FEASIBILITY STUDY

ON

BOHOL IRRIGATION DEVELOPMENT PROJECT

(PHASE II)

IN

THE REPUBLIC OF THE PHILIPPINES

EXECUTIVE SUMMARY

NOVEMBER, 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

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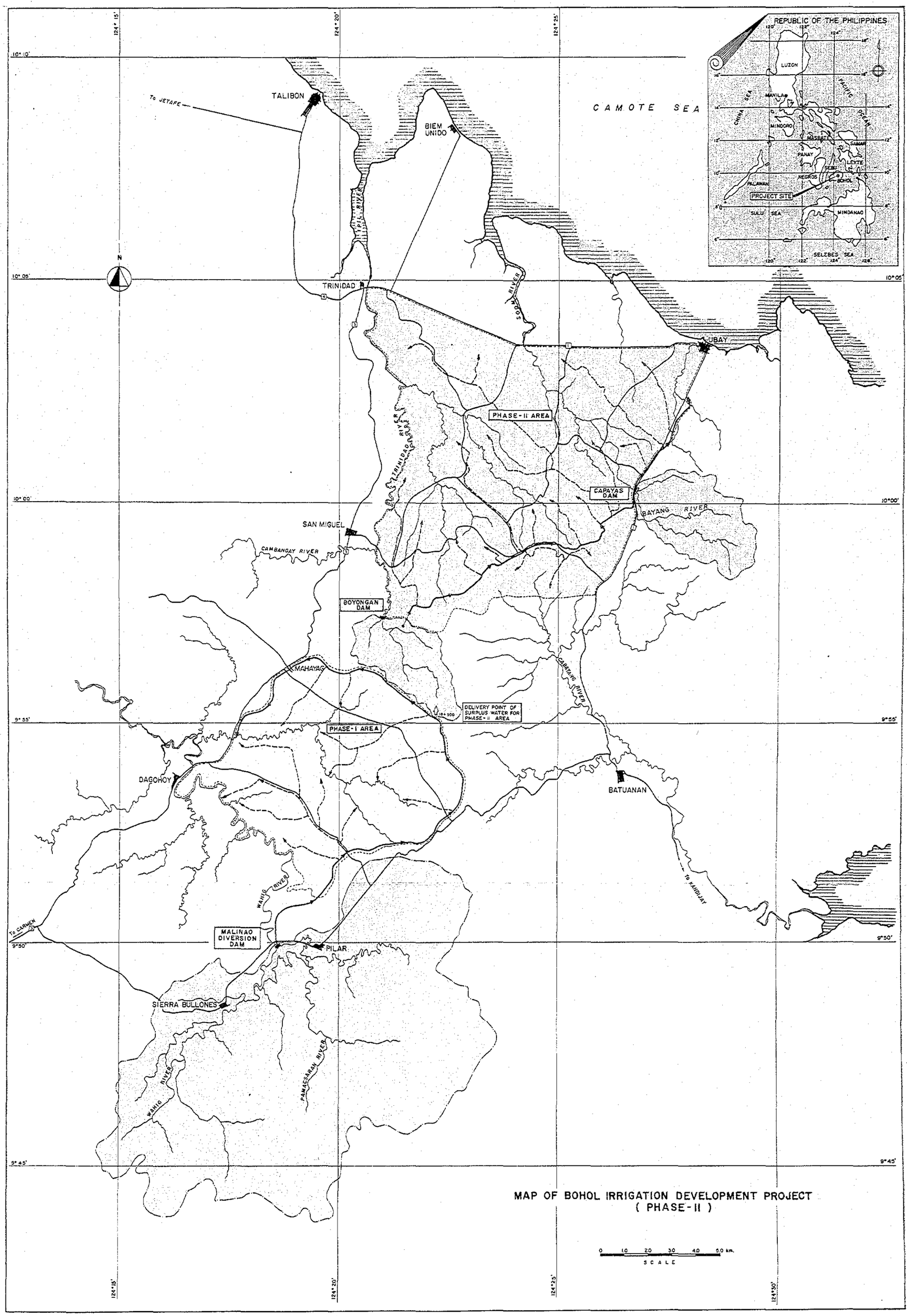
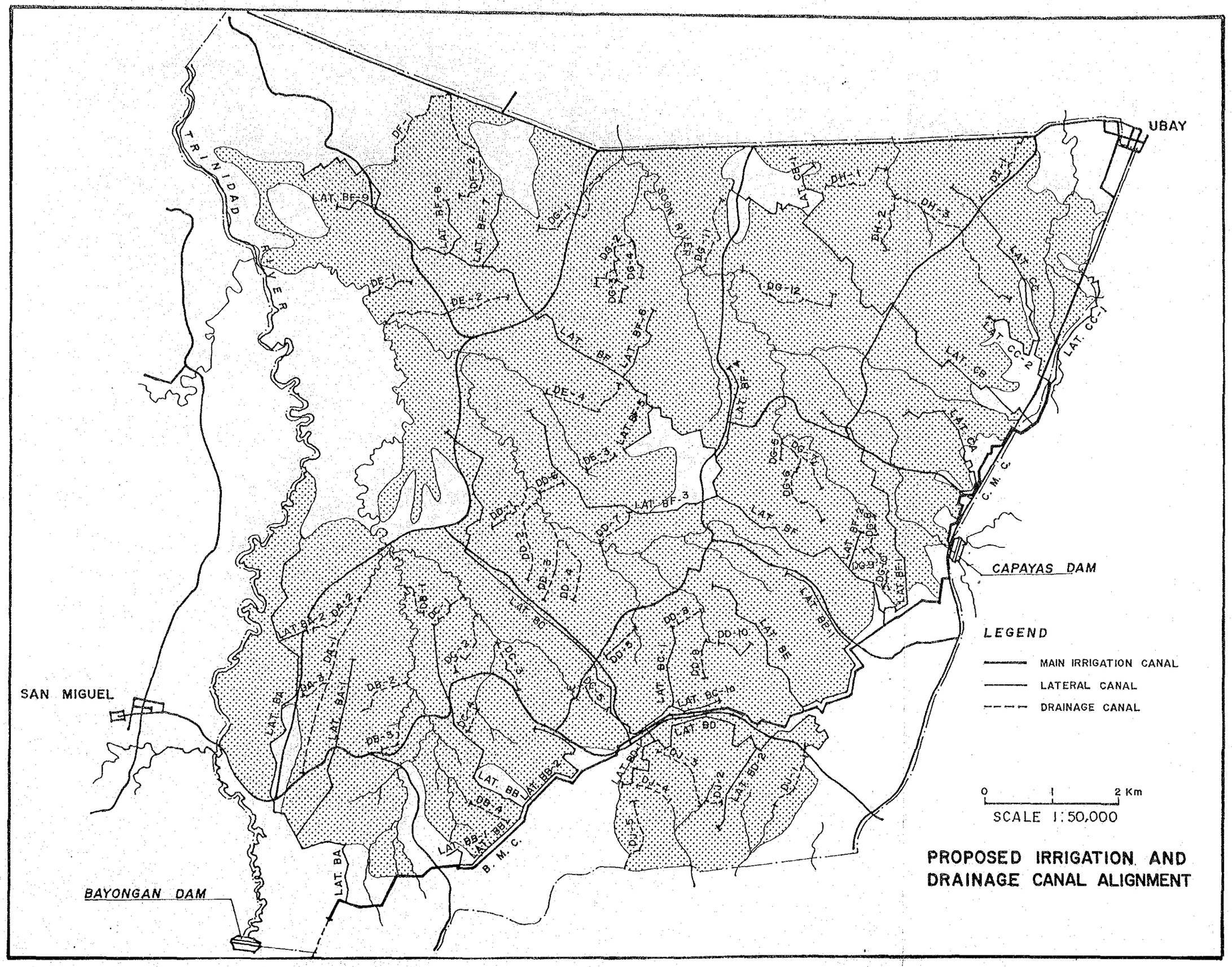


MAP OF BOHOL IRRIGATION DEVELOPMENT PROJECT
(PHASE-II)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SOOM RIVER
SAN MIGUEL
BAYONGAN DAM
CAPAYAS DAM
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LAT. BF-8
LAT. BF-7
LAT. BF
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LAT. BF-5
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DJ-2
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DJ-4
DJ-5
C. M. C.
B. M. C.
LEGEND
MAIN IRRIGATION CANAL
LATERAL CANAL
DRAINAGE CANAL
0
1
2 Km
SCALE 1:50,000
PROPOSED IRRIGATION AND
DRAINAGE CANAL ALIGNMENT

OUTLINE OF BOHOL IRRIGATION PROJECT (PHASE II)

1. Project Area
   - Location : Municipality of San Miguel, Trinidad and Ubay
   - No. of Barangay : 22 Barangay
   - Population : 10,870 Persons (166 persons/sq.km)

2. Irrigation Service Area: 5,300 ha
   - Dry Season Cropping Area
     - ° Paddy : 3,540 ha (65%)
     - ° Upland Crop : 1,760 ha (35%)
   - Wet Season Cropping Area
     - ° Paddy : 5,300 ha

3. Water Resources	Average Year	Dry Year
Trinidad River	10.3 MCM	8.0 MCM
Bayang River	11.0 MCM	8.7 MCM
Surplus of Phase I	49.0 MCM	30.6 MCM
Total	70.3 MCM	47.3 MCM

4. Reservoir Dimension	Bayongan	Capayas
Drainage Area	11.2 sq.km	14.6 sq.km
Reservoir Area	2.8 MSM	0.6 MSM
Full Water Level	50.0 m	34.0 m
Low Water Level	38.0 m	30.0 m
Total Reservoir Capacity	27.5 MCM	2.3 MCM
Effective Reservoir Capacity	22.5 MCM	1.6 MCM
Dead Reservoir Capacity	5.0 MCM	0.7 MCM

5. Dam Dimension	Bayongan	Capayas
Dam Type	Fill Type	Fill Type
Dam Height	31.0 m	17.0 m
Dam Length	810 m	1,150 m
Dam Volume	1.1 MCM	0.2 MCM
Intake Discharge	9.74 cu.m/sec	2.13 cu.m/sec
Intake Type	Tunnel	Conduit Pipe
Spillway Flood Discharge	20.0 cu.m/sec	226.0 cu.m/sec
Spillway Type	Chute	Side Channel

6. Canal Dimension	Bayongan System	Capayas System
Service Area	4,140 ha	1,160 ha
Maximum Canal Capacity	9.74 cu.m/sec	2.13 cu.m/sec
Main Canal Type	Concrete Lining	-do-
Lateral Canal Type	Earth Canal	-do-
Main Canal Length	12.5 km	3.3 km
Lateral Canal Length	68.9 km	18.9 km

7. On-Farm Development	Bayongan System	Capayas System
Existing Area	1,230 ha	470 ha
Land Reclamation Area	2,910 ha	690 ha
Total	4,140 ha	1,160 ha

8. Project Cost
   - Foreign Cost : 400.0 Million Pesos
   - Local Cost : 258.0 Million Pesos
   - Total : 658.0 Million Pesos

9. Project Evaluation
   - Internal Rate of Return : 15.4%

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1. BACKGROUND OF THE PROJECT

1. BACKGROUND OF THE PROJECT

1.1. Agriculture in Bohol Province

Bohol province is located in the Central Visayas, having an area of 4,110 sq.km and population of about 806,000. A major industry in Bohol island is agriculture, and the rural population of about 680,000 is engaged in the agricultural works for about 129,400 ha of farm land. The agricultural economy in Bohol island, however, has been in depression due to such constraints to agriculture in undulating land, poor soil, irregular distribution of rainfall, limited means of transportation, insufficient extension services, etc.

Paddy cropping, which is quite essential to support the local farmers' economy, has been practised in the paddy fields of about 90,000 ha out of the total agricultural land of about 129,400 ha. And most of these paddy fields are still rainfed fields. In ordinary years, however, only the fields covering 40,000 ha to 60,000 ha can be cropped due to water shortage. In the droughty year like 1982, cropping can be carried out in the fields of about 43,000 ha only. Such upland crops as corn, vegetable, legume, etc. have been grown in the field of about 27,000 ha, although suffering from water shortage as well.

The annual paddy production ranges from 90,000 to 100,000 tons, which can not meet the demand of about 130,000 tons in Bohol island. The production of upland crops is also insufficient to demand. Bohol province receives supply of paddy and upland crops from other provinces in the country to cover the deficit for demand.

The Central Government and the Bohol provincial government have promoted the agricultural development in Bohol island, and in order to increase the farmers' income, to stabilize the local agro-economy and to satisfy local inhabitants with the food supply in Bohol province, the both governments have been trying to improve the present agricultural conditions.

The National Irrigation Administration (NIA) has carried out communal irrigation projects with storage dams, diversion dams and irrigation networks in small scale so as to meet the farmers' requirement. In addition, the agencies of the Ministry of Agriculture have rendered services to improve the farming technics. In spite of such efforts, the agricultural productivity and the rural income have still remained lower than those of the national average.

1.2. Bohol Irrigation Project with Phase I and Phase II

The Bohol Irrigation Project with Phase I and Phase II is a large scale project to develop the irrigation service areas of about 10,000 ha in the best use of the water in the Wahig-Pamacsalan river and has been planned by NIA under the technical cooperation of the Japanese Government.

The project consists of Phase I and Phase II, having an irrigation service area of about 5,000 ha, respectively. Phase I project is now under implementation by NIA by the OECF Loan (Japan), and is expected to provide the Malinao dam across the Wahig-Pamacsalan river and the main canal for the service area of about 5,000 ha. This main canal has a function to convey the water to Phase II area after diverted at the Malinao dam.

The construction of Phase I project will be completed by 1988.

The Phase II project is planned to use the surplus water diverted from the Wahig-Pamacsalan river and to irrigate the Phase II service area of about 5,000 ha. The Philippine Government requested the Japanese Government to carry out the Feasibility Study of Phase II project in order to ensure the technical and economical feasibility for the project implementation.

In response to the request from the Philippine Government, the Japanese Government decided to undertake the feasibility study of the Phase II project under the Japanese technical cooperation.

The Japan International Cooperation Agency (JICA) commenced the feasibility study in mid-January, 1985 and completed the study at the end of September 1985.

The report consists of Main Report, Annex I and II and Supplemental Report on the Capayas Irrigation System.

2. PRESENT CONDITION IN THE PROJECT AREA

2. PRESENT CONDITION IN THE PROJECT AREA

2.1. Location and Geography

The project area is located in the north-eastern part of Bohol island, about 100 km far from Tabgilaran, capital of the Island, as shown in the Project Map. The whole project area is approximately 12,700 ha, extending at the elevation of 40 to 5.0 m from the south to north direction in undulating hilly topography. The project area is formed with extensive sequence of sedimentary formation consisting mainly of siltstone, mudstone and sandstone.

Several well-developed streams flow from the southern ridge in the project area to the northern area near No.1 Highway between Trinidad and Ubay, and finally empty themselves into the Camotes Sea in collecting the rainwater in the project area.

The Bayongan reservoir area proposed in the project is located at the east-south corner of the project area and the catchment area covers 11.2 sq.km, in steep hilly topography at the elevation of about 40 to 100 m and covered with cogon, shrub and coconut. The Capayas reservoir area proposed in the project is located near a bridge where the existing highway crosses the Bayang river and the catchment area is 13.1 sq.km in gentle hilly topography at the elevation of about 30 m to 100 m.

The project service area is formed with the depression area between hills and hilly areas at the elevation ranging from 40 to 5.0 m. The paddy fields extend in the depression area along the streams and the hilly area is covered with grass and shrub. A few kinds of upland crops and coconut are grown in the scattered areas in the hilly land.

Several swamps covered with broad leaf are found in the downstream of the rivers and streams, and inundated by two to three meters in depth.

2.2. Administrative and Population

(1) Administrative Division

The project area administratively consists of parts of three municipalities of San Miguel, Trinidad and Ubay, including 82 barangays, out of which 22 are located in the project area.

The outline of administration is referred to as follows:

Item	Administrative Division				Project Service Area
	San Miguel	Trinidad	Ubay	Total	
No. of Barangay	18	20	44	82	22
Total Area (sq.km)	91.6	94.3	205.6	393.4	127
Agriculture Area (ha)	6,400	8,100	9,200	23,700	6,100
Population ('000)	12.2	15.1	38.3	65.6	10.9

Several governmental agencies relating to the agricultural development are working in the Bohol province. NIA is one of the important agencies to plan, design, and construct the irrigation and drainage projects as well as the operation and maintenance of the project facilities. The Provincial office of NIA is located at Tagbilaran and in charge of the communal irrigation project. The branch office of the Ministry of Agriculture and Foods also is located therein with staffs being engaged in the extension service to improve the farming technics.

(2) Population

The population in the project area is about 10,900, which account for 17 percent of the total population of 65,600 in three municipalities. The population growth of the project area is as high as 2.0 percent per annum on an average for the period from 1970 to 1980, but those people more than 15 years old account only for 0.7 percent. This phenomenon is caused by discharge of a large

number of workable people who are looking for jobs and higher living standard in taking into consideration the poor agricultural condition in the project area.

2.3. Water Resources

The project area has the annual average rainfall of about 2,000 mm, which serve as one of the water resources for agriculture and play an important role for rainfed cultivation. The rainfall, however, has a seasonal fluctuation in its amount of only 50 to 100 mm per month in February to June and sometimes to August. In addition, the consecutive droughty days more than 10 days appear in the dry months and also in June which is most important for the land preparation for paddy transplantation.

Such a small amount of rainfall in the dry months and consecutive droughty days often result in water shortage for the rainfed paddy cultivation in the project area. Under such condition, the cropping areas are unavoidably reduced in acreage and agricultural productivity is decreased considerably. Therefore, it is essentially required to give supplemental water by irrigation for securing bumper of harvest in the droughty condition in the project area.

Some rivers and streams flow down from the south to north direction at the depression area between hills in the project area. These rivers and streams however have not much runoff even in the wet season, and no runoff observed at all in the dry season due to their small catchment areas with less than five square kilometer.

Two rivers of the Bayongan and the Bayang only can be considered as available water resources for irrigation in the project. These two rivers have the catchment areas ranging from 11 to 13 sq.km at the proposed damsite and an annual average runoff of about 10 MCM, respectively. Naturally, such river runoff has also

seasonal fluctuation and dries up in the dry season. Consequently, the runoff will be available for irrigation only by reservoir control.

The water resources by rainfall and runoff of the two rivers however, are insufficient to cover the irrigation water demand in the project service areas. The most important water resources in Phase II project are the surplus water to be introduced from the Phase I project, where the water is diverted from the Wahig-Pamacsalan river for Phase I and Phase II areas through the Malinao dam. This river has a large catchment area of 138 sq.km and as much annual runoff as about 110 MCM at the damsite.

In the dry season, most of the diverted water is used primarily for the irrigation in the service area of Phase I due to little effective rainfall in the area, while much surplus water is available in the river in the wet season even if the Phase I project uses the diverted water for the irrigation in the Phase I service area. The surplus water can be easily conveyed to Phase II project through the same irrigation main canal to be constructed in Phase I project, because the Bayongan reservoir site proposed in Phase II is located at the terminal point of the main canal and at the lower position with full water level of 50 m lower than the canal water level of about 120 m.

The surplus water conveyed through the main canal is about 50 MCM on an annual average and can be used for the irrigation in Phase II service area after controlled by reservoir to meet the irrigation requirement.

2.4. Soils and Land Use

The soils in the project area belong to Ubay soil series and are mainly delivered from sedimentary deposits of shale, sandstone and mudstone including some deposits of conglomerates.

The soils have coarse to medium texture with highly gravelly contents which occasionally exceed 60 percent in the sub-soil layer and are generally found as shallow as 10 to 40 cm. The soils present a high acidic character with pH value of four to five and poor fertility.

Land classification has been studied based not only on the soil properties but land slope, because the land development cost to form the paddy fields in the hilly areas depends on the land slope conditions. Out of the total project area of 12,700 ha, the land belonging to Class I with landslope less than three percent is about 7,100 ha and Class II land with landslope between three and five percent is about 2,700 ha.

The Class I land will be available economically as paddy fields by the land development but the Class II land only as upland crop areas due to high cost of land development. The Class III and IV lands will not be used as cultivation areas but as grassland to maintain the watershed in good conditions.

In the Class I and II lands, the area of about 6,000 ha is cultivated with paddy, upland crops and coconut, and the remaining area of about 3,800 ha is grassland.

The existing paddy field is about 2,200 ha, extending in the depression area along the river and stream. The upland crop and coconut areas are about 3,800 ha, dotted in the hilly area. The present land use in the project area is summarized as follows:

Land Use	Area
Paddy Field	2,200 ha
Upland Crops	2,300
Coconut	1,500
Grassland	6,300
Forest	200
Wasteland	200
Total	12,700 ha

About 70 percent out of the total farm households is a full land owner and the remaining 30 percent consists of share-tenants, leaseholders, and part-owners.

The average farm size is 2.3 to 2.6 ha for full land owners and share-tenants, and 3.2 to 3.6 ha for other farmers.

Aside from the above land ownership of individual farmers, in the project area there are three estate farms covering the total area of about 1,900 ha, which is cultivated by tenant-farmers.

2.5. Present Agriculture

Paddy is most important as a major crop in the project area. The farmers have developed the terrace paddy field in the depression, forming small plots with length of 30 to 50 m and width of 10 to 20 m, and paddy is cropped by transplanting method with carabao.

Rain water and stream water are used in paddy cultivation through plot-to-plot system. In case that rain water and stream water are sufficient, paddy cropping is carried out both in the wet and the dry seasons, and the cropping intensity reaches 140 to 160 percent. The paddy productivity, however, is as low as 1.6 ton/ha due to the insufficient water supply to paddy growing period and traditional farming practice. In droughty years, the farmers are forced to reduce the cropping acreages due to lack of irrigation water.

The farmers living in the hilly areas are engaged in only upland cropping in the rainfed fields due to unavailability of streamflow for paddy growing. Carabao or manpower is employed for cultivation, and drought-resistant cassava and sweet potato are grown in the area. The productivity of cassava and sweet potato is also very low by 4.7 tons/ha and 2.0 tons/ha respectively, due to poor soil fertility in the hilly areas, serious pests resulting from high humidity, insufficient rainwater and traditional farming practice.

Paddy, although a major crop in Bohol province, is in deficit by about 32,000 tons to the demand due to low productivity. Upland crops, particularly corn, beans and vegetables, have come short in production as well, and some amount of paddy and upland crops are imported from other provinces of the country to suffice the deficiency. Accordingly, an increase in agricultural production by Phase I and II projects will be easily absorbed into local consumption.

Extension services to improve the farming practices and to vitalize agricultural activities in the project area and also in Bohol province, are very limited due to lack of extension staffs in numbers available. The service area by one extension staff is about 1,800 ha, and the service ratio is about one second of standard extension service in the Philippines.

There are three agricultural research institutes in Bohol island, the BPI Bohol Experimental Farm, the BS Soil Water Research and Demonstration Project Farm and the BAI Ubay Stock Farm, and Agricultural Promotion Center (APC). The research activities were quite limited to the field in the rainfed agriculture. Each institute, however, is currently strengthened to initiate the research activities for the irrigated agriculture in taking into consideration the Bohol Irrigation Project Phase I and II. Especially, APC which was established in 1985 by Grant-aid of the Japanese Government and has been managed by Philippine officials with assist of Japanese agriculture experts in the intensive research for selecting suitable crops, introducing the modernized farming techniques, etc.

The farmer's average gross income is about ₱6,800 in agricultural production and the net average income is about ₱4,300, consisting of the net farm income of about ₱3,500 and the other cash income of about ₱800. The said income is about 20 percent lower than that of the Central Visayas.

2.6. Social Infrastructure

Domestic water in the project area has been supplied both with wells and surface water, and the amount supplied is almost sufficient to the rural requirements, except Ubay district which has suffered from the water shortage.

Rural electrification in the project area has covered five barangays since 1981 and will be expanded to remaining 17 barangays by 1989. At present, however, only a small number of households is electrificated and its ratio remains 10 to 20 percent.

There are two national highways surrounding the project area; Highway No.1 at the east and north boundaries and Highway No.2 at the west boundary. In addition, two feeder roads connecting two highways are crossing through the center of the project service area. Barangay roads, however, are insufficient to communicate each barangay.

The density of roads at barangay level is as thin as 12.4 m/ha.

Although the highways are paved with gravel and well maintained, the feeder roads and barangay roads are in bad conditions such as no pavement, no drainage facilities and undulated slope, and therefore, they become unavailable in the wet season.

3. PROJECT FORMULATION

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3.1. Objectives and Components of the Project

The objectives of the project are to establish the irrigated agriculture, to improve the traditional farming practices and vitalize the depressed rural circumstances, to increase agricultural productivity and income of rural inhabitants, and to contribute to the local economy in Bohol province.

The project components are planned with the following development concept to successfully achieve the objectives mentioned above.

- Water resources development consisting of two reservoirs, Bayongan and Capayas to control the runoff of the Bayongan and the Bayang rivers as well as the surplus water to be introduced by Phase I project.

- Land resources development to improve the existing paddy fields along the depression area between hills and to reclaim the new land located in hilly area by converting the present grassland and upland crops area into paddy field.

- Irrigation development to supply irrigation water in meeting the water requirement in the service area by providing irrigation networks and to establish the water operation and management method.

- Irrigated agricultural development to select a suitable cropping pattern and intensity under the maximum utilization of water and land resources, to improve the present farming practices for increasing the agricultural productivity and the farmer's income, and to introduce the concept of agro-processing and market establishment.

3.2. Land Use Plan

The land use plan for the total project area of 12,700 ha has been made based on the topographic map of 1:4,000 in taking the following considerations:

- The higher elevation area which can not be irrigated by gravity irrigation system should be excluded from the proposed service area due to high water cost resulting from construction of pumping facilities.

- The existing paddy fields should be included as much as possible in the proposed service area, because such fields do not require the cost of land reclamation and the farmers should receive the contribution by the project with the first priority.

- The hilly existing grassland, upland crops fields and suitable land as paddy fields should be converted to the paddy fields due to the increase of rice productivity which is presently deficient in Bohol province.

- The hilly land with a slope more than three percent should be excluded from the proposed reclamation land to the paddy fields due to its high cost by the land reclamation works.

In the above considerations, the proposed service area in the project is determined as 7,100 ha in total, and the proposed land use in Bayongan and Capayas systems is formulated as follows:

Description	Bayongan System (ha)	Capayas System (ha)	Total (ha)
Total Project Service Area	5,580	1,520	7,100
Net Irrigation Area	4,140	1,160	5,300
Net Upland Crop Area under Rainfed	980	220	1,200
Other Land occupied by Right-of-Way	460	140	600

3.3. Available Water Resources

Available water resources for Phase II project are the runoff of the two rivers of the Bayongan and the Bayang and the surplus water to be introduced from Phase I project.

The runoff of the two rivers can be used as the water sources by controlling the two reservoirs of the Bayongan and the Capayas. The surplus water from Phase I area is estimated based on the following study process:

- Review of the runoff at the proposed Malinao damsite across the Wahig-Pamacsalan river

- Review of the irrigation requirement in the Phase I project service area

- Review of water operation study of the Phase I project based on diverted discharge capacity of Phase I main canal

- Determination of the most suitable plan for Phase I as follows, in accordance with the review of operation study and the result of discussion with NIA

Cropping Area and Intensity		
Wet season	:	4,960 ha (100%)
Dry season	:	2,980 ha (60%)
Water requirement		
Wet season	:	28.4 MCM (570 mm/ha)
Dry season	:	20.6 MCM (690 mm/ha)
Number of Water Shortage	:	6 years during 28 years
Main Irrigation Canal Capacity	:	11.8 cu.m/sec

- The surplus water is estimated by the water operation study based on the diverted water amount from the Malinao dam in the canal capacity of 11.8 cu.m/sec and the constant release of irrigation requirement in Phase I, and as a result, about 49 MCM per annum on an average and about 31 MCM per annum in the average dry year can be introduced to the Phase II project area.

Total available water for Phase II, including runoff of the two rivers and the surplus water are summarized as follows:

Water Sources	Average Year	Dry Year
Bayongan River	10.3 MCM	8.0 MCM
Bayang River	11.0 "	8.7 "
Surplus Water	49.0 "	31.0 "
Total	70.3 MCM	47.3 MCM

3.4. Reservoir Plan

The two reservoirs of the Bayongan and the Capayas are proposed in the project to control the inflow and to use it for irrigation.

The Bayongan reservoir, located upstream of the Bayongan river, is planned as the main reservoir of the project to store the runoff of the Bayongan river and the surplus water to be introduced from Phase I project. One of the tributaries to the reservoir approaches the terminal point of Phase I main canal so that the reservoir can receive easily the surplus water only through a short distance feeder canal. Since the reservoir is located at the highest position in the project area, the reservoir water can be delivered with the gravity irrigation system to the service area.

Based on 11 case studies of reservoir operation with various cropping intensities and reservoir capacities, the most optimum reservoir capacity was proposed as 27.5 MCM under the condition of 200 percent cropping intensity for the net service area of 5,300 ha.

The reservoir outline and dimensions are shown in TABLE-1.

The Capayas reservoir is planned as the supplemental reservoir to control the Bayang river water and to receive the supplemental water to be introduced from the Bayongan reservoir through the main canal of Phase II. The reservoir site is located at the place where the highway bridge crosses the Bayang river and the terminal point of the main canal.

The reservoir has small capacity of 2.34 MCM only but will give the following advantages to the project:

- The Capayas reservoir can use the Bayang river water to the Capayas irrigation service area and can reduce the reservoir capacity of Bayongan reservoir, and as a result, the project can be economized.

- Since the Capayas reservoir is located near the Capayas service area, the water operation for irrigation by the Capayas reservoir will be made more smoothly and timely than that of the Bayongan reservoir located far from the Capayas service area.

- Construction of the Capayas dam and its irrigation system will be completed at earlier stage than those of the Bayongan because of small scale works, so that the model of land reclamation, farming practices and water management can be introduced in the Capayas system prior to completion of Bayongan system. This model will bring about the early and stable benefit in the project.

The reservoir outline and dimensions are shown in TABLE-1.

3.5. Irrigation Plan

The irrigation requirement of the project service area of 5,300 ha is estimated taking into account the crop water requirement, effective rainfall and irrigation losses and the result is summarized as follows:

Crops	Average Year (mm/ha)	Dry Year (mm/ha)
Wet Season Paddy	485	696
Dry Season Paddy	455	713

The total water requirement for the project is determined based on the service area of 5,300 ha and the cropping intensity by 200 percent and broken down as below.

	Average Year	Dry Year
Bayongan System	36 MCM	40 - 50 MCM
Capayas System	10 "	10 - 13 "
Total	46 MCM	40 - 63 MCM

The water requirement of 0.3 MCM for Ubay domestic water is included in the aforesaid amount for Capayas.

The irrigation water supply plan is made by dividing the total service area of 5,300 ha into the irrigation rotation units of 145 in total, 112 units in Bayongan system and 33 units in Capayas system, respectively. Each unit area is about 30 to 50 ha.

The diversion water requirement to design the irrigation canal capacity is estimated below in taking into consideration the peak water requirement:

Land soaking and land preparation	:	1.837 l/sec (Canal)
Crop growing stage	:	1.442 l/sec (Canal)
On-farm level	:	2.183 l/sec (Farm Ditch)

3.6. Agriculture Plan

Paddy is selected as the most suitable crop to be introduced in the project and planned to be cultivated in the whole irrigation area of 5,300 ha in the wet season and for the area of 3,540 ha in the dry season because of the following reasons:

- Paddy is the crop which is most familiar to farmers and prevails in the project area.

- The properties of the soils in the service area are more suitable to paddy cultivation than upland crops cultivation. In the case that appropriate farming practices are introduced, the paddy yield will easily reach more than 4.0 tons/ha, which has already been proved by the demonstration farm in Agricultural Promotion Center (APC) of Bohol.

- Paddy production in Bohol is deficient to the consumers' demand in Bohol province and Central Visayas, so that paddy can be a stable and security crop from viewpoint of the marketability.

Some upland crops are proposed as the dry season crops in the project taking into consideration the land condition, consumers' demand in the project area and Bohol province. In accordance with the availability of land and irrigation water, irrigated upland crop area of 1,760 ha in the dry season and the rainfed upland crop area of 1,200 ha are planned in the project.

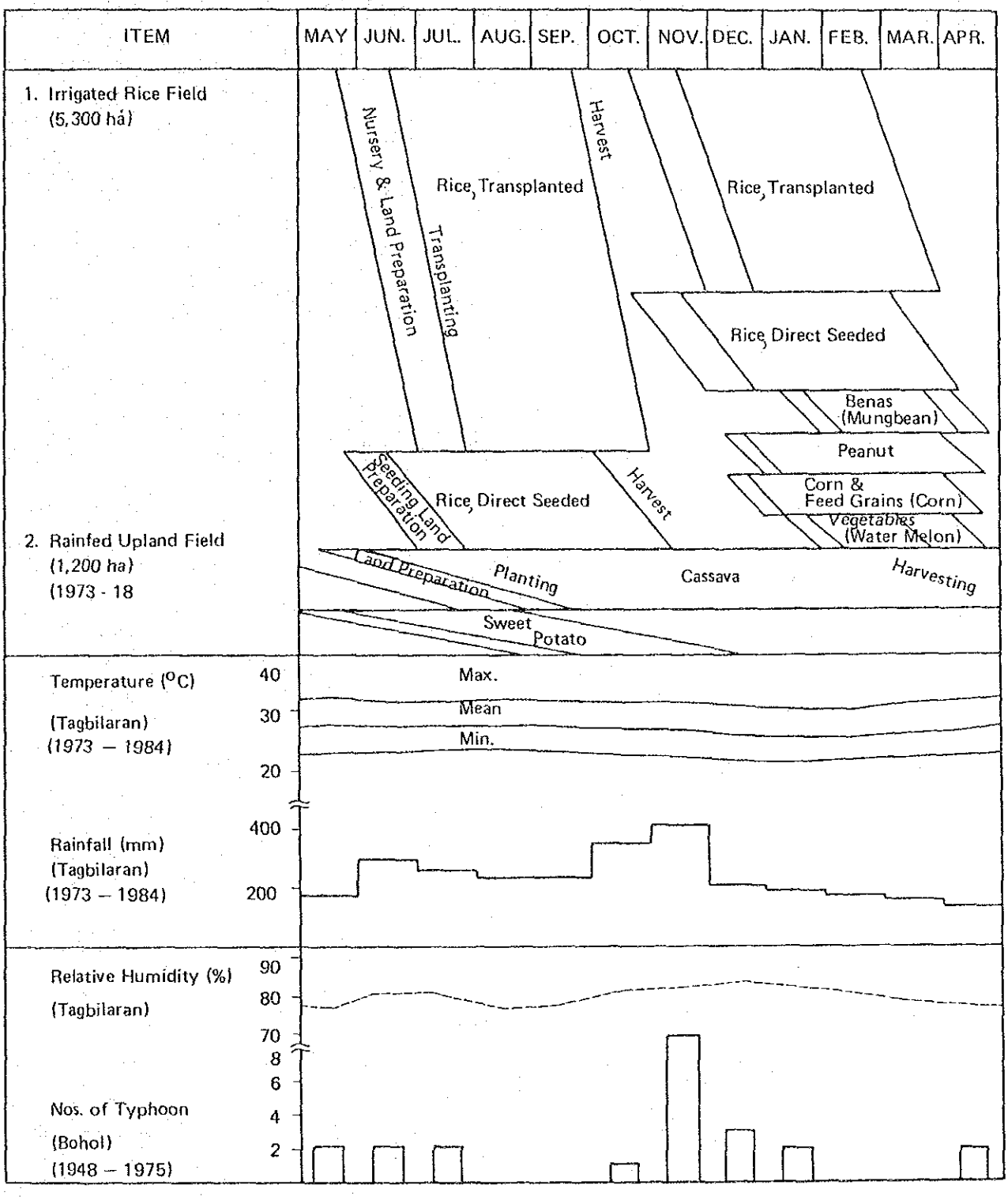
The proposed cropping pattern is shown in FIGURE-1.

The agricultural production with project is considerably increased from the present as shown in the following table:

	Present			With Project		
	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)
Rice	2,490	1.32	3,500	7,720	-	33,410
Beans	-	-	-	420	1.0	420
Peanut	-	-	-	420	1.7	710
Corn	-	-	-	420	2.7	1,130
Fruits/Vegetable	-	-	-	420	8.9	3,740
Cassava	570	4.71	2,630	720	14.2	10,220
Sweet Potato	430	2.02	870	480	10.8	5,180
Total				10,600		54,800

In the above table, the cropping area with project for paddy and upland crops excluding cassava and sweet potato is estimated at 4,980 ha on an average in the dry season and 4,920 ha in the wet season for the total area of 5,300 ha taking into account the area reduction due to water shortage in the particular dry year.

FIGURE-1 PROPOSED CROPPING PATTERN



4. PROJECT FACILITIES

4. PROJECT FACILITIES

The facilities proposed in the project consist of the two dams at Bayongan and Capayas, two irrigation canal systems of the Bayongan and the Capayas, and the paddy fields with necessary facilities for land development.

4.1. Bayongan Dam

The proposed bayongan damsite is located about six kilometer upstream from San Miguel along the Bayongan river. The damsite extends in low and gentle hills at the height of 30 to 50 m from the river bed and provide a large reservoir capacity. The damsite consists mainly of siltstone with alternating beds of siltstone, mudstone and sandstone covered with overburden as thin as two to five meters, having the foundation suitable for dam construction with the permeability less than 10 lugeon and enough bearing capacity by N-value more than 50.

The impervious and semi-pervious materials for dam embankment are easily and sufficiently obtained in the reservoir area. The filter and rock materials are also available at the Hinlayagan river and Dagohoy quarry site respectively not so far from the damsite.

In accordance with the conditions of topography, geology and construction materials, the Bayongan dam is designed in the zone type earth dam with height of 30 m and length of 850 m. The spillway is designed as the designed flood capacity of only 20 cu.m/sec taking into consideration a big surcharge effect by the reservoir area which occupies about 2.8 sq.km equivalent to one fourth of the catchment area. The intake facility is designed with the designed capacity of 9.74 cu.m/sec and with the tunnel structure through the left abutment of the dam.

The outline and dimensions of the Bayongan dam is summarized in TABLE-1 and the preliminary design of the dam is shown in the attached drawings.

4.2. Capayas Dam

The Capayas dam will be constructed at the site where the highway bridge crosses the Bayang river. The base rock at the damsite consists of siltstone and conglomerate, and appears in the riverbed, although covered with thin overburden layer in both abutments. The dam foundation is formed by impervious and consolidated layers without any problem at all to construct the dam. The construction material is also easily obtained in the reservoir area.

The homogeneous earthfill type is adopted for the Capayas dam taking into consideration the height of 17 m and availability of embankment materials. Since the both banks of the damsite are formed with very gentle slope, long earth dikes of 1,150 m with height of five to ten meters will be planned at the both banks.

The spillway will be constructed at the left bank with design capacity of 417 cu.m/sec, and the intake is provided at the right bank with the design capacity of 2.13 cu.m/sec.

The outline and dimensions of the Capayas dam is summarized in TABLE-1 and its preliminary design is shown in the attached drawings.

4.3. Irrigation Canal

The irrigation canal is planned in dividing the canal system into two for Bayongan and Capayas. The main canal for the Bayongan system area of 4,140 ha is placed between the Bayongan dam outlet and the Capayas reservoir, running in the south border of the

TABLE -1 OUTLINE OF RESERVOIR AND DAM

Description	Unit	Bayongan	Capayas
1. General			
Name of Basin		Bayongan	Capayas
Name of River		Bayongan Creek	Bayang
Base Rock Formation		Siltstone, Mudstone & Sandstone	Siltstone, Mudstone, Sandstone & Conglomerate
Catchment Area	sq.Km	11.2	14.6
Annual Mean Rainfall	mm	2,050	2,050
Annual Mean Runoff	MCM	10.29	10.99
2. Reservoir			
Reservoir Area	sq.Km	2.77	0.56
Total Reservoir Capacity	MCM	27.54	2.34
Effective Reservoir Capacity	MCM	22.48	1.63
Dead Water Capacity	MCM	5.06	0.71
High Water Level	m		35.50
Full Water Level	m	50.00	34.00
Low Water Level	m	38.00	30.00
Effective Water Depth	m	12.00	4.00
3. Dam			
Dam Type		Zone	Homogeneous
Dam Height	m	31.00	17.00
Dam Length	m	810.00	1,150.00
Dam Crest Width	m	7.00	6.00
Dam Crest Elevation	m	53.00	37.00
Embankment Volume	1,000 cu.m	1,126	233
4. Spillway			
Type		Chute	Side Channel
Design Flood Discharge	cu.m/sec	454.8	419.1
Design Flood Capacity for Spillway	cu.m/sec	20.0	226.0
Overflow Depth	m	0.60	1.50
Overflow Length	m	20.0	60.0
5. Intake Facilities			
Type		Tunnel	Conduit
Maximum Intake Capacity	cu.m/sec	9.74	2.13
Size of Intake	mm	2,400	1,300

project area through the flat hilly area at the elevation of 40 to 35 m. The main canal is designed with the total length of 12.5 km, the maximum discharge capacity of 9.74 cu.m/sec and the concrete lining.

The main canal of the Capayas system area starts from the Capayas dam outlet and reaches near Ubay. The canal alignment is placed at the west border of the project area through moderately undulated hilly area having the elevation of 30 to 25 m. The main canal is designed with the total length of 3.3 km, the maximum discharge capacity of 2.13 cu.m/sec and the concrete lining.

The lateral canals in the both service areas of the Bayongan and the Capayas systems are provided at the higher places of the hilly areas in order to cover the service area as widely as possible by the gravity system. Nine lines of the laterals and 21 lines of sub-laterals with total length of 87.83 km are planned with design discharge capacity ranging from 3.15 cu.m/sec to 0.04 cu.m/sec and with earth canal. The size of the unit commanded by a lateral canal varies from 160 ha to 1,700 ha consisting of 5 to 56 service units.

The irrigation diagrams and the outline of the canals for Bayongan and the Capayas systems are shown in FIGURE-2 and TABLE-2.

4.4. On-Farm Development

The on-farm development is planned with one rotation area of 30 to 50 ha which is divided into about five rotation service units. The on-farm development works include land levelling, turnouts, main farm ditches, supplementary farm ditches, diversion boxes, farm drains, farm roads, etc. and these small-scale structures are constructed by the irrigators' association with the assistance of NIA. The land levelling works for the hilly areas to prepare paddy fields, however, may be made by NIA together with the construction of the lateral canals.

FIGURE-2 PROPOSED IRRIGATION SYSTEMS IN LATERAL CANAL

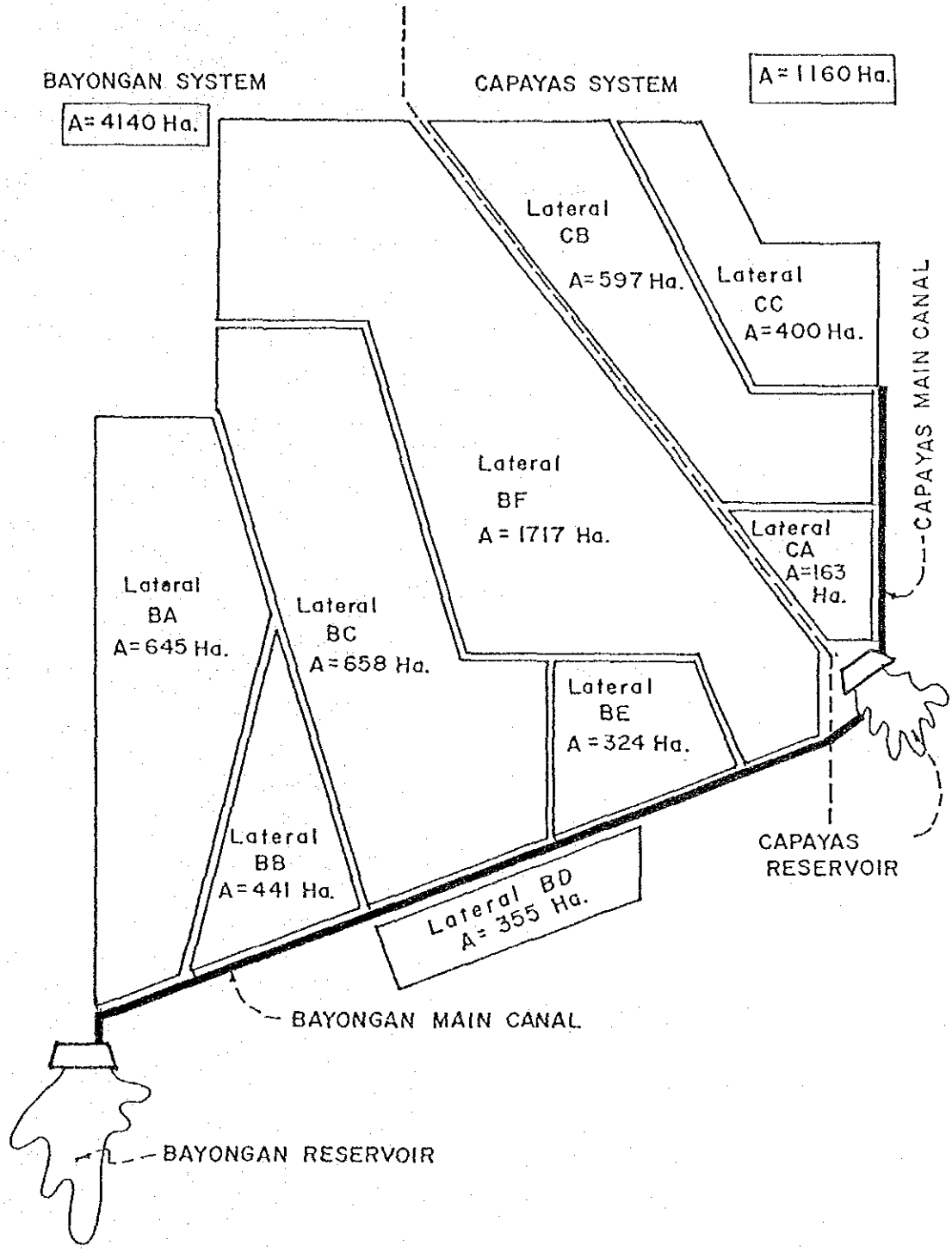


TABLE -2 OUTLINES OF IRRIGATION CANALS

Description	Unit	Bayongan System	Capayas System	Total
Irrigation Area	ha	4,140	1,160	5,300
No. of Service Unit	unit	112	33	145
Total Length of Canal	km	81.32	22.13	103.45
Main Canal	km	12.45	3.27	15.72
Lateral Canal*	km	68.87	18.86	87.73
Canal Density, Total	m/ha	19.60	19.00	19.50
Main Canal	m/ha	3.00	2.80	3.00
Lateral Canal*	m/ha	16.60	16.20	16.50
No. of Lateral	line	6	3	9
No. of Sub-Lateral	line	18	3	21
Maximum Design Discharge				
Main Canal	cu.m/sec.	9.74	2.13	-
Lateral Canal	cu.m/sec.	3.15	1.10	-
Canal Gradient				
Main Canal		1/7,000	1/3,000	-
Lateral Canal*		1/5,000-1/1,000	1/3,000-1/1,000	-
Length of Lining Section				
Main Canal	km	12.45	3.27	15.72
Related Structure				
No. of Head Regulator	place	6	3	9
No. of Turnout	place	126	36	162
No. of Check	place	62	14	76
No. of Drop	place	84	29	113
No. of Spillway	place	4	3	7
No. of Crossing	place	105	35	140
No. of Bridge	place	29	4	33
No. of Syphon	place	-	2	2
No. of Cross Drain	place	75	50	125
Length of O&M Road				
Main Canal	km	9.9	2.6	12.5
Lateral Canal*	km	52.0	16.0	68.0

* including sub-lateral canal

4.5. Project Cost

The project cost is estimated under the following conditions:

- The exchange rate of US$1.00 is equivalent to ₱18.0.
- The construction works are made on the contract basis.
- The project cost consists of the construction cost and the related costs for on-farm works, land acquisition, engineering and administration, O & M equipment and pilot farm.
- The physical contingency is set at 15 percent of the project direct cost. The price escalation is predicted at 6.0 to 9.0 percent for the foreign currency and 8 to 20 percent for the local currency.

The summary of project cost is shown in TABLE-3.

TABLE -3 THE PROJECT COST

(Unit: ₱'000)

Description	Foreign Currency	Local Currency	Total
1. Construction Cost			
a) Preparatory Work	2,000	1,700	3,700
b) Capayas System			
° Dam Works	16,900	8,300	25,200
° Canal Works	8,700	4,600	13,300
° Land Leveling	3,000	1,300	4,300
° (Sub-Total)	28,600	14,200	42,800
c) Bayongan System			
° Dam Works	81,100	33,800	114,900
° Canal Works	42,700	23,700	66,400
° Land Leveling	12,700	5,400	18,100
(Sub-Total)	136,500	62,900	199,400
Total	167,100	78,800	245,900
2. On-farm Development Cost	14,300	7,300	21,600
3. Land Acquisition, Compensation and Resettlement Cost	0	4,500	4,500
4. Engineering & Administration	35,000	7,900	42,900
5. O & M Equipment	6,300	800	7,100
6. Pilot Farm	3,800	0	3,800
7. Total (1 - 6)	226,500	99,300	325,800
8. Physical Contingencies	34,500	14,700	49,200
9. Total (7 - 8)	261,000	114,000	375,000
10. Price Escalation	139,000	144,000	283,000
11. Grand Total	400,000	258,000	658,000

5. PROJECT IMPLEMENTATION AND OPERATION

5. PROJECT IMPLEMENTATION AND OPERATION

5.1. Project Implementation

The executing agency of the project will be the National Irrigation Administration (NIA), which has sufficient capability and abundant experience in carrying out the detailed design, construction and operation and maintenance for the project facilities.

The NIA will execute the detailed design for the major project facilities in recruiting a consulting firm, the construction works on the contract basis under the supervision of the consultant, and the operation and maintenance through guidance of the irrigators' association.

The foreign currency portion of the project cost will be financed by an international financing agency while the local currency portion will be provided by the Philippine Government.

The detailed design and implementation of the project will take about six years after completion of the Feasibility Study; three years for loan procedures and detailed design and three years for construction.

The summary of the construction schedule and implementation program are shown in FIGURE-3 and FIGURE-4.

5.2. Operation and Maintenance

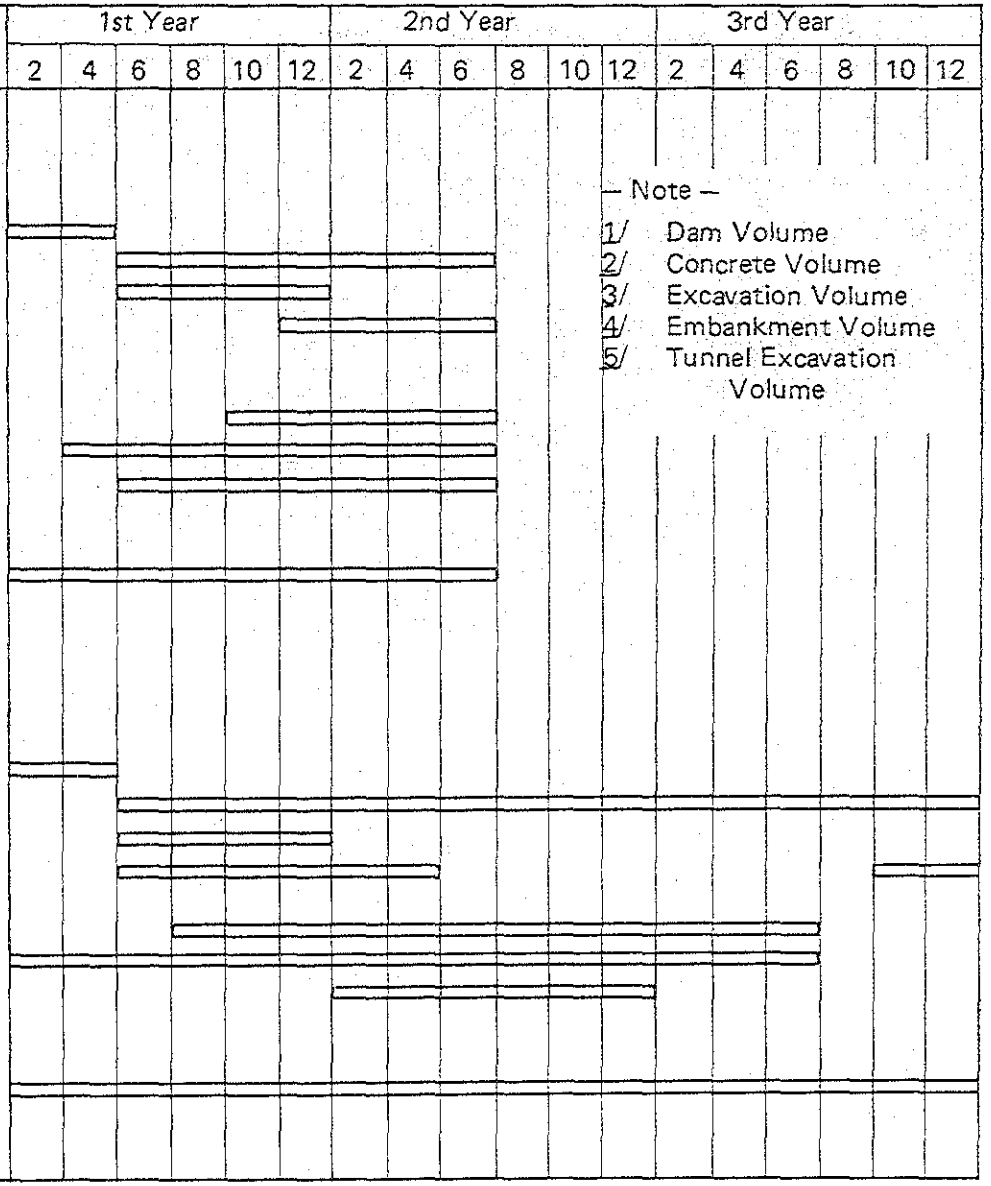
After implementation, the entire facilities of the project are to be taken over by the Bohol Irrigation System Office of NIA in Bohol. The operation and maintenance of reservoirs and the main and lateral canals will be carried out by the organization to be established under the Bohol Irrigation System Office.

Since the Bohol Irrigation Projects of Phase I and Phase II will have similar facilities and are closely related to each other in their water supply by diverted water from the Malinao dam for irrigation of Phase I and Phase II projects, the operation and maintenance should be made by the same organization; in other words the organization established in Phase I project will also be available only by expanding the organization capacity.

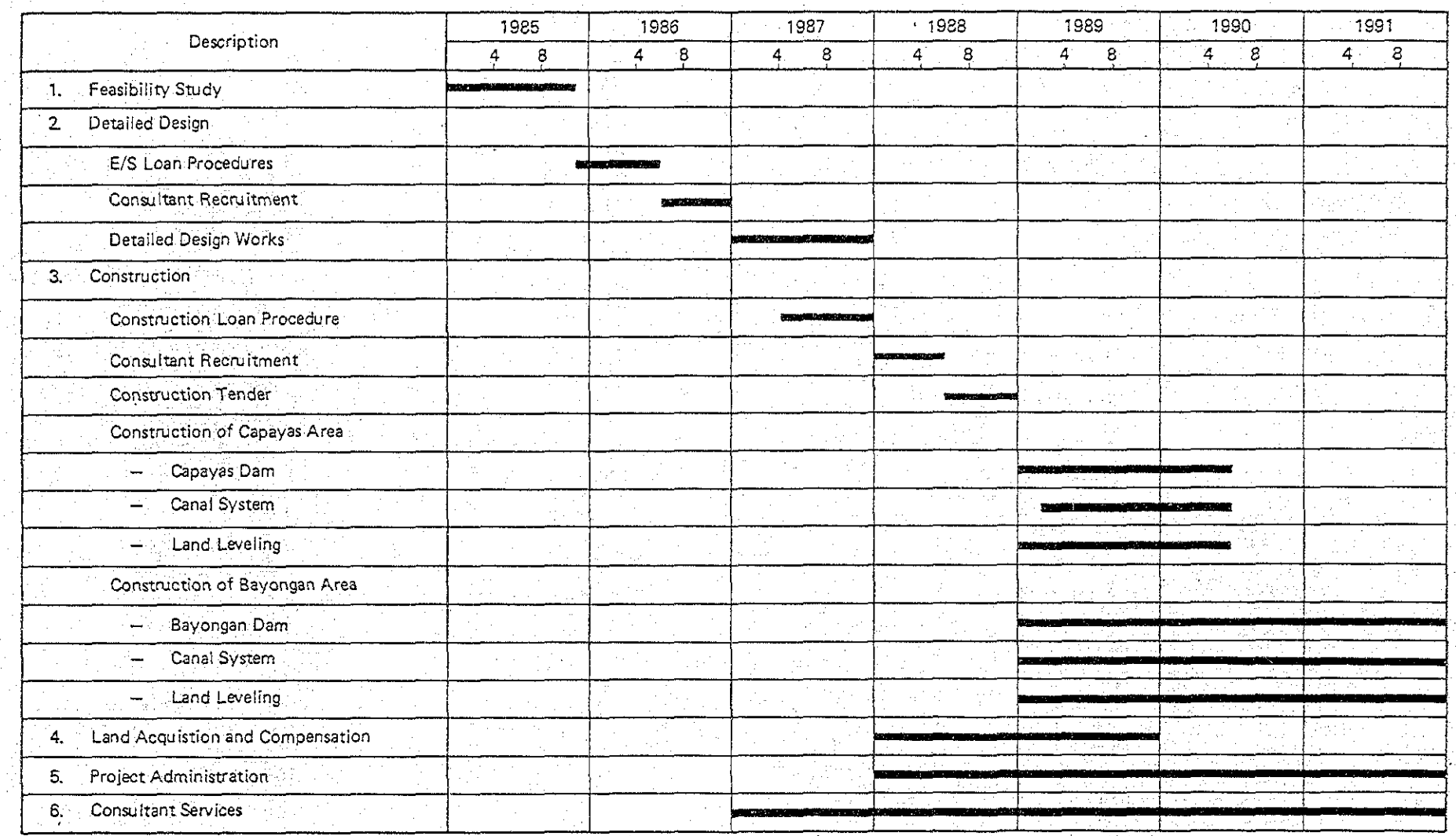
On the other hand, Farmer Irrigators' Association should be established by the beneficiary farmers at each irrigation rotation unit and carry out the operation and maintenance of on-farm level facilities in cooperating with the Bohol Irrigation System Office. The Farmer Irrigators' Association will be established during the construction period of the project facilities and the on-farm facilities such as farm ditches, farm road, etc. so that the farmers can use the irrigation water without any delay at the completion of project facilities. The NIA and the other government agencies concerned should assist the Farmer Irrigators' Association technically and financially in the construction of the on-farm development facilities. The Farmer Irrigators' Association will not only carry out the on-farm level water management but also cooperate with NIA in collecting the irrigation fee nd repayment fee of credit for the on-farm development cost.

FIGURE-3 CONSTRUCTION SCHEDULE

Description	Quantity
A. Capayas System	
1. Capayas Dam	
○ Temporary Work	
○ Dam Work	1/ 233,000 cu.m
○ Spillway Work	2/ 2,600 cu.m
○ Intake Work	3/ 850 cu.m
2. Irrigation & Drainage Canal	
○ Main Canal	3/ 8,400 cu.m
○ Lateral Canal	4/ 74,100 cu.m
○ Drainage Canal	3/ 24,500 cu.m
3. On-farm Work	
○ Land Leveling	690 ha
B. Bayongan System	
1. Bayongan Dam	
○ Temporary Work	
○ Dam Work	1/ 1,159,000 cu.m
○ Spillway Work	2/ 1,800 cu.m
○ Intake Work	5/ 27,000 cu.m
2. Irrigation & Drainage Canal	
○ Main Canal	3/ 271,300 cu.m
○ Lateral Canal	3/ 172,100 cu.m
○ Drainage Canal	3/ 18,500 cu.m
3. On-farm Work	
○ Land Leveling	2,910 ha



FIGURE–4 IMPLEMENTATION PROGRAM FOR THE PROJECT



6. PROJECT EVALUATION

6. PROJECT EVALUATION

6.1. Project Benefit

The project service area is expanded to 6,500 ha including irrigation area of 5,300 ha and rainfed area of 1,200 ha, while the present service area is 3,680 ha in the rainfed fields. The cropping intensity is also increased to 200 percent with project in the ordinary year and at 177 percent on an average taking into account the reduction of irrigation area in the dry year. This expansion area and increase in cropping intensity with irrigation will bring about a great deal of agricultural benefit of about 75 million pesos at the full development stage as shown in the following table.

Incremental Net Production Value (NPV)

(Unit: Million Pesos)

	1990	1991	1992	1995	1997	1999
With Project						
Gross Production Value	17.1	23.4	84.3	113.9	125.1	133.9
Production Cost	7.0	9.2	41.9	46.4	49.7	49.7
N.P.V.	10.1	14.2	42.4	67.5	75.4	84.2
Without Project						
Gross Production Value	13.4	13.5	13.5	13.7	13.8	13.8
Production Cost	4.9	4.9	4.9	5.0	5.1	5.1
N.P.V.	8.5	8.6	8.6	8.7	8.7	8.7
Incremental N.P.V.	1.6	5.6	33.8	58.8	66.7	75.5

In addition to the agricultural benefit mentioned above, the benefit from domestic water supply by about 1.0 million pesos and the benefit from fishery by about 2.0 million pesos will be expected with the project.

6.2. Economic Internal Rate of Return

Economical feasibility of the project is appraised by economic internal rate of return (EIRR). The EIRR of the project is estimated as 15.4 percent based on the project benefit and the economic project cost, so that the project is judged economically feasible.

The sensitive analysis is also made under several conditions and the result is summarized below:

Sensitivity Analysis

Case	EIRR (%)
1. Original	15.4
2. Increase of Project Cost	
- 10%	14.2
- 20%	13.3
3. Decrease of Target Yield	
- 10%	13.0
- 20%	10.5
4. Fall of Paddy Price	
- 5%	14.5
- 10%	13.6
5. Increase of Production Cost of Crops	
- 10%	14.4
- 20%	13.5
6. Delay to Start On-Farm Development	
- One year	14.1
- Two years	13.3
- Three years	12.6

7. RECOMMENDATIONS

7. RECOMMENDATIONS

7.1. Recommendation on Project Implementation

The Bohol Irrigation Development Project-Phase II is technically and economically feasible since it presents no technical problem to construct the project facilities and the EIRR of 15.4 percent. Therefore, the Phase II project is recommended to be implemented following the Phase I project which is presently in the implementation stage. The project implementation should be considered by the Philippine Government on not only the project feasibility but also the following points:

- The project has a big potential to supply agricultural products, especially paddy to meet the demand in Bohol province and Central Visayas which always faces food shortage.

- The project includes the expansion in the irrigation area by land reclamation in the hilly area, expansion of agricultural economy in Bohol province and absorption of surplus labour force in the rural area. In addition, the irrigated agricultural development of the hilly area in the project will become one of the models in the similar natured projects of the Philippines, because there remain many hilly areas with potential to be developed in the country.

- The Phase I project has been in the implementation stage. In case that the Phase II project is not implemented, a critical income disparity will take place between the local people of Phase I and II service areas.

- The project will also contributes to raising the rural economy in Bohol province by producing agricultural products of about 50,000 tons per annum and expanding the agro-processing and marketing sectors.

7.2. Recommendations on Detailed Design Stage

Since the feasibility study has been made based on the map of 1/4,000, sufficient data are collected and analysis is made under cooperation with a number of NIA staffs, the detailed design works will be carried out easily and smoothly. The major subjects in the detailed design are recommended as follows:

- Review of the runoffs of the two rivers, the Bayongan and the Bayang based on the observation records which cover the last year.

- Review of the reservoir operation study based on the review results of the river runoff. It is not necessary to review the surplus water introduced from Phase I project because this analysis was already made in detail and accuracy in the Feasibility Study.

- Geological investigation by some boreholes will be required for the Bayongan and the Capayas dams, especially at the structural foundations such as intakes and spillway routes. The geological investigation at dam foundation should be made only by test pits to confirm the rock foundation, because the dam foundation is consolidated and impervious, and it is considered there will be no problem at all to construct a dam.

- Topographical survey along the canal alignment including the installation of bench marks and control points will be required for the detailed design of the canals.

- Geological investigation for the canal alignments should be made only with test pits to confirm the foundation conditions of the canals.

- Selection of the suitable hilly land for development and the topographical survey in such land should be conducted to make the detailed land development plan.

- Land acquisition in the Bayongan reservoir and along the canal alignment should be proceeded. The resettlement plan and program for villages and farm land in Bayongan reservoir area will be required in the detailed design stage.

7.3. Recommendations on Construction

The construction of the Phase II project should be commenced about one year before the completion of Phase I construction taking into consideration the disbursement schedule by the Philippine Government.

However, the construction of the Capayas irrigation system including the dam, canals and land development is recommendable to commence in early stage, if possible, because of the following reasons:

- The Capayas system consists of small scale project facilities with the project cost of about 110 million pesos and with a short period of two and a half years consisting of one year for detailed design and one and a half year for construction. Capayas system can irrigate about 620 ha in wet season and 700 ha in dry season on average. However, in the normal year, 750 ha of land can be irrigated for both wet and dry season by the stored water in the Capayas reservoir only.

- The early implementation of the Capayas system can provide many development models prior to the completion of the whole project facilities of Phase II. That is to say, the methods of land development, water management for irrigation, modernized farming practices including farm mechanization, etc. will be introduced in this service area and the farmers should become familiar with irrigated farming. The development model in the Capayas system will be useful and contribute to the development of the Bayongan system covering the larger service area of about 5,600 ha.

- This idea of stage development can make the disbursement schedule of Phase II project easy from the financial viewpoint.

In accordance with the above consideration, the Supplementary Report for the Capayas Irrigation System is prepared. In case that the construction of the Capayas irrigation system is implemented as the first stage development, it is recommendable to use this Supplemental Report for carrying out the project implementation.

7.4. Recommendation for Successful Irrigated Agricultural Development

During the construction or after completion of the project facilities, the following activities should be performed to achieve the successful irrigated agricultural development in the project area.

i) Land Development

The project includes the land development works of about 3,600 ha in the proposed irrigable area of 5,300 ha in

order to prepare the paddy land which is converted from the existing upland area and grassland with a topographical slope less than three percent.

Such land development works are carried out in principal by the farmer himself. However, the following government assistance and support are required to achieve successfully the implementation of the land development.

- Technical assistance by NIA to prepare the plan and design and to supervise the construction for the suitable land development based on the topographic condition and land classification.

- Administrative cooperation by the governmental agency concerned such as Ministry of Agrarian Reform to allocate the land to the farmers to be immigrated.

- Financial support by the governmental agency concerned to provide the credit to the farmers' activities for the land development.

ii) On-Farm Development

The on-farm development works consisting of farm ditches, farm roads, land consolidation etc. should be constructed by the Farmer Irrigators' Associations. Otherwise, the developed irrigation water by the project can not be used effectively for the farm land. The NIA and the other governmental agencies concerned should assist the Farmer Irrigators' Associations technically and financially, so that they can construct smoothly the on-farm facilities.

The Farmer Irrigators' Associations should be established during the construction stage of the project facilities made by NIA and should complete the on-farm works so as to receive the irrigation water on time after completion of the project facilities.

iii) Operation and Maintenance of Project Facilities

The NIA should establish an organization for operation and maintenance of the completed project facilities and carry out the water management guidance to the Farmer Irrigators' Associations.

Since the Phase I project will be under the operation and maintenance by its own organization when the Phase II project is completed, the organization for Phase II should be established by expanding the Phase I organization, so that the operation and maintenance of the both projects can be made effectively by one organization, because the both projects use the same water resources of the Wahig-Pamacsalan river.

iv) Agricultural Extension Services

The Bureau of Plant Industry of the Ministry of Agriculture and Foods should increase the number of staffs and activities in the project area to expand the agricultural extension services for introducing modernized farming practices.

v) Agricultural Development Coordinating Committee

The Agricultural Development Coordinating Committee should be established in the project area to coordinate the following activities;

- To supply fertilizers, pesticides and agricultural machines to the farmers,

- To provide agricultural credit to assist the farmers' investments,

- To provide loading and storage facilities for marketing of agricultural products,

- To increase rice mills in number and their capacity to meet the paddy production, and

- To enlarge road and port facilities for smooth transportation of agricultural products.

DRAWINGS

DRAWINGS

N

DAM AXIS
(S 17° 30' E)

STA. 0+0.00

MAX. WATER LEVEL 50.60
NORMAL WATER LEVEL 50.00
LOW WATER LEVEL 38.00

STA.0+670.00
R=213.00, I.A.=41°30'

STA.0+883.54

STA.0+885.50

Access Road to Trinidad

MAIN CANAL

2.4 ø Irrigation Tunnel

O & M Building
Gate House

℄ of Spillway

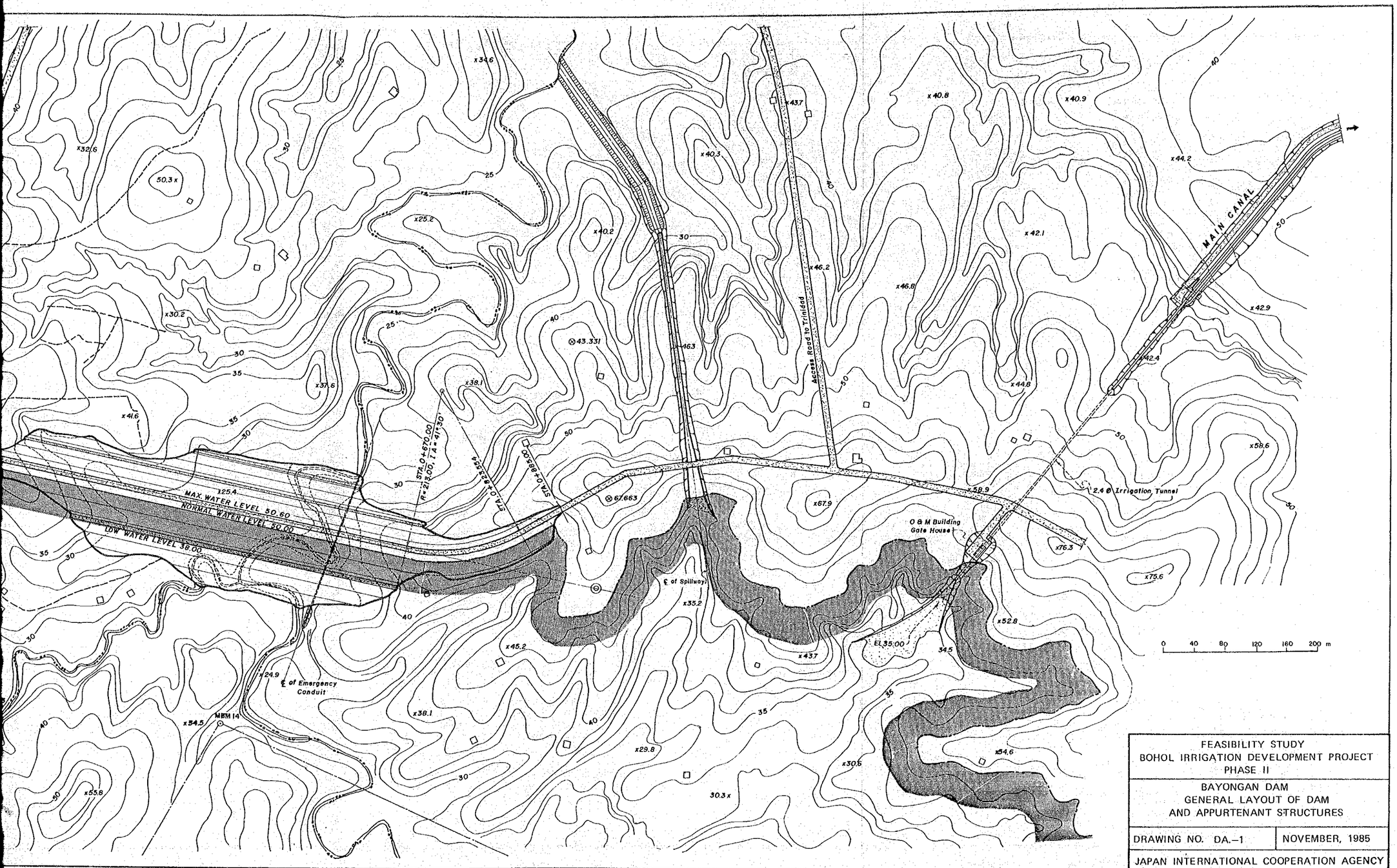
℄ of Emergency
Conduit

MBM 14

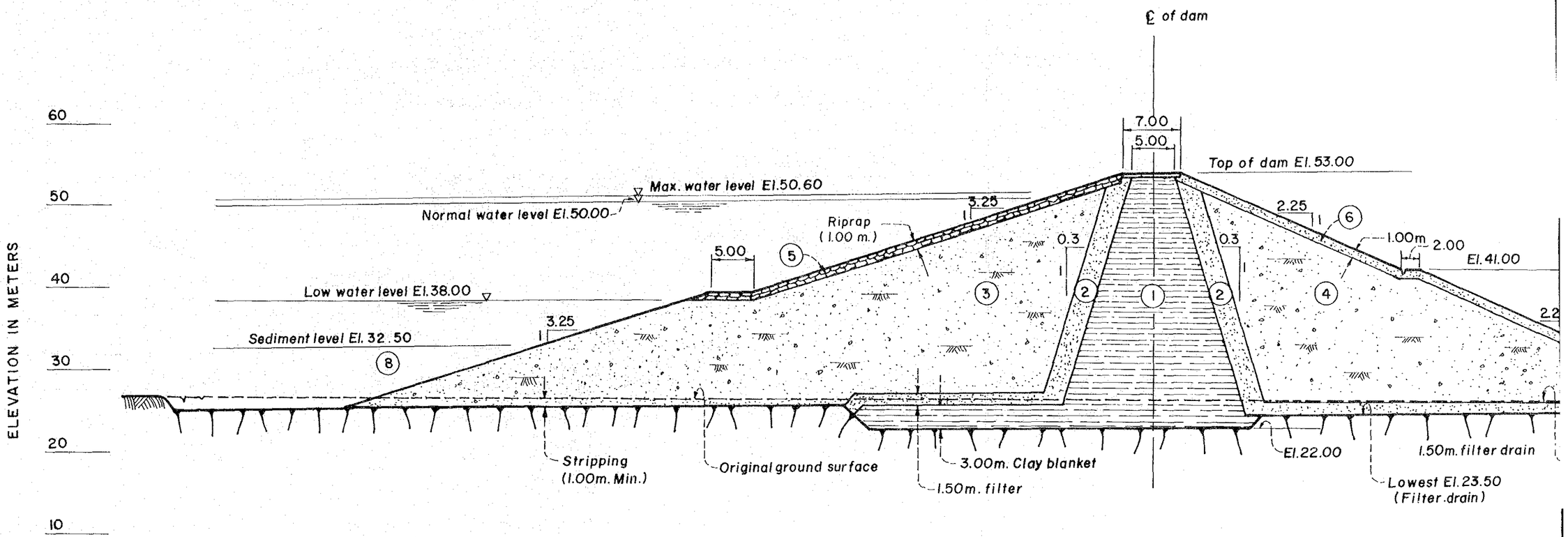
EL.35.00

0 40 80 120

FEASIBILITY BOHOL IRRIGATION DE PHASE
BAYONGAN GENERAL LAY AND APPURTENAN
DRAWING NO. DA.-1
JAPAN INTERNATIONAL

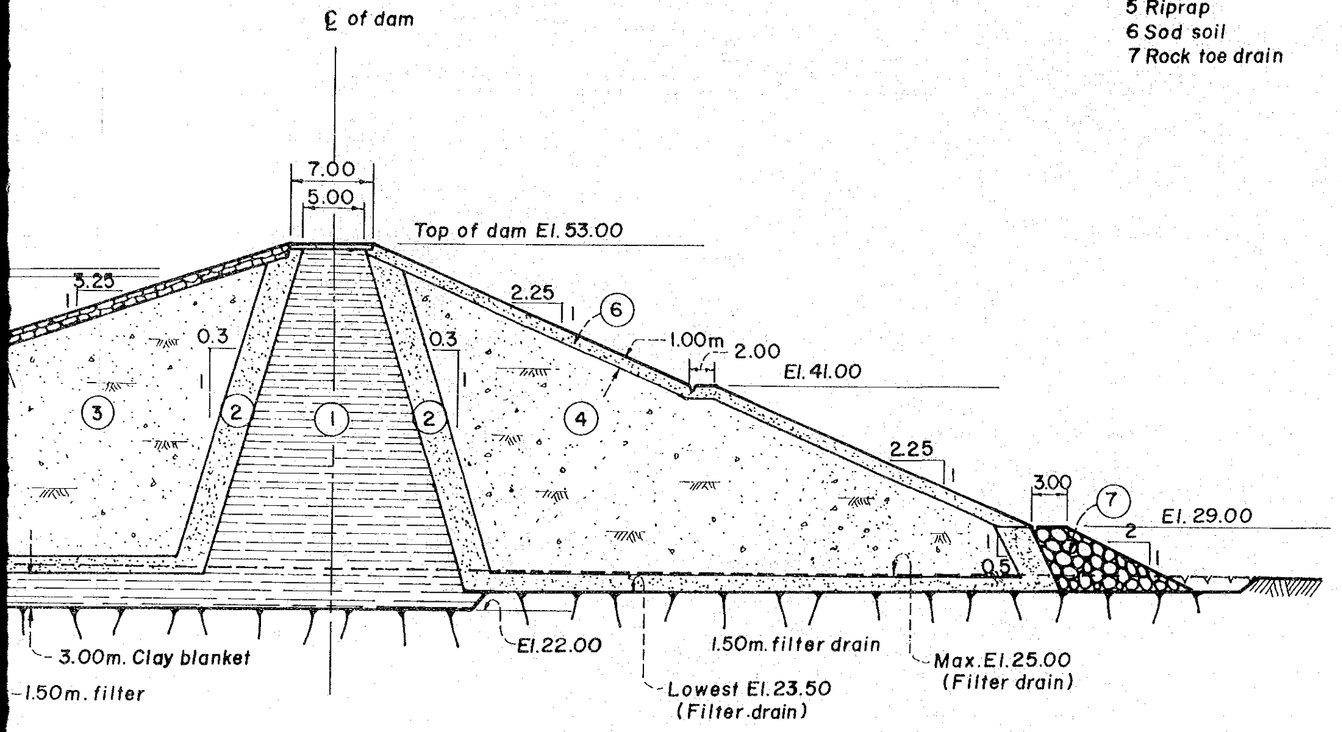


FEASIBILITY STUDY BOHOL IRRIGATION DEVELOPMENT PROJECT PHASE II
BAYONGAN DAM GENERAL LAYOUT OF DAM AND APPURTENANT STRUCTURES
DRAWING NO. DA.–1 | NOVEMBER, 1985
JAPAN INTERNATIONAL COOPERATION AGENCY



MAXIMUM SECTION OF DAM EMBANKMENT

SCALE 1:400



EMBANKMENT
1:400

LEGEND:

1 Core
2 Filter
3 U/S Shell
4 D/S Shell
5 Riprap
6 Sod soil
7 Rock toe drain

SOURCE:

Borrow area
Quarry/ Borrow areas
Borrow area
Borrow area
Quarry sites
Borrow area
Quarry sites

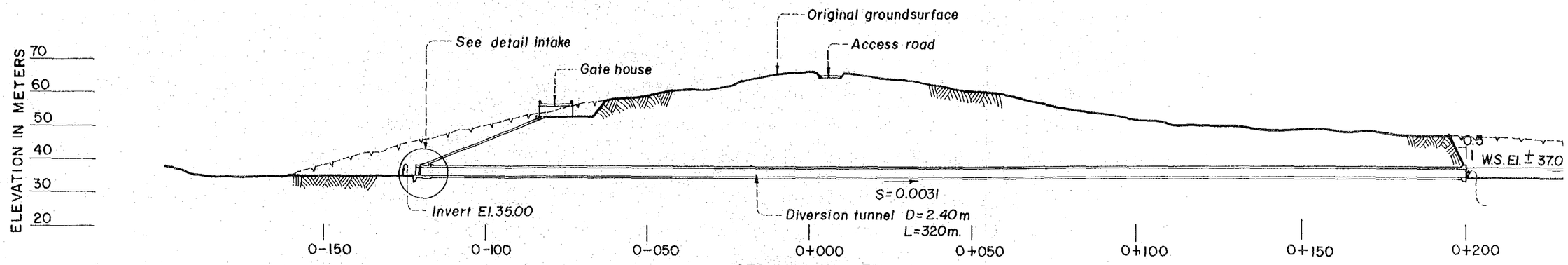
REMARKS:

Selected gravel from borrow area
Selected gravel fill
random fill materials
Overburden soil

0 8 16 24 32 40 m

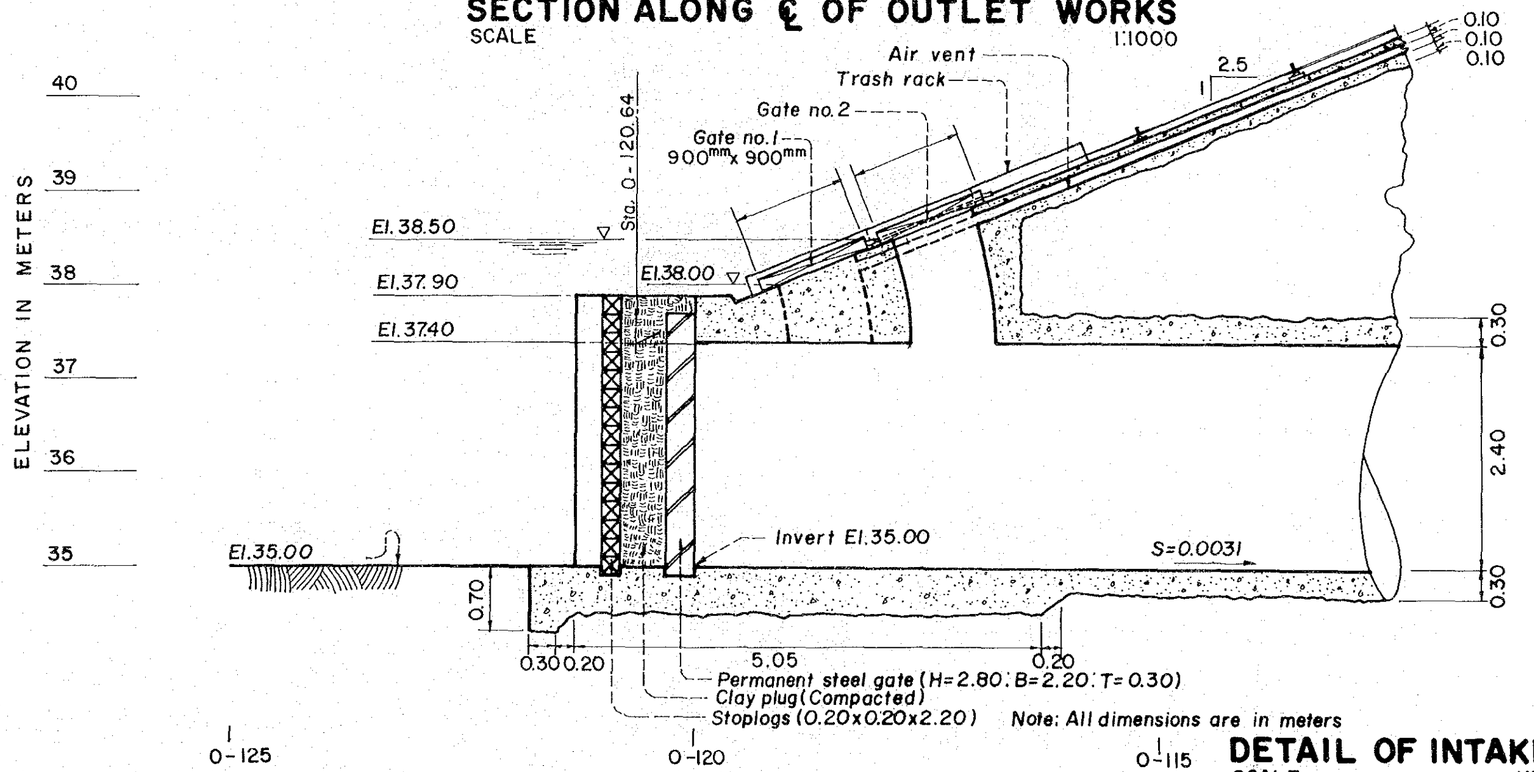
SCALE 1: 400

FEASIBILITY STUDY BOHOL IRRIGATION DEVELOPMENT PROJECT PHASE II	
BAYONGAN DAM MAXIMUM SECTION OF DAM	
DRAWING NO. DA.-3	NOVEMBER, 1985
JAPAN INTERNATIONAL COOPERATION AGENCY	



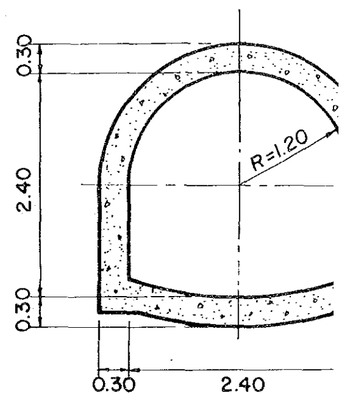
SECTION ALONG ℄ OF OUTLET WORKS

SCALE 1:1000



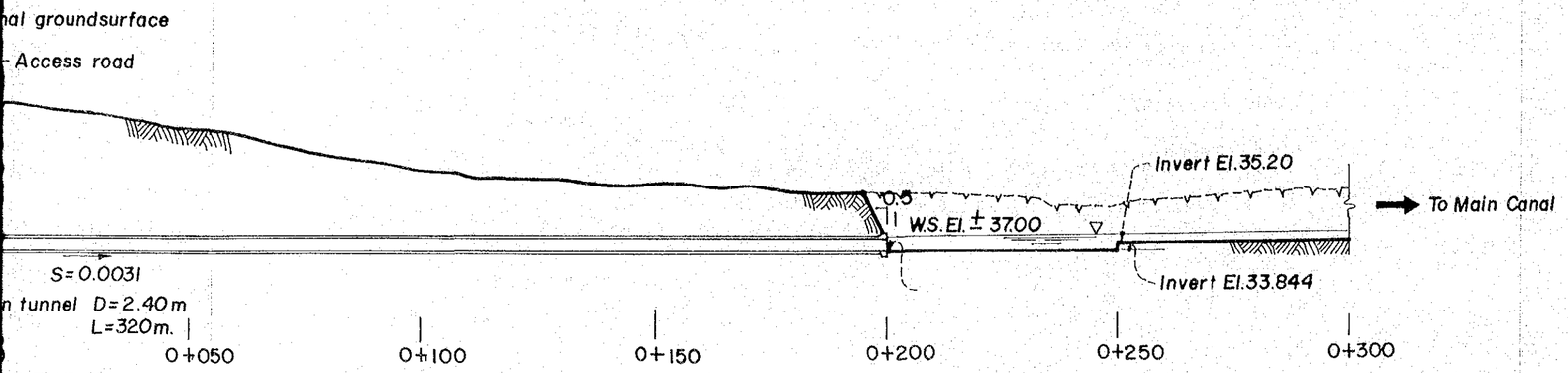
DETAIL OF INTAKE

SCALE 1:50



STD. CROSS SEC
DIVERSION TI

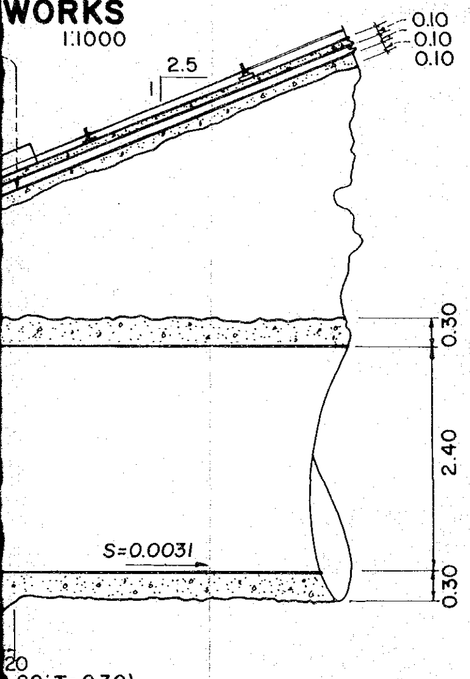
SCALE



METERS

WORKS

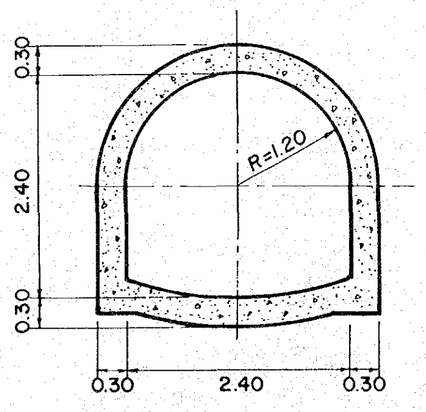
1:1000



: All dimensions are in meters

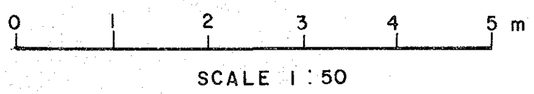
0-115 **DETAIL OF INTAKE**

SCALE 1:50

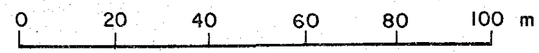


STD. CROSS SECTION OF DIVERSION TUNNEL

SCALE 1:50



SCALE 1:50



SCALE 1:1000

FEASIBILITY STUDY
BOHOL IRRIGATION DEVELOPMENT PROJECT
PHASE II

BAYONGAN DAM
DETAIL OF INTAKE, SECTION OF OUTLET WORKS AND DIVISION TUNNEL

DRAWING NO. DA.-4 | NOVEMBER, 1985

JAPAN INTERNATIONAL COOPERATION AGENCY