300 x 0.05102 = US$61,300 ---------- (A)

(b) Operation, maintenance and replacement cost

Operation and maintenance cost	US$20,600
Replacement cost US$60,000 x 0.03722 =	US$ 2,200
Total	US$22,800 - (B)

(c) Annual cost, (A) + (B)

(3) Benefit - Cost Ratio

$$\frac{\text{Annual benefit}}{\text{Annual cost}} = \frac{\text{US\$107,600}}{\text{US\$ 84,100}} = 1.28$$

CASE II

Annual interest rate	3.5 percent
Unredeemable period	5 years
Amortization period	6th year to 30th year
Maturity period	30 years

(1) Annual benefit

Year	Annual benefit US$	Present worth US$
1	0	0
2	36,800	34,400
3	86,800	78,300
4	107,600	93,800
5	119,600	
'	"	
'	"	1,760,200
'	"	
30	"	
	Total	1,966,700

Annual equivalent benefit

US$1,966,700 x 0.0543 = US$106,900

(2) Annual cost

(a) Construction cost inclusive of the interest during construction US$908,100

Initial farm investment	US$300,000
Total (Initial investment)	US$1,208,100

Annual equivalent of initial investment

US$1,208,100 x 0.05437 = US$65,700 ... (A)

(b) Operation, maintenance and replacement cost

Operation and maintenance cost	US$20,600
Replacement cost US$60,000 x 0.035 =	US$ 2,100
Total	US$22,700 ... (B)

(c) Annual cost, (A) + (B) US$88,400

(3) Benefit - Cost Ratio

$$\frac{\text{Annual benefit}}{\text{Annual cost}} = \frac{\text{US\$106,900}}{\text{US\$ 88,400}} = 1.21$$

As shown above, the benefit - cost ratios evaluated from the financial view points in both cases exceed 1:1. Accordingly, the Tha Ngon Project is financially feasible and profitable. The benefit - cost ratios will increase if other benefits are taken into account.

9.1.3 Internal Rate of Return

The justifiability of the investment for the Tha Ngon Project is appraised by evaluating the internal rate of return on the investment.

Assuming that the loan with 30 years of maturity period is available, the internal rate of return is evaluated at 5.3 percent.

9.2 Economy from the Farmers' viewpoints

As a rule, all the loans are to be repaid by the project beneficiaries. In this project, the source of revenue appropriated for the repayment of loans will be the water charge assessed on the irrigated farmers.

The annual water charge will cover the annual repayment amount of irrigation system construction cost and initial farm investment as well as the annual operation, maintenance and replacement cost. For the

first four years, however, the water charge will be based only on the operation, maintenance and replacement cost. The followings show the water charges to be assessed in both cases described in the foregoing section 9.1.2.

	Irrigation Farming Years		
	1st year (US$/Farm)	2nd to 4th year (US$/Farm)	5th year and after (US$/Farm)
Case I	0	57.6	252.2
Case II	0	57.2	268.2

As mentioned in chapter V, the farmers will obtained 299 U.S. dollars of farm profit (or capacity to pay) for the payment of water charge from the 5th year of the irrigation farming. After the payment of water charge mentioned above from the farm profit, the farmers will get about 47 U.S. dollars of net farm profit in Case I and 31 U.S. dollars in Case II. Accordingly, it could be said that the project is justifiable from the farmers' viewpoints.

9.3 Financial Statement

As stated above, the repayment of loans will be made out of a part of the water charge to be assessed on the irrigated farmers. Based upon the anticipated loans and the above repayment policy, the financial statements were demonstrated in two cases as shown in Table 9.1 and 9.2.

Both statements show that the Project can be satisfactorily managed from the financial point of view throughout the maturity period of the loans.

Table 9.1 Case I - Financial Statement

interest rate 3 %
undredeemable periods 5 years
maturity period 30 years

year/1	Gross/2 Revenue	Operation Maintenance Cost	Net/3 Revenue	Construction Cost			Initial Farm Investment			Total Loan Repayment	Surplus/4	Accumulated Surplus
				Loan	Accumulated Loan	Loan Repayment	Loan	Accumulated Loan	Loan Repayment			
	10^3US$	10^3US$	10^3US$	10^3US$	10^3US$	10^3US$	10^3US$	10^3US$	10^3US$	10^3US$	10^3US$	10^3US$
1												
2	0			901.3	901.3		300.0	300.0				
3	23.0	22.8	0.2		928.3			309.0			0.2	0.2
4	23.0	22.8	0.2		956.2			318.3			0.2	0.4
5	23.0	22.8	0.2		984.9			327.8			0.2	0.6
6	100.9	22.8	78.1		1,014.4			337.7			78.1	78.7
7	100.9	22.8	78.1		1,044.9	58.3		347.8	19.4	77.7	0.4	79.1
8	100.9	22.8	78.1		1,016.2	58.3		338.3	19.4	77.7	0.4	79.5
9	100.9	22.8	78.1		986.6	58.3		328.5	19.4	77.7	0.4	79.9
10	100.9	22.8	78.1		956.1	58.3		318.4	19.4	77.7	0.4	80.3
11	100.9	22.8	78.1		924.7	58.3		308.0	19.4	77.7	0.4	80.7
12	100.9	22.8	78.1		892.4	58.3		297.3	19.4	77.7	0.4	81.1
13	100.9	22.8	78.1		859.1	58.3		286.2	19.4	77.7	0.4	81.5
14	100.9	22.8	78.1		824.8	58.3		274.8	19.4	77.7	0.4	81.9
15	100.9	22.8	78.1		789.5	58.3		263.1	19.4	77.7	0.4	82.3
16	100.9	22.8	78.1		753.1	58.3		251.0	19.4	77.7	0.4	82.7
17	100.9	22.8	78.1		715.6	58.3		238.5	19.4	77.7	0.4	83.1
18	100.9	22.8	78.1		677.0	58.3		225.7	19.4	77.7	0.4	83.5
19	100.9	22.8	78.1		637.3	58.3		212.5	19.4	77.7	0.4	83.9
20	100.9	22.8	78.1		596.4	58.3		198.9	19.4	77.7	0.4	84.3
21	100.9	22.8	78.1		554.2	58.3		184.9	19.4	77.7	0.4	84.7
22	100.9	22.8	78.1		510.8	58.3		170.5	19.4	77.7	0.4	85.1
23	100.9	22.8	78.1		466.1	58.3		155.6	19.4	77.7	0.4	85.5
24	100.9	22.8	78.1		420.0	58.3		140.3	19.4	77.7	0.4	85.9
25	100.9	22.8	78.1		372.6	58.3		124.5	19.4	77.7	0.4	86.3
26	100.9	22.8	78.1		323.7	58.3		108.3	19.4	77.7	0.4	86.7
27	100.9	22.8	78.1		273.4	58.3		91.6	19.4	77.7	0.4	87.1
28	100.9	22.8	78.1		221.6	58.3		74.4	19.4	77.7	0.4	87.5
29	100.9	22.8	78.1		168.2	58.3		56.7	19.4	77.7	0.4	87.9
30	100.9	22.8	78.1		113.2	58.3		38.4	19.4	77.7	0.4	88.3
31	100.9	22.8	78.1		56.5	56.5		19.6	19.6	76.1	2.0	90.3

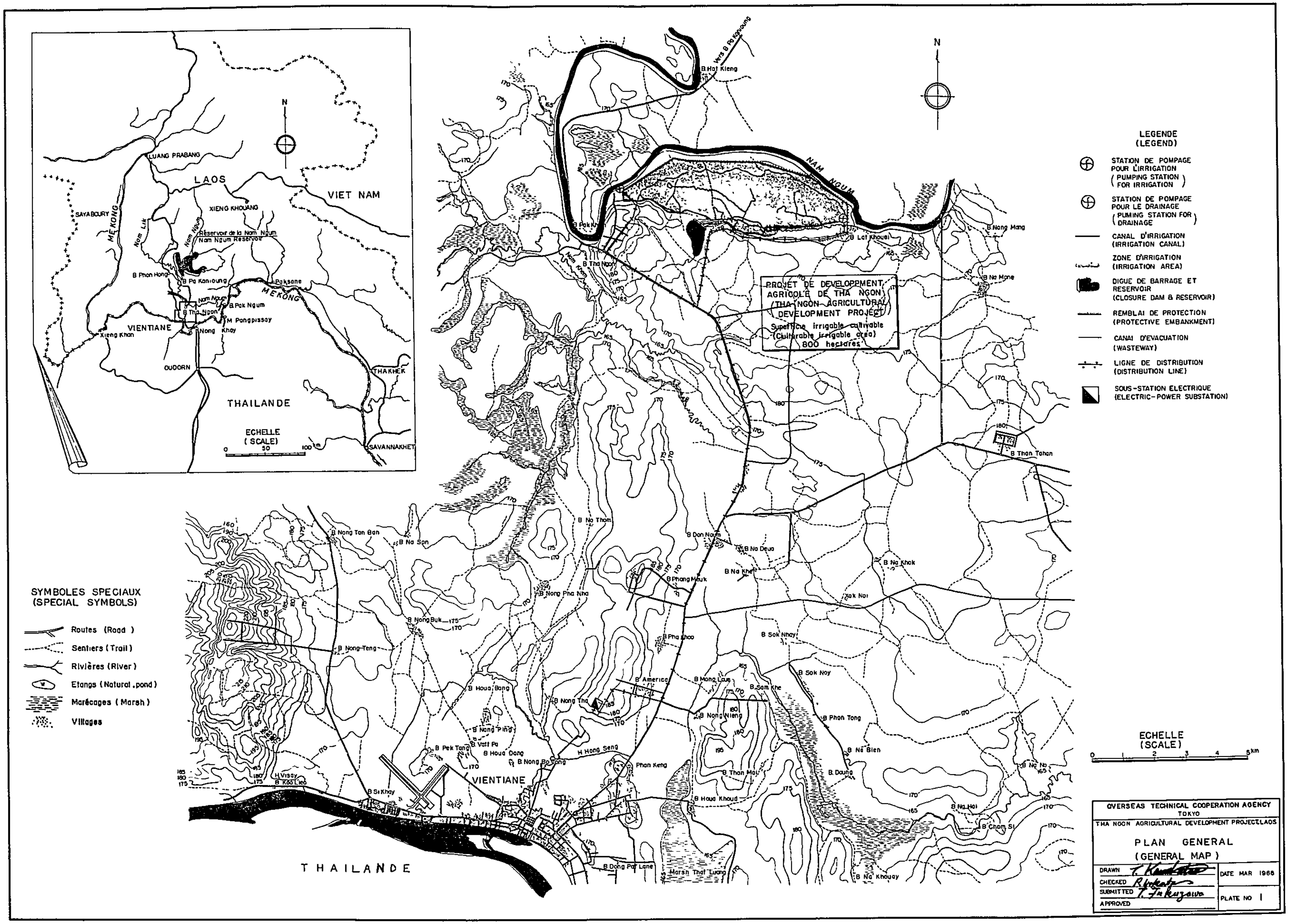
/1: From the beginning year of construction works. /2: Water charge to be assessed on the irrigated farmers.
/3: Difference between Gross Revenue and Operation & Maintenance Cost. /4: Difference between Net Revenue and Total Loan Repayment.

Table 9.2 Case II - Financial Statement

interest rate 3.5 %
unredeemable periods 5 years
naturity period 30 years

year/1	Gross Revenue/2	Operation & Maintenance Cost	Net Revenue/3	Construction Cost			Initial Farm Investment			Total Loan Repayment	Surplus/4	Accumulated Surplus
				Loan	Accumulated Loan	Loan Repayment	Loan	Accumulated Loan	Loan Repayment			
	10^3US$	10^3US$	10^3US$	10^3US$	10^3US$	10^3US$	10^3US$	10^3US$	10^3US$	10^3US$	10^3US$	10^3US$
1												
2	0			908.1	908.1		300.0	300.0				
3	22.9	22.7	0.2		939.9			310.5			0.2	0.2
4	22.9	22.7	0.2		972.8			321.4			0.2	0.4
5	22.9	22.7	0.2		1,006.8			332.6			0.2	0.8
6	107.3	22.7	84.6		1,042.0			344.3			84.6	85.4
7	107.3	22.7	84.6		1,078.5	63.3		356.3	20.9	84.2	0.4	85.8
8	107.3	22.7	84.6		1,050.7	63.3		347.1	20.9	84.2	0.4	86.2
9	107.3	22.7	84.6		1,022.0	63.3		337.6	20.9	84.2	0.4	86.6
10	107.3	22.7	84.6		992.3	63.3		327.8	20.9	84.2	0.4	87.0
11	107.3	22.7	84.6		961.5	63.3		317.6	20.9	84.2	0.4	87.4
12	107.3	22.7	84.6		929.6	63.3		307.1	20.9	84.2	0.4	87.8
13	107.3	22.7	84.6		896.6	63.3		296.2	20.9	84.2	0.4	88.2
14	107.3	22.7	84.6		862.5	63.3		284.9	20.9	84.2	0.4	88.6
15	107.3	22.7	84.6		827.2	63.3		273.2	20.9	84.2	0.4	89.0
16	107.3	22.7	84.6		790.6	63.3		261.1	20.9	84.2	0.4	89.4
17	107.3	22.7	84.6		752.8	63.3		248.6	20.9	84.2	0.4	89.8
18	107.3	22.7	84.6		713.6	63.3		235.7	20.9	84.2	0.4	90.2
19	107.3	22.7	84.6		673.1	63.3		222.3	20.9	84.2	0.4	90.6
20	107.3	22.7	84.6		631.1	63.3		208.4	20.9	84.2	0.4	91.0
21	107.3	22.7	84.6		587.7	63.3		194.1	20.9	84.2	0.4	91.4
22	107.3	22.7	84.6		542.8	63.3		179.3	20.9	84.2	0.4	91.8
23	107.3	22.7	84.6		496.3	63.3		163.9	20.9	84.2	0.4	92.2
24	107.3	22.7	84.6		448.2	63.3		148.0	20.9	84.2	0.4	92.6
25	107.3	22.7	84.6		398.4	63.3		131.5	20.9	84.2	0.4	93.0
26	107.3	22.7	84.6		346.8	63.3		114.5	20.9	84.2	0.4	93.4
27	107.3	22.7	84.6		293.4	63.3		96.9	20.9	84.2	0.4	93.8
28	107.3	22.7	84.6		238.2	63.3		78.7	20.9	84.2	0.4	94.2
29	107.3	22.7	84.6		181.0	63.3		59.8	20.9	84.2	0.4	94.6
30	107.3	22.7	84.6		121.8	63.3		40.3	20.9	84.2	0.4	95.0
31	107.3	22.7	84.6		60.6	60.6		20.1	20.1	84.2	0.4	95.4

/1: From the beginning year of construction work. /2: Water charge. /3: Difference between Gross Revenue and Operation & Maintenance Cost
/4: Difference between Net Revenue and Total Loan Repayment.


LEGENDE
(LEGEND)
STATION DE POMPAGE POUR L'IRRIGATION (PUMPING STATION FOR IRRIGATION)
STATION DE POMPAGE POUR LE DRAINAGE (PUMING STATION FOR DRAINAGE)
CANAL D'IRRIGATION (IRRIGATION CANAL)
ZONE D'IRRIGATION (IRRIGATION AREA)
DIGUE DE BARRAGE ET RESERVOIR (CLOSURE DAM & RESERVOIR)
REMBLAI DE PROTECTION (PROTECTIVE EMBANKMENT)
CANAl D'EVACUATION (WASTEWAY)
LIGNE DE DISTRIBUTION (DISTRIBUTION LINE)
SOUS-STATION ELECTRIQUE (ELECTRIC-POWER SUBSTATION)
SYMBOLES SPECIAUX
(SPECIAL SYMBOLS)
Routes (Road)
Sentiers (Trail)
Rivières (River)
Etangs (Natural pond)
Marécages (Marsh)
Villages
PROJET DE DEVELOPPMENT AGRICOLE DE THA NGON
(THA NGON AGRICULTURAL DEVELOPMENT PROJECT)
Superficie irrigable cultivable
(Cultivable irrigable area)
800 hectares
NAM NGUM
VIENTIANE
THAILANDE
LAOS
VIET NAM
MEKONG
LUANG PRABANG
SAYABOURY
XIENG KHOUANG
Réservoir de la Nam Ngum
Nam Ngum Reservoir
Paksane
THAKHEK
SAVANNAKHET
OUDORN
ECHELLE
(SCALE)
OVERSEAS TECHNICAL COOPERATION AGENCY
TOKYO
THA NGON AGRICULTURAL DEVELOPMENT PROJECT, LAOS
PLAN GENERAL
(GENERAL MAP)
DRAWN
CHECKED
SUBMITTED
APPROVED
DATE MAR 1966
PLATE NO 1

N

NAM NGUM

B Tha Som Mo

CANAL PRINCIPAL DU NORD
(NORTH MAIN CANAL)

BM No 2
165.114

BM No 3
164.750

STATION DE POMPAGE DE THA NGOM
(THA NGOM PUMPING STATION)
145 KW x 2

BM No 1
165.530

RESERVOIR DE REGULATION
(REGULATING POND)
PHE (HWL) 1685 M
PBE (LWL) 1675 M

CANAL PRINCIPAL DU SUD
(SOUTH MAIN CANAL)

160 Ha

600 Ha

DIGUE DE BARRAGE DE NONG SAM KHA
(NONG SAM KHA CLOSURE DAM)

RESERVOIR DE NONG SAM KHA
(NONG SAM KHA RESERVOIR)
NIVEAU DES CRUES (FWL) 16750 M
PHE (HWL) 16700 M
PBE (LWL) 16550 M

Centre d'Application de l'Agriculture et de l'Elevage Lao - Japonais

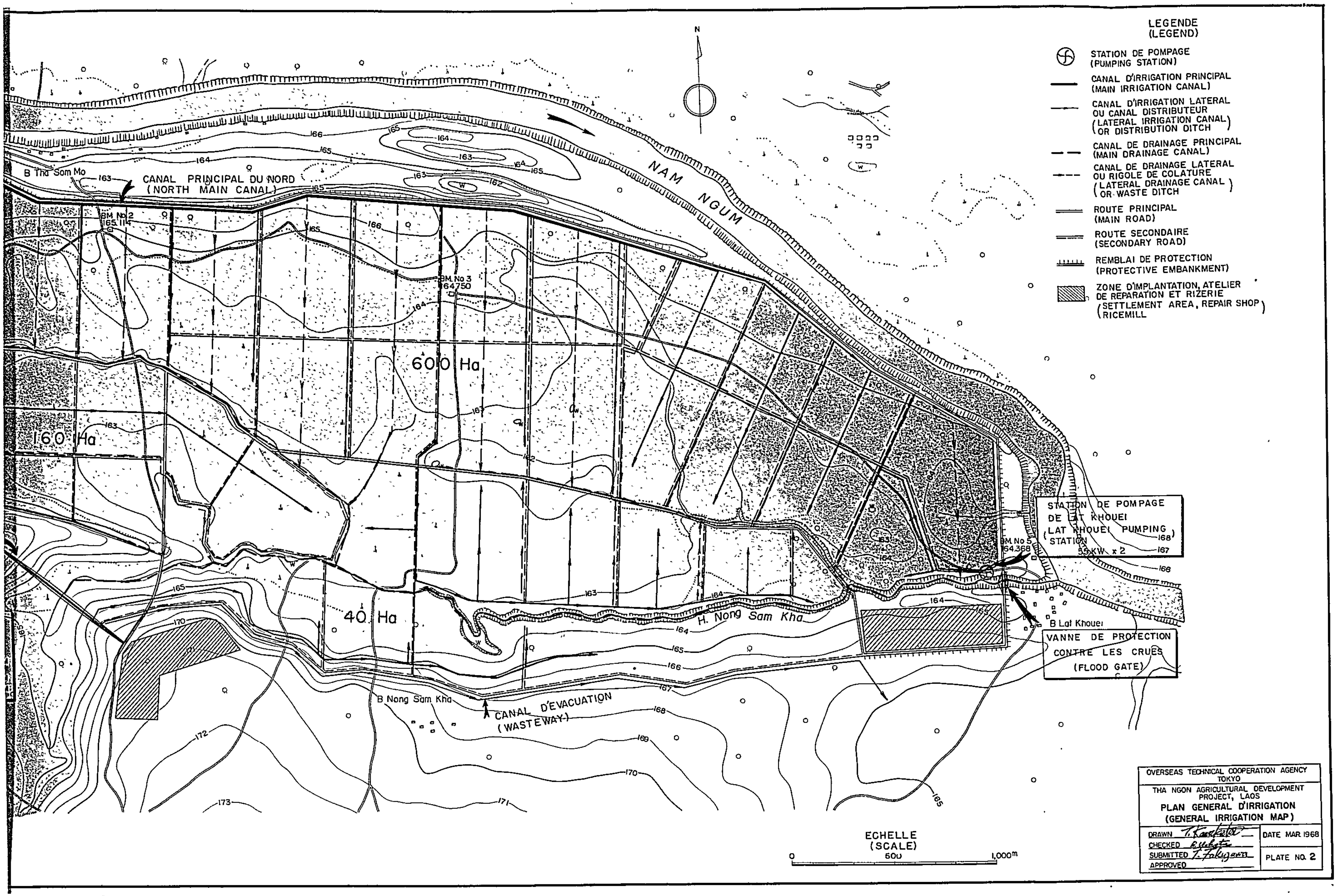
Vers Vientiane

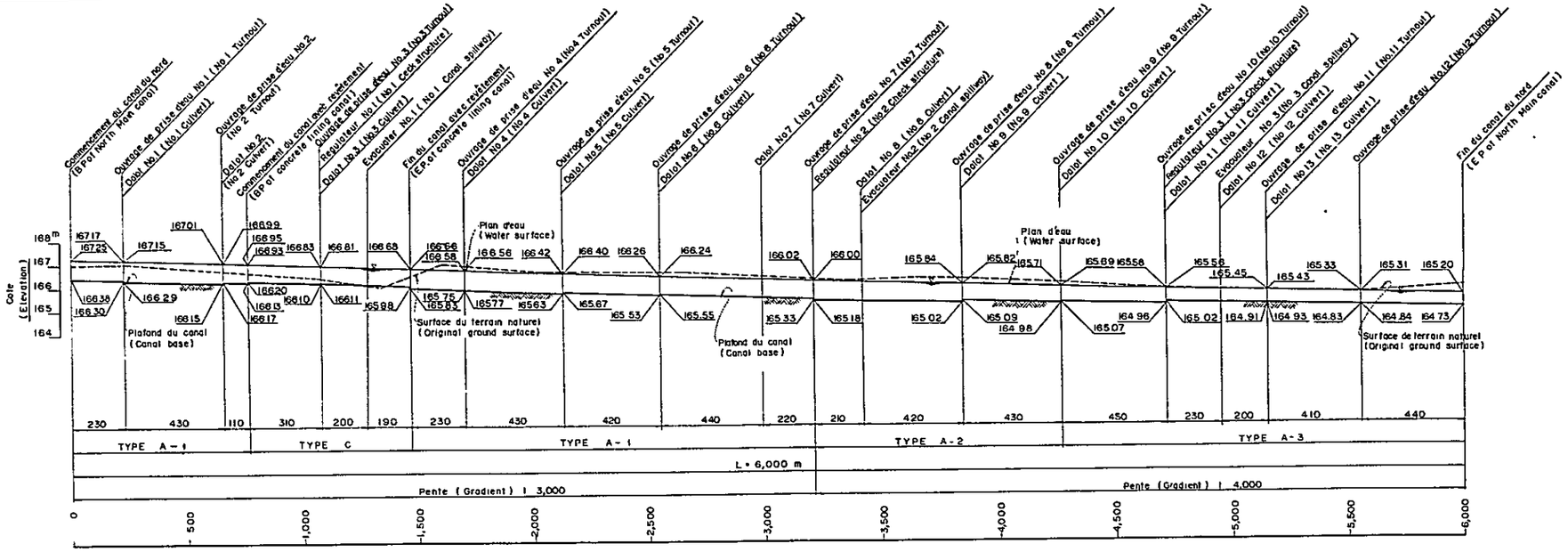
40 Ha

B Nong Sam Kha

CANAL D'EVACUATION
(WASTEWAY)

H Nong Sam


LEGENDE
(LEGEND)
STATION DE POMPAGE
(PUMPING STATION)
CANAL D'IRRIGATION PRINCIPAL
(MAIN IRRIGATION CANAL)
CANAL D'IRRIGATION LATERAL
OU CANAL DISTRIBUTEUR
(LATERAL IRRIGATION CANAL
OR DISTRIBUTION DITCH)
CANAL DE DRAINAGE PRINCIPAL
(MAIN DRAINAGE CANAL)
CANAL DE DRAINAGE LATERAL
OU RIGOLE DE COLATURE
(LATERAL DRAINAGE CANAL
OR WASTE DITCH)
ROUTE PRINCIPAL
(MAIN ROAD)
ROUTE SECONDAIRE
(SECONDARY ROAD)
REMBLAI DE PROTECTION
(PROTECTIVE EMBANKMENT)
ZONE D'IMPLANTATION, ATELIER
DE REPARATION ET RIZERIE
(SETTLEMENT AREA, REPAIR SHOP
RICEMILL)
N
NAM NGUM
B Tha Som Mo
CANAL PRINCIPAL DU NORD
(NORTH MAIN CANAL)
BM No 2
165.114
BM No 3
164.750
600 Ha
160 Ha
40 Ha
H. Nong Sam Kha
B Nong Sam Kha
CANAL D'EVACUATION
(WASTEWAY)
STATION DE POMPAGE
DE LAT KHOUEI
(LAT KHOUEI PUMPING
STATION)
55 KW x 2
BM No 5
164.368
B Lat Khouei
VANNE DE PROTECTION
CONTRE LES CRUES
(FLOOD GATE)
ECHELLE
(SCALE)
0
500
1,000m
OVERSEAS TECHNICAL COOPERATION AGENCY
TOKYO
THA NGON AGRICULTURAL DEVELOPMENT
PROJECT, LAOS
PLAN GENERAL D'IRRIGATION
(GENERAL IRRIGATION MAP)
DRAWN T. Kawakita
CHECKED
SUBMITTED T. Fukuyama
APPROVED
DATE MAR 1968
PLATE NO. 2



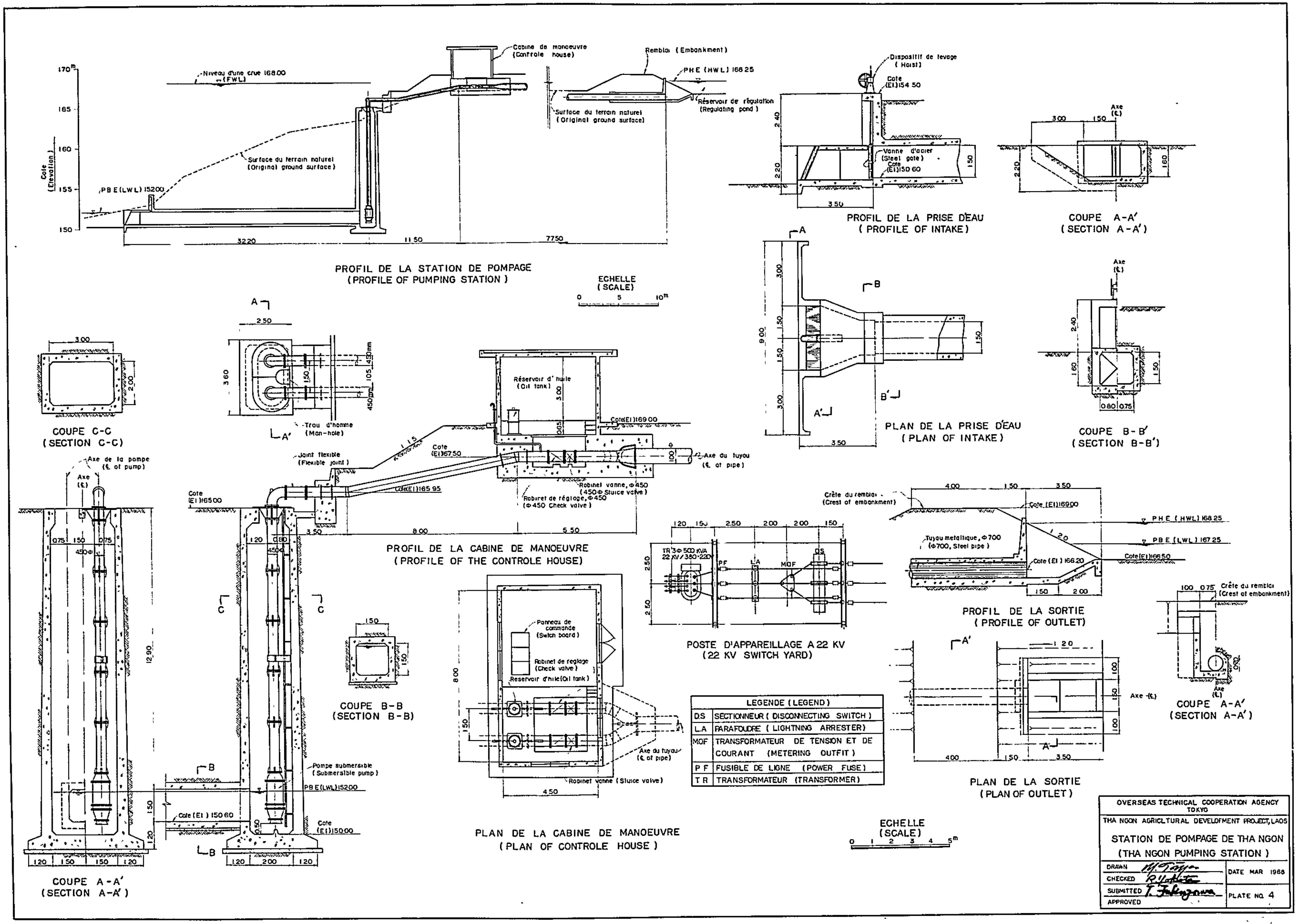
PROFILE TYPE EN TRAVERS
(TYPICAL CROSS SECTION)

TABLEAU DES DIMENSIONS
(TABLE OF DIMENSIONS)

CANAL	TYPE DE CANAL (CANAL TYPE)	DEBIT (DISCHARGE)	VITESSE (VELOCITY)	DIMENSION (M)					
				B	H	F	W	C_B	C_L
		L/s	m/s						
NORD (NORTH)	A - 1	760	0 41	1 00	0 87	0 43	4 90	1 00	0.50
	A - 2	545	0 34	0 90	0 82	0.38	4 50	1 00	0 50
	A - 3	265	0 27	0.70	0 62	0 33	3 55	1 00	0 50
	C	705	0 68	0 75	0 73	0 32	3.45	1 00	0 50
SUD (SOUTH)	D	200	0 43	0 50	0.47	0 23	2 30	0 50	0 50
	B	190	0 28	0 60	0 53	0.27	3.00	1 00	0 50

Nota: ⚠ Talus interieur de la Rembai de protection.
(Inside slope of the protective embankment)

OVERSEAS TECHNICAL COOPERATION AGENCY TOKYO	
THA NGON AGRICULTURAL DEVELOPMENT PROJECT, LAOS	
PROFIL DES CANAUX PRINCIPAUX D'IRRIGATION (PROFILE OF MAIN IRRIGATION CANAL)	
DRAWN M. Tokio	DATE MAR 1968
CHECKED R. Hotta	
SUBMITTED T. Ishigami	PLATE NO. 3
APPROVED	



LEGENDE (LEGEND)	
DS	SECTIONNEUR (DISCONNECTING SWITCH)
LA	PARAFOUDRE (LIGHTNING ARRESTER)
MOF	TRANSFORMATEUR DE TENSION ET DE COURANT (METERING OUTFIT)
PF	FUSIBLE DE LIGNE (POWER FUSE)
TR	TRANSFORMATEUR (TRANSFORMER)

OVERSEAS TECHNICAL COOPERATION AGENCY TOKYO

THA NGON AGRICULTURAL DEVELOPMENT PROJECT, LAOS

STATION DE POMPAGE DE THA NGON

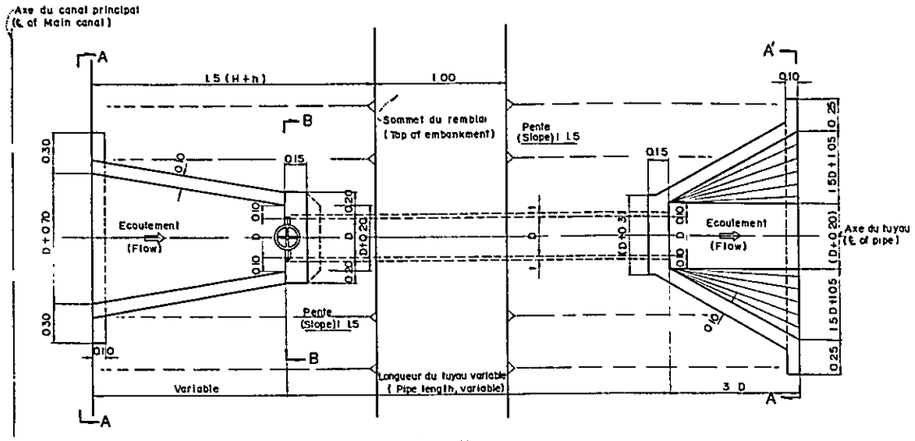
(THA NGON PUMPING STATION)

DRAWN
CHECKED
SUBMITTED
APPROVED

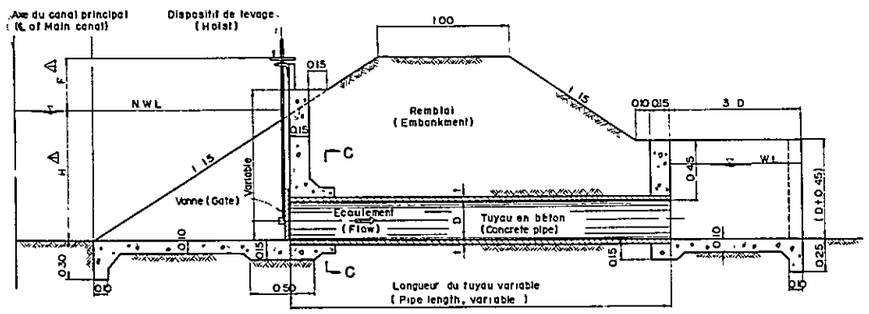
DATE MAR 1968

PLATE NO. 4

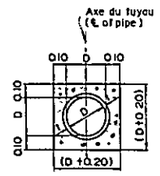
TYPE - A



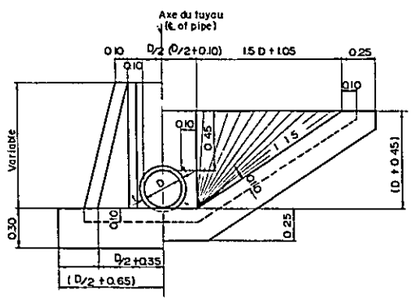
PLAN



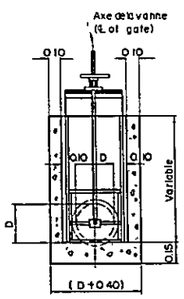
PROFIL
(PROFILE)



COUPE C-C
(SECTION C-C)

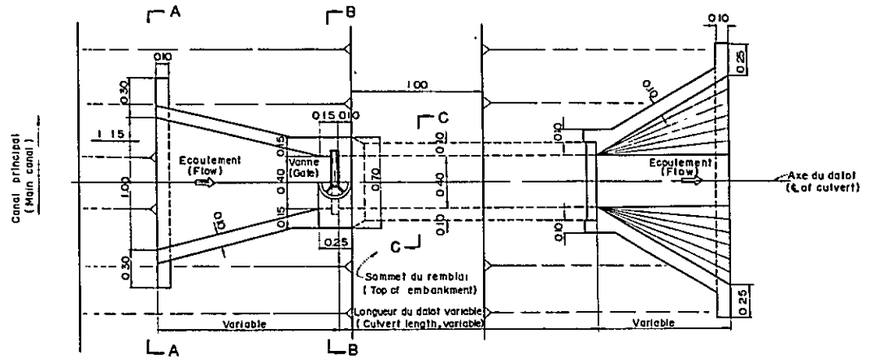


COUPE A-A'
(SECTION A-A')

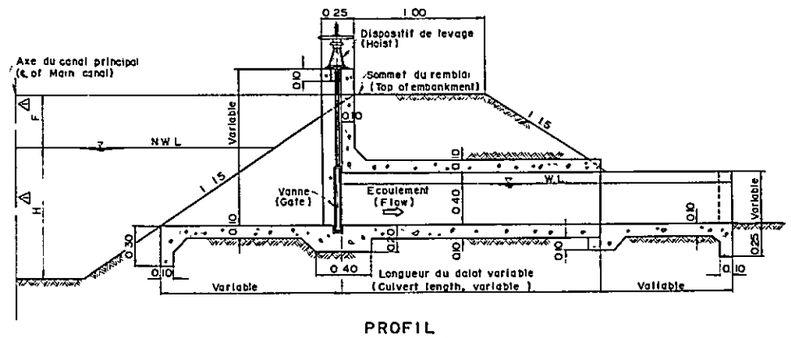


COUPE B-B
(SECTION B-B)

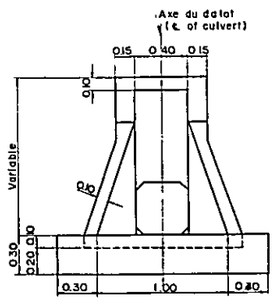
TYPE - B



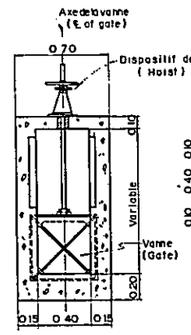
PLAN



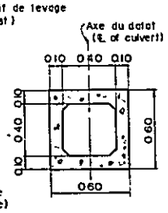
PROFIL
(PROFILE)



COUPE A-A
(SECTION A-A)



COUPE B-B
(SECTION B-B)

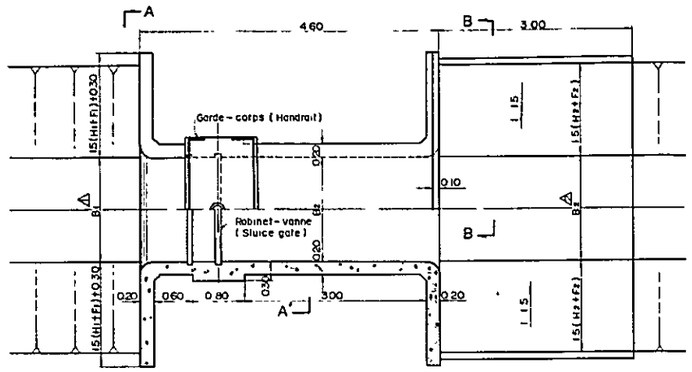


COUPE C-C
(SECTION C-C)

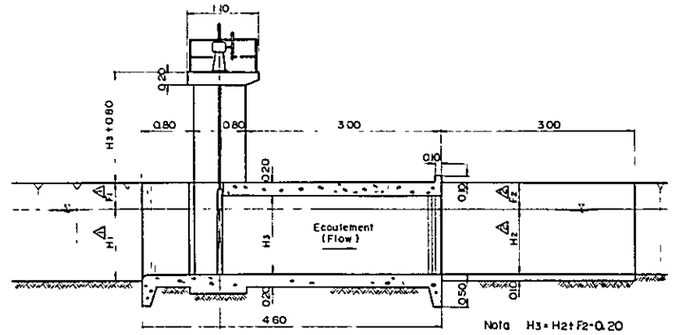
Nota: ⚠ Voir Planche No 3 (Refer to Plate No. 3)

OVERSEAS TECHNICAL COOPERATION AGENCY TOKYO	
THA NGON AGRICULTURAL DEVELOPMENT PROJECT, LAOS	
OUVRAGE DE PRISE D'EAU TYPE (TYPICAL TURNOUT)	
DRAWN	DATE MAR. 1968
CHECKED	
SUBMITTED	PLATE NO. 5
APPROVED	

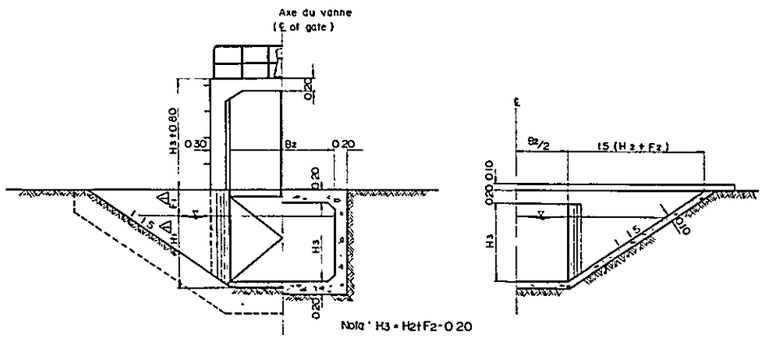
OUVRAGE DE CONTROLE TYPE A
(CHECK STRUCTURE TYPE-A)



PLAN



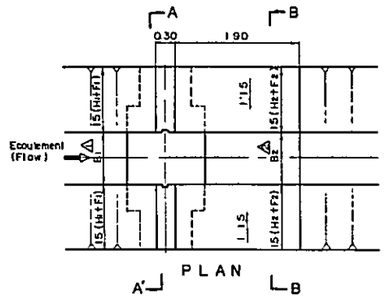
PROFIL
(PROFILE)



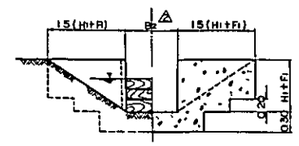
COUPE A-A'
(SECTION A-A')

COUPE B-B
(SECTION B-B)

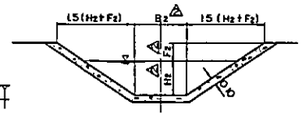
OUVRAGE DE CONTROLE TYPE-B
(CHECK STRUCTURE TYPE-B)



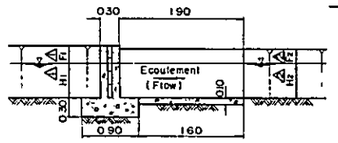
PLAN



COUPE A-A'
(SECTION A-A')

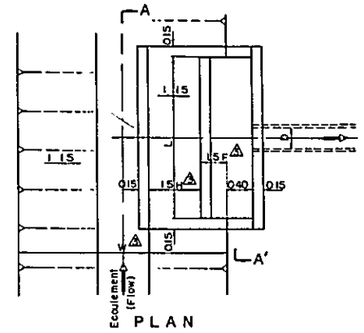


COUPE B-B
(SECTION B-B)

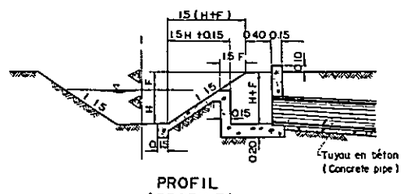


PROFIL
(PROFILE)

EVACUATEUR TYPE DE CANAL DU TYPE DEVERSOIR
(TYPICAL CANAL OVERFLOW SPILLWAY)

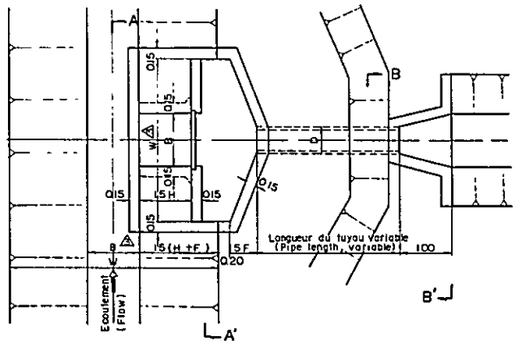


PLAN

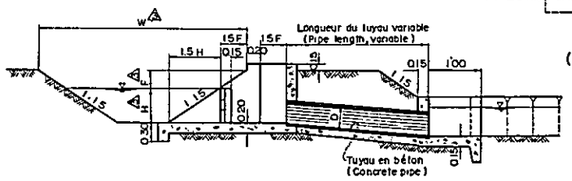


PROFIL
(PROFILE)

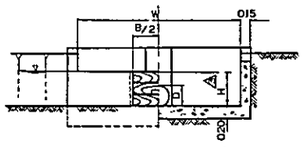
OUVRAGE DE DECHARGE AVEC PARTIE DEVERSANTE
(WASTEWAY WITH OVERFLOW PORTION)



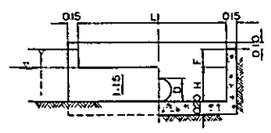
PLAN



PROFIL
(PROFILE)



COUPE A-A'
(SECTION A-A')



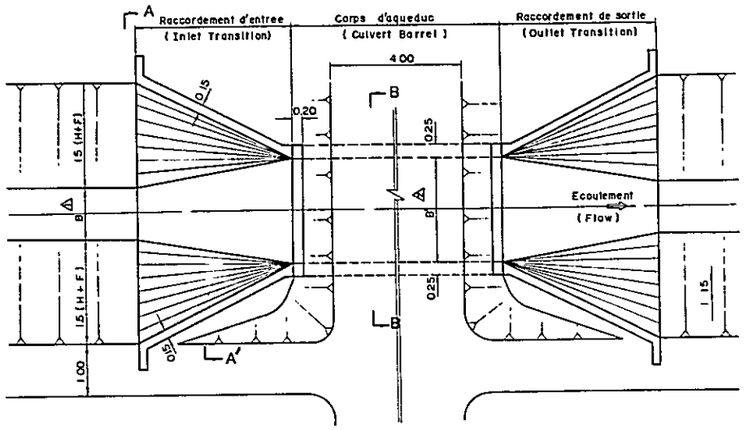
COUPE A-A'
(SECTION A-A')

COUPE B-B'
(SECTION B-B')

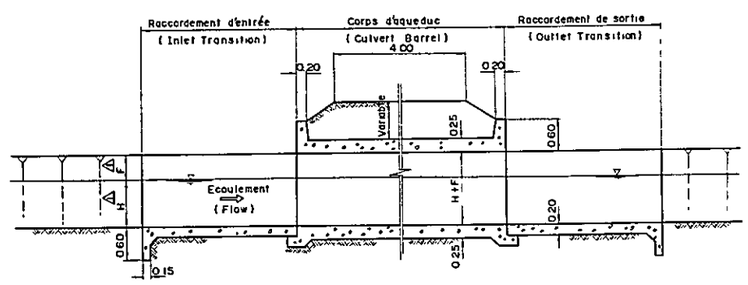
Nota,
- ⚠1 Voir la Planche No. 3 pour les dimensions des canaux du cours supérieur. (Dimensions of the upstream canals, Refer to Plate No. 3)
- ⚠2 Voir la Planche No. 3 pour les dimensions des canaux du cours inférieur. (Dimensions of the downstream canals, Refer to Plate No. 3)
- ⚠3 Voir la Planche No 3 pour les dimensions de ces canaux. (Dimensions of the canals, Refer to Plate No. 3)

OVERSEAS TECHNICAL COOPERATION AGENCY TOKYO	
THA NGON AGRICULTURAL DEVELOPMENT PROJECT, LAOS	
REGULATEUR ET EVACUATEUR TYPES (TYPICAL CHECK STRUCTURE & CANAL SPILLWAY)	
DRAWN M. Tojo	DATE MAR 1968
CHECKED R. Yuhta	
SUBMITTED T. Fukuzawa	PLATE NO 6
APPROVED	

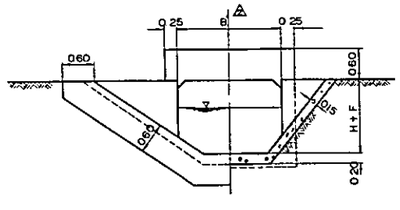
DALOT
(CULVERT TYPE- A)



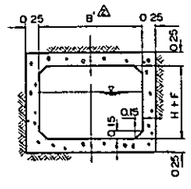
PLAN



PROFIL
(PROFILE)



COUPE A-A'
(SECTION A-A')

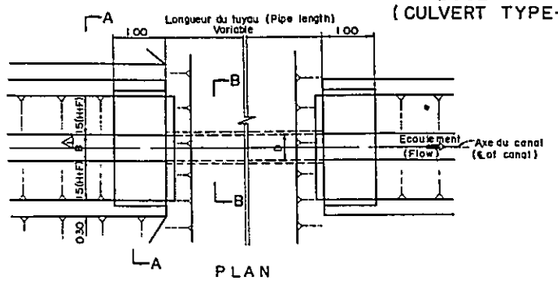


COUPE B-B
(SECTION B-B)

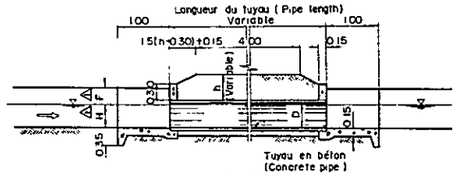
Nota : ⚠ Voir planche No. 3
: ⚠ B'= (H+F) / 0.7

Note : ⚠ Refer to Plate No.3
: ⚠ B'= (H+F) / 0.7

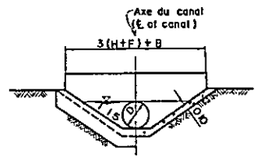
BUSE
(CULVERT TYPE- B)



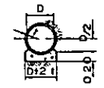
PLAN



PROFIL
(PROFILE)

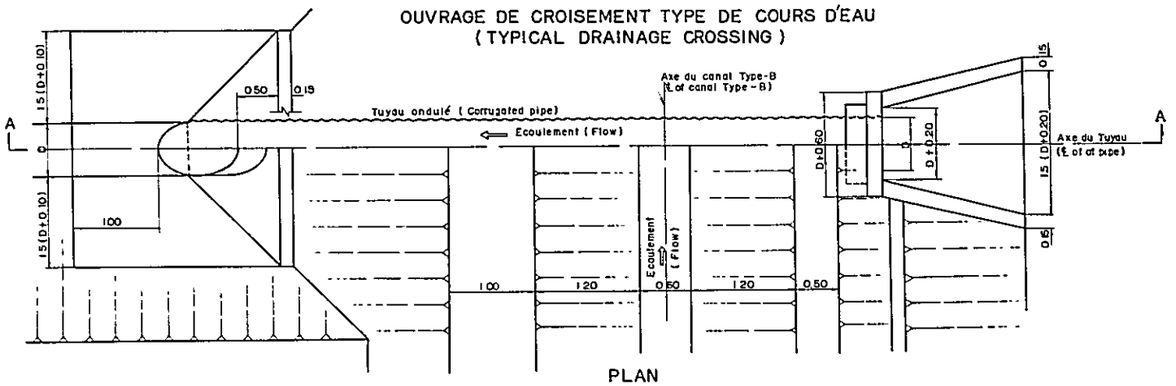


COUPE A-A
(SECTION A-A)

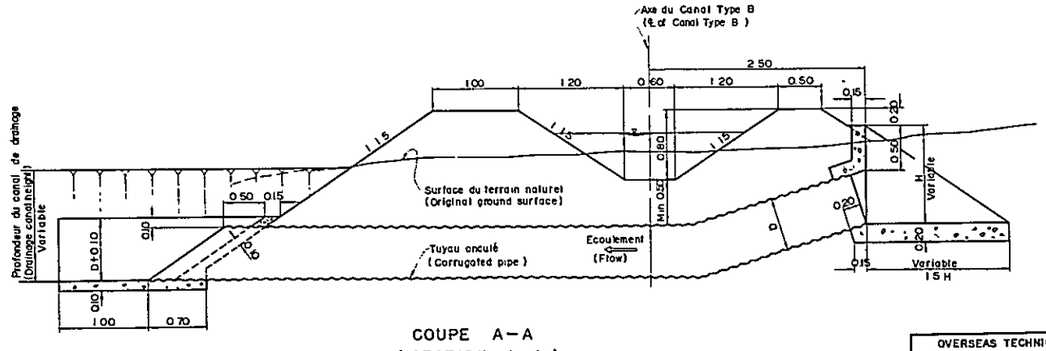


COUPE B-B
(SECTION B-B)

OUVRAGE DE CROISEMENT TYPE DE COURS D'EAU
(TYPICAL DRAINAGE CROSSING)



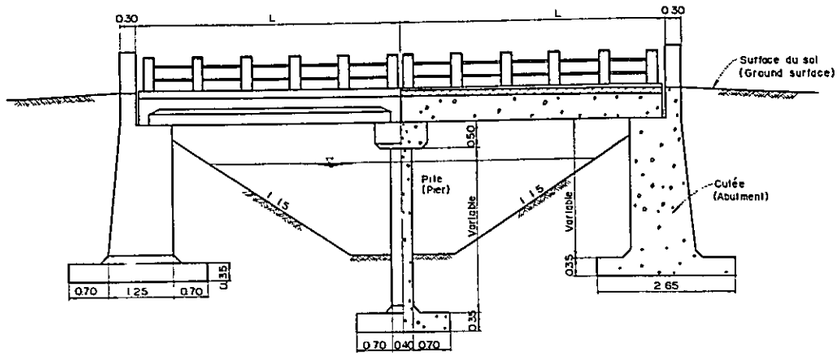
PLAN



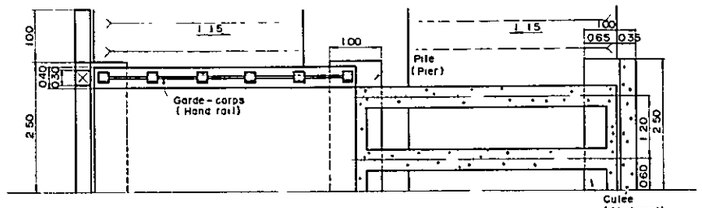
COUPE A-A
(SECTION A-A)

OVERSEAS TECHNICAL COOPERATION AGENCY TOKYO	
THA NGON AGRICULTURAL DEVELOPMENT PROJECT, LAOS	
AQUEDUCS ET OUVRAGE DE CROISEMENT TYPES DE COURS D'EAU (TYPICAL CULVERT & DRAINAGE CROSSING	
DRAWN	DATE MAR 1968
CHECKED	
SUBMITTED	PLATE NO. 7
APPROVED	

PONT-TYPE
(TYPICAL BRIDGE)



PROFIL
(PROFILE)



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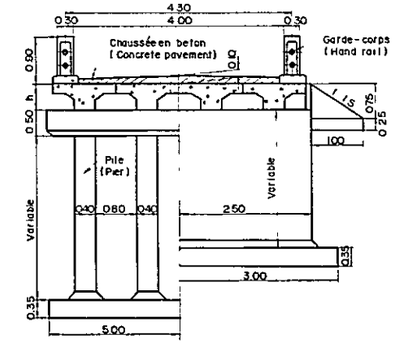
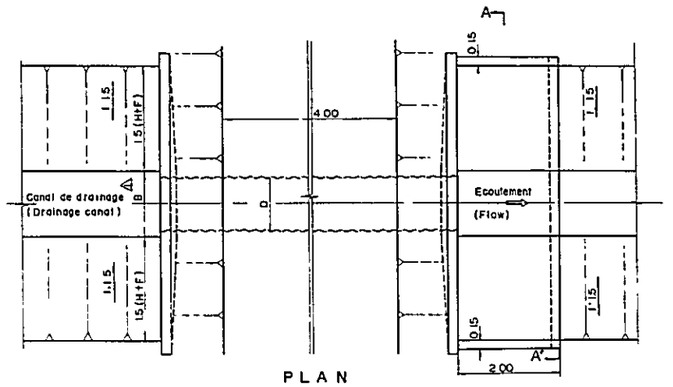


COUPE DE LA PILE
(SECTION OF PIER)

COUPE DE LA CULEE
(SECTION OF ABUTMENT)

AQUEDUC DE DRAINAGE TYPE
(TYPICAL DRAINAGE CULVERT)



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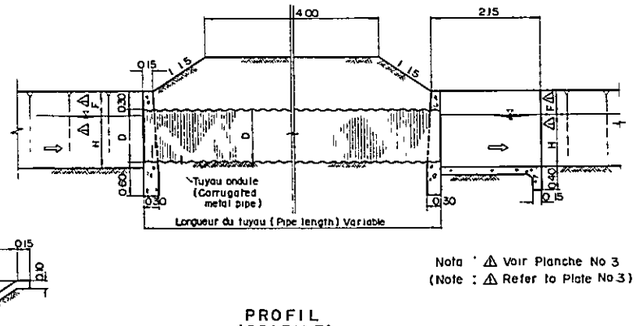
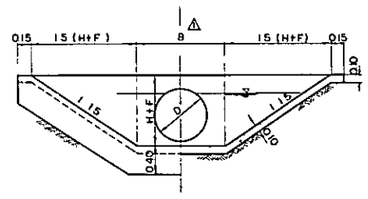
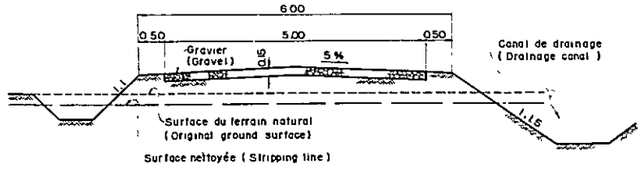


Nota : ⚠ Voir Planche No 3
(Note : ⚠ Refer to Plate No 3)

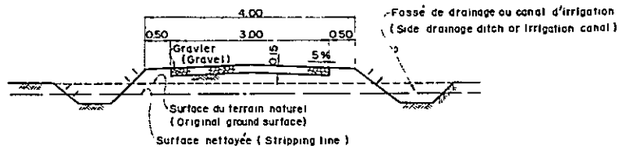
PROFIL
(PROFILE)



COUPE A-A'
(SECTION A-A')



PROFIL EN TRAVERS TYPE DE LA ROUTE PRINCIPALE
(TYPICAL SECTION OF MAIN ROAD)

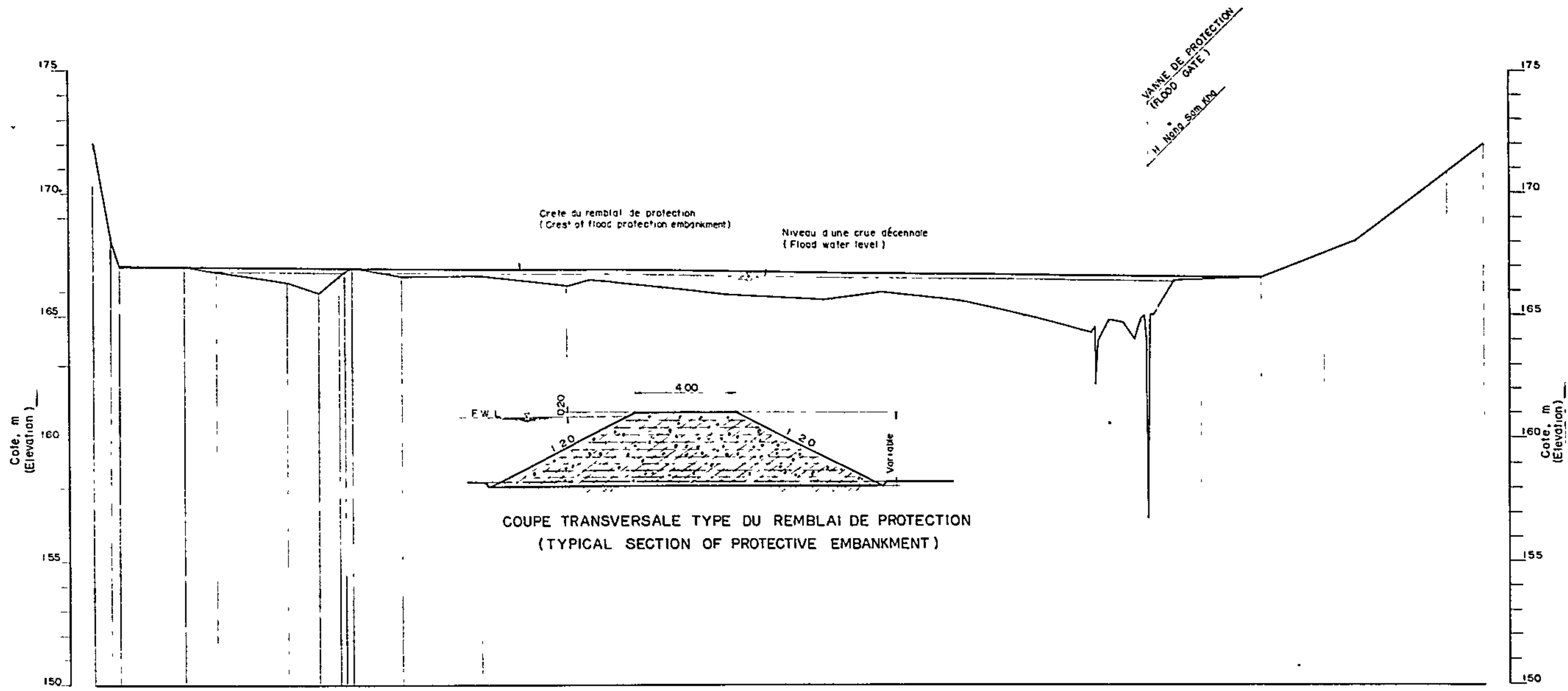


PROFIL EN TRAVERS TYPE DE LA ROUTE SECONDAIRE
(TYPICAL SECTION OF SECONDARY ROAD)

ECHELLE
(SCALE)

0 0.5 1 2 3 4 5m

OVERSEAS TECHNICAL COOPERATION AGENCY TOKYO	
THA NGON AGRICULTURAL DEVELOPMENT PROJECT, LAOS	
PONT, AQUEDUC DE DRAINAGE TYPES ET PROFILS EN TRAVERS TYPES DES ROUTES (TYPICAL BRIDGE, DRAINAGE CULVERT & CROSS SECTION OF ROADS)	
DRAWN	DATE MAR 1968
CHECKED	
SUBMITTED	PLATE NO 8
APPROVED	



COUPE TRANSVERSALE TYPE DU REMBLAI DE PROTECTION
(TYPICAL SECTION OF PROTECTIVE EMBANKMENT)

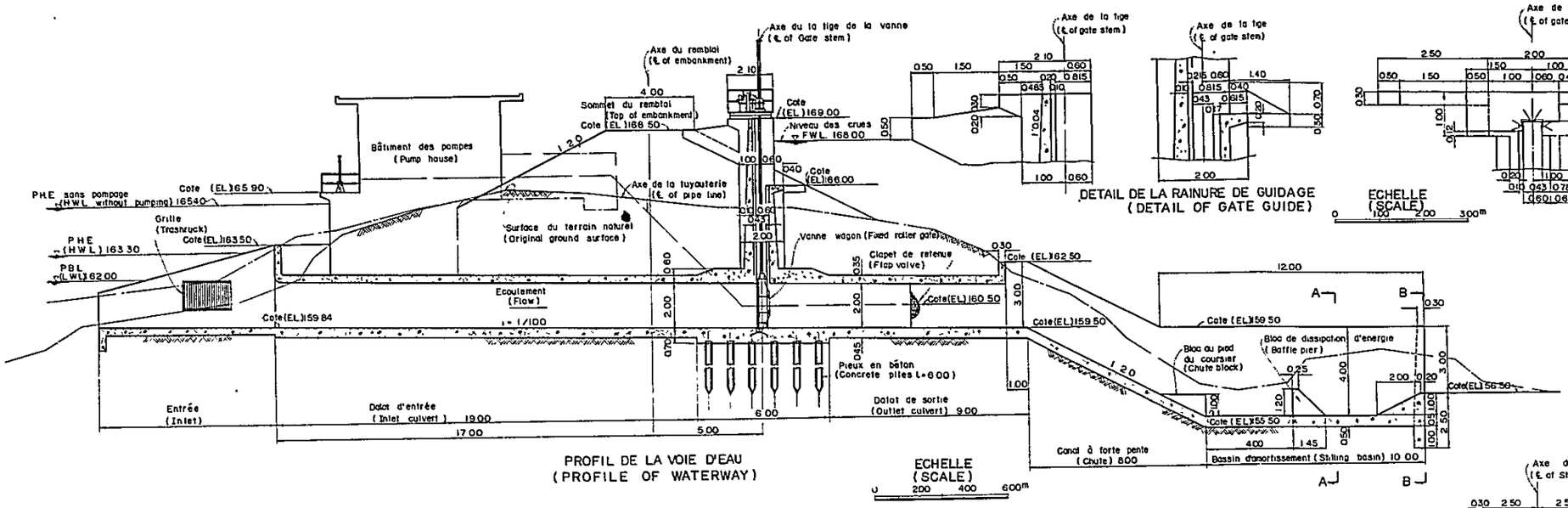
REPERE DE DISTANCE (STATION)	DISTANCE	DISTANCE ACCUMULÉE (ACCUMULATED DIST.)	COTE DU TERRAIN (GROUND-SURFACE ELEVATION)	COTE DE LA CRETE DU REMBLAI (CREST ELEVATION OF DIKE)
No 0	0	0	172 00	
+ 140	140	140	168 00	167 00
+ 210	70	210	167 00	167 00
+ 740	530	740	167 00	
No 1	260	1,000	166 80	
+ 570	570	1,570	166 30	
+ 830	260	1,830	165 90	
No 2	170	2,000	166 60	
+ 50	50	2,050	166 80	
+ 100	50	2,100	166 90	
+ 500	400	2,500	166 60	
No 3	500	3,000	166 60	
+ 150	150	3,150	166 60	
+ 850	700	3,850	166 20	
No 4	150	4,000	166 40	
+ 40	40	4,040	166 40	
+ 630	590	4,630	166 10	
No 5	370	5,000	165 90	
+ 130	130	5,130	165 80	
+ 930	800	5,930	165 60	
No 6	70	6,000	165 60	
+ 390	390	6,390	165 90	
No 7	610	7,000	165 60	
+ 40	40	7,040	165 60	
+ 540	500	7,540	165 00	
No 8	460	8,000	164 40	
+ 100	100	8,100	164 30	
+ 140	40	8,140	162 10	
+ 240	100	8,240	164 80	
+ 360	120	8,360	164 70	
+ 450	90	8,450	164 00	
+ 500	50	8,500	164 90	
+ 560	60	8,560	156 70	166 50
+ 780	220	8,780	166 40	166 50
No 9	220	9,000	166 40	166 50
+ 500	500	9,500	166 50	166 50
No 10	500	10,000	167 50	166 50
+ 250	250	10,250	168 00	166 50
No 11	750	11,000	170 80	
+ 300	300	11,300	172 00	

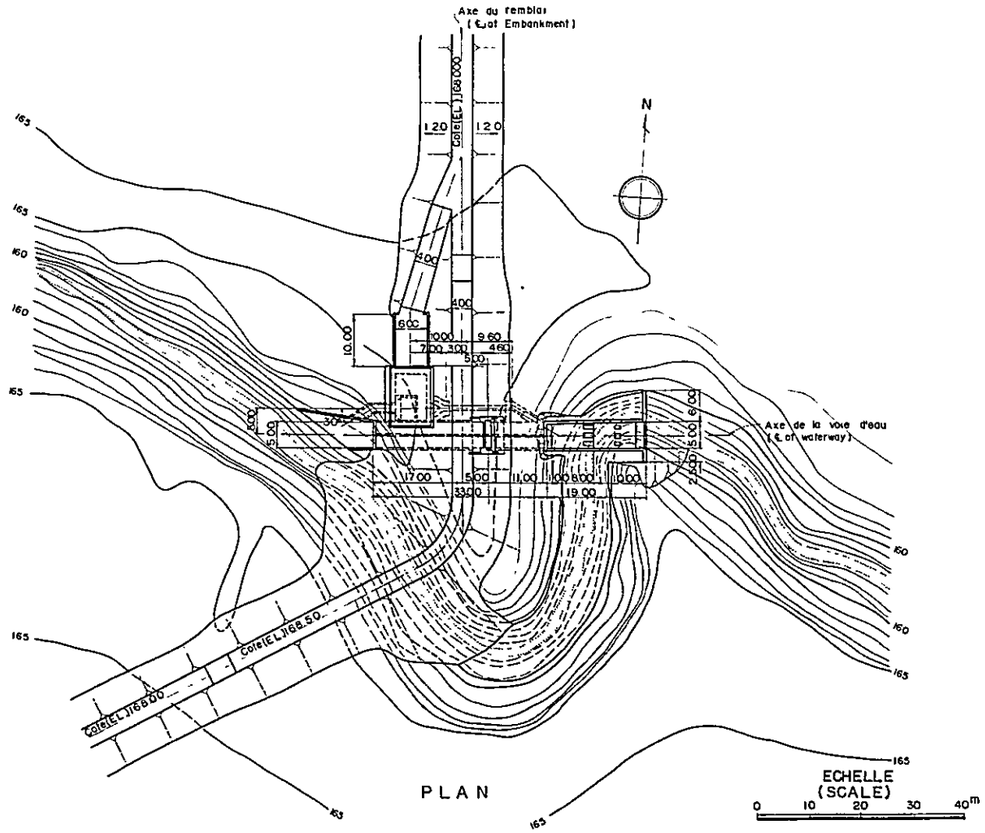
OVERSEAS TECHNICAL COOPERATION AGENCY
TOKYO
THA NGON AGRICULTURAL DEVELOPMENT PROJECT, LAOS

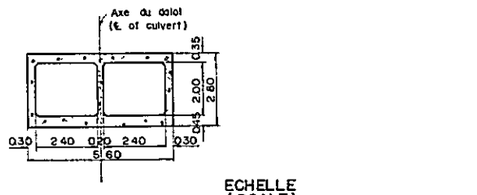
REMBLAI DE PROTECTION
(PROTECTIVE EMBANKMENT)

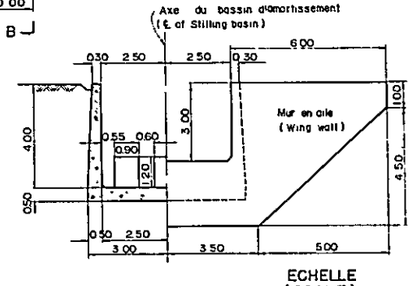
DRAWN
CHECKED
SUBMITTED
APPROVED

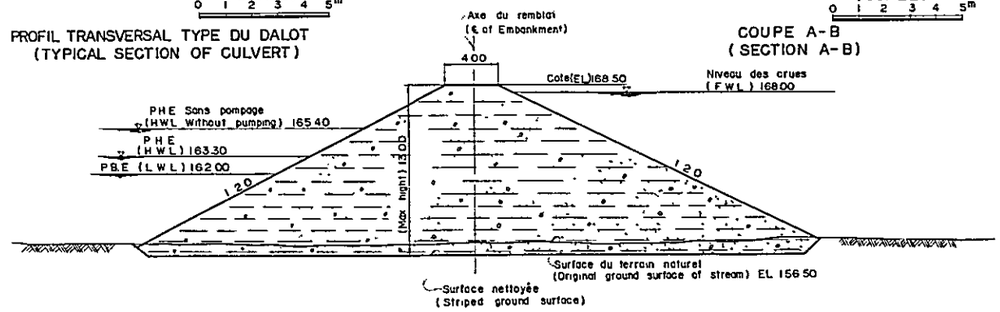
DATE MAR 1968
PLATE NO 9





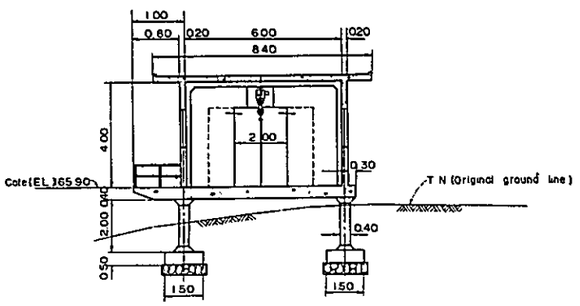




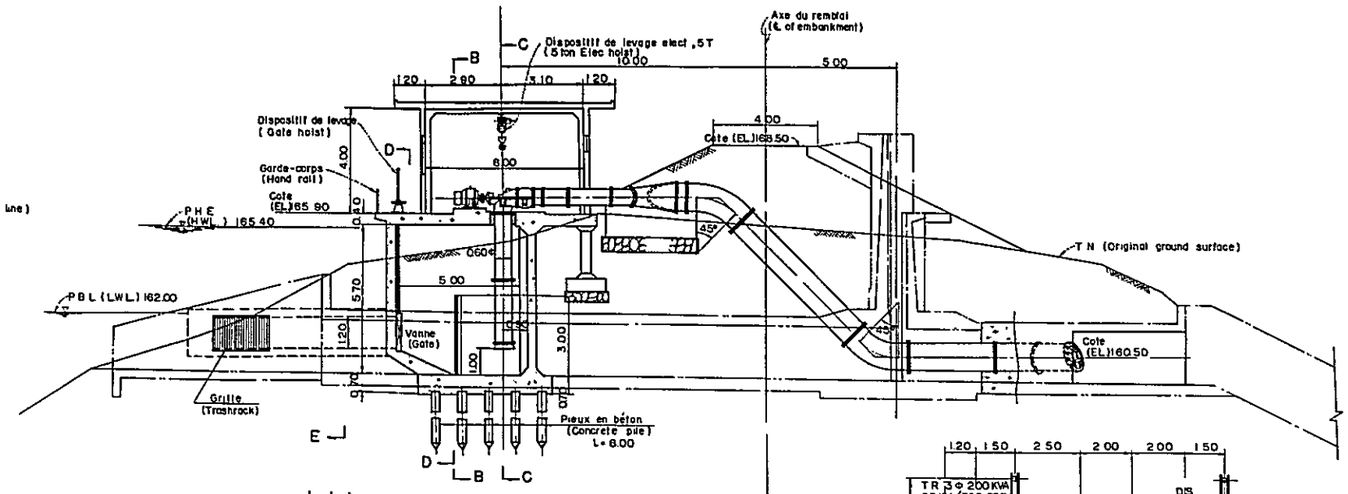


COUPE A-B
(SECTION A-B)

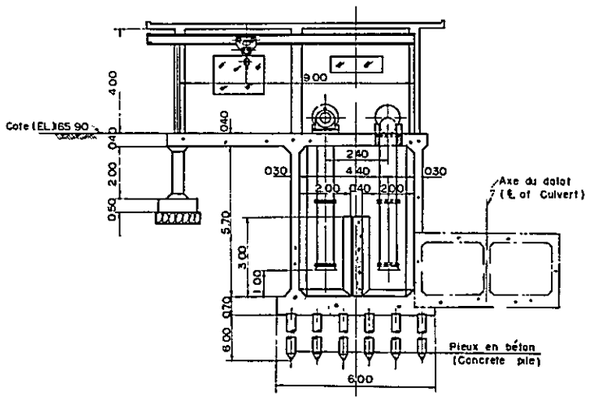
OVERSEAS TECHNICAL COOPERATION AGENCY TOKYO	
THA NGON AGRICULTURAL DEVELOPMENT PROJECT, LAOS	
VANNE DE PROTECTION CONTRE LES CRUES (FLOOD GATE)	
DRAWN T. Kawabata	DATE MAR 1968
CHECKED	
SUBMITTED T. Takagawa	PLATE NO. 10
APPROVED	



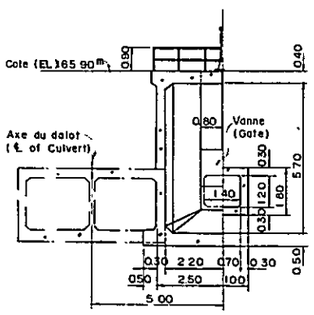
COUPE A-A
(SECTION A-A)



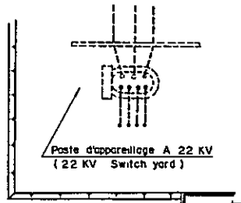
PROFIL
(PROFILE)

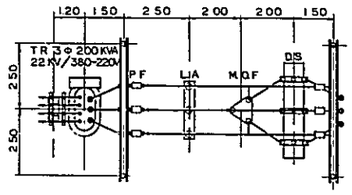


COUPE B-C
(SECTION B-C)

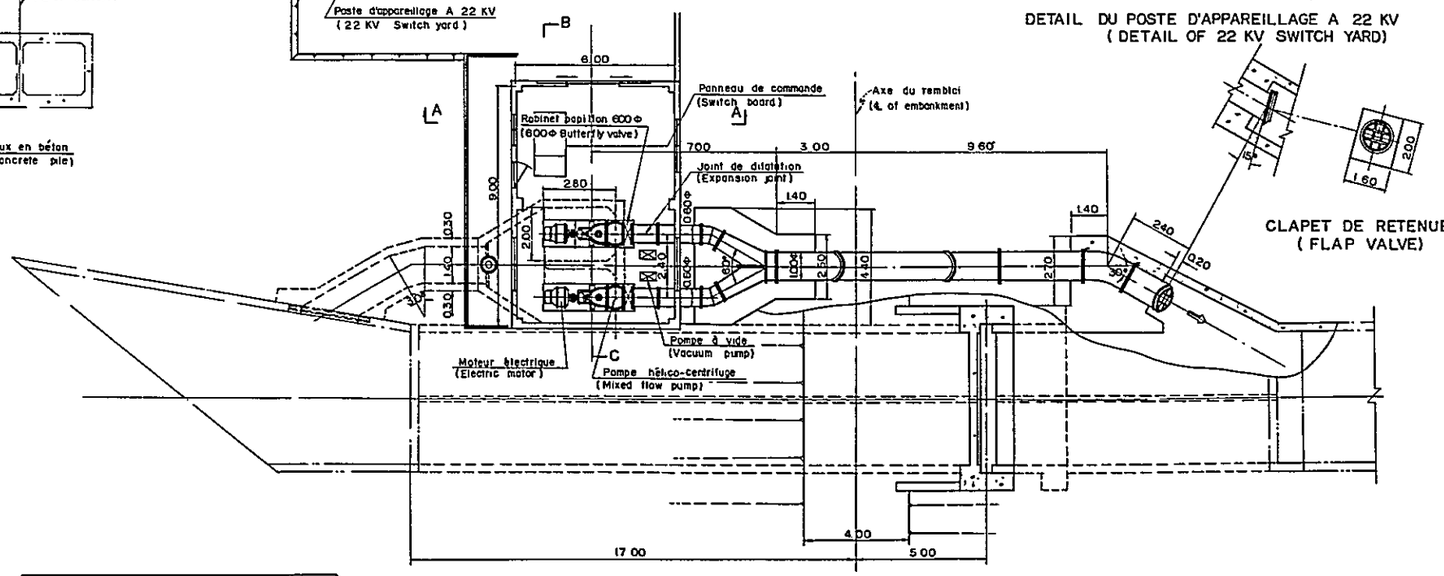


COUPE D-E
(SECTION D-E)





DETAIL DU POSTE D'APPAREILLAGE A 22 KV
(DETAIL OF 22 KV SWITCH YARD)



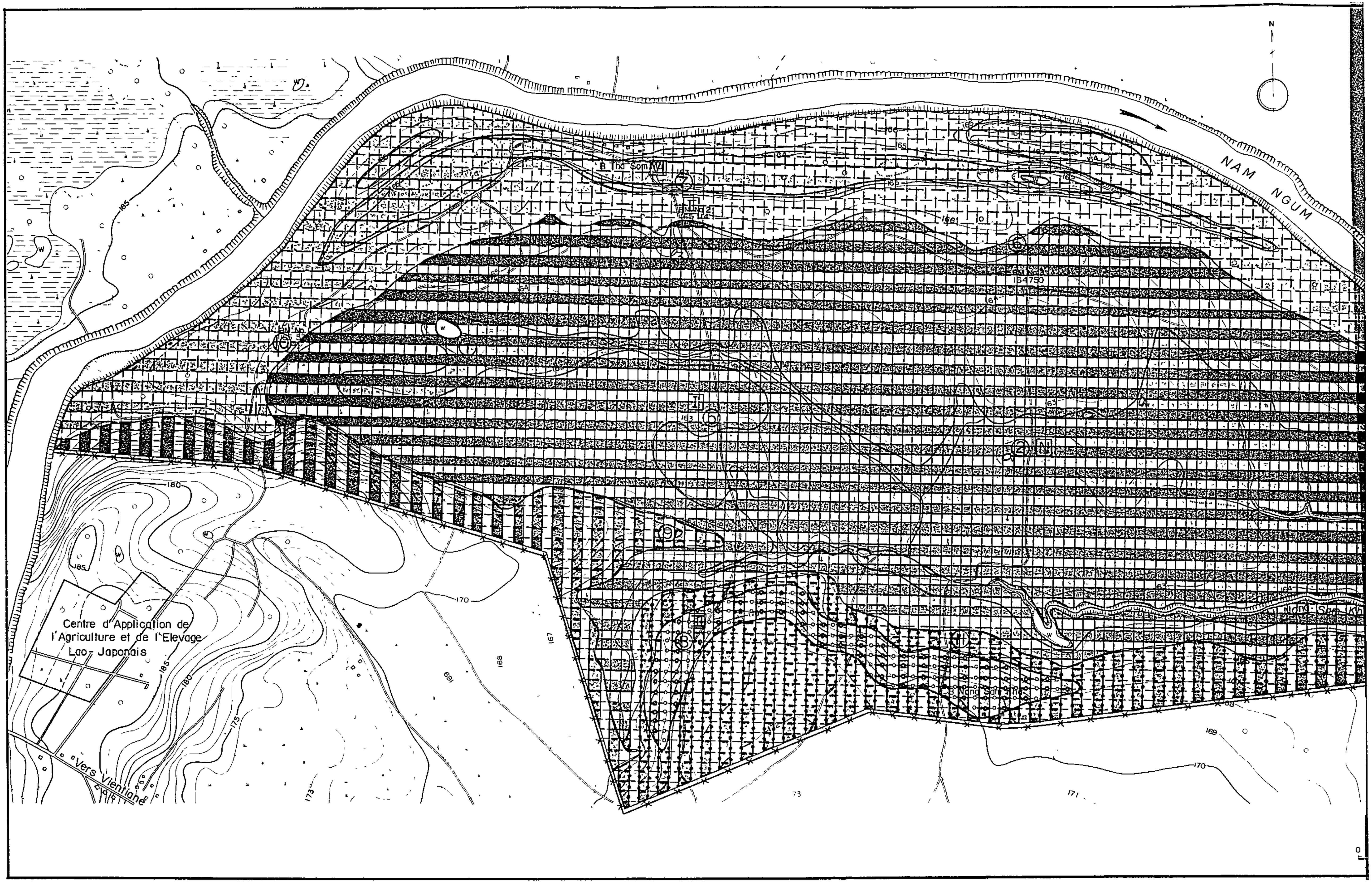
PLAN

CLAPET DE RETENUE
(FLAP VALVE)

LEGENDE (LEGEND)	
DS	SECTIONNEUR (DISCONNECTING SWITCH)
LA	PARAFOUDRE (LIGHTNING ARRESTER)
MOF	TRANSFORMATEUR DE TENSION ET DE COURANT (METERING OUTFIT)
P F	FUSIBLE DE LIGNE (POWER FUSE)
T R.	TRANSFORMATEUR (TRANSFORMER)

ECHELLE
(SCALE)
0 5 10m

OVERSEAS TECHNICAL COOPERATION AGENCY TOKYO	
THA NGON AGRICULTURAL DEVELOPMENT PROJECT, LAOS	
STATION DE POMPAGE POUR LE DRAINAGE (DRAINAGE PUMPING STATION)	
DRAWN T. Kamakura	DATE MAR. 1968
CHECKED R. Yokota	
SUBMITTED T. Fukuyama	PLATE NO. 11
APPROVED	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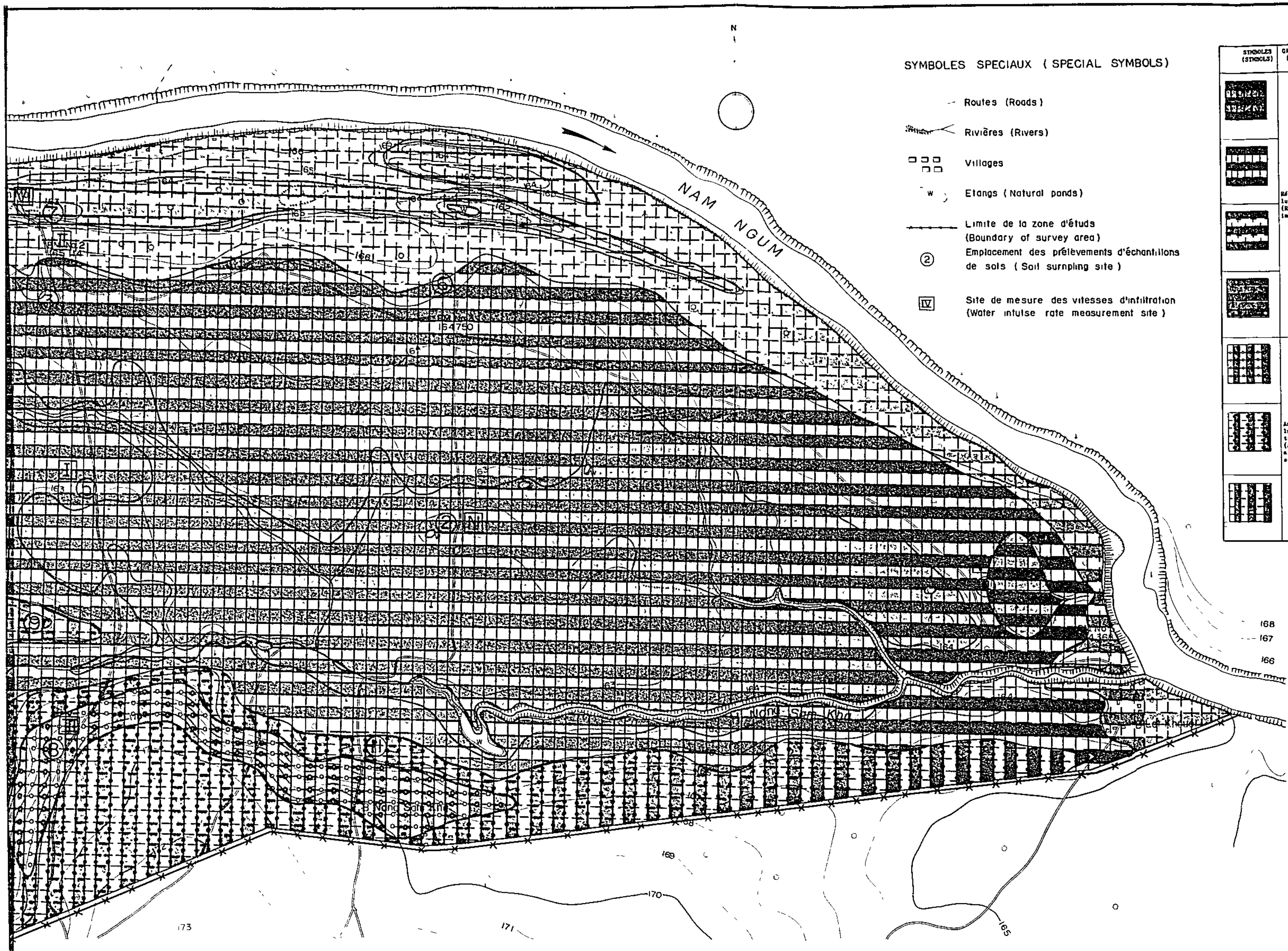

SYMBOLES (SYMBOLS)	GROUPE DE SOLS (SOIL GROUP)	GROUPE SECONDAIRE DE SOLS (SOIL SUBGROUP)	TYPE DE SOLS (SOIL TYPE)	PHASE DE SOLS (SOIL PHASE)
	Récents sols alluviaux jeunes (Recent alluvial immature soils)	Récents sols hydromorphes alluviaux (Recent alluvial hydromorphic soils)	Type 1 Type à surface argileuse et à sous-sol argileux (Clayey surface - clayey subsoil type)	Phase A Phase des terres basses très profondes, très peu drainées, herbeuses, presque plates (Very deep, very poorly drained, grassy, nearly flat, lowland phase)
			Type 2 Type à surface limoneuse et à sous-sol argileux (Loamy surface - clayey subsoil type)	Phase B Phase des terres basses très profondes, peu drainées, herbeuses, légèrement élevées, presque plates (Very deep, poorly drained, grassy, slightly elevated, nearly flat, lowland phase)
		Récents sols des levées naturelles, alluviaux (Recent alluvial natural levee soils)	Type 3 Type à surface limoneuse et à sous-sol limoneux (Loamy surface - loamy subsoil type)	Phase C Phase des terres des levées, très profondes, modérément bien drainées, arbres clairsemés, herbeuses, légèrement élevées, presque plates. (Very deep, moderately well drained, sparsely wooded, grassy, slightly elevated, nearly flat, levee land phase)
				Phase D. Phase des terres des levées à dépression, profondes, peu drainées, herbeuses. (Deep, poorly drained, grassy, depressed levee land phase)
	Anciens sols alluviaux latéritiques (Ancient alluvial lateritic soils)		Type 4 Type à surface sableuse et à sous-sol de gravier (Sandy surface - gravelly subsoil type)	Phase E Phase des terres hautes, de couche extrêmement peu profonde, imparfaitement drainées, aux arbres clairsemés, à pente douce (Very shallow, imperfectly drained, sparsely wooded, gently sloping upland phase.)
				Phase F Phase des terres hautes, de couche peu profonde, modérément bien drainées, arbres clairsemés, à pente douce. (Moderately shallow, moderately well drained, sparsely wooded, gently sloping upland phase)
			Type 5 Type à surface sableuse et à sous-sol argileux (Sandy surface - clayey subsoil type)	Phase G Phase des terres hautes, profondes, modérément bien drainées, boisées, à pente douce (Deep, moderately well drained, wooded, gently sloping upland phase)

ECHELLE
(SCALE)
0 500 1,000m

OVERSEAS TECHNICAL COOPERATION AGENCY
TOKYO

THA NGON AGRICULTURAL DEVELOPMENT PROJECT, LAOS

CARTE DES SOLS
(SOIL MAP)

DRAWN K. Onaka	DATE MAR 1968
CHECKED	
SUBMITTED T. Fukuzawa	PLATE NO 13
APPROVED	

N

NAM NGUM

I

II-A

II-A

II-A

II-A

II-B

II-B

IV

IV

IV

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l'Agriculture et de l'Elevage
Lao-Japonais

Vers Vientiane

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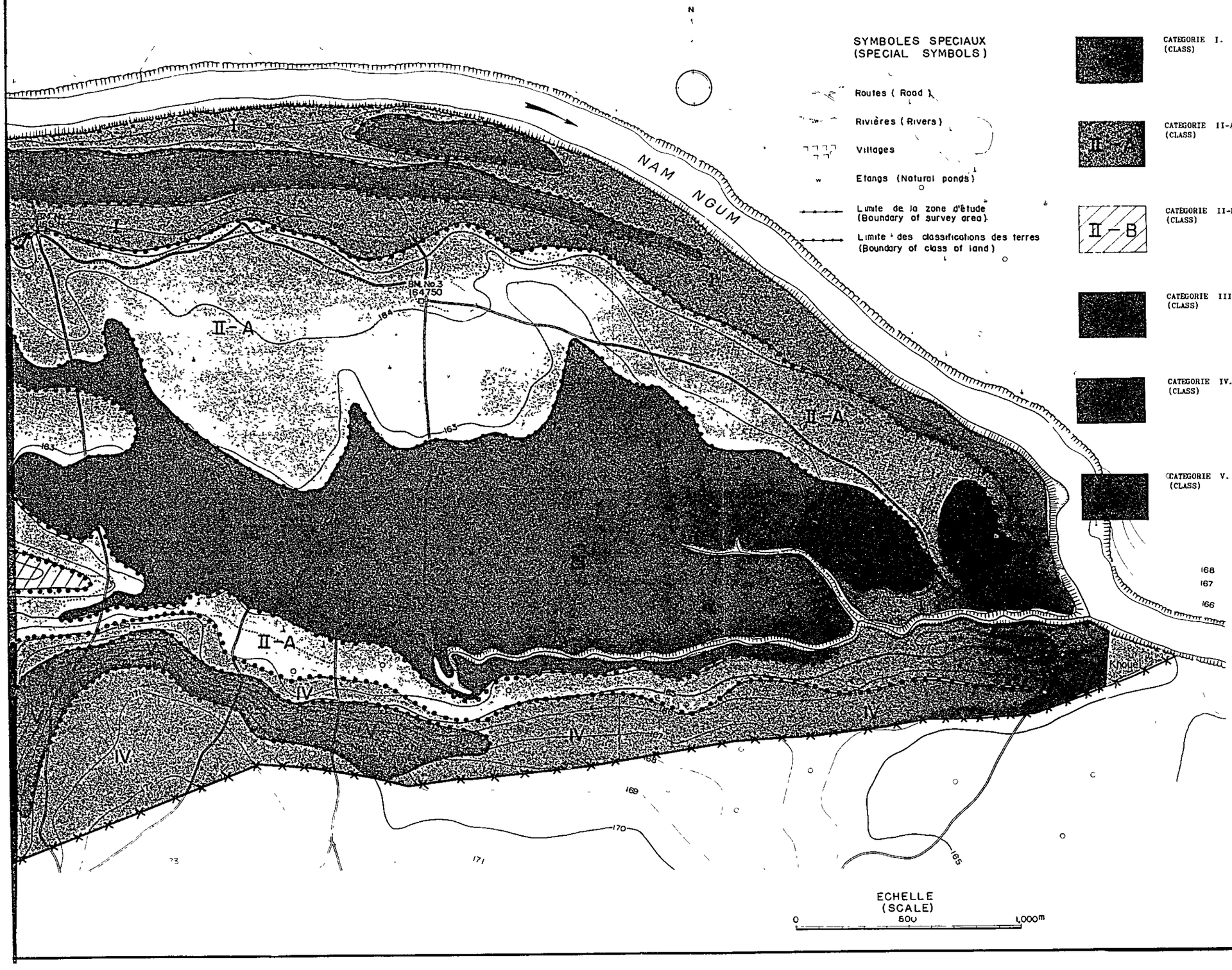


CATEGORIE I. (CLASS)
Sol convenant à l'agriculture par irrigation.
Terrain facilement utilisable par l'installation de simples systèmes d'irrigation et de drainage.
(Soil suitable for irrigation agriculture.
Land easily utilizable by installing simple irrigation and drainage systems.)

CATEGORIE II-A. (CLASS)
Sol convenant à la culture de riz par irrigation.
L'installation complète des systèmes d'irrigation et de drainage est nécessaire.
(Soil suitable for irrigated culture of paddy rice.
Complete irrigation and drainage systems are required)

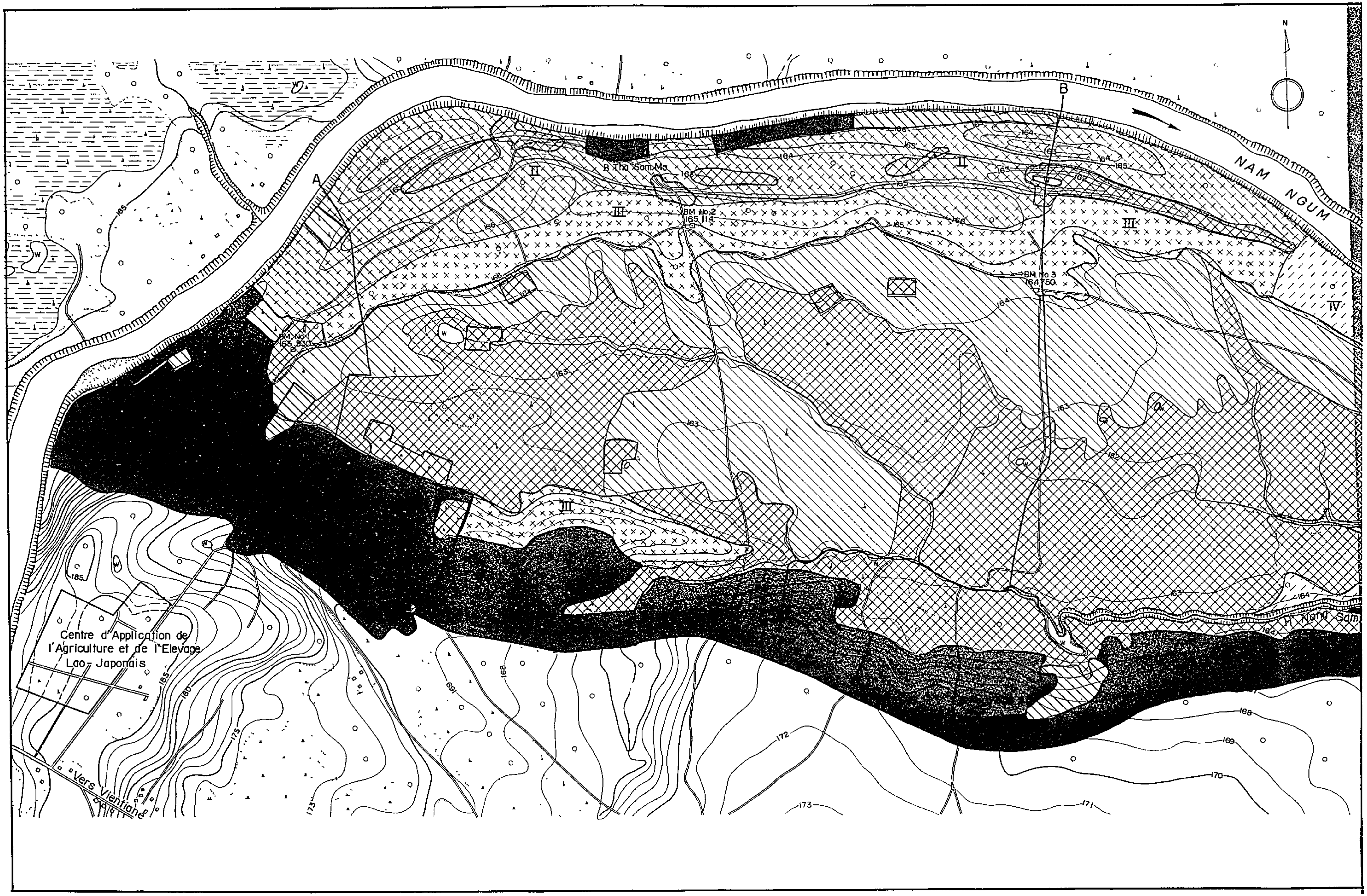
CATEGORIE II-B. (CLASS)
Sol convenant à la culture des terres hautes par irrigation.
L'installation complète du système d'irrigation est nécessaire
(Soil suitable for irrigated culture of upland crops.
Complete irrigation system is required.)

CATEGORIE III. (CLASS)
Sol convenant à la culture du riz par irrigation.
L'installation complète des systèmes d'irrigation et de drainage est absoluement nécessaire.
(Soil suitable for irrigated culture of paddy rice.
Complete drainage and irrigation systems are absolutely necessary)

CATEGORIE IV. (CLASS)
Sol utilisable pour la culture des terres hautes par irrigation.
L'installation complète du système d'irrigation, l'application des mesures de protection contre l'érosion et l'amendement du sol sont nécessaires.
(Soil utilizable for irrigated culture of upland crops.
Complete installation of irrigation system, application of protective measures against erosion and soil amendment are necessary.)

CATEGORIE V. (CLASS)
Convenant aux cultures vivaces et herbages plutôt qu'aux cultures ordinaires irriguées.
(Suitable for perennial crop culture and pasture rather than irrigated culture of common crops)

OVERSEAS TECHNICAL COOPERATION AGENCY TOKYO	
THA NGON AGRICULTURAL DEVELOPMENT PROJECT, LAOS CARTE DES CLASSES D'APTITUDE A L'EXPLOITATION DES TERRES (LAND-USE-CAPABILITY CLASS MAP)	
DRAWN CHECKED SUBMITTED T. Fukuyama APPROVED	DATE MAR 1968 PLATE NO 14



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BM No 3
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l'Agriculture et de l'Elevage
Lao-Japonais
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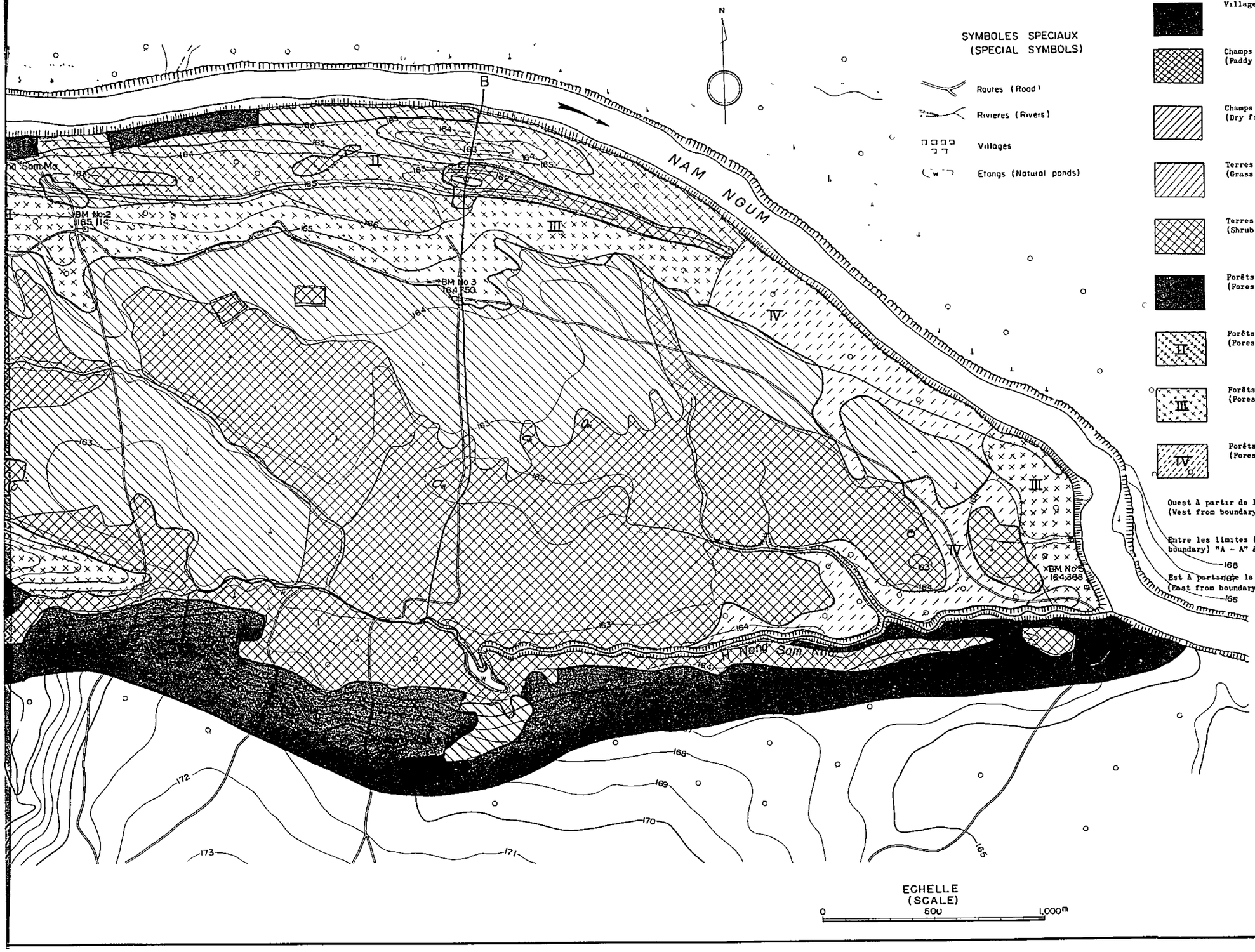


SYMBOLES SPECIAUX
(SPECIAL SYMBOLS)

- Routes (Road)
- Rivieres (Rivers)
- Villages
- Etangs (Natural ponds)

- Villages.
- Champs de riz. (Paddy fields)
- Champs de cultures sèches. (Dry fields)
- Terres recouvertes d'herbes. (Grass lands)
- Terres recouvertes de broussailles. (Shrub)
- Forêts à grands arbres. (Forests with large trees)
- I — Forêts à grands arbres clairsemés. (Forests with sparce large trees)
- II — Forêts à arbres de grandeur moyenne. (Forests with medium trees)
- III — Forêts à petits arbres. (Forests with small trees)
- IV

Ouest à partir de la limite (West from boundary) "A – A":	Zone utilisée principalement par les habitants de (Area used mainly by inhabitants of) Ban Tha Ngon.
Entre les limites (Between boundary) "A – A" & "B – B" :	Zone utilisée principalement par les habitants de (Area used mainly by inhabitants of) Ban Tha Som Mo.
Est à partir de la limite (East from boundary) "B – B":	Zone utilisée principalement par les habitants de (Area used mainly by inhabitants of) Ban Lat Khouei.

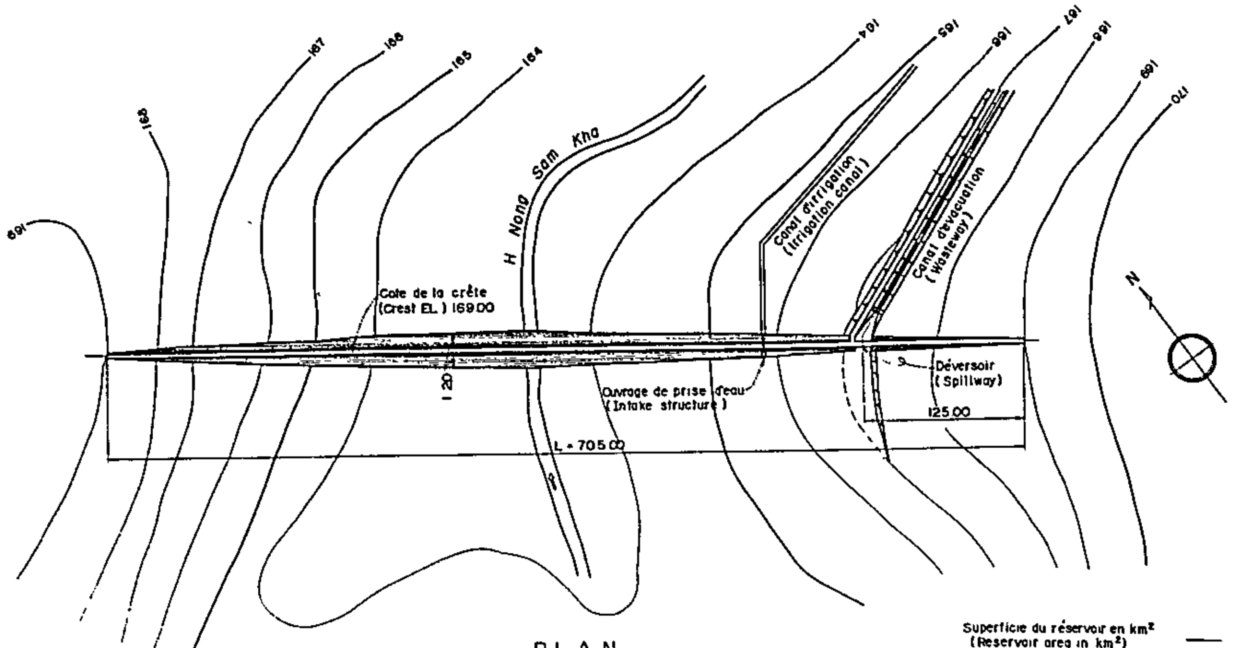
ECHELLE
(SCALE)
0 500 1,000m

OVERSEAS TECHNICAL COOPERATION AGENCY
TOKYO

THA NGON AGRICULTURAL DEVELOPMENT PROJECT, LAOS

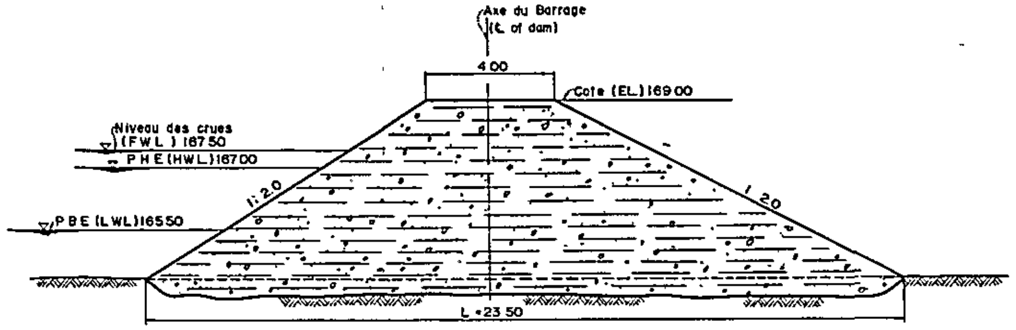
CARTE DE REPARTITION DES PLANTES
(MAP OF VEGETATION DISTRIBUTION)

DRAWN U. Taiyo	DATE MAR 1968
CHECKED	
SUBMITTED T. Fukuzawa	PLATE NO 15
APPROVED	

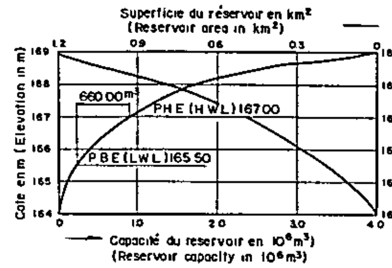


PLAN

ECHELLE (SCALE) 0 50 100 150m

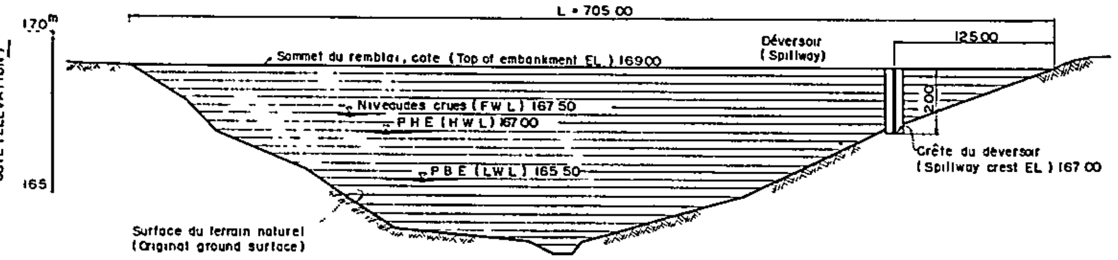


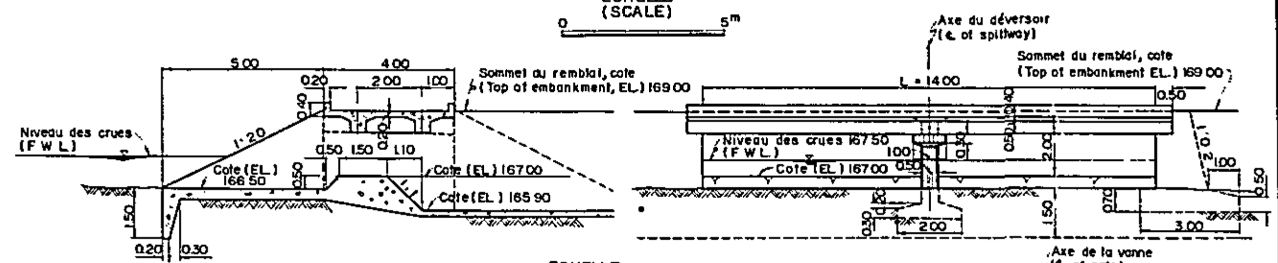
ECHELLE (SCALE) 0 5m



SUPERFICIE ET COURBE DE JAUGEAGE D'UN RESERVOIR

(AREA AND CAPACITY CURVE)

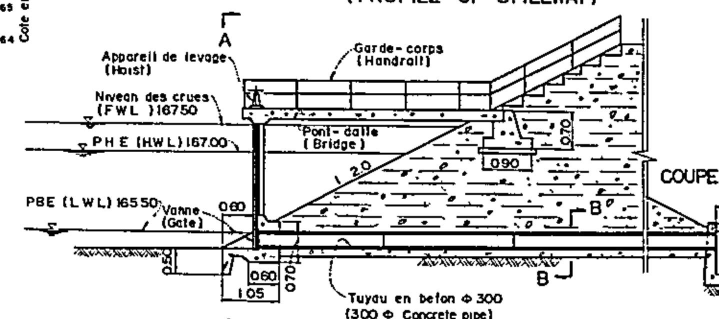


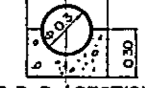


ECHELLE (SCALE) 0 5m

PROFIL DU DEVERSOIR

(PROFILE OF SPILLWAY)



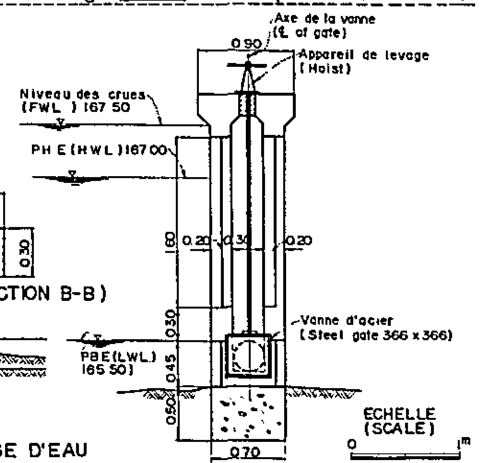


COUPE B-B (SECTION B-B)

ECHELLE (SCALE) 0 1 2 3m

OUVRAGE DE PRISE D'EAU

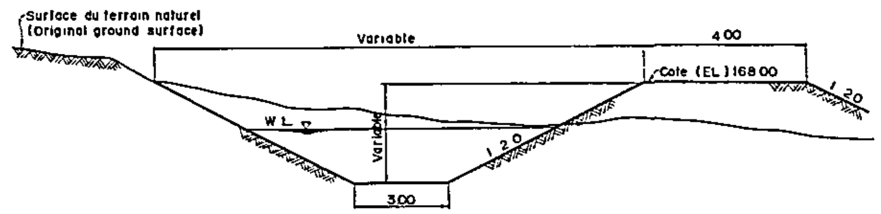
(INTAKE STRUCTURE)



ECHELLE (SCALE) 0 1m

COUPE A-A

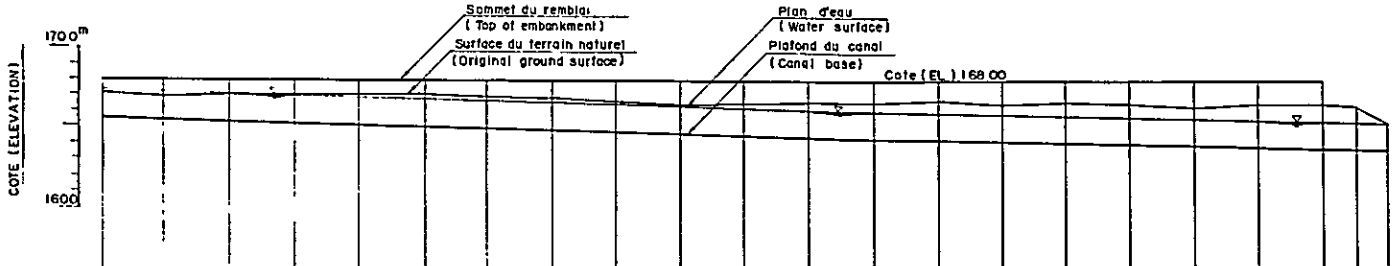
(SECTION A-A)



PROFIL TRANSVERSAL TYPE DU CANAL D'EVACUATION

(TYPICAL SECTION OF WASTEWAY)

ECHELLE (SCALE) 0 5m



COTE DE LA CRETE (CREST ELEVATION)	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0	168.0		
COTE DU PLAFOND DU CANAL (CANAL BASE ELEVATION)	165.6	165.5	165.4	165.3	165.2	165.1	165.0	164.9	164.8	164.7	164.6	164.5	164.4	164.3	164.2	164.1	164.0	163.9	163.8	163.7	163.65	163.6
COTE DU TERRAIN (GROUND SURFACE ELEVATION)	167.0	166.9	167.0	167.0	167.0	167.0	166.9	166.8	166.6	166.5	166.5	166.6	166.5	166.6	166.4	166.5	166.4	166.2	166.4	166.4	166.2	165.1
DISTANCE ACCUMULEE (ACCUMULATED DISTANCE)	0	200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000	2,200	2,400	2,600	2,800	3,000	3,200	3,400	3,600	3,800	3,900	4,000

OVERSEAS TECHNICAL COOPERATION AGENCY TOKYO

THA NGON AGRICULTURAL DEVELOPMENT PROJECT, LAOS

BARRAGE DE NONG SAM KHA ET CANAL D'EVACUATION

(NONG SAM KHA DAM & WASTEWAY)

DRAWN T. Kawakita
CHECKED R. Yoshida
SUBMITTED T. Fukuzawa
APPROVED

DATE MAR 1968

PLATE NO 12