6) Water level of reservoir

Minimum water level is estimated at El. 60.0 m considering sedimentation volume for 25 years and 1.0 m allowance. Maximum water level for the simulation is equal to the crest elevation of spillway

(2) Optimum development scale

The optimum development scale of proposed Penyempeng Embung coincides with the maximum development scale considering the proposed agricultural development plan. The optimum development scale is thus in line with the height of 39.0 m and effective storage capacity of 7.2 million cubic meters (MCM). The result of reservoir operation is shown in Figure 4.2.

4.2 Delineation of Beneficiary Area

(1) Delineation of beneficiary irrigation area

By developing available water resources of the Brang Penyempeng river through construction of the proposed Penyempeng Embung at the maximum scale, irrigation water can be supplied to wet paddy field of 350 ha in net for the both seasons. The beneficiary area of the proposed Embung comprises the presently irrigated paddy field of 86 ha and newly converted field from the existing rainfed paddy field of 135 ha and dry upland of 129 ha. Taking such sufficient water supply condition into account, it becomes possible that the future cropping pattern under the "With-Project" condition aims to maximize rice production, sustain soil fertility and enhance cash income sources. In this regard, the proposed cropping pattern is to be double cropping of irrigated paddy coupled with irrigated cropping of mungbean and red onion as the second dry season Palawija crops to the full extent as shown below and illustrated in Figure 4.3

Under the "Without-Project" condition, no new irrigation water source can be developed so that the future cropping pattern is to remain in the same condition of the present pattern.

Future Cropping Pattern

Condition	Wet season			Dry Season		
	Crop	Water Supply	Area (ha)	Crop	Water Supply	Area (ha)
With Project	Paddy	Irrigated	350	Paddy	Irrigated	350
				Mungbean	Irrigated	175
				Red onion	Irrigated	175
Without Project	Paddy	Irrigated	86	Paddy	Rainfed	86
	Paddy	Rainfed	135	(Fallow)		-
	Soybean	Rainfed	129	(Fallow)		-

(2) Delineation of beneficiary area for domestic and livestock water supply

There is no water demand for domestic and livestock use in the Project area. It is therefore to utilize reservoir water of the proposed Embung for the irrigation purpose only.

4.3 Embung Development Plan

Following the results of the geological and material surveys as well as the optimization study, the proposed development plan of Penyempeng Embung is determined.

In terms of dam type, earth zone type is applied in due consideration of the foundation strength and the availability of embankment materials. As for the foundation treatment, it is proposed to adopt the curtain grout, the consolidation grout, the blanket grout with a length of 7,400 m considering the geological condition of the proposed Embung site.

The main components of Penyempeng Embung are the main dam, spillway, river diversion conduit and water supply facility as shown in Figure 4.4. In order to provide the reservoir with the optimum storage capacity of 7.200 MCM, the full supply level (F.S.L.) is set at El. 83.0 m. Taking overflow depth of spillway and freeboard into account, the dam height of Penyempeng Embung becomes 39.0 m above the river bed. In order to release the flood discharge during the construction period, a river diversion tunnel with a concrete pipe of 5.0 m in diameter is provided below the dam body. The spillway is designed on the left bank of the main dam to release the flood discharge of 411 m^3/sec from the catchment area of 41.1 km^2. For the purpose of supplying irrigation water to the beneficiary area, such related facilities are provided as an intake structure in the reservoir, water supply pipe with a diameter of 620 mm below the dam body and valve house at the downstream of the main dam.

The principal features of Penyempeng Embung are summarized below.

(1)	Reservoir	
	- Catchment area	41.1 km^2
	- F.S.L.	El. 83.0 m
	- Minimum operating level	El. 60.0 m
	- Effective storage capacity	7,200,000 m^3
	- Dead storage capacity	550,000 m^3
	- Gross storage capacity	7,750,000 m^3
	- Sediment deposition level	El. 59.0 m
(2)	Main dam	
	- Type	Zone-fill dam
	- Height	39.0 m above river bed
	- Crest elevation	E. 87.5 m
	- Crest length	360 m
	- Crest width	10.0 m
	- Upstream slope	1 : 2.5
	- Downstream slope	1 : 2.0
	- Total embankment volume	615,000 m^3
	- Foundation Treatment	Curtain Grout Consolidation Grout Blanket Grout (Total length = 7,400 m)
(3)	Spillway	
	- Design flood (1/100 year)	411 m^3/sec
	- Type	Side-channel
	- Crest elevation of overflow weir	El. 83.0 m
	- Width of overflow weir	85.0 m
	- Discharge capacity	420 m^3/sec
	- Overflow depth	1.7 m
	- Length	305 m
(4)	River diversion	
	- Design flood (1/5 year)	234 m^3/sec
	- Type	Tunnel
	- Diameter	5.0 m
	- Length	430 m

(5) Water supply system

- Inlet structure	1.5 x 1.5 m with trashracks
- Pipe diameter	ϕ 620 mm steel pipe to be installed in R/D Tunnel
- Length	250 m
- Design discharge	900 lit/sec
- Valve house	left abutment of the dam site
Type	Through valve
Diameter	ϕ360 mm x 3 units
Outlet elevation	El. 58.0 m

5. PRELIMINARY DESIGN OF FACILITIES

5.1 Preliminary Design of Embung

(1) Dam height

Resulting from the optimization study based on irrigation benefit and the construction cost, the dam height is decided on the basis of "Reservoir Storage Curve" as shown Figure 4.1.

(2) Freeboard

The freeboard of main dam is designed taking into consideration the rise of reservoir water surface due to extraordinary flood discharge and wave uprush on the slope.

The following formula is applied for the design of the dam in the Penyempeng Embung.

$$Hf = 0.05h + 1.0 \text{ (m)}$$

where, Hf : freeboard
h : height from river bed to the designed flood level.

(4) River diversion tunnel during construction

During the dam construction period, river flow including floods has to be diverted to avoid inundation of the Embung construction site. This can be effectively and economically made by providing a random-filled cofferdam and the river diversion tunnel with a diameter of 5.0m as shown in Figure 4.4.

(5) Spillway

The spillway is located on the left abutment of main dam, which is composed of side channel type overflow weir, throughway and chuteway. The over flow weir is designed to cope with the inflow design flood with a flood surcharge space provided above F.S.L. The inflow design flood is determined at 100 year probable flood having a peak discharge of 411 m^3/sec.

Based on the result of comparative study on combination of overflow depth and width of the spillway, the overflow depth at 1.7 m and the width of 85.0 m are decided so as to minimize the costs of the spillway and the main dam.

A non-gated ogee crest would be set at El. 83.0 m to coincide with F.S.L. A bridge would be provided over the throughway of the spillway.

(6) Water supply system

In order to supply the water to the downstream irrigation area, the water supply system is provided to release the water of 900 lit/sec. The water supply system consists of intake structure, pipe line and valve house. The intake structure is located at the front of diversion tunnel above the sediment deposition level of El. 59.0m. Fixed trashracks are provided on the intake structure. Steel pipe with a diameter of 620 mm is connected from the plug portion of the diversion tunnel to the downstream as shown in Figure 4.4.

A valve house would be constructed near the downstream toe of the dam. In the valve house, three units of the through valves with a diameter of 360 mm are installed.

5.2 Preliminary Design of Irrigation Facilities

(1) Basic concept

The following basic concepts are applied for the preliminary design of irrigation facilities in line with the development strategy:

- Irrigation water impounded by the Embung is supplied firstly to the existing cropped field, irrigated or rainfed, in the beneficiary area;
- Irrigation area is defined taking into consideration the available cropped field and the effective storage capacity of Embung;
- Irrigation canals from the outlet of Embung to the head of existing cropped field is constructed in the form of open channel as much as possible from the economic viewpoint;
- Irrigation system in the existing cropped field is be developed by farmers themselves, as the irrigation system commands around 50 ha only. No consideration is taken into in terms of new land reclamation;
- Proper design of canal alignment for gravity irrigation is considered paying special attention to avoid adverse effect on environment; and,
- Drainage improvement is not required for the existing cropped field since the beneficiary area is situated on well drained land.

(2) Irrigation plan

The water taken from the reservoir is led to the valve house through the cast iron pipe provided inside the diversion tunnel driven through the left abutment of the dam.

Irrigation water is discharged to the irrigation inlet box to make the open flow from the pipe pressure flow. Irrigation water is divided into two flows by the turnout situated next to the irrigation inlet box. One flow is led to the existing irrigation canal on the right bank of the Buas river by an open channel. The other is led to the newly irrigated paddy field on the left bank through a newly constructed open channel. Irrigation water on the right bank is delivered to wet paddy field by using the existing irrigation canals.

General layout is shown in Figure 5.1 including the layout of irrigation canals.

(3) Design discharge and initial water level

Design discharge for canal and related structures are decided based on the irrigation water requirement and proposed cropping pattern. Peak semi-monthly base diversion requirement for the unit area of 1.0 ha is a design discharge after multiplying the irrigation area. Peak diversion requirement occurs in the second half month of May for the dry season paddy crop and its design discharge is estimated at 900 lit/sec for the net irrigation area of 350 ha. This design discharge is enough to flow design discharge for the dry season Palawija crops of net area of 350 ha at peak time.

Initial water level at the irrigation inlet box is decided taking into consideration the elevation at the box site. As a result, the initial water level is El. 58.0 m at the irrigation inlet box.

(4) Irrigation facilities

The proposed canal layout and design of irrigation facilities are made based on the 1/5,000 topographic map prepared under the Study and in accordance with the following conditions :

- Canal alignment should be straight and short as much as possible.
- The alignment should be planned so as not to pass through villages and not to give damages to public facilities.
- The types of canal related structures should be minimized as much as possible.
- The structures should be simplified as much as possible.

Irrigation canals are constructed in the form of stone masonry trapezoid canal taking into account the design discharge of the canal, steep topographic condition, construction method and available construction materials in the Project area. Canal related structures required are irrigation inlet box, turnouts, siphon and irrigation division boxes. Required irrigation facilities are summarized below.

Irrigation Facilities Requirements

Facilities	Quantities
- Valve house (included in the facilities for Embung)	1 No.
- Irrigation inlet box	1 No.
- Masonry canal to be constructed	8.2 km
- Masonry canal to be rehabilitated	1.1 km
- Turnout	3 Nos.
- Siphon	1 No.
- Irrigation division box	82 Nos.

5.3 Preliminary Design of O & M Road

No all weathered road is available in and around the Embung site. It is therefore planned to provide O&M road to the dam site aiming at smooth undertaking of O&M works after completion of the Embung. Main features are summarized below.

Main Features of O&M Road

Item	Unit	Quantities
Required length	km	1.64
Width	m	7.0
Pavement		Gravel
Cross drain	Nos.	1

6. EMBUNG CONSTRUCTION PLAN

6.1 Construction Schedule

(1) Basic condition

All the construction works will be carried out by a local contractor selected by local competitive bidding.

The construction plan is based on the mode of construction and the target schedule of construction works as well as local conditions such as availability of construction labor, material and equipment, as well as weather and topographic conditions of the construction site.

It is assumed that 200 working days per year are available for conducting the earthfill embankment works, 270 days per year for the filter and rock embankment works and 300 days per year for concreting works in view of the daily rainfall distribution in the Project area. For each working day, 8-hour shift is applied.

(2) Construction schedule

The overall construction schedule is determined as shown in Figure 6.1 taking into account the necessary time of detailed design, bidding procedure including the time of tender evaluation and award of the contract. The major points of construction schedule are described below.

1) Mobilization and preparation works

Immediately after received the "Notice to Proceed", the contractor would commence the mobilization of the construction equipment and key staffs to the site from beginning of November in the first year. Following the above, preparatory works would be commenced at the Project site.

2) Setting out and excavation works

During the mobilization, setting out of all the structures would be commenced by the contractor at the Project site. Construction of temporary access roads such as access to the borrow area and access to major structural sites shall be started by using equipment available at the Project site. The excavation works for the river diversion channel and the main dam would be commenced at the beginning of March in the second year.

3) Concrete work of river diversion tunnel and foundation treatment

Concrete work of the river diversion tunnel will be commenced in August of the third year and completed in March in the third year. The foundation treatment for the main dam by means of grouting will be done during the wet season between the second and third year.

4) Main dam embankment

After the river water is switched into the river diversion tunnel in April in the third year, embankment works of the main dam will be done in dry season of the third and fourth years. During the wet season between the third and fourth year, the foundation treatment by the grouting for upper portion of the main dam will be done.

5) Spillway and water supply system

Excavation of the spillway will be commenced in September of the second year and completed in July of the third year. The concrete work of the spillway will be done for 14 months from August in the third year to September in the fourth year. At the time of the plug in the river diversion tunnel, steel pipe with diameter of 620 mm will be installed from the plug portion to the valve house through the river diversion tunnel. Construction of the valve house will be completed in dry season of the fourth year.

6) Commencement of reservoir water impounding

Commencement of the reservoir water impounding will be done at the beginning of October in the fourth year after completion of the main dam embankment and spillway construction. Considering the rainfall in November and December in the fourth year, the Penyempeng reservoir would be quite full and the water could be supplied to the water users from January in the fifth year.

7) Water distribution system

Construction works for the water distribution system will be executed in parallel with the Embung construction works by using mainly manpower because of the work quantities in the fourth year are not so much. These works shall be completed by the end of December before supplying the reservoir water to the beneficiary area.

6.2 Construction Plan of Embung

(1) Preparatory works

The preparatory works consist of preparation of temporary buildings, construction plant and repair shop, arrangement power and water supply systems as well as communication system, construction of access and haul roads, and so on. All of these works will be conducted from November in the first year to February in the second year.

1) Temporary buildings and yards

The temporary buildings required for the construction would include office, quarters, workshop, warehouse and storage yards. These temporary buildings will be built by the contractor.

2) Water and power supply

The water required for the construction works and the daily use in the construction camp is planned to be taken from the rivers or springs near the Embung site or the wells drilled in the contractor's yard.

The electric power for the construction camp is planned to be supplied by the contractor's diesel generators.

(2) River diversion works

The river flow will be released through the river diversion tunnel during the third and fourth year, and therefore the river diversion tunnel will be constructed in the left abutment of the main dam.

After completion of the main dam embankment and the spillway excavation around the end of September in the fourth year, the river diversion tunnel shall be closed by the closing gate and plugged by the concrete using concrete pump.

(3) Main dam works

Following the foundation excavation, foundation treatment with grouting and completion of the river diversion tunnel, the dam embankment works will be commenced at the beginning of April in the third year. Considering a total embankment volume of 615,000 m^3 and the dry season period of 13 months until the end of September in the fourth year, the daily embankment volume is to be 1,900 m^3 , which is quarried from the borrow area and the quarry site around the Embung construction site.

(4) Spillway construction

Excavation of the spillway will be scheduled to be performed for about 11 months in the second and third year. Most of the excavated materials from the spillway may be used for the main dam embankment so that the excavated material will be stocked on the designated area.

After completion of the spillway excavation, concrete works for weir and chuteway will be commenced. Before starting the reservoir water impounding at the beginning of October in the fourth year, major concrete works of the spillway shall be completed in order to release the flood discharge in the following wet season.

(5) Water supply system

Inlet structure of the water supply system is constructed above the sediment load disposition level of El. 59.0 m. Connecting with the inlet structure, pipe culvert with a diameter of 620 mm is constructed up to the downstream end of the main dam. Plug of the river diversion tunnel and steel pipe should be completed immediately after starting the reservoir water impounding around October in the fourth year.

The valve house of the water supply system will be constructed before the reservoir water reaches to F.S.L of El. 83.0 m around the end of December in the fourth year.

6.3 Construction Plan of Irrigation Facilities and O&M Road

Since the irrigation facilities and O&M road to be constructed are rather small in work quantities scattering in the beneficiary area in comparison with the Embung construction works, almost all the works except earth works for irrigation canal and road will be basically executed by man power. Earth works for the irrigation canal and road such as clearing, stripping, excavation and embankment works will be executed by using heavy construction equipment including bulldozer, excavator, compactor and so on All of these works will be executed in parallel with the Embung construction works.

6.4 Institutional Arrangement for Project Implementation

(1) Responsible organization for Project implementation

In the course of Project implementation, DPUP of NTB, after getting approval from DGWRD, will direct the PKSA Sumbawa Project Office to commence undertaking of detailed investigation work of the Penyempeng Embung. This work will be done by the Survey Section of the said Project Office. Under the PKSA Sumbawa Project Office, the Sub Project Office in charge of West Region of Sumbawa will be responsible for carrying out

detailed design work. Based on the cost estimate, DPUP of NTB will disburse budget for land acquisition and construction of Embung and related facilities to the Project Office using development budget allocated from the Central Government. Before starting construction work, land acquisition work will be carried out by the Land Acquisition Section of the Project Office. Supervision of construction works, being entrusted to a contractor through tendering, will be the responsibility of the said Sub Project Office.

(2) Technical resources input

In due consideration of the current availability of engineers and technical staff as well as the annual development target in the PKSA Sumbawa Project Office, it is necessary to utilize technical resources outside the Project Office to the maximum extent for enabling the Project Office to realize its target. In this connection, undertaking of detailed investigation and design works for the Penyempeng Embung need to be entrusted to consultants aiming to secure smooth implementation of the Project in accordance with the implementation program made by the Project Office.

(3) Organization for O&M

After completing all of Project works for Penyempeng Embung, DPUP of NTB will submit its completion report to the Minister for Public Works through DGWRD and therefrom the notice of Project completion will be transferred to the Minister for Home Affairs. After receiving the Minister's direction, the Governor of NTB Province will order DPUP of NTB to take a necessary action for O&M of the said Project facilities. Following this, DPUP of NTB will direct its Provincial O&M Project Office to arrange O&M works and disburse the Provincial Government's budget to DPUP Kabupaten Sumbawa Office.

(4) Water User's Association (P3A)

In the Project area, the existing P3A has been active since 1988. It is therefore necessitated to make the new beneficiary farmers become members of this P3A and to train them by using training materials and modules prepared by the Water User Training Program under DGWRD.

7. COST ESTIMATE

7.1 Basic Assumption of Cost Estimate

Project cost of the proposed works for developing the Penyempeng Embung is estimated on the basis of assumptions as follows :

- All the civil works of the Project will be executed on the contract basis. Contractor(s) will be selected through the competitive bidding;
- Project cost includes the physical contingency of 15% of the construction costs in view of the preliminary nature of the estimate. The price contingency of 20% is also included in the cost estimate taking into account the recent price escalation of construction materials in Indonesia;
- The associated costs to be financed by the Government, such as the cost for strengthening the extension services, facilities of the Water Users' Association and improvement of the social infrastructures except for those included in the proposed Project works, are not included in the cost estimate;
- The direct construction cost is estimated based on the calculated work quantities of the Project works and unit prices of the works. The unit prices of the works are estimated based on the current prices in NTB as of October 1994 and the data collected from the on-going projects in NTT and NTB. The basic prices for construction works include delivery cost of construction materials to the Project site;
- The contract tax, which is a value added tax imposed by the government at a rate of 10% against the total contract cost, is included in the estimate of the Project cost;
- Engineering service cost for the consultants in conducting detailed design and construction supervision is estimated based on such assumption as 15% of direct construction cost;
- Administration cost consists of PRWS's staff salary for construction management, vehicle running cost and other related cost only for the Project implementation. Administration cost is estimated at around 5% of the direct construction cost with reference to the recent other project costs in NTT and NTB;
- Land acquisition cost including the purchase of the Embung site, reservoir area, borrow areas, and land of pipe line, irrigation canal and permanent structures and is estimated at 0.5 % of the direct construction cost taking into consideration the present condition of the Project area based on the survey results under the Study; and,
- The currency for cost estimate is expressed in Indonesian Rupiah (Rp.) since all construction materials are available in Indonesia and the payment for construction works will be executed with Indonesian Rupiah.

7.2 Construction Cost

The Project cost, as an initial investment by the Project, is composed of direct construction cost, administration cost, engineering service cost, physical contingency, contract tax, land acquisition cost and price contingency. The total Project cost for constructing the Penyempeng Embung is estimated at Rp. 25,301 million as shown in Table 7.1. Detail of direct construction cost estimated based on the calculated work quantities of the proposed Project works and unit prices of the works is shown in Table 7.2 together with work quantities of the main work items and unit prices.

The total Project cost for constructing the Penyempeng Embung is summarized below.

Summary of Project Cost for Penyempeng Scheme

Unit : Rp. Million

Item		Project cost
I.	Direct construction cost	13,889
1.1	Preparatory works	661
1.2	Embung construction	11,648
1.3	Irrigation facilities	1,477
1.4	Domestic water supply	0
1.5	Operation & maintenance road	103
II.	Administration cost	694
III.	Engineering services	2,083
IV.	Physical contingencies	2,500
V.	Contract tax	1,847
VI.	Land acquisition	69
VII.	Price contingency	4,217
	Grand Total	25,301

7.3 Operation and Maintenance Cost

The O&M costs consist of salaries of O&M staff, cost for maintaining the Project facilities, material and labor cost for repairing works, and running cost of Project facilities. The annual O&M costs are estimated at Rp. 126.5 million, which is equivalent to 0.5 % of the Project cost.

8. PROJECT JUSTIFICATION

8.1 Satisfaction of BHN

As no water demand for domestic and livestock use by the beneficiary inhabitants, no social impact can be expected in the Project area by the development of Penyempeng Embung at the proposed site on the Brang Penyempeng river.

8.2 Economic Consideration

(1) Economic cost

The financial costs are to be converted into the economic costs by applying the economic conversion factor (ECF) established by DGWRD in 1985. The ECFs applied are: 0.71 for preparatory works and all civil works including Embung, irrigation facilities, domestic water supply system and road networks; 0.75 for unskilled on-farm labor and farm labor; 0.80 for land clearing, on-farm development and operation and maintenance cost; and tertiary irrigation system development, 0.90 for design and survey works and administration; and 1.00 for O&M equipment and replacement cost.

When the financial cost is converted to the economic cost, the contract tax, land acquisition cost and price contingency are fully excepted. In this Study, only the purchasing cost of consumables and goods appropriated in the administration cost is to be converted to the economic administration cost, as the normal payment to civil servants is principally appropriated in the operation budget of the Government. As the construction cost of dam and engineering cost estimated include some allowance to cover additional cost for expatriates, 50% of the engineering cost is to be converted to the economic cost in order to make the estimated cost equal to the level of local cost.

The economic cost converted and its annual disbursement schedule are shown in Table 8.1.

(2) Economic benefit

The irrigation benefits of the Project are principally derived from increased crop production attributable to stable irrigation water supply, full utilization of available farm land resources and optimum farm input supply. Table 8.2 gives financial and economic prices of farm inputs and outputs estimated for major islands. Based on the proposed quantity of farm inputs, anticipated crop yield and economic farm gate prices, the economic crop budget is estimated as shown in Table 8.3.

The annual net incremental benefit is thus estimated to be Rp. 1,138.5 million. This increment benefit will accure from the first year when irrigation water can be released from the Pelangan Embung. Taking the present agricultural situation and farmers capability into account, it is assumed that five years are needed as the build-up period to attain the anticipated crop yield level. In the proposed reservoir area, there will be no production foregone in the proposed reservoir area by constructing the proposed Penyempeng Embung.

(3) Economic evaluation

The economic internal rate of return (EIRR) is examine as shown in Table 8.4 on costs and benefits as at August 1994. The result of economic analysis shows that EIRR is 6.5%, but the proposed Penyempeng Embung Project would still have a significant positive impact on the development of the economically depressed area within Sumbawa island as it can be expected to increase paddy production by 2,467 tons or 4.6 times and to enhance cash

income source by introducing irrigated cultivation of red onion with very high demand in local markets of urban areas.

(4) Farm budget analysis

With the implementation of Penyempeng Embung Project, the net on-farm income of farmers holding a unit farm size of 1.0 ha can be expected to increase by Rp. 3,535,200/year from Rp. 720,300/year under the "Without Project" condition with the cropping intensity of 139% to Rp. 4,255,500/year under the "With Project" condition with the cropping intensity of 300% as shown in Table 8.5 and below. Such improvement of farm budget would give much incentive for farmers to make further investment in improvement of their living standard and also could increase their payment capacity enabling beneficiary farmers to pay irrigation water charge to some extent.

Farm Budget for Unit Farm Size of 1 Ha

Crop	Watering Condition	Without Project		With Project	
		Crop Intensity (%)	Income (Rp.)	Crop Intensity (%)	Income (Rp.)
Paddy	Wet/Rainfed	38.6	160,094	-	-
	Wet/Irrigated	24.6	138,621	100.0	926,375
	Dry/Rainfed	38.6	0	-	936,375
	Dry/Irrigated	-	140,021	100.0	-
Soybean	Wet/Rainfed	36.8	281,549	-	-
Mungbean	Dry/Irrigated	-	0	50.0	537,210
Red onion	Dry/Irrigated	-	0	50.0	1,855,500
Total		138.6	720,285	300.0	4,255,460

8.3 Environmental Impact Assessment

Environmental impact assessment for the Project is carried out in consideration of the development objectives of the Project.

(1) Environmental features of the Project area

The principal features of human and physical environment in the Penyempeng Project area are summarized as below.

Environmental Features in the Penyempeng Project Area

Item	Description
1. Human Environment	
Social intention	Insufficiency of reliable water sources and facilities for irrigation water
Human use	Use of well water
Economic activities	Cultivation of irrigated paddy and Palawija, and livestock farming
Health and sanitation	Prevalence of waterborne intestinal diseases
2. Physical environment	
Geology/land	Volcanic rock of Tertiary
Surface/ground water	Surface water from catchment area of 41 km^2 is observed
Endemic fauna and flora	None
3. Others	None

(2) Environmental impact assessment

The results of environmental impact assessment reveal that there exist no negative impacts by the Penyempeng Embung development in this Project area.

(3) Primary information of environmental assessment

To support environmental analysis presentation for this Project implementation on the Indonesian rule, primary information on environmental assessment is compiled in the Attachment to the Volume 4.

8.4 Contribution to Women in Development

Since housewives in the Project area manage their family budgets, an increase of the farmer's income would encourage women in investing surplus in improvement and diversification of their income sources.

9. CONCLUSION AND RECOMMENDATIONS

9.1 Conclusion

On the basis of categorization of 157 candidate schemes for the Study, the Penyempeng Embung scheme is selected representing a typical sample scheme of which potential beneficiary area has its irrigation water intake on the source river of the proposed Embung, good farming system and inhabitants' demand for further use of irrigation water. The proposed Penyempeng Embung site has physically irrigable land resources of 350 ha in net and the annual discharge of 24.4 MCM from its catchment area of 41.1 km^2.

As there is no limitation in the topographic condition and the availability of water resources, the future water demand for irrigation use in the beneficiary area is the determining factor in the optimization of development scale. To cover the physically irrigable area by gravity method to the maximum extent, the dam height of Penyempeng Embung is thus set to be 39.0 m with the total and effective storage capacities of 7.75 and 7.2 MCM, respectively. Under such condition, it can be expected to practice double cropping of irrigated paddy followed by irrigated cropping of high-valued Palawija crops for the dry season in the beneficiary area.

The structural components are main dam, spillway, diversion tunnel and dam O&M road as well as irrigation water distribution system. The zoned fill dam is constructed with the crest length of 360 m, embankment volume of 615,000 m^3 and side-channel typed spillway having design flood discharge of 411 m^3/sec and overflow weir width of 85 m. The required investment cost amounts to Rp. 25.3 billion of which direct construction cost is estimated to be 13.9 billion.

The results of feasibility study reveal that construction of the candidate Embung at the proposed site is technically sound but economically marginal because a large volume of embankment is required. Therefore, such type of Embung is worth implementing from the technical viewpoint but needs further socio-economic justification paying special attention to policy issues to reduce the economic gap and to eradicate poverty both predominant in NTB.

9.2 Recommendations

In the intensification of the farming system to the target level with the cropping intensity of 300%, it is recommended to improve farming practices and on-farm irrigation water management skills of the beneficiary farmers through strengthening of agricultural extension services and water management training programs.

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Feasibility Study on Penyempeng Embung Development Project

Tables

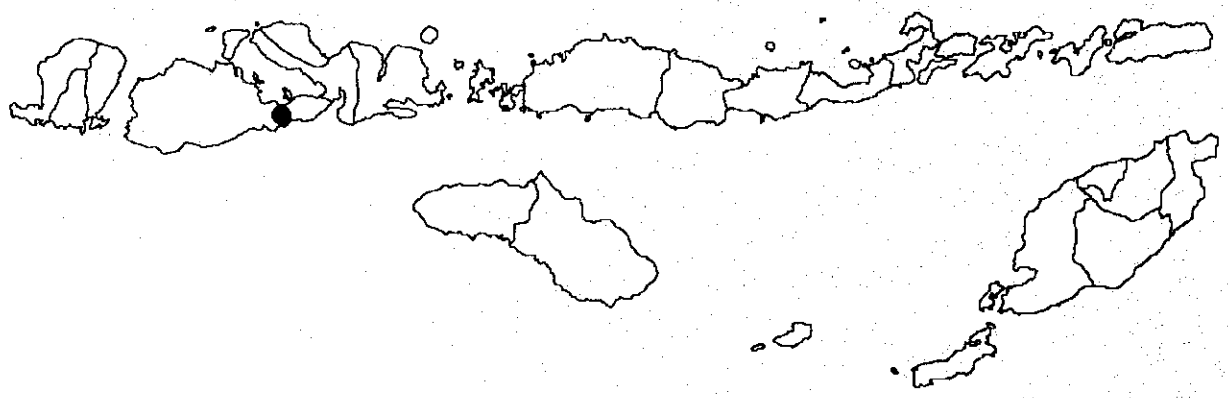


Table 1.1 Rainfall Record in Empang

Station : Empang
Kec./Kab : Empang/Sumbawa
Elevation : + 25 m
Location : BT 117 58 25
LS 08 45 10

Year	Jan.		Feb.		Mar.		Apr.		Mei		Jun.		Jul.		Ags.		Sep.		Okt.		Nop.		Des.		Annual	Daily Max.
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II		
1955	33	214	271	43	53	56	43	10	69	29	47	10	36	107	0	42	0	0	0	29	199	89	61	84	1,525	83
1957	39	163	117	185	104	152	12	0	0	0	0	0	0	0	0	5	0	0	0	0	5	98	77	121	1,078	95
1958	0	53	131	203	118	145	5	69	38	0	0	44	3	1	0	10	0	0	0	8	48	40	54	55	123	1,148	88
1959	222	49	206	97	119	145	21	12	0	29	13	0	0	0	0	0	0	0	0	0	0	13	60	106	121	1,213	88
1960	16	241	189	132	0	62	39	50	59	20	0	0	0	12	5	40	0	45	5	11	20	78	0	142	1,166	87
1961	46	89	102	84	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	2	17	60	478	83
1964	148	29	130	49	161	52	13	54	29	5	53	0	0	0	0	0	58	35	261	140	173	110	0	59	1,559	108
1965	180	67	81	161	225	11	230	0	11	12	0	0	0	0	0	0	0	0	0	0	61	3	0	0	1,042	127
1966	113	118	110	79	177	236	34	6	0	15	16	0	0	0	14	2	0	51	2	20	9	44	182	216	1,444	90
1967	207	417	62	59	163	51	8	14	0	1	0	0	0	4	0	1	6	1	36	0	51	14	161	135	1,391	107
1968	157	114	118	306	28	74	84	0	71	67	5	5	34	108	0	0	0	0	11	13	0	7	101	97	1,400	130
1969	22	43	29	100	11	126	0	0	0	0	0	0	0	0	0	0	0	0	28	0	0	8	19	45	431	57
1970	63	124	182	200	82	56	5	47	0	0	5	3	0	0	0	0	0	23	0	22	50	50	72	147	1,131	54
1971	66	170	239	90	146	131	0	51	12	72	0	0	0	0	0	0	0	23	1	106	71	53	196	38	1,465	100
1972	239	4	99	160	108	112	2	44	0	0	0	0	0	0	0	0	0	0	0	0	0	10	86	40	904	67
1973	109	147	162	15	147	61	55	64	16	22	0	0	0	0	0	0	24	20	0	21	10	17	54	66	1,010	50
1974	184	14	93	285	220	103	36	0	19	0	0	0	0	0	0	8	12	49	5	67	111	134	65	65	1,470	82
1975	108	92	182	294	220	143	254	205	163	0	0	0	0	45	0	0	134	0	70	30	45	0	164	170	2,319	75
1976	169	157	80	154	124	0	48	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	12	25	776	42
1977	239	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	-	-
1978	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	-	-
1979	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	-	-
1980	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	15	98	181	224	-	-
1981	421	179	297	220	28	0	7	174	15	20	9	7	0	0	1	23	1	0	2	0	53	88	103	34	1,682	120
1982	180	95	60	198	176	42	4	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	297	1,111	100
1983	384	38	85	13	2	0	3	15	0	0	0	0	0	0	0	0	0	0	4	0	43	176	22	118	903	115
1984	103	162	113	261	213	4	98	62	1	0	0	0	0	0	0	0	41	5	100	10	16	71	x	x	-	88
1985	36	49	151	185	233	0	24	32	0	58	12	0	50	0	0	0	0	0	0	2	3	118	25	39	1,017	107
1986	x	x	65	98	84	86	0	9	0	0	0	4	0	2	0	0	0	0	13	31	17	11	96	42	-	50
1987	191	177	64	289	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	107	240	292	384	1,768	200
1988	13	96	34	10	71	229	0	0	0	0	0	0	0	0	0	0	0	0	0	0	81	62	96	101	793	92
1989	42	475	88	149	44	156	20	12	0	0	9	35	1	24	0	44	0	0	0	77	30	10	178	23	1,417	140
1990	218	297	150	44	193	3	7	49	17	33	0	0	0	0	0	0	24	3	0	0	0	3	161	132	1,334	111
1991	236	163	180	131	28	32	78	50	0	0	0	0	6	13	0	0	5	0	0	0	31	74	17	27	1,071	89
1992	61	110	85	167	98	76	82	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	137	137	128	144	111	75	41	34	17	12	5	3	4	10	1	6	10	8	19	21	41	57	88	108	1,217	-

note. : x => data not available

Table 1.2 Climate in Plampang

Station : Plampang
Kec./Kab : Plampang / Sumbawa
Elevation : + 25 m
Location : BT. 117 47' 00"
LS. 08 45'45"

Description	Unit	Jan.	Feb.	Mar.	Apr.	Mei	Jun.	Jul	Ags.	Sep.	Okt.	Nop.	Des.	Annual Mean	Year
Mean Temperature	C	27.7	27.7	28.0	28.3	27.8	27.2	26.6	26.9	27.8	29.0	29.1	28.0	27.8	1977 - 1984
Mean Maximum Temperature	C	31.8	32.3	32.7	33.4	32.9	32.1	31.7	32.2	33.2	34.4	34.5	32.9	32.8	1977 - 1984
Mean Minimum Temperature	C	23.6	23.3	23.2	23.2	22.9	22.4	21.7	21.8	22.5	23.4	23.8	23.2	22.9	1977 - 1984
Mean Relative Humidity	%	90.0	90.0	88.0	88.0	87.0	86.0	84.0	83.0	81.0	77.0	79.0	88.0	85.1	1977 - 1983
Mean Maximum Relative Humidity	%	96.0	96.0	96.0	96.0	95.0	95.0	93.0	93.0	91.0	85.0	88.0	95.0	93.3	1977 - 1983
Mean Minimum Relative Humidity	%	79.0	77.0	73.0	69.0	71.0	70.0	68.0	65.0	62.0	59.0	62.0	73.0	69.0	1977 - 1983
Mean Dew Point	C	24.7	24.4	24.7	24.6	24.4	23.4	22.6	22.3	23.0	23.7	24.6	24.8	23.9	1977 - 1983
Mean Sunshine Hours	%	33.0	37.0	49.0	59.0	60.0	62.0	65.0	73.0	72.0	73.0	58.0	44.0	57.1	1977 - 1984
Mean Solar Radiation	Cal/Cm2	297.0	291.0	341.0	346.0	328.0	325.0	315.0	350.0	378.0	403.0	373.0	339.0	340.5	1977 - 1982
Mean Wind Velocity	Km/hr	5.1	3.2	3.5	2.6	4.0	5.7	7.3	8.4	9.4	9.2	7.7	3.6	5.8	1977 - 1983
Mean Evaporation	mm/day	4.2	4.2	4.9	5.1	5.2	5.3	5.7	6.6	7.8	8.7	8.5	5.1	5.9	1977 - 1983
Mean Monthly Rainfall	mm	319.0	355.0	178.0	92.0	48.0	68.0	10.0	19.0	5.0	13.0	115.0	202.0	1,424.0	1977 - 1984

Table 1.3 Typical Soil Profile in the Penyempeng Project Area

Profile No.:		8
Soil Classification:		*Ustic Endoauerts*
Physiography:		Mountain foot slope
Topography:		Undulating (6 - 8 %)
Land Use/Vegetation:		Irrigated paddy field
Parent material:		Bassaltic rock
Drainage:		Moderate
Groundwater Table:		> 5 m
Permeability:		Slow (0.33 cm/hr)
Land Morphology:		Cracking 2 - 5 cm width, 60 cm depth
Horizon	Depth (cm)	Description
Ap	0 - 20	Black (10YR 2/1, moist); clay loam; strong, angular blocky, coarse structure; very sticky, very plastic, very firm, extremely hard consistency; clear, smooth horizon boundary
Bw1	20 - 50	Black (10YR 2/1, moist); clay loam; strong, blocky, coarse structure; very sticky, very plastic, very firm, extremely hard consistency; clear, smooth horizon boundary
Bw2	50 - 110+	Black (10YR 2/1, moist); clay loam; medium, angular blocky and massive, coarse structure; very sticky, very plastic, very firm, extremely hard consistency

Source: Soil survey carried out by the local consultant under supervision of the JICA Study Team

Table 1.4 Results of Soil Laboratory Test in the Penyempeng Project Area

Soil Pit	Layer	Texture			Permeability	pH	pH	Organic	Total N	Ava. P	CEC	Ex. Na	Ex. Ca	Ex. K	Ex. Mg	Base	EC
		Sand (%)	Silt (%)	Clay (%)	(cm/hr)	(H2O)	(KCl)	matter	(%)	(ppm)	(me/100g)	(me/100g)	(me/100g)	(me/100g)	(me/100g)	Saturation (%)	(mS/cm)
2	Ap	74.4	9.3	16.3	5.0	7.2	6.4	1.05	0.03	2.06	30.13	1.28	12.24	1.09	3.62	61	0.42
	Bw1	81.2	13.8	5.0	6.1	7.3	6.5	0.61	0.04	1.94	19.93	0.63	8.68	1.13	2.37	64	0.12
	Bw2	82.7	10.3	7.0		6.5	5.8	1.65	0.04	2.34	25.71	0.64	10.68	1.00	2.48	58	0.20
6	A	54.6	10.4	35.0	0.3	6.6	5.7	0.94	0.05	2.13	37.22	1.12	9.52	1.37	4.14	43	0.46
	Bw1	58.6	10.3	31.0	0.3	6.7	6.5	0.68	0.04	2.14	41.52	1.23	16.66	1.81	4.99	59	0.46
	Bw2	53.7	17.3	29.0		6.8	6.4	2.08	0.03	2.25	39.80	1.75	14.19	1.60	4.57	56	0.98
8	Ap	46.0	19.0	35.0	0.3	7.1	6.3	1.84	0.04	4.37	44.85	1.73	17.68	2.05	2.17	53	0.68
	Bw1	46.0	17.0	37.0	0.2	7.1	5.9	2.37	0.03	3.09	41.83	1.95	13.33	2.09	1.59	45	0.76
	Bw2	54.4	3.3	42.3		7.7	6.6	2.37	0.03	2.46	40.39	3.18	12.09	1.86	0.99	45	0.60

Source: Soil survey carried out by the local contractor under supervision of the JICA Team

Table 1.5 Soil Classification in the Penyempeng Project Area

Land Unit	Description	Physiography	Topography	Potential Suitability			Area	
				Paddy	Soybean	Maize	(ha)	(%)
I	Lithic Ustorthents shallow; fine clay-coase loamy; neutral; very high CEC; very rapid-slow permeability; well-moderate drainage	Alluvial fan	Undulating (2-8%)	S1/S3	S1/S3	S3	25	4%
II	Aquic Ustifluvents deep; fine clay; neutral; high CEC; moderate permeability well drainage	Alluvial fan	Flat (<1%)	S1	S1	S1	15	2%
III	Oxtaquic Ustropupts very deep; fine loamy-coarse loamy; very high CEC; slightly slow-rapid permeability; well-moderate drainage	Alluvial fan	Flat-undulating (1-5%)	S1	S1	S1	70	11%
IV	Aquic Ustropepts very deep; coarse loamy; neutral; high CEC; moderate permeability; well drainage	Mountain foot slope-alluvial fan	Flat (2-3%)	S1	S1	S1	15	2%
V	Typic Haplusterts deep; fine loam-coarse loamy; high CEC; slightly slow-slow permeability; moderate drainage	Mountain foot slope	Undulating-rolling (4-12%)	S1	S1/S3	S1	196	30%
VI	Chromic Calciusterts deep; very fine clay; high CEC; slow permeability; moderate drainage	Alluvial fan	Undulating (2-3%)	S3	S3	S3	17	3%
VII	Chromic Haplusterts deep; very fine clay; high CEC; slow permeability; moderate drainage	Mountain foot slope	Flat-undulating (0-5%)	S1	S3	S3	183	28%
VIII	Oxyaquic Ustifluvents deep; fine loam; neutral; high CEC; slow permeability; moderately well drainage	Alluvial fan	Undulating (2-4%)	S1	S1	S1	33	5%
IX	Vertic Ustropepts deep; very fine clay; neutral; very high CEC; slow permeability; moderately well drainage	Alluvial fan	Undulating (2-4%)	S3	S3	S1	22	3%
X	Ustic Endoaquerts deep; fine clay; neutral; very high CEC; slow permeability; moderate drainage	Mountain foot slope	Undulating (6-8%)	S1	S1	S1	39	6%
#	Unclassified						49	7%
	Total						664	100%

Source: Soil survey carried out by the local consultant under supervision of the JICA Team

Table 1.6 Summary of Far Household Economic Survey in the Penyempeng Project Area

	Item	Unit	Respond't No. 1	Respond't No. 2	Respond't No. 3	Respond't No. 4	Respond't No. 5	Respond't No. 6	Respond't No. 7	Respond't No. 8	Respond't No. 9	Respond't No. 10	Respond't No. 11	Respond't No. 12	Respond't No. 13	Respond't No. 14	Respond't No. 15	Average
1	Sex and Age		Male 45	Male 50	Male 23	Male 41	Male 53	Male 60	Male 55	Male 53	Male 35	Male 40	Male 42	Male 42	Male 32	Male 45	Male 43	Male 44
2	No. of Family Member		M-1/F-1	M-2/F-2	M-1/F-1	M-2/F-1	M-1/F-4	M-2/F-2	M-0/F-2	M-0/F-2	M-2/F-2	M-3/F-1	M-2/F-1	M-1/F-2	M-1/F-1	M-2/F-2	M-2/F-4	M-1/F-2
3	Type of Side Job		HC Driver	None	Worker	Worker	None	None	None	Desa Ser.	None	None	HC Driver	None	None	HC Driver	HC Driver	
4	Own Farmland	ha	1.02	2.51	2.01	1.12	2.48	2.31	1.97	2.08	1.19	0.86	3.21	4.26	1.25	2.16	1.76	2.01
	Rented Farmland	ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Yield Division	ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	(Paddy field)	ha	1.00	2.50	2.00	0.70	1.50	1.00	0.21	1.00	0.60	0.85	1.50	2.00	1.00	1.00	0.25	1.14
5	Cropped Area	ha	1.00	5.50	4.00	1.45	2.47	2.37	2.38	1.20	1.70	2.20	4.70	2.82	3.00	2.50	1.75	2.60
	(Paddy)	ha	1.00	2.50	2.00	0.70	1.50	1.00	0.63	1.00	0.60	1.35	1.50	0.61	2.00	1.00	0.25	1.18
	(Palawija)	ha	0.00	3.00	2.00	0.75	0.97	1.37	1.75	0.20	1.10	0.85	3.20	2.21	1.00	1.50	1.50	1.43
	(Others)	ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	Cow/Buffalo	head	5	0	5	0	0	2	2	0	2	5	2	4	0	4	0	2
	Horse	head	1	0	3	0	0	1	0	0	0	5	1	2	0	2	1	1
	Goat/Sheep	head	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pig	head	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Chicken/Duck	head	0	0	0	2	4	0	0	0	2	0	0	0	5	26	2	3
7	Gross Income	Rp.'000/yr	1,380.0	5,969.3	2,326.0	1,880.0	2,018.5	1,340.0	2,174.0	2,400.0	900.0	1,180.0	2,967.5	4,100.0	1,825.0	2,490.0	1,915.0	2,324.4
	(Crop)	Rp.'000/yr	180.0	5,969.3	1,786.0	1,640.0	2,018.5	1,100.0	2,174.0	2,160.0	900.0	1,180.0	2,487.5	3,950.0	1,825.0	1,050.0	355.0	1,918.4
	(Livestock)	Rp.'000/yr	0.0	0.0	300.0	0.0	0.0	240.0	0.0	0.0	0.0	0.0	0.0	150.0	0.0	0.0	0.0	46.0
	(Side job)	Rp.'000/yr	1,200.0	0.0	240.0	240.0	0.0	0.0	0.0	240.0	0.0	0.0	480.0	0.0	0.0	1,440.0	1,560.0	360.0
	(Miscellaneous)	Rp.'000/yr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	Expenditure	Rp.'000/yr	1,316.8	5,501.7	2,685.0	1,326.4	2,046.1	1,317.9	1,426.1	2,055.1	1,484.3	2,114.8	3,335.9	3,251.6	1,785.2	2,202.1	2,051.3	2,260.0
	(Food/drink)	Rp.'000/yr	640.8	1,122.0	1,086.0	914.4	756.0	780.0	720.0	958.8	738.0	936.0	1,040.4	1,452.0	596.0	1,305.6	1,290.0	955.7
	(Living)	Rp.'000/yr	525.0	951.2	784.0	174.7	433.6	250.4	397.4	574.8	372.8	682.8	1,039.6	1,234.6	454.0	478.0	504.0	590.5
	(Education)	Rp.'000/yr	0.0	1,320.0	180.0	60.0	360.0	50.0	0.0	0.0	50.0	50.0	600.0	0.0	0.0	60.0	120.0	190.0
	(Production)	Rp.'000/yr	151.0	2,108.5	635.0	177.3	496.5	237.5	308.7	521.5	323.5	446.0	655.9	565.0	735.2	358.5	137.3	523.8
9	Surplus/Deficit	Rp.'000/yr	63.2	467.6	-359.0	553.6	-27.6	22.1	747.9	344.9	-584.3	-934.8	-368.4	848.4	39.8	287.9	-136.3	64.3
10	Saving	Rp.'000/yr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	180.0	0.0	36.0	0.0	250.0	0.0	0.0	0.0	31.1

Source : JICA Agro-economy Survey

Table 2.1 Estimated Evapotransiration in Penyempeng Project

Site : Penyempeng
Meteorological Station : Plampang

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
T mean	C	27.70	27.70	28.00	28.30	27.80	27.20	26.60	26.90	27.80	29.00	29.10	28.00
RH mean	%	90.00	90.00	88.00	88.00	87.00	86.00	84.00	83.00	81.00	77.00	79.00	88.00
U km/day	km/day	122.40	76.80	84.00	62.40	96.00	136.80	175.20	201.60	225.60	220.80	184.80	86.40
ea	mbar	36.96	36.96	37.59	38.26	37.17	35.91	34.65	35.28	37.17	39.87	40.10	37.59
RH/100		0.90	0.90	0.88	0.88	0.87	0.86	0.84	0.83	0.81	0.77	0.79	0.88
ed	mbar	33.26	33.26	33.08	33.67	32.34	30.88	29.11	29.28	30.11	30.70	31.68	33.08
(ea-ed)	mbar	3.70	3.70	4.51	4.59	4.83	5.03	5.54	6.00	7.06	9.17	8.42	4.51
f(u)		0.60	0.48	0.50	0.44	0.53	0.64	0.74	0.81	0.88	0.87	0.77	0.50
(1-W)		0.23	0.23	0.23	0.23	0.23	0.24	0.25	0.24	0.23	0.23	0.23	0.23
(1-W)f(u)(ea-ed)	mm/day	0.52	0.41	0.52	0.46	0.60	0.77	1.01	1.18	1.45	1.79	1.46	0.52
Ra	mm/day	16.40	16.30	15.50	14.20	12.80	12.00	12.40	13.50	14.80	15.90	16.20	16.20
n	hr/day	2.64	2.96	3.92	4.72	4.80	4.96	5.20	5.84	5.76	5.84	4.64	3.52
N	hr/day	12.60	12.40	12.10	11.80	11.60	11.50	11.60	11.80	12.00	12.30	12.60	12.70
(0.25+0.50n/N)		0.35	0.37	0.41	0.45	0.46	0.47	0.47	0.50	0.49	0.49	0.43	0.39
Rs	mm/day	5.82	6.02	6.39	6.39	5.85	5.59	5.88	6.72	7.25	7.75	7.03	6.30
Rns	mm/day	4.65	4.82	5.11	5.11	4.68	4.47	4.70	5.37	5.80	6.20	5.63	5.04
f(T)		16.22	16.22	16.30	16.34	16.26	16.14	16.02	16.06	16.26	16.50	16.50	16.30
f(ed)		0.08	0.08	0.08	0.08	0.09	0.09	0.10	0.10	0.09	0.09	0.09	0.08
f(n/N)		0.29	0.31	0.39	0.46	0.47	0.49	0.50	0.55	0.53	0.53	0.43	0.35
Rnl=f(T)f(ed)f(n/N)	mm/day	0.38	0.42	0.53	0.60	0.65	0.72	0.79	0.85	0.81	0.80	0.63	0.47
Rn =Rns-Rnl		4.27	4.40	4.58	4.51	4.02	3.75	3.91	4.52	4.99	5.40	5.00	4.57
W		0.77	0.77	0.77	0.77	0.77	0.76	0.76	0.76	0.77	0.77	0.77	0.77
W Rn		3.27	3.37	3.52	3.48	3.09	2.86	2.95	3.42	3.82	4.18	3.88	3.51
c		1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Eto	mm/day	4.17	4.16	4.45	4.33	4.05	3.99	4.36	5.07	5.80	6.57	5.87	4.44

Source : JICA Study Team estimation by Modified Penman method based on the meteorological dat at the Plampang station.

Table 2.2 Effective Rainfall in Penyempeng Project

Site : Penyempeng
Meteorological Station : Empang

Month	Evapotrans-piration (ETo)	Average Rainfall		Annual-base Dependable Rainfall	Effective Rainfall	
					Paddy	Palawija
	[1] (mm)	[2] (mm)	[3] (%)	[4] (mm)	[5] (mm)	[6] (mm)
January	129	274	22.5%	201	141	122
February	117	272	22.4%	199	140	114
March	138	186	15.3%	136	95	93
April	130	75	6.2%	55	38	39
May	126	29	2.4%	21	15	16
June	120	8	0.7%	6	4	0
July	135	14	1.2%	10	7	0
August	157	7	0.6%	5	4	0
September	174	18	1.5%	13	9	11
October	204	40	3.3%	29	21	26
November	176	98	8.1%	72	50	58
December	138	196	16.1%	144	101	97
Total	1,744	1,217	100.0%	892	624	576

Note ;

[1] : Estimated by Modified Penman Method based on Plampang station
[2] : Rainfall data in station compiled by P3SA (1955-1992)
[3] : Percentage of monthly rainfall to annual rainfall, calculated from column [2]
[4] : 892 mm (Calculated 80 % dependable annual rainfall) x [3]
[5] : [4] x 0.70
[6] : Derived by USDA SCS Method introduced by Design Criteria KP-01, where effective storage is assumed 75 mm

Source : JICA Study Team estimation based on the rainfall data at the Empang staiotn

Table 2.3 Irrigation Water Requirement in Penyempeng Project (1/3)

Site : Penempeng
Crops : Wet Season Paddy

Item		Month	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul		Aug.		Sep.		Oct.		Nov.		Dec.		Annual
		(days)	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
			15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	
I. Evapotranspiration (Eto)		mm/day	4.17	4.17	4.16	4.16	4.45	4.45	4.33	4.33	4.05	4.05	3.99	3.99	4.36	4.36	5.07	5.07	5.80	5.80	6.57	6.57	5.87	5.87	4.44	4.44	
		mm	63	67	58	58	67	71	65	65	61	65	60	60	65	70	76	81	87	87	99	105	88	88	67	71	1,743
II. Wet Season Paddy																											
(1) Proposed cropping pattern / Crop coefficient																											
- WP-1			1.10	1.10	1.05	1.05	0.95	0.00																	LP	LP	
- WP-2			LP	1.10	1.10	1.05	1.05	0.95	0.00																	LP	
- WP-3			LP	LP	1.10	1.10	1.05	1.05	0.95	0.00																	
(2) Crop consumptive use (Etc)																											
- WP-1		mm	69	73	61	61	63	0																			328
- WP-2		mm		73	64	61	70	68	0																		336
- WP-3		mm			64	64	70	75	62	0																	335
(3) Land preparation (IR)																											
- WP-1		mm																							183	195	378
- WP-2		mm	182																							195	377
- WP-3		mm	182	194																							376
(4) Percolation																											
- WP-1		mm	30	32	28	28	30																				
- WP-2		mm		32	28	28	30	32																			
- WP-3		mm			28	28	30	32	30																		
(5) Water layer replacement (RW)																											
- WP-1		mm		50		50																					
- WP-2		mm			50		50																				
- WP-3		mm				50		50																			
(6) Effective rainfall (ER)		mm	68	73	70	70	46	49	19	19	7	8	2	2	3	4	2	2	4	5	10	11	25	25	49	52	625
(7) Field water requirement																											
- WP-1		mm	31	82	19	69	47	0																	134	143	526
- WP-2		mm	114	32	72	19	104	51	0																	143	535
- WP-3		mm	114	121	22	72	54	108	73	0																	564
(8) Diversion requirement		mm	133	121	58	82	105	81	37	0															69	147	833
		m3/ha	1,330	1,210	580	820	1,050	810	370	0															690	1,470	8,330

Source : JICA Study Team estimate based on the meteorological data at the Plampang and the Empang station

Table 2.3 Irrigation Water Requirement in Penyempeng Project (2/3)

Site : Penyempeng
Crops : Dry Season Paddy

Item		Month (days)	Jan. 1 15	Jan. 2 16	Feb. 1 14	Feb. 2 14	Mar. 1 15	Mar. 2 16	Apr. 1 15	Apr. 2 15	May 1 15	May 2 16	Jun. 1 15	Jun. 2 15	Jul 1 15	Jul 2 16	Aug. 1 15	Aug. 2 16	Sep. 1 15	Sep. 2 15	Oct. 1 15	Oct. 2 16	Nov. 1 15	Nov. 2 15	Dec. 1 15	Dec. 2 16	Annual
I.	Evapotranspiration (Eto)	mm/day	4.17	4.17	4.16	4.16	4.45	4.45	4.33	4.33	4.05	4.05	3.99	3.99	4.36	4.36	5.07	5.07	5.80	5.80	6.57	6.57	5.87	5.87	4.44	4.44	
		mm	63	67	58	58	67	71	65	65	61	65	60	60	65	70	76	81	87	87	99	105	88	88	67	71	1,743
II.	Dry Season Paddy																										
(1)	Proposed cropping pattern / Crop coefficient																										
	- DP-1								LP	LP	LP	1.10	1.10	1.05	1.05	0.95	0.00										
	- DP-2										LP	LP	1.10	1.10	1.05	1.05	0.95	0.00									
	- DP-3											LP	LP	1.10	1.10	1.05	1.05	0.95	0.00								
(2)	Crop consumptive use (Etc)																										
	- DP-1	mm										71	66	63	69	66	0										335
	- DP-2	mm											66	66	69	73	72	0									346
	- DP-3	mm												66	72	73	80	77	0								368
(3)	Land preparation (IR)																										
	- DP-1	mm								183	180	192															555
	- DP-2	mm									180	192															372
	- DP-3	mm										192	179														371
(4)	Percolation																										
	- DP-1	mm										32	30	30	30	32	0										
	- DP-2	mm											30	30	30	32	30	0									
	- DP-3	mm												30	30	32	30	32	0								
(5)	Water layer replacement (RW)																										
	- DP-1	mm											50		50												
	- DP-2	mm												50		50											
	- DP-3	mm													50		50										
(6)	Effective rainfall (ER)	mm	68	73	70	70	46	49	19	19	7	8	2	2	3	4	2	2	4	5	10	11	25	25	49	52	625
(7)	Field water requirement																										
	- DP-1	mm								164	173	287	144	91	146	94	0										1,099
	- DP-2	mm									173	184	94	144	96	151	100	0									942
	- DP-3	mm										184	177	94	149	101	158	107	0								970
(8)	Diversion requirement	mm								84	177	336	213	168	200	178	132	55	0								1,544
		m3/ha								840	1,770	3,360	2,130	1,680	2,000	1,780	1,320	550	0								15,430

Source : JICA Study Team estimate based on the meteorological data at the Plampang and the Empang station

Table 2.3 Irrigation Water Requirement in Penyempeng Project (3/3)

Site : Penyempeng
Crops : Palawija (1) & (2) : Soybeans and Mungbeans

Item		Jan. 1	Jan. 2	Feb. 1	Feb. 2	Mar. 1	Mar. 2	Apr. 1	Apr. 2	May 1	May 2	Jun. 1	Jun. 2	Jul 1	Jul 2	Aug. 1	Aug. 2	Sep. 1	Sep. 2	Oct. 1	Oct. 2	Nov. 1	Nov. 2	Dec. 1	Dec. 2	Annual
		15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	
I. Evapotranspiration (Eto)	mm/day	4.17	4.17	4.16	4.16	4.45	4.45	4.33	4.33	4.05	4.05	3.99	3.99	4.36	4.36	5.07	5.07	5.80	5.80	6.57	6.57	5.87	5.87	4.44	4.44	
	mm	63	67	58	58	67	71	65	65	61	65	60	60	65	70	76	81	87	87	99	105	88	88	67	71	1,743
II. Palawija(1) & (2) : Soybeans and Mungbeans																										
(1) Proposed cropping pattern / Crop coefficient(Kc)								Soybeans										Mungbeans								
- Pwj(1), (2) -1								0.50	0.75	1.00	1.00	0.82	0.23					0.45	0.75	1.05	0.30					
- Pwj(1), (2) -2									0.50	0.75	1.00	1.00	0.82	0.23					0.45	0.75	1.05	0.30				
- Pwj(1), (2) -3										0.50	0.75	1.00	1.00	0.82	0.23					0.45	0.75	1.05	0.30			
(2) Crop consumptive use(Etc)																										
- Pwj(1), (2) -1	mm							32		46	65	60	49	15				39		74	110	26				
- Pwj(1), (2) -2	mm									30	49	60	60	54	16					44	79	92	26			
- Pwj(1), (2) -3	mm										32	45	60	65	57	17					47	66	92	20		
(3) Effective rainfall (ER)	mm	59	63	57	57	45	48	20	19	8	8	0	0	0	0	0	0	5	6	13	13	29	29	47	50	576
(4) Field water requirement																										
- Pwj(1), (2) -1	mm							13		38	57	60	49	15				33		61	97	0				423
- Pwj(1), (2) -2	mm									22	41	60	60	54	16					31	66	63	0			413
- Pwj(1), (2) -3	mm										24	45	60	65	57	17					34	37	63	0		404
(5) Diversion requirement	mm							9		40	81	110	113	89	49	12		22		62	132	67	42	0		827
	m3/ha							90		400	810	1,100	1,130	890	490	120		220		620	1,320	670	420	0		8,280
III. Palawija (3) & (4) : Mungbeans and Red onion																										
(1) Proposed cropping pattern / Crop coefficient(Kc)								Mungbeans										Red onion								
- Pwj(3), (4)-1								0.45	0.75	1.05	0.30							0.50	0.60	0.95	0.75					
- Pwj(3), (4)-2									0.45	0.75	1.05	0.30							0.50	0.60	0.95	0.75				
- Pwj(3), (4)-3										0.45	0.75	1.05	0.30							0.50	0.60	0.95	0.75			
(2) Crop consumptive use(Etc)																										
- Pwj(3), (4)-1	mm							29		46	68	18						44		59	100	66				
- Pwj(3), (4)-2	mm									27	49	63	18							49	63	84	66			
- Pwj(3), (4)-3	mm										29	45	63	20							53	53	84	50		
(3) Effective rainfall (ER)	mm	59	63	57	57	45	48	20	19	8	8	0	0	0	0	0	0	5	6	13	13	29	29	47	50	576
(4) Field water requirement																										
- Pwj(3), (4)-1	mm							10		38	60	18						38		46	87	37				333
- Pwj(3), (4)-2	mm									19	41	63	18							36	50	55	37			319
- Pwj(3), (4)-3	mm										21	45	63	20							40	24	55	3		269
(5) Diversion requirement	mm							7		38	81	84	54	13				25		55	118	77	61	2		614
	m3/ha							70		380	810	840	540	130				250		550	1,180	770	610	20		6,150

Source : JICA Study Team estimate based on the meteorological data at the Plampang and the Empang station

Table 3.1 Estimated Catchment Rainfall in Penyempeng Embung Site

Unit : mm

year	Jan		Feb		Mar.		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
1966	136	142	132	95	212	283	41	7	0	18	19	0	0	0	17	2	0	61	2	24	11	53	218	259	1,732
1967	248	500	74	71	196	61	10	17	0	1	0	0	0	5	0	1	7	1	43	0	61	17	193	162	1,668
1968	188	137	142	367	34	89	101	0	85	80	6	6	41	130	0	0	0	0	13	16	0	8	121	116	1,680
1969	26	52	35	120	13	151	0	0	0	0	0	0	0	0	0	0	0	0	34	0	0	10	23	54	518
1970	76	149	218	240	98	67	6	56	0	0	6	4	0	0	0	0	0	28	0	26	60	60	86	176	1,356
1971	79	204	287	108	175	157	0	61	14	86	0	0	0	0	0	0	0	28	1	127	85	64	235	46	1,757
1972	287	5	119	192	130	134	2	53	0	0	0	0	0	0	0	0	0	0	0	0	0	12	103	48	1,085
1973	131	176	194	18	176	73	66	77	19	26	0	0	0	0	0	0	29	24	0	25	12	20	65	79	1,210
1974	221	17	112	342	264	124	43	0	23	0	0	0	0	0	0	10	14	59	6	80	133	161	78	78	1,765
1975	130	110	218	353	264	172	305	246	196	0	0	0	0	54	0	0	161	0	84	36	54	0	197	204	2,784
1976	203	188	96	185	149	0	58	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	14	30	931
1977	287	146	214	108	247	192	48	0	43	0	0	0	0	0	0	0	0	0	0	0	0	0	126	128	1,539
1978	242	164	236	233	115	218	116	65	0	60	328	47	49	0	49	0	0	0	0	0	68	60	114	222	2,386
1979	270	158	77	132	222	49	0	0	58	53	60	0	0	0	0	0	0	0	0	0	0	0	155	66	1,300
1980	281	274	270	80	101	0	0	121	0	0	0	0	0	0	0	0	0	0	0	0	18	118	217	269	1,749
1981	505	215	356	264	34	0	8	209	18	24	11	8	0	0	1	28	1	0	2	0	64	106	124	41	2,019
1982	216	114	72	238	211	50	5	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54	356	1,333
1983	461	46	102	16	2	0	4	18	0	0	0	0	0	0	0	0	0	0	5	0	52	211	26	142	1,085
1984	124	194	136	313	256	5	118	74	1	0	0	0	0	0	0	0	49	6	120	12	19	85	103	48	1,663
1985	43	59	181	222	280	0	29	38	0	70	14	0	60	0	0	0	0	0	0	2	4	142	30	47	1,221
1986	209	108	78	118	101	103	0	11	0	0	0	5	0	2	0	0	0	0	16	37	20	13	115	50	986
1987	229	212	77	347	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	128	288	350	461	2,121
1988	16	115	41	12	85	275	0	0	0	0	0	0	0	0	0	0	0	0	0	0	97	74	115	121	951
1989	50	570	106	179	53	187	24	14	0	0	11	42	1	29	0	53	0	0	0	92	36	12	214	28	1,701
1990	262	356	180	53	232	4	8	59	20	40	0	0	0	0	0	0	29	4	0	0	0	4	193	158	1,602
1991	283	196	216	157	34	38	94	60	0	0	0	0	7	16	0	0	6	0	0	0	37	89	20	32	1,285
Mean	200	177	153	176	143	94	42	46	19	18	18	4	6	9	3	4	11	8	13	18	37	62	127	132	1,516

Table 3.2 Estimated Discharge at Penyempeng Embung Site

Unit : 1000 m3

	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual
year	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
1966	2,236	2,334	2,170	1,562	3,485	4,653	674	0	0	0	0	0	0	0	0	0	0	1,003	0	395	0	871	3,584	4,258	27,225
1967	4,077	8,220	1,217	1,167	3,222	1,003	0	0	0	0	0	0	0	0	0	0	0	0	707	0	1,003	0	3,173	2,663	26,452
1968	3,091	2,252	2,334	6,033	559	1,463	1,660	0	1,397	1,315	0	0	674	2,137	0	0	0	0	0	0	0	0	1,989	1,907	26,811
1969	427	855	575	1,973	0	2,482	0	0	0	0	0	0	0	0	0	0	0	0	559	0	0	0	378	888	8,137
1970	1,249	2,450	3,584	3,946	1,611	1,101	0	921	0	0	0	0	0	0	0	0	0	460	0	427	986	986	1,414	2,893	22,028
1971	1,299	3,354	4,718	1,776	2,877	2,581	0	1,003	0	1,414	0	0	0	0	0	0	0	460	0	2,088	1,397	1,052	3,863	756	28,638
1972	4,718	0	1,956	3,156	2,137	2,203	0	871	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,693	789	17,523
1973	2,154	2,893	3,189	0	2,893	1,200	1,085	1,266	0	427	0	0	0	0	0	0	477	395	0	411	0	0	1,069	1,299	18,758
1974	3,633	0	1,841	5,622	4,340	2,039	707	0	378	0	0	0	0	0	0	0	0	970	0	1,315	2,187	2,647	1,282	1,282	28,243
1975	2,137	1,808	3,584	5,803	4,340	2,828	5,014	4,044	3,222	0	0	0	0	888	0	0	2,647	0	1,381	592	888	0	3,239	3,354	45,769
1976	3,337	3,091	1,578	3,041	2,450	0	954	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	493	14,944
1977	4,718	2,400	3,518	1,776	4,061	3,156	789	0	707	0	0	0	0	0	0	0	0	0	0	0	0	0	2,071	2,104	25,300
1978	3,978	2,696	3,880	3,831	1,891	3,584	1,907	1,069	0	986	5,392	773	806	0	806	0	0	0	0	0	1,118	986	1,874	3,650	39,227
1979	4,439	2,598	1,266	2,170	3,650	806	0	0	954	871	986	0	0	0	0	0	0	0	0	0	0	0	2,548	1,085	21,373
1980	4,620	4,505	4,439	1,315	1,660	0	0	1,989	0	0	0	0	0	0	0	0	0	0	0	0	0	1,940	3,567	4,422	28,457
1981	8,302	3,535	5,853	4,340	559	0	0	3,436	0	395	0	0	0	0	0	460	0	0	0	0	1,052	1,743	2,039	674	32,388
1982	3,551	1,874	1,184	3,913	3,469	822	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	888	5,853	21,554
1983	7,579	756	1,677	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	855	3,469	427	2,334	17,097
1984	2,039	3,189	2,236	5,146	4,209	0	1,940	1,217	0	0	0	0	0	0	0	0	806	0	1,973	0	0	1,397	1,693	789	26,634
1985	707	970	2,976	3,650	4,603	0	477	625	0	1,151	0	0	986	0	0	0	0	0	0	0	0	2,334	493	773	19,745
1986	3,436	1,776	1,282	1,940	1,660	1,693	0	0	0	0	0	0	0	0	0	0	0	0	0	608	0	0	1,891	822	15,108
1987	3,765	3,485	1,266	5,705	477	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,104	4,735	5,754	7,579	34,870
1988	0	1,891	674	0	1,397	4,521	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,595	1,217	1,891	1,989	15,175
1989	822	9,371	1,743	2,943	871	3,074	395	0	0	0	0	690	0	477	0	871	0	0	0	1,512	592	0	3,518	460	27,339
1990	4,307	5,853	2,959	871	3,814	0	0	970	0	658	0	0	0	0	0	0	477	0	0	0	0	0	3,173	2,598	25,680
1991	4,653	3,222	3,551	2,581	559	625	1,545	986	0	0	0	0	0	0	0	0	0	0	0	0	608	1,463	0	526	20,319
Mean	3,280	2,899	2,510	2,856	2,338	1,532	660	708	256	278	245	56	95	135	31	51	170	126	178	283	553	955	2,058	2,163	24,415
	6,179		5,366		3,870		1,367		534		302		230		82		296		460		1,509		4,221		

Table 3.3 Probable Flood Discharge at Penyempeng Embung Site

Characteristics of the catchment area								
Catchment Area	(km2)	41.10						
Eelevation at Dam Site (1)	(m)	100						
Maximum elevation in the catchment area (2)	(m)	600						
Height (3)=(2)-(1)	(h)	500						
Length of Catchment Area (l	(m)	10,000						
Flow velocity	W2 (km/hr)	11.93						
Time of concentration	T2 (hrs)	0.84						
Probable Flood Discherge								
Return Period	(years)	2	5	10	20	50	100	200
Rainfall	(mm/day)	84	115	136	155	182	202	222
Rainfall intensity within the time of concentration	(mm)	19	26	30	35	41	45	49
Probable Flood Discharge	(m3/s)	171	234	277	316	371	411	452
Specific Discharge	(m3/s/km2)	4	6	7	8	9	10	11

To estimate design rainfall, the Log Pearson III method is adopted.
The rational method is adopted for estimation of the design flood discharge.
C = 0.8 is used to estimate designed flood discharge by the rational method.

Table 3.4 Result of Water Quality Test in Penyempeng Embung Site

DESCRIPTION	UNIT	1 Upstream of proposed embung	2 Embung Site	3 Embung Site	4 downstream of proposed embung	Max. Limit of B Class by GR. NO. 20/1990
I. PHYSICS						
1 Temperature	C	29.00	29.00	28.00	26.00	Normal water temperature
2 Dissolved solid matter	mg/liter	313.00	294.00	278.00	248.00	1000
3 Electric Conductivety	umhos/cm	425.00	400.00	376.00	338.00	-
II. CHEMISTRY						
a. Unorganic chemistry						
1 Mercury	mg/liter	0.00	0.00	0.00	0.00	0.001
2 Ammonia	mg/liter	0.00	0.00	0.00	0.00	0.5
3 Arsenic	mg/liter	-	-	-	-	0.05
4 Barium	mg/liter	-	-	-	-	5
5 Ferro	mg/liter	0.00	0.00	0.00	0.00	1
6 Fluoride	mg/liter	0.00	0.26	0.21	0.55	1.5
7 Cadmium	mg/liter	0.00	0.00	0.00	0.00	0.005
8 Chloride	mg/liter	42.60	39.10	42.60	36.90	600
9 Chronium, valense-6	mg/liter	0.00	0.00	0.00	0.00	0.05
10 Manganese	mg/liter	0.00	0.00	0.00	0.00	0.5
11 Nitrate, N	mg/liter	0.00	0.00	0.00	0.00	10
12 Nitric, N	mg/liter	0.00	0.00	0.00	0.00	1
13 Dissolved Oxygen	mg/liter	8.77	8.69	7.46	8.42	*
14 pH	-	8.00	8.00	8.00	6.80	5-9
15 Selenium	mg/liter	-	-	-	-	0.01
16 Zinc	mg/liter	0.00	0.00	0.00	0.00	5
17 Cyanide	mg/liter	0.00	0.00	0.00	0.00	0.1
18 Sulphate	mg/liter	5.70	4.00	4.20	3.00	400
19 Sulfide, H2S	mg/liter	0.00	0.00	0.00	0.00	0.1
20 Copper	mg/liter	0.00	0.00	0.00	0.00	1
21 Lead	mg/liter	0.00	0.00	0.00	0.00	0.1
b. Organic Chemistry						
1 Aldrin and Dieldrin	mg/liter	0.00	0.00	0.00	0.00	0.017
2 Chlordane	mg/liter	0.00	0.00	0.00	0.00	0.003
3 DDT	mg/liter	0.00	0.00	0.00	0.00	0.042
4 Endrine	mg/liter	0.00	0.00	0.00	0.00	0.001
5 Fenol	mg/liter	0.00	0.00	0.00	0.00	0.001
6 Heptachlor and Heptachlor Epoxide	mg/liter	-	-	-	-	0.018
7 Carbon Cloroform Ektract	mg/liter	-	-	-	-	0.5
8 Lindane	mg/liter	0.00	0.00	0.00	0.00	0.056
9 Methoxychlor	mg/liter	-	-	-	-	0.035
10 Oil and Fat	mg/liter	0.00	0.00	0.00	0.00	Nil
11 Organofosphate and Carbomate	mg/liter	0.00	0.00	0.00	0.00	0.1
12 PCB	mg/liter	-	-	-	-	Nil
13 Senyawa atife biru (Sulfaktan)	mg/liter	0.00	0.00	0.00	0.00	0.5
14 Toxaphene	mg/liter	0.00	0.00	0.00	0.00	0.005
III MICRO BIOLOGY						
1 Coliform tinja	per 100 ml	12,000	9,400	14,000	9,400	2,000
2 Total Coliform	per 100 ml	33,000	17,000	22,000	18,000	10,000

NOTE:
* = The water level shall be more than or equal to 6.
mg = miligram
ml = Milimeter
Bq = Bequerel

Heavy metals are classified into dissolved matter.

Source : JICA's Water Quality Test

Table 7.1 Summary of Construction Cost in Penyempeng Project

Item	Amount (Rp. million)
I. Direct Construction Cost	
1.1 Preparatory Works	661
1.2 Embung Construction	
1) Main dam	6,030
2) Spillway	3,036
3) Diversion Tunnel	1,063
4) Seepage protection works	0
5) Miscellaneous	1,519
Sub-total of 1.2	11,648
1.3 Irrigation Facilities	1,477
1.4 Domestic Water Supply	0
1.5 Embung Operation and Maintenance Road	103
Sub-total of I.	13,889
II. Administration Cost	694
III. Engineering Services	2,083
Sub-total of I, II & III	16,667
IV. Physical Contingency	2,500
Sub-total of I, II, II, & IV	19,167
V. Contract Tax	1,847
VI. Land Acquisition Cost	69
Sub-total I, II, III, IV, V & VI	21,084
VII. Price Contingency	4,217
GRAND TOTAL	25,301

Table 7.2 Direct Construction Cost in Penyempeng Project (1/2)

Item	Unit	Unit Price Rp.	Quantity	Total 1000 Rp.
I. Dam				
1. Main Dam				
1.1 Earth/stone works				
1) Clearing	m2	400	39,300	15,720
2) Excavation, common	m3	3,500	39,300	137,550
, weathered rock	m3	7,500	36,900	276,750
, rock	m3	11,500	2,400	27,600
3) Embankment, impervious soil	m3	8,000	109,200	873,600
, filter	m3	12,000	53,000	636,000
, transition	m3	12,000	44,100	529,200
, random material	m3	6,000	408,300	2,449,800
4) Stone masonry	m3	80,000	0	0
5) Rip-rap protection	m3	15,000	18,100	271,500
1.2 Grouting	m	71,000	7,400	525,400
1.3 Other miscellaneous works				287,156
Sub-total of 1.				6,030,276
2. Spillway				
2.1 Earth works				
1) Clearing	m2	400	12,500	5,000
2) Excavation, common soil	m3	3,500	14,700	51,450
, weathered rock	m3	7,500	43,900	329,250
, rock	m3	11,500	87,800	1,009,700
3) Backfill	m3	5,200	6,300	32,760
2.2 Concrete works				
1) Concrete - A	m3	250,000	660	165,000
2) Concrete - B	m3	170,000	1,520	258,400
3) Reinforcement bar	ton	1,500,000	33	49,500
4) Form	m2	15,000	66,000	990,000
2.3 Other miscellaneous works	L.S			144,553
Sub-total of 2.				3,035,613
3. Diversion Tunnel				
3.1 Earth works				
1) Clearing	m2	400	1,500	600
2) Excavation	m3	11,500	22,500	258,750
3) Backfill	m3	5,200	0	0
3.2 Concrete works				
1) Concrete - A	m3	250,000	1,760	440,000
2) Concrete - B	m3	170,000	0	0
3) Reinforcement bar	ton	1,500,000	90	135,000
4) Form	m2	15,000	8,800	132,000
3.3 Other miscellaneous works	L.S			96,635
Sub-total of 3.				1,062,985
4. Miscellaneous & Others				1,519,331
Total - I.				11,648,205

Table 7.2 Direct Construction Cost in Penyempeng Project (1/2)

Item	Unit	Unit Price Rp.	Quantity	Total 1000 Rp.
II. Irrigation Facilities				
1. Canal works (including the rehabilitation works)				
1.1 Earth works				
1) Clearing	m2	400	81,600	32,640
2) Excavation	m3	5,000	17,900	89,500
3) Embankment	m3	6,300	25,000	157,500
1.2 Stone masonry	m3	80,000	12,200	976,000
Sub-total of 1.				1,255,640
2. Related structures				
2.1 Turnout	nos.	2,600,000	3	7,800
2.2 Syphon	nos.	5,500,000	1	5,500
2.3 Aqueduct	nos.	6,000,000		0
2.3 Cross drain	nos.	4,700,000		0
2.4 Irrigation division box	nos.	900,000	82	73,800
2.5 Division box for livestock	nos.	1,200,000		0
Sub-total of 2.				87,100
3. Miscellaneous & Others	L.S			134,274
Total - II				1,477,014
III. Dam Operation and Maintenance Road				
1. Road Works				
1.1 Earth works				
1) Clearing	m2	400	15,000	6,000
2) Excavation	m3	5,000	2,200	11,000
3) Embankment	m3	6,300	6,400	40,320
4) Pavement (lime stone)	m3	15,000	2,100	31,500
2. Related structures				
2.1 Cross drain	nos.	4,700,000	1	4,700
3. Miscellaneous and others	L.S			9,352
Total - III				102,872
GRAND TOTAL				13,228,091

Table 8.1 Economic Construction Costs and Annual Disburement Schedule

Penyempeng Project (Unit : Rp. million)

Item	SCF	Total cost	1st year	2nd year	3rd year	4th year
1 Direct Construction Cost		8,783	235	1,909	3,287	3,352
1) Preparatory Works	0.71	469	235	234	0	0
2) Dam Construction						
- Main dam	0.71	4,281	0	855	1,713	1,713
- Spillway	0.71	2,156	0	216	862	1,078
- Diversion tunnel	0.71	755	0	604	151	0
- Seepage protection works	0.71	0	0	0	0	0
Sub-total		7,192	0	1,675	2,726	2,791
3) Irrigation Facilities	0.71	1,049	0	0	524	525
4) Domestic Water Supply System	0.71	0	0	0	0	0
5) Dam O & M Road	0.71	73	0	0	37	36
2 Administration Cost	0.90	625	17	136	234	238
3 Engineering Services	0.90	835	250	167	209	209
4 Physical Contingency		1,317	35	286	493	503
Total		11,560	537	2,498	4,223	4,302

Note : Standard Conversion Factors (SFC). Source ; Pedoman Pengamatan dan Evaluasi Proyek-Proyek Pengairan, Direktorato Jeneral Pengairan, 1985

Table 8.2 Financial and Economic Prices of Farm Inputs and Outputs in NTB

	Item		Unit	Lombok Financial Price *1	Lombok Economic Price *2	Sumbawa Financial Price *1	Sumbawa Economic Price *2
1	Farm Products						
	Paddy *3		kg	280	397	260	394
	Maize *3		kg	200	220	200	215
	Mungbeans *3		kg	1,000	906	1,000	901
	Soybeans *3		kg	900	647	900	642
	Red onion *4		kg	900	704	800	699
	Tobacco *5		kg	900	522	900	521
2	Seeds						
	Paddy	Certified	kg	605	605	605	605
		Own	kg	-	325	-	325
	Maize	Certified	kg	922	922	922	922
		Own	kg	-	297	-	297
	Mungbeans	Certified	kg	1,383	1,383	1,383	1,383
		Own	kg	-	893	-	893
	Soybeans	Certified	kg	617	617	617	617
		Own	kg	-	606	-	606
	Red onion		kg	850	850	850	850
	Tobacco		kg	25,000	25,000	25,000	25,000
3	Fertilisers						
	Urea		kg	350	414	350	419
	TSP		kg	400	486	400	491
	KCl		kg	400	416	400	421
4	Agro-chemicals						
	Insecticides	Liquid type	lit	10,000	10,000	10,000	10,000
		Powder type	kg	3,000	3,000	3,000	3,000
	Rodenticides		kg	5,500	5,500	5,500	5,500
5	Labour						
	Hired labour *6		man-day	3,000	2,250	2,500	1,875
	Family labour		man-day	-	2,250	-	1,875
6	Draft Animal						
	Hired		head-day	6,000	6,000	5,000	5,000
	Own		head-day	-	6,000	-	5,000
7	Farm Machinery						
	Tractor		ha	250,000	250,000	200,000	200,000

Remarks : *1 ; As of 1994

*2 ; Projected prices in 2005 at 1994 constant prices

*3 ; Dry grain

*4 ; Fresh

*5 ; Fresh leaves

*6 ; Economic conversionfactor is 0.75.

Table 8.3 Economic Crop Budget per Ha

Penyempeng Project

Item		Q'ty of Unit	Value (Rp.)	Without Project: Paddy (Irrigated) Q'ty	Paddy (Irrigated) Am't (Rp.)	Paddy (1st crop) (Rainfed) Q'ty	Paddy (1st crop) (Rainfed) Am't (Rp.)	Paddy (2nd crop) (Rainfed) Q'ty	Paddy (2nd crop) (Rainfed) Am't (Rp.)	Soybean (Rainfed) Q'ty	Soybean (Rainfed) Am't (Rp.)	With Project: Paddy (1st crop) (Irrigated) Q'ty	Paddy (1st crop) (Irrigated) Am't (Rp.)	Paddy (2nd crop) (Irrigated) Q'ty	Paddy (2nd crop) (Irrigated) Am't (Rp.)	Mungbean (Irrigated) Q'ty	Mungbean (Irrigated) Am't (Rp.)	Red Onion (Irrigated) Q'ty	Red Onion (Irrigated) Am't (Rp.)
1 Gross Production Value																			
Paddy		kg	394	3,000	1,182,000	2,000	788,000	1,800	709,200	0	0	4,500	1,773,000	4,500	1,773,000	0	0	0	0
Soybean		kg	642	0	0	0	0	0	0	900	577,800	0	0	0	0	0	0	0	0
Mungbean		kg	901	0	0	0	0	0	0	0	0	0	0	0	0	1,200	1,081,200	0	0
Red onion		kg	699	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7,500	5,242,500
2 Production Cost																			
Seed																			
Paddy	Certified	kg	605	50	30,250	0	0	0	0	0	0	25	15,125	25	15,125	0	0	0	0
	Own	kg	325	0	0	50	16,250	50	16,250	0	0	0	0	0	0	0	0	0	0
Soybean	Certified	kg	617	0	0	0	0	0	0	10	6,170	0	0	0	0	0	0	0	0
	Own	kg	606	0	0	0	0	0	0	30	18,180	0	0	0	0	0	0	0	0
Mungbean	Certified	kg	1,383	0	0	0	0	0	0	0	0	0	0	0	0	10	13,830	0	0
	Own	kg	893	0	0	0	0	0	0	0	0	0	0	0	0	20	17,860	0	0
Red onion	Certified	kg	850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,000	1,700,000
Fertiliser																			
Urea		kg	419	225	94,275	150	62,850	150	62,850	25	10,475	300	125,700	300	125,700	75	31,425	300	125,700
TSP		kg	491	75	36,825	50	24,550	50	24,550	50	24,550	100	49,100	100	49,100	100	49,100	200	98,200
KCl		kg	421	35	14,735	0	0	0	0	25	10,525	50	21,050	50	21,050	50	21,050	100	42,100
Agro-chemicals																			
Insecticide	Lquid	lit	10,000	2.0	20,000	0.5	5,000	0.5	5,000	0.0	0	2.0	20,000	1.0	10,000	2.0	20,000	10.0	100,000
	Powder	kg	3,000	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Rodenticide		kg	5,500	2.0	11,000	0.5	2,750	0.5	2,750	0.0	0	2.0	11,000	2.0	11,000	1.0	5,500	3.0	16,500
Labor																			
Family		md	1,875	127	238,125	65	121,875	60	112,500	25	46,875	172	322,500	167	313,125	80	150,000	151	283,125
Hired		md	1,875	13	24,375	10	18,750	10	18,750	0	0	13	24,375	13	24,375	0	0	99	185,625
Draft Animal																			
Family		ad	5,000	20	100,000	10	50,000	10	50,000	10	50,000	20	100,000	20	100,000	10	50,000	20	100,000
Hired		ad	5,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tractor		ha	200,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total production cost					569,585		302,025		292,650		166,775		688,850		669,475		358,765		2,651,250
3 Net Production Value					612,415		485,975		416,550		411,025		1,084,150		1,103,525		722,435		2,591,250

Table 8.4 Economic Costs and Benefits Flow

Penyempeng Project Unit : Million Rp.

Year	Cost				Benefit			Increment
	Capital	Replace	O&M	Total	Irrigation	Negative	Total	
1.	537	0	0	537	0	0	0	-537
2.	2,498	0	0	2,498	0	0	0	-2,498
3.	4,223	0	0	4,223	0	0	0	-4,223
4.	4,302	0	47	4,349	0	0	0	-4,349
5.	0	0	47	47	683	0	683	636
6.	0	0	47	47	797	0	797	750
7.	0	0	47	47	911	0	911	864
8.	0	0	47	47	1,025	0	1,025	978
9.	0	0	47	47	1,139	0	1,139	1,092
10.	0	0	47	47	1,139	0	1,139	1,092
11.	0	0	47	47	1,139	0	1,139	1,092
12.	0	0	47	47	1,139	0	1,139	1,092
13.	0	0	47	47	1,139	0	1,139	1,092
14.	0	0	47	47	1,139	0	1,139	1,092
15.	0	0	47	47	1,139	0	1,139	1,092
16.	0	0	47	47	1,139	0	1,139	1,092
17.	0	0	47	47	1,139	0	1,139	1,092
18.	0	0	47	47	1,139	0	1,139	1,092
19.	0	0	47	47	1,139	0	1,139	1,092
20.	0	0	47	47	1,139	0	1,139	1,092
21.	0	0	47	47	1,139	0	1,139	1,092
22.	0	0	47	47	1,139	0	1,139	1,092
23.	0	0	47	47	1,139	0	1,139	1,092
24.	0	0	47	47	1,139	0	1,139	1,092
25.	0	0	47	47	1,139	0	1,139	1,092
26.	0	0	47	47	1,139	0	1,139	1,092
27.	0	0	47	47	1,139	0	1,139	1,092
28.	0	0	47	47	1,139	0	1,139	1,092
29.	0	0	47	47	1,139	0	1,139	1,092

EIRR = 6.5 %

Table 8.5 Financial Crop Budget per Ha

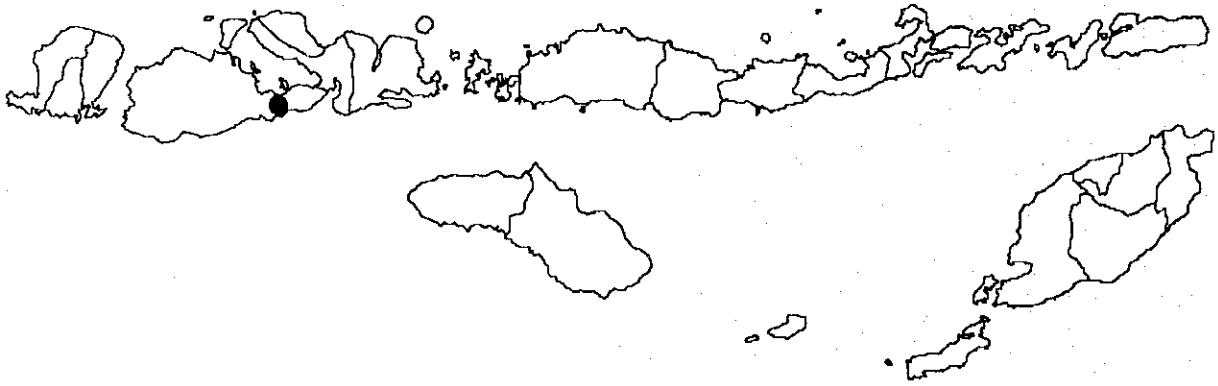
Penyempeng Project

Item		Q'ty of Unit	Value (Rp.)	Without Project								With Project							
				Paddy (Irrigated)		Paddy (1st crop) (Rainfed)		Paddy (2nd crop) (Rainfed)		Soybean (Rainfed)		Paddy (1st crop) (Irrigated)		Paddy (2nd crop) (Irrigated)		Mungbean (Irrigated)		Red Onion (Irrigated)	
				Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)
1 Gross Production Value																			
Paddy		kg	260	3,000	780,000	2,000	520,000	1,800	468,000	0	0	4,500	1,170,000	4,500	1,170,000	0	0	0	0
Soybean		kg	900	0	0	0	0	0	0	900	810,000	0	0	0	0	0	0	0	0
Mungbean		kg	1,000	0	0	0	0	0	0	0	0	0	0	0	0	1,200	1,200,000	0	0
Red onion		kg	800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7,500	6,000,000
2 Production Cost																			
Seed																			
Paddy	Certified	kg	605	50	30,250	0	0	0	0	0	0	25	15,125	25	15,125	0	0	0	0
	Own	kg	0	0	0	50	0	50	0	0	0	0	0	0	0	0	0	0	0
Soybean	Certified	kg	617	0	0	0	0	0	0	10	6,170	0	0	0	0	0	0	0	0
	Own	kg	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0
Mungbean	Certified	kg	1,383	0	0	0	0	0	0	0	0	0	0	0	0	10	13,830	0	0
	Own	kg	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0
Red onion	Certified	kg	850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,000	1,700,000
Fertiliser																			
Urea		kg	350	225	78,750	150	52,500	150	52,500	25	8,750	300	105,000	300	105,000	75	26,250	300	105,000
TSP		kg	400	75	30,000	50	20,000	50	20,000	50	20,000	100	40,000	100	40,000	100	40,000	200	80,000
KCl		kg	400	35	14,000	0	0	0	0	25	10,000	50	20,000	50	20,000	50	20,000	100	40,000
Agro-chemicals																			
Insecticide	Lquid	lit	10,000	2.0	20,000	0.5	5,000	0.5	5,000	0.0	0	2.0	20,000	1.0	10,000	2.0	20,000	10.0	100,000
	Powder	kg	3,000	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Rodenticide		kg	5,500	2.0	11,000	0.5	2,750	0.5	2,750	0.0	0	2.0	11,000	2.0	11,000	1.0	5,500	3.0	16,500
Labor																			
Family		md	0	127	0	65	0	60	0	25	0	172	0	167	0	80	0	151	0
Hired		md	2,500	13	32,500	10	25,000	10	25,000	0	0	13	32,500	13	32,500	0	0	99	247,500
Draft Animal																			
Family		ad	0	20	0	10	0	10	0	10	0	20	0	20	0	10	0	20	0
Hired		ad	5,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tractor		ha	200,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total production cost					216,500		105,250		105,250		44,920		243,625		233,625		125,580		2,289,000
3 Net Production Value					563,500		414,750		362,750		765,080		926,375		936,375		1,074,420		3,711,000

The Study on The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara

Feasibility Study on Penyempeng Embung Development Project

Figures



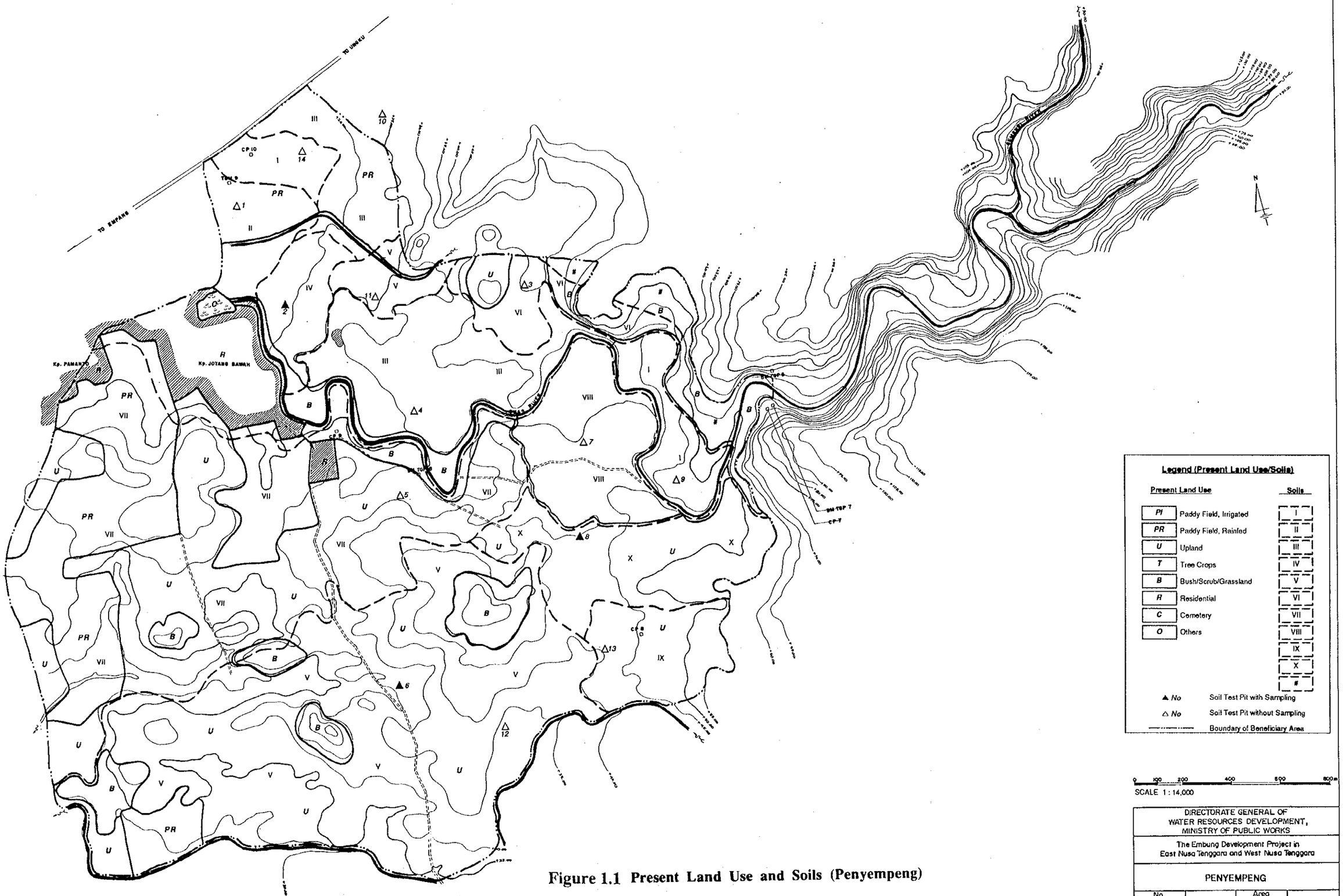


Figure 1.1 Present Land Use and Soils (Penyempeng)

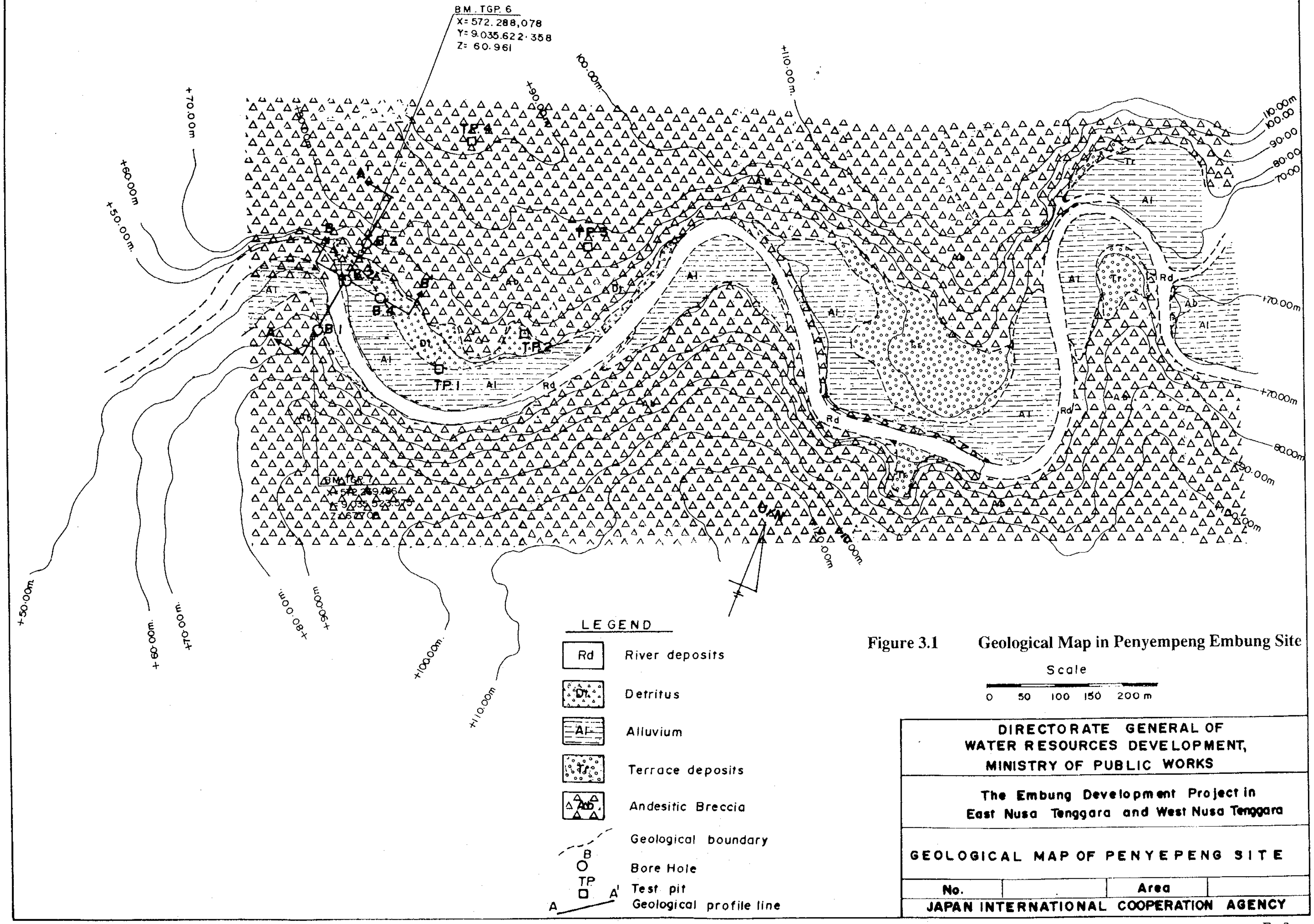


Figure 3.1 Geological Map in Penyempeng Embung Site

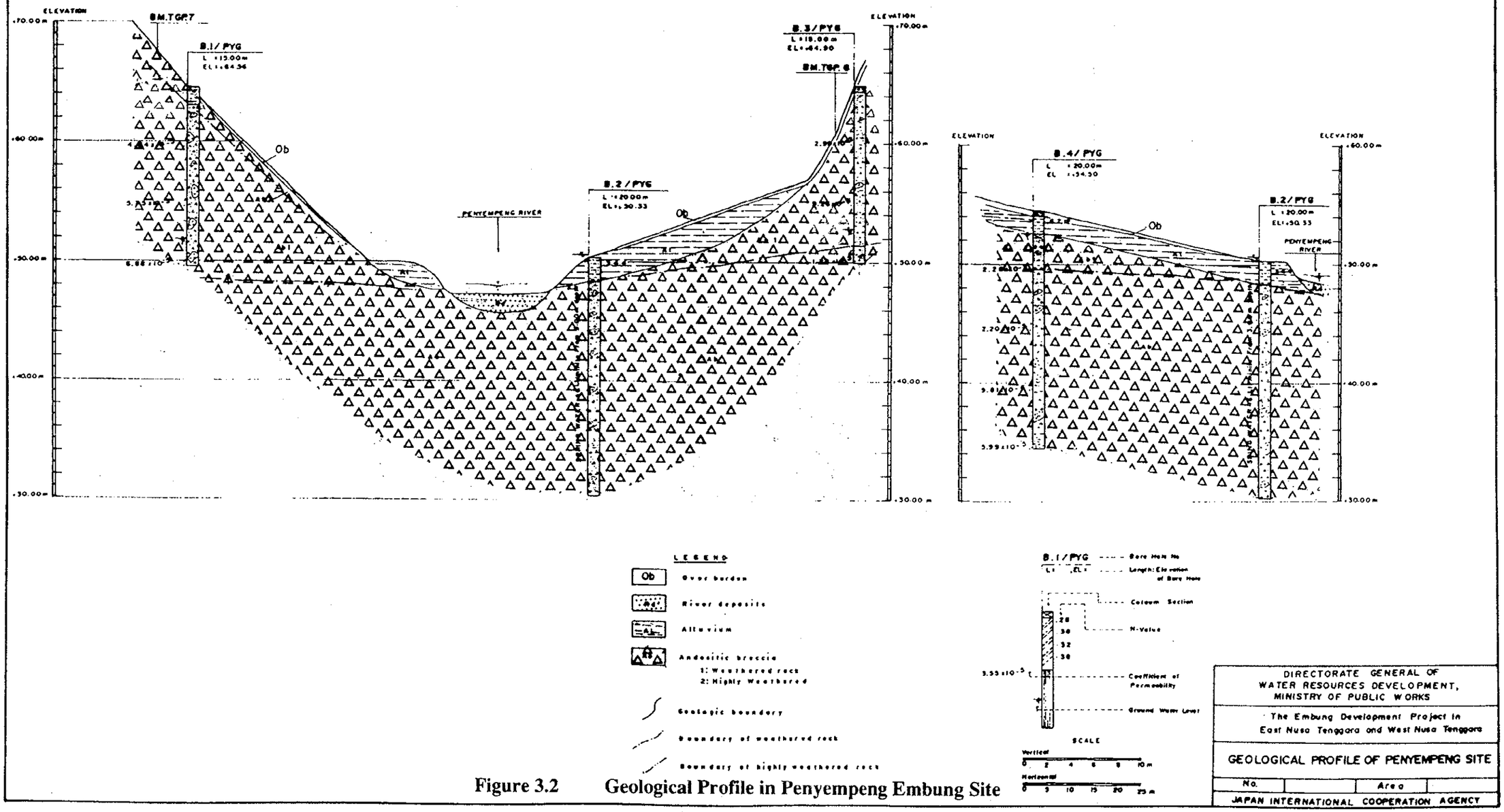


Figure 3.2 Geological Profile in Penyempeng Embung Site

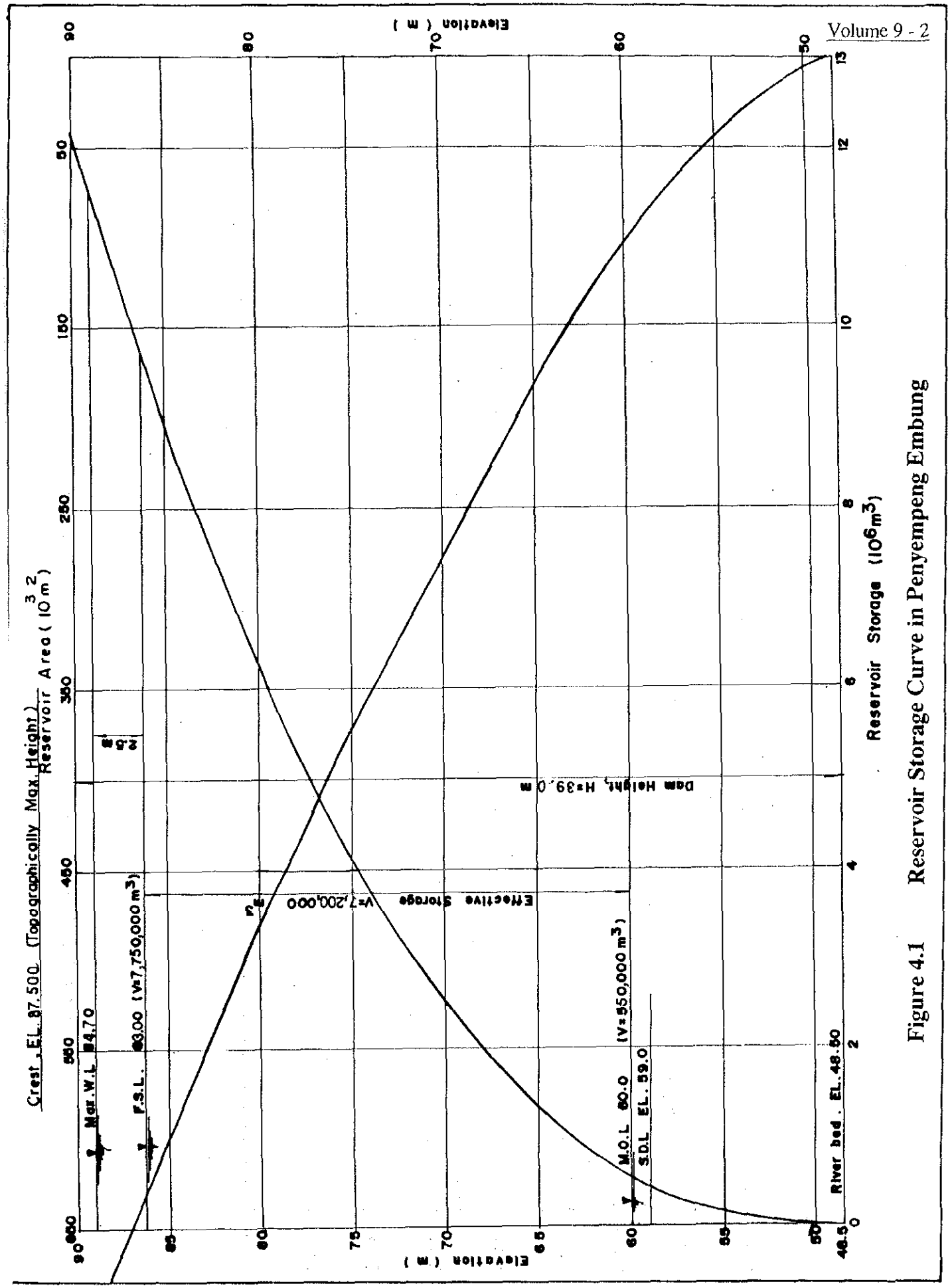


Figure 4.1 Reservoir Storage Curve in Penyempeng Embung

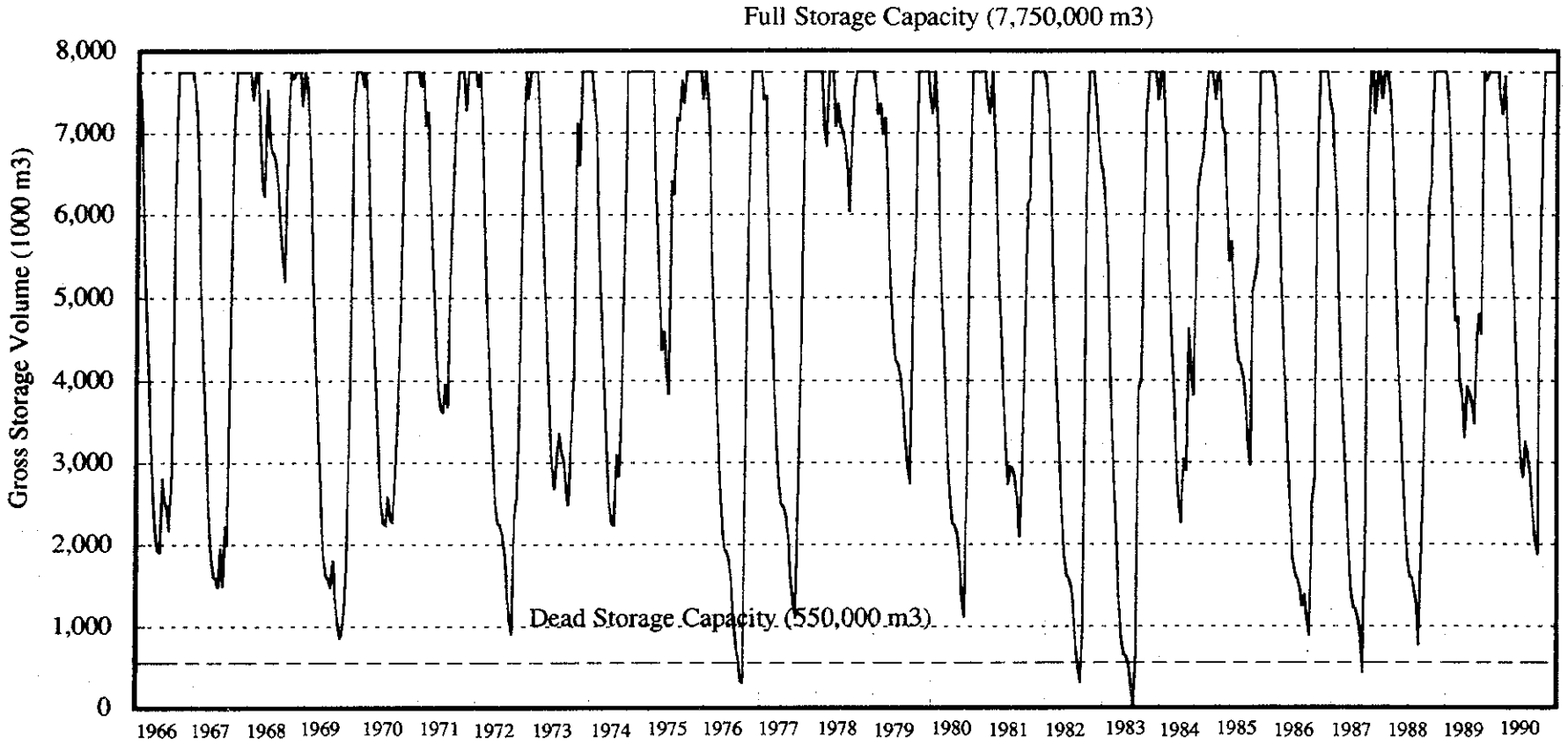
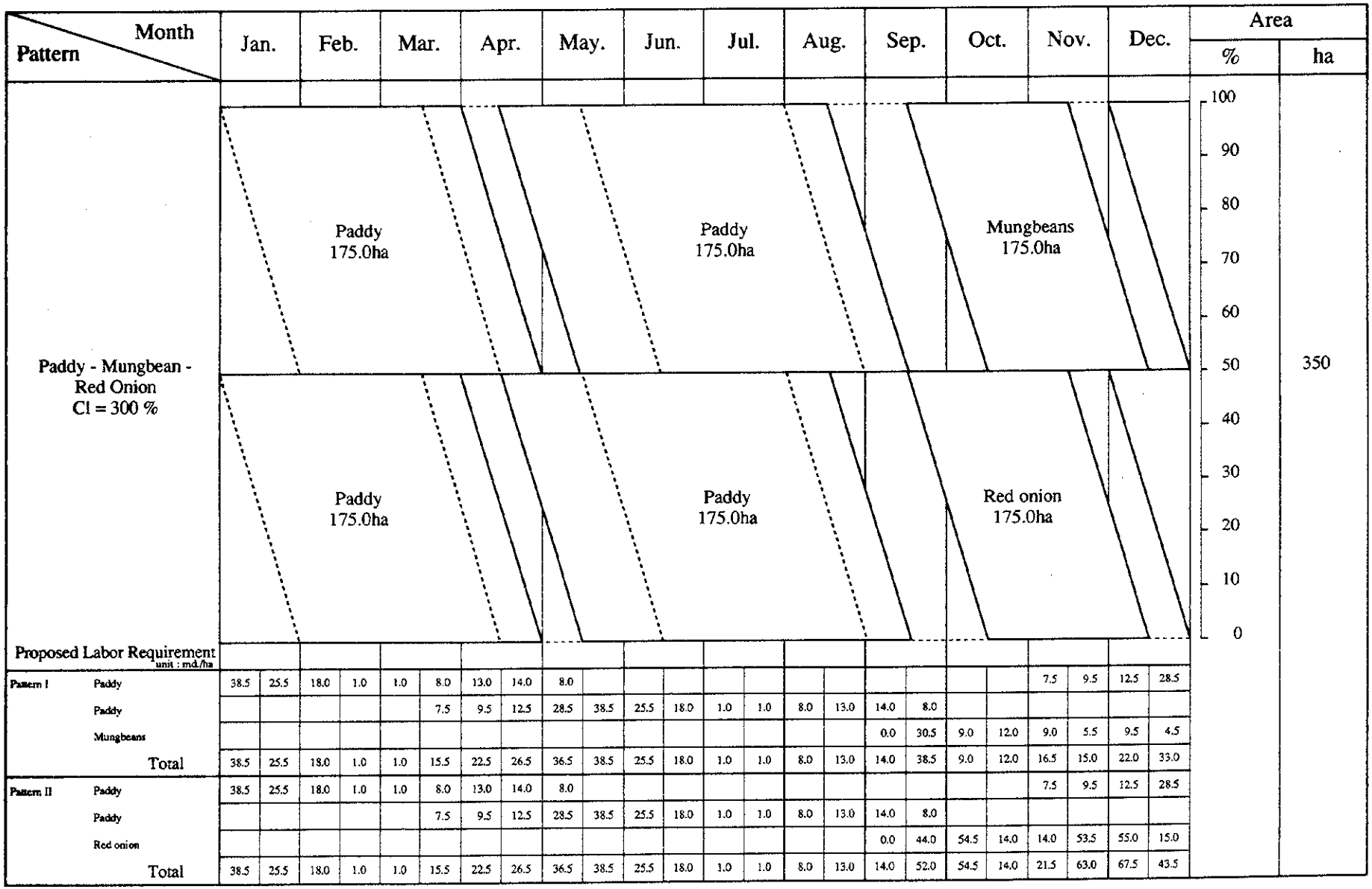


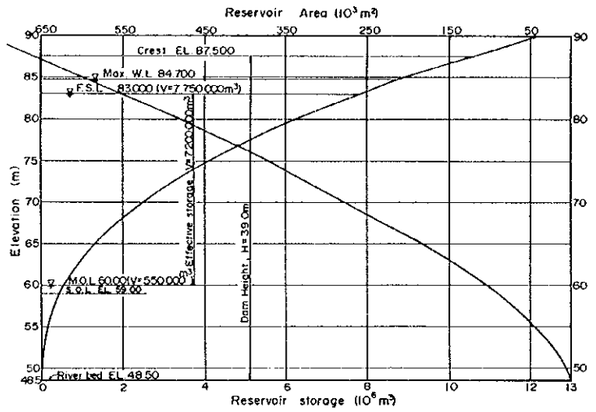
Figure 4.2 Result of Reservoir Operation in Penyempeng Embung



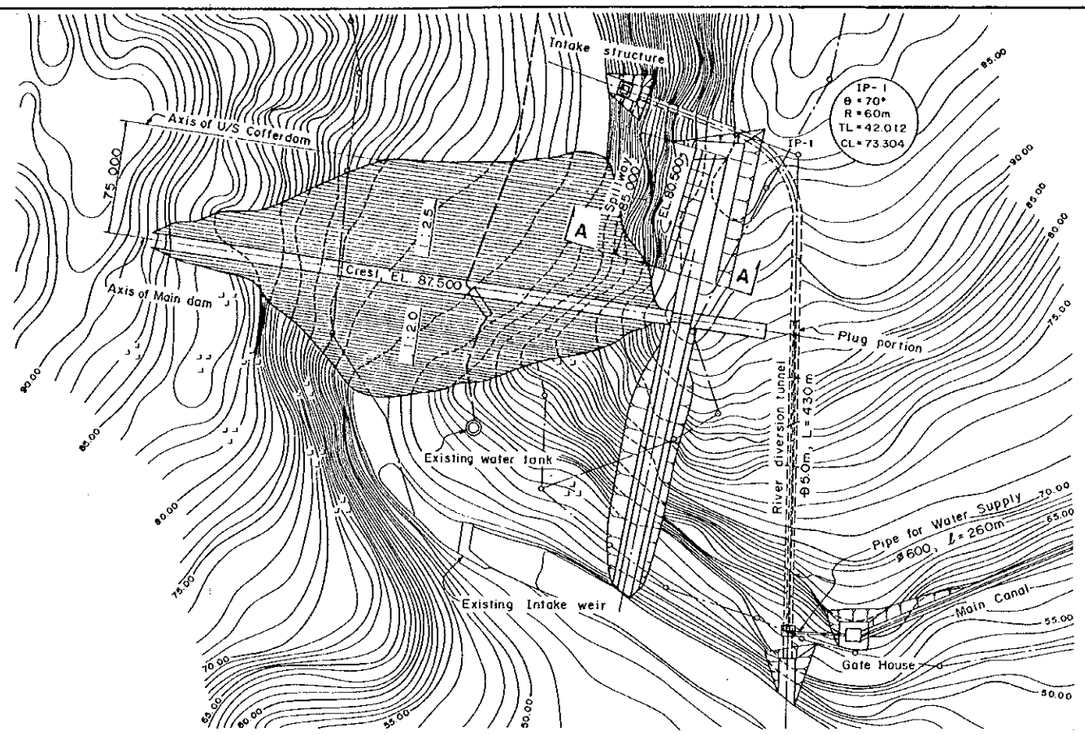
Proposed Labor Requirement
unit : md./ha

		Jan.		Feb.		Mar.		Apr.		May.		Jun.		Jul.		Aug.		Sep.		Oct.		Nov.		Dec.	
Pattern I	Paddy	38.5	25.5	18.0	1.0	1.0	8.0	13.0	14.0	8.0												7.5	9.5	12.5	28.5
	Paddy						7.5	9.5	12.5	28.5	38.5	25.5	18.0	1.0	1.0	8.0	13.0	14.0	8.0						
	Mungbeans																	0.0	30.5	9.0	12.0	9.0	5.5	9.5	4.5
	Total	38.5	25.5	18.0	1.0	1.0	15.5	22.5	26.5	36.5	38.5	25.5	18.0	1.0	1.0	8.0	13.0	14.0	38.5	9.0	12.0	16.5	15.0	22.0	33.0
Pattern II	Paddy	38.5	25.5	18.0	1.0	1.0	8.0	13.0	14.0	8.0												7.5	9.5	12.5	28.5
	Paddy						7.5	9.5	12.5	28.5	38.5	25.5	18.0	1.0	1.0	8.0	13.0	14.0	8.0						
	Red onion																	0.0	44.0	54.5	14.0	14.0	53.5	55.0	15.0
	Total	38.5	25.5	18.0	1.0	1.0	15.5	22.5	26.5	36.5	38.5	25.5	18.0	1.0	1.0	8.0	13.0	14.0	52.0	54.5	14.0	21.5	63.0	67.5	43.5

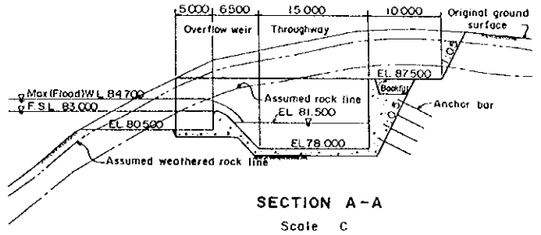
Figure 4.3 Proposed Cropping Pattern for Penyempeng Project



RESERVOIR STORAGE CURVE AT PENYEMPENG

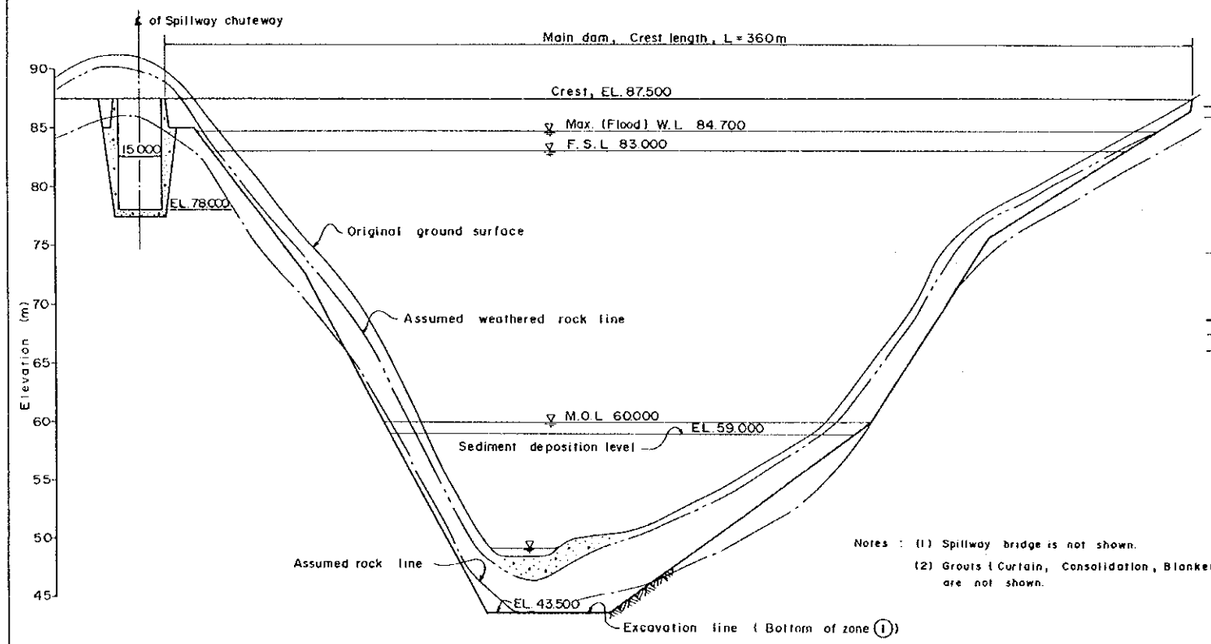


PLAN Scale A



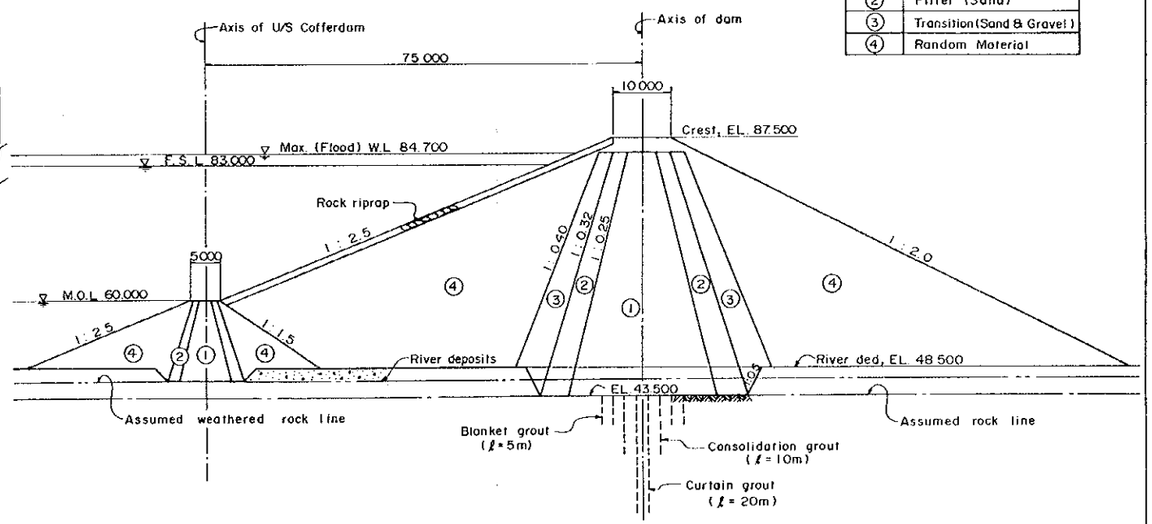
SECTION A-A
Scale C

Zone	Material
①	Impervious soil
②	Filter (Sand)
③	Transition (Sand & Gravel)
④	Random Material



Notes : (1) Spillway bridge is not shown.
(2) Grouts (Curtain, Consolidation, Blanket) are not shown.

PROFILE OF MAIN DAM
Scale H = 1 : 1.000
V = 1 : 250



MAXIMUM CROSS SECTION OF MAIN DAM
Scale B

Scale A 0 50 100 150 200m
Scale B 0 10 20 30 40 50m
Scale C 0 10 20 30 40m

Figure 4.4
General Plan of Penyempeng Embung

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT, MINISTRY OF PUBLIC WORKS
The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara
GENERAL PLAN OF PEYEMPENG EMBUNG
No. | Area
JAPAN INTERNATIONAL COOPERATION AGENCY

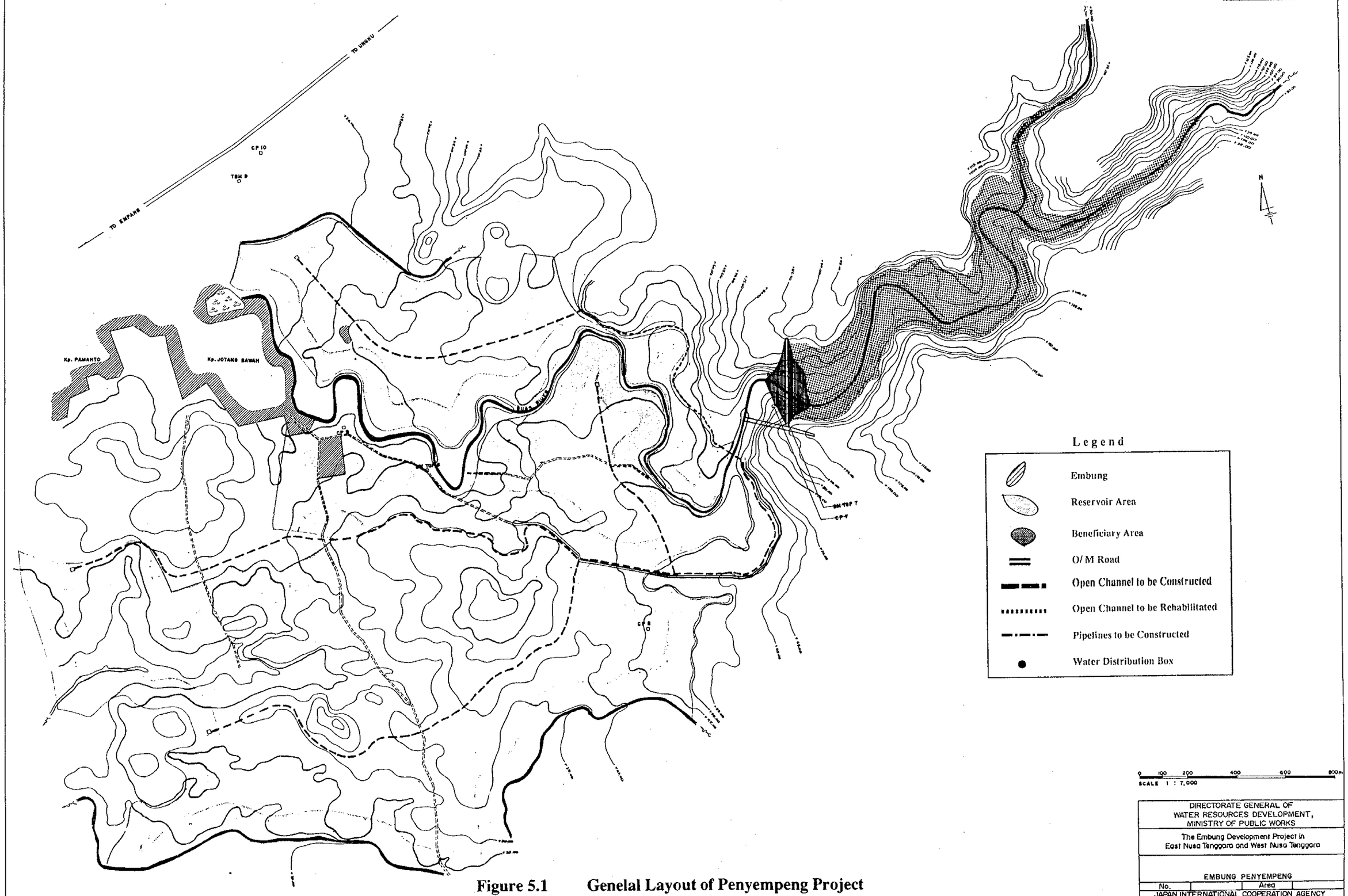


Figure 5.1 Genelal Layout of Penyempeng Project

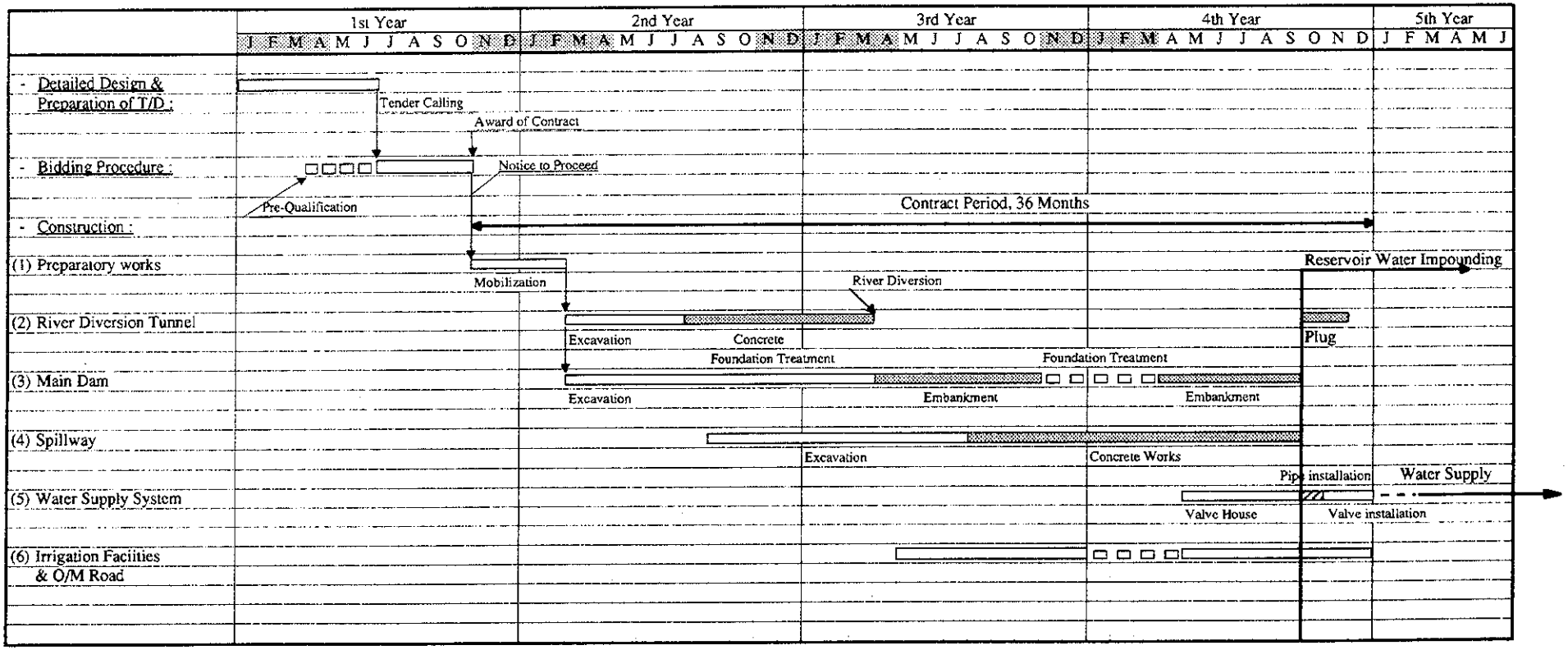


Figure 6.1 Construction Time Schedule for Penyempeng Project

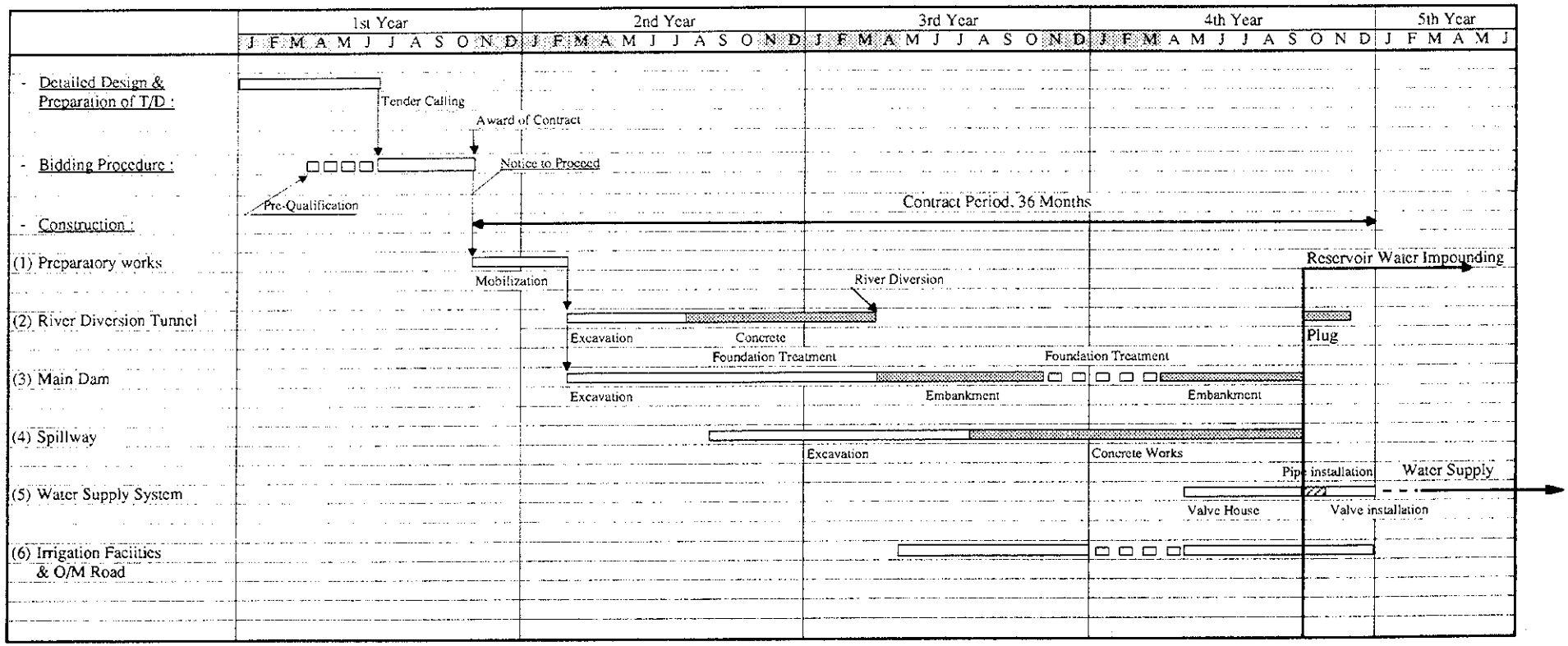


Figure 6.1 Construction Time Schedule for Penyempeng Project

Japan International
Cooperation Agency
(JICA)

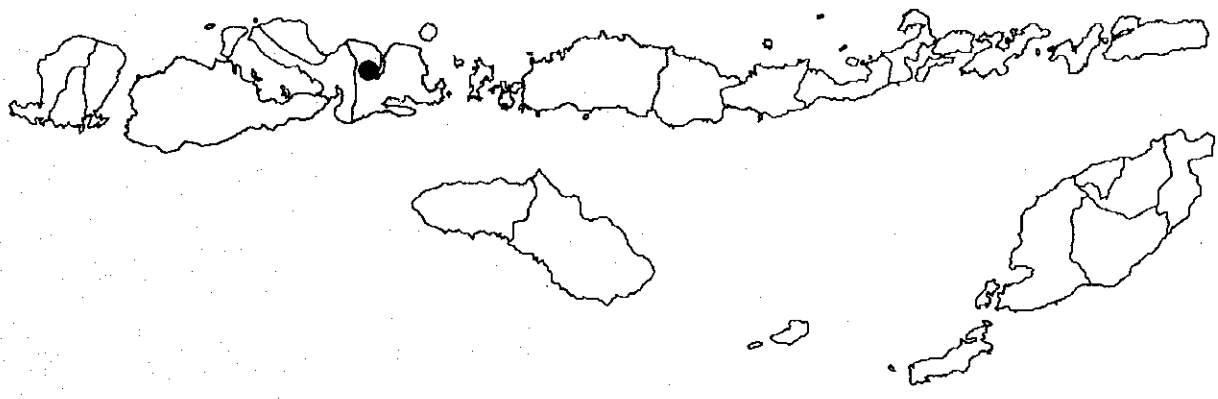
Directorate General of
Water Resources Development,
Ministry of Public Works

The Study
on
The Embung Development Project
(Small Scale Imponding Pond Development Project)
in
East Nusa Tenggara and West Nusa Tenggara
in
The Republic of Indonesia

Final Report

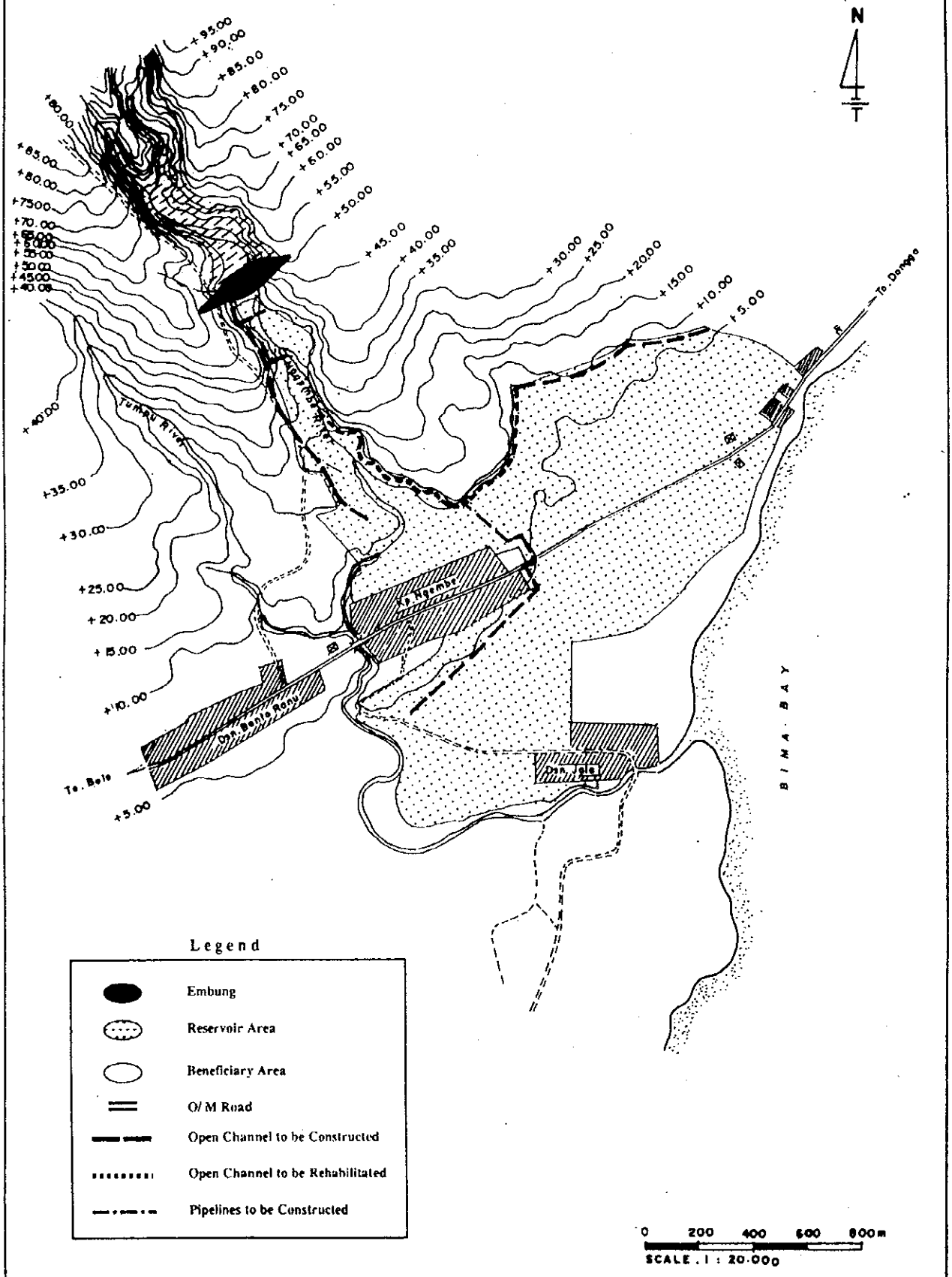
Volume 9-3

Feasibility Study
on
Ncoha II Embung Development Project



May 1995

Nippon Koei Co., Ltd.



Location Map : NCOHA II

THE STUDY
ON
THE EMBUNG DEVELOPMENT PROJECT
(SMALL SCALE IMPOUNDING POND DEVELOPMENT PROJECT)
IN
EAST NUSA TENGGARA AND WEST NUSA TENGGARA
IN
THE REPUBLIC OF INDONESIA

FINAL REPORT

VOLUME 9-3

FEASIBILITY STUDY
ON
NCOHA II EMBUNG DEVELOPMENT PROJECT

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1. PRESENT SITUATION OF THE PROJECT AREA

1.1 Location and Topography

The Project area is located in Nggembe Village in Kecamatan Belo of Kabupaten Bima. The proposed Embung site is located upstream of the Nggembe river, about 60 km west from Bima of the Nusa Tenggara Barat (NTB).

Topographical condition of the catchment area is fairly steep slope up to the mountain zone.

Beneficiary area is situated along the Nggembe river between the mountainous zone and coastal area of Bima bay.

1.2 Climate and Hydrology

The nearest climate station from the site is Godo Station while there are three rainfall stations near the proposed Embung site; Sila, Raba, and Teke. The wet season usually starts from late November and ends late March in the Project area with the average annual rainfall of 1,030 mm. Mean annual temperature is 27.8 °C with the average maximum temperature of 33.0 °C and the average minimum temperature of 22.4 °C. Mean relative humidity is 84.8 %. Average sunshine hours are 3 to 5 hr/day during the wet season and increase to 6 to 7 hr/day in the dry season. Winds are stronger from June to September and weaker from December to March with the average wind velocity of 4.8 km/hr. Table 1.1 and Table 1.2 show monthly rainfall record at the Sila station and climate data at the Godo station.

The Nggole rises near the Mt. Doro Lambuwu where the altitude is approximately 1,000 m and follows a southeasterly course until it reaches Ncoha Village. Then it turns westwards to discharges into Bima Bay. The surface of the catchment area is mostly covered with bush. The catchment area at the proposed Embung site is 12.6 km^2 . There is no gauging station on this river.

1.3 Geology

The proposed Embung site is underlain by mainly old volcanic products of Mt. Lambuwu of the Quaternary age. This volcanic products are half-consolidated rock and not homogeneous. The geological formation is: andesitic breccia composed of mainly andesitic breccia, soft rock; lithlogy varying from andesitic breccia to pumiceous tuff breccia; terrace deposits composed of mainly sand and gravel, forming terrace with flat to gentle slope; alluvium composed of sand, silt and gravel, forming lowland; and, river deposits composed of sand, silt, gravel and boulder, and distributed along the existing river bed.

1.4 Soils and Land Use

The Project area of Ncoha II lies on the bottom of U-shaped valley to alluvial plain of the Nggembe river. The lowest portion is coastal plain or tidal area.

Parent materials of soil are basaltic rocks, calcareous rocks and mixed alluvial materials. Soil drainage on farmland is moderate to well. Soil depth is very deep recording more than 100 cm. Soil texture of surface soil varies from clay to silt.

The results of the soil survey are shown in Table 1.3 on a typical soil profile out of six soil test pits, Table 1.4 on soil laboratory tests for soil samples taken from three representative pits out of six pits and Table 1.5 on the soil classification.

The wet paddy field covers 277 ha or 52% of the Project area from alluvial fan to alluvial plain. The upper part of wet paddy field of 44 ha is irrigated by the two existing intake weirs. These weirs and the existing irrigation canals are heavily suffered by sediment of river deposits during the wet season so that irrigation water supply is still unstable. The remaining 233 ha of paddy field in the lower plain are under the rainfed condition.

Undulating hilly area remains in bush/scrub and some areas are used for an extensive agriculture such as shifting cultivation and grazing land. Tidal area of 67 ha is used as fish pond.

The present land use is classified on the 1/5,000 topographic map and summarized below.

Present Land Use on the Project Area of Ncoha II

Unit: ha

Land Use	Irrigated	Rainfed	Others	Total
Paddy field	44	233		277
Upland	0	13		13
Tree crops	0	0		0
Bush/Scrub/Grassland			125	125
Residential			36	36
Cemetery			4	4
Others			80	80
Total	44	233	245	245

Source : The JICA Study Team

The present land use and soil classification of the Project area is illustrated in Figure 1.1.

1.5 Demography

The demographic condition in the Project area as of 1993 is revealed by a total population of 2,274 and a total number of households of 443 including farm households of 422 as shown below. The average family size is 5.1 persons. Dominant ethnic is originated from Bajonese and the majority of inhabitants embrace Islam religion. Their education attainment is commonly primary school grade.

Present Demographic Condition

Village	Sub-Village	Total Population (person)	Total Household (No.)	Family Size (person)	Farm Household (No.)
Nggembe	Nggembe	1,763	318	5.5	302
	Bontoramu	511	125	4.1	120
Total		2,274	443	5.1	422

Source : JICA Water Use Survey

1.6 Domestic Water Use

Available water source facilities are dug and pump wells for supplying domestic and river flow for getting livestock water in the Project area. The present water use in each sub village clarified under the Study is summarized below:

- In Nggembe Sub-Village, there are 24 pump wells and 51 dug wells both used as drinking water sources for inhabitant. Breeding households bring their cattle to the Nggembe river 300 m away from the village. The length of prevailing water

shortage period is five months from August to December for drinking and livestock water; and,

- In Bontoramu Sub-Village, there are five pump wells and four dug wells both used as drinking water sources for inhabitant. Breeding households bring their cattle to the Nggembe river 300 m away from the village. The length of prevailing water shortage period is five months from August to December for drinking and livestock water.

1.7 Social Infrastructures

The access from Mataram, the provincial capital of NTB, to the Project area is the Mataram-Labuhan Lombok road, Lombok-Sumbawa ferry between Labuhan Lombok and Alas, and trans-Sumbawa road. The proposed Embung site is linked by a gravel road from the trans-Sumbawa road. The existing rural electrification network has already been extended to the Project area.

Inhabitants are generally using a public bathing place with toilet and washing facilities for defecating purposes. There are an auxiliary hospital within the Project area and an integrated health service center and a hospital in Bima 4.5 km away.

1.8 Agriculture and Livestock

(1) Present cropping pattern and intensity

The average annual planted areas of major crops are summarized below.

Present Cropping Pattern and Intensity

Cropping Pattern	Net Area (ha)	Planted Area (ha)	Proportion of Planted Area (%)	Cropping Intensity (%)
(1) Paddy - Palawija	27.0	40.0	15.2	150
(2) Paddy - Fallow	210.0	210.0	80.2	100
(3) Upland crop - Fallow	12.0	12.0	4.6	100
Total / Average	249.0	262.0	100.0	117

Source : The JICA Land Use Survey and Inventory Survey

(2) Farming practice and farm inputs

On the irrigated paddy field, the wet season irrigated paddy and the dry season rainfed mungbean are cultivated, while on the rainfed paddy field single cropping of the wet season paddy is common. Mungbean is grown on dry upland.

In terms of paddy, most farmers carry out land preparation with an animal-drawn plough and harrow the land once or twice every crop season, while this work done by other marginal farmers depend on their own man power. High yielding rice varieties such as IR36, IR64 and Krueng Aceh predominate. Rice seed is sown on a nursery bed of which area is in the ratio of one twentieth against the main paddy field. Manual weeding is usually made one to three times throughout the rice growing period. Harvesting is carried out by using a sickle and hand threshing is conducted by beating rice plants against a frame.

Common cultivation method of dry upland crop is very simple as manual land preparation, planting, weeding and harvesting are predominant.

Farm inputs and labor requirements currently used for growing these crops are given below.

Present Farm Inputs and Labor Requirements

Description	Unit	Wet Paddy	Mungbean
Farm Inputs			
Seed	kg/ha	50	35
Fertilizer			
Urea	kg/ha	300	25
TPS	kg/ha	100	-
KCl	kg/ha	50	-
Agro-chemicals	lit/ha	-	-
Labor Requirements			
Nursery	md/ha	4	-
Land preparation	md/ha	2	2
	ad/ha	5	-
Planting	md/ha	3	2
Transplanting	md/ha	15	-
Weeding	md/ha	10	4
Pest & disease control	md/ha	2	2
Farm management	md/ha	2	1
Harvesting	md/ha	15	8
Transportation	md/ha	5	4
Others	md/ha	4	2
Total	md/ha	62	25
	ad/ha	5	-

Source : The JICA Farm Economy Survey

(3) Crop yield and production

The present crop yield and production in the Project area are estimated as shown below. Unit yields of major crops remain extremely low due to limited irrigation water source, insufficient farm input supply and traditional farming practices.

Present Crop Yield and Production

Crops	Planted Area (ha)	Unit Yield (ton/ha)	Production (ton)
Wet Paddy Field			
Irrigated			
Wet season paddy	40	3.00	120
Rainfed			
Wet season paddy	210	2.00	420
Dry season Palawija			
Mungbean	20	0.50	10
Upland Field			
Mungbean	12	0.70	8

Source: The JICA Inventory Survey

(4) Livestock population

Various kinds of livestock are raised in the Project area and their population is given below. Cows and buffaloes play important roles in land preparation as draft power. Other livestock are raised for self-consumption.

Current Population of Livestock

Unit: head

Breeding Household	Cow	Buffalo	Horse	Goat /Sheep	Pig	Chicken/ Duck
118	114	33	6	240	0	0

Source: The JICA Water Use Survey

1.9 Irrigation Facilities

In the Project area, there exists wet paddy field of 11 ha in gross on the right bank and 150 ha on the left bank of the Nggembe river. The right bank area has been irrigated by the existing weir situated at around 250 m downstream of the proposed Embung site. This weir is deteriorated severely. Irrigation water taken by the weir is led by the existing canal to wet paddy field with a distance of about 600 m. This canal is an earth canal functioning not so well. The paddy field of 33 ha on the left bank is irrigated by the traditional weir and the remaining 117 ha are rainfed. A free intake weir is under construction in the same place of this traditional weir. Irrigation water taken by the weir is led by the existing canal to wet paddy field with a distance of about 200 m. This canal is an earth-lined as a whole, but some portions are lined by stone masonry. It is functioning well. Due to the shortage of surface water of the river and poor conditions of all wet facilities, the existing paddy field has been irrigated only for the wet season.

1.10 Agro-economy

(1) Farmers group

Farmers are members of Agricultural Cooperative (KUD). From its branch shop , they commonly purchase fertilizers and use credit services. Some farmers are also members of Village Youth Association or Village Program of Women Education. About 75% of farmers benefited by the existing irrigation scheme are involved in Water Users' Association (P3A/HIPPA), established in 1990, to maintain on-farm irrigation service facilities and manage irrigation water distribution.

(2) Agricultural supporting services

Agricultural extension services are provided to farmers by field extension workers (PPL) attached to a rural extension center (BPP) in Belo. Usually, farmers receive PPL's visiting service very few because of limited budget for field operation in BPP. Some PPLs are livestock specialists to provide various services under the instructions of a specialized agricultural extension agent (PPS) assigned to a district center for agricultural extension (WKBPP). Veterinary care services are given to breeding households through an animal health center of the Veterinary Service of the Department of Livestock. The present level of livestock extension services is similar to that of the agricultural extension services.

Credit services are available in KUD as well as in the service network of the Indonesian People's Bank (Bank Rakyat Indonesia) both handling "Credit for Farmer (KUT)" and "Income Generating Project for Marginal and Landless Farmers (P4K)". Financial sources of these credits are the Government for KUT and IFAD for P4K aiming at group financing.

Sumbawa Water Resources Development and Conservation Project Office (Proyek PKSA Sumbawa) under the NTB Provincial Public Works Service (DPUP) is responsible for new water resource development and watershed management. New development of irrigation system is the responsibility of Sumbawa Irrigation Project Office, while upgrading

and rehabilitation works are the main task of Provincial Project Office for Rehabilitation and Upgrading of Irrigation. Operation and maintenance (O&M) works of all facilities are conducted by Provincial Project Office for Operation and Maintenance (PPO&M APBD). These project offices are under the direction of DPUP.

(3) Farmers' Household Economy

The results of agro-economy survey carried out in the Project area under the Study reveal that the average income and expenditure of 15 sample farmers amount to Rp. 1.43 million and Rp. 2.63 million, respectively. Sample farmers make up for deficit in their household economy by selling their livestock. Table 1.6 shows the summary of replies of 15 respondents.

2. DEVELOPMENT NEEDS AND CONCEPTS

2.1 Development Needs and Constraints

(1) Population increase

The future population in the Project area is anticipated by referring to "Projection of Population for Kabupaten/Kotamadya in Indonesia 1990-2000" prepared by National Statistic Bureau and the Second Long Term Development Plan (PJPT II). The total number of inhabitants living in the Project area will increase from 2,274 persons as at 1993 to 2,426 persons in 1998, 2,574 persons in 2003, 2,711 persons in 2008, 2,832 persons in 2013 and 2,943 persons in 2018.

(2) Basic human needs (BHN)

The inhabitants in the Project area are unsatisfied with the present condition of rural infrastructures because the existing domestic water supply sources are insufficient to meet drinking and livestock water requirements during five months between August and December. However, countermeasures for securing domestic water supply sources for the dry season have been already planned in this area.

(3) Economic development needs

All of 422 farm households have principally consumed their farm products for their own use and then sold the remaining amount to local markets. There is not much possibilities of developing manufacturing and service sector industries in and around the Project area so as to offer new job opportunities to farmers. It is therefore indispensable for promoting public investment to economic infrastructures, especially for irrigation water source facilities, which encourage farmers to improve their farming system and enable them to increase their agricultural production. Increasing farm outputs could clue farmers themselves to upgrade their living standard and to catch up with faster economic growth of other sectors and places.

(4) Inhabitants' intention to development pattern

Inhabitants in the Project area intend to use their farm land more intensive because no expansion of land holding size can be expected. To do so, they need all year-round water source facilities from which they will be able to get sufficient irrigation water for growing the dry season crops.

(5) Development constraints

The present constraints against economic development in the Project area are featured by the condition that available surface runoff of the river has not been fully utilized. The reason is that the existing intake weir established on the Nggole river can divert only the wet season discharge, because this river dries up during the dry season. Such limited use of water resources has acted as the barrier to promote development of intensive agriculture. Thus, no more utilization of the Nggole river can be expected unless countermeasures to regulate the wet season runoff are practiced for the full use of surface runoff.

2.2 Development Concepts and Approach

(1) Development concepts

The existing gap of economic status between NTB and other Provinces is caused by insufficient fulfillment of BHN, slow pace of poverty alleviation and less concerns about a

balanced investment to regional development. In harmony with the national policy to correct this economic imbalance, the development concept is formed aiming at improvement of social and economic infrastructures with the highest priority so as to meet BHN and increase agricultural outputs. Among others in the Project area, it is prerequisite to pay special attention to how to solve the dry season irrigation water shortage problems originated from insufficient use of potential water resources in the Nggole river basin.

(2) Development strategies and approach

To overcome development constraints prevailing in the Project area, water resources seasonally available are to be regulated by means of constructing Embung as water reservoir on the Nggole river. Approach to development planning of the potential Embung is as follows:

- To put the priority to supply irrigation water taking into account inhabitants' needs and intention;
- To project the future water demand for irrigation use at the target year of 2008 being the last year of Pelita VIII;
- To examine development potential of the Ncoha II Embung from the technical viewpoints;
- To determine the optimum development scale of the Embung;
- To make preliminary design and cost estimate; and
- To conduct investment justification from the viewpoints of economic soundness, social satisfaction and environmental impact.

2.3 Land Potential

The present rainfed paddy field of 233 ha would be subjected to irrigation development of the proposed Ncoha II Embung. All the land, which are suitable for agricultural use from the topographical condition, are already covered by wet paddy field with or without irrigation. Therefore, no land transformation to wet paddy field is expected in the future land use in this area.

As for irrigation area, the present rainfed paddy field on the upper right bank and on the left bank could be irrigated without an installation of aqueduct over the Nggembe or Tumpu river. The additional irrigated paddy field area is probably expected to be 4 ha on the right bank and 113 ha on the left bank.

Rainfed paddy field -> Irrigated paddy field 117 ha

In conclusion, the future land use plan of the Project area is offered as shown below.

Future Land Use Plan on the Project Area of Ncoha II

Unit: ha

Land Use	Irrigated	Rainfed	Others	Total
Paddy field	161	116		277
Upland	0	13		13
Tree crops	0	0		0
Bush/Scrub/Grassland			125	125
Residential			36	36
Cemetery			4	4
Others			80	80
Total	161	129	245	535

Source : the JICA Study Team

There is about 3 ha of the rainfed paddy field in the impounding area of the proposed Embung. The alternative land for the impounding paddy field is available in the newly developed paddy field with irrigation water supply. The high-valued land from the upland field could be compensated in the land acquisition.

2.4 Agricultural and Livestock Development Plan

(1) Alternative cropping patterns

In formulating the future cropping patterns in the Project area, the following basic principles have been adopted:

- Higher benefit for farmers;
- Optimum use of irrigation water;
- Practical farming system for family labor; and,
- Crops and cropping patterns acceptable to farmers.

Wet paddy is the most predominant crop in the Project area and acceptable to farmers as they have long experience in rice cultivation. Therefore, they could easily master irrigated rice cultivation method to realize higher production and thereby large irrigation benefit under the condition of "With Project". Aiming to determine the optimum development scale of the proposed Embung, the following alternative cropping patterns are established.

Alternative Cropping Patterns

Pattern Code	Wet season		Dry season			
			First cropping		Second Cropping	
	Crop	Coverage (%)	Crop	Coverage (%)	Crop	Coverage (%)
With Project B-12	Paddy	100	Paddy	100	-	-
With Project B-21	Paddy	100	Mungbean	100	-	-
With Project B-22	Paddy	100	Mungbean	100	Red onion	100

Remarks : * ; Mixed with groundnut

(2) Farm input and labor requirements

Under the "With Project" condition, farmers who are depending on unreliable rainfall, river flow or irrigation water can be expected to get stable irrigation water supply. They will be able to increase farm inputs to the optimal level with less risk. Proposed farm inputs are estimated in consideration of the present level in advanced irrigation areas as well as data collected from BPP. Labor requirements are also expected to increase substantially in

cultivation under the technical irrigation system. On the other hand, farm input and labor requirements are expected to remain at present level under the "Without Project" condition.

Proposed Farm Input and Labor Requirements

Item	Unit	Wet Paddy	Mungbean	Red Onion
Farm Inputs				
Seed	kg/ha	25	30	2,000
Fertilizer				
Urea	kg/ha	300	75	300
TPS	kg/ha	100	100	200
KCl	kg/ha	50	50	100
Agro-chemicals	lit/ha	2	2	10
Rodenticide	kg/ha	2	1	3
Labor	md/ha	185	80	250
Draft Animal	ad/ha	20	10	20

(3) Proposed farming practices

Proposed farming practices for wet paddy are as follows:

- High yielding rice varieties to be used under the With Project condition are IR64, Krueng Aceh, Pelita, C4 and IR36 with maturing periods of 110 to 135 days. These varieties are moderately resistant or resistant to several major rice pests and diseases. Land preparation on wet paddy field has to be done by animal ploughing and harrowing;

- Fertilizers need to be applied three times; the first application at the final stage of land preparation, and the second and third applications as top-dressing at the 20th and 37th day after transplanting, respectively. The top-dressing will be applied while water depth on wet paddy field is shallow. The phosphorous (TPS) and potassium (KCl) fertilizers have to be applied at the final stage of land preparation. The required amount of fertilizers is 60 kg/ha of N, 30 kg/ha of P and 30 kg/ha of K;

- Seed rates are 20 to 40 kg/ha for nursery. The best period for transplanting is 3 to 4 weeks after sowing, when the seedlings have 5 to 6 leaves. Ratio of the nursery bed to the main wet paddy field is about one twentieth. Planting density is about 2 to 3 plants per hill and spacing of hill is 20 cm x 20 cm;

- Weeding is required to be performed two to three times during the rice growing period according to weed growth. Irrigation water supply needs to be guaranteed during the most critical stages of the plant growth such as tillering, booting, flowering and germination stages. Timely control of insects, pest and diseases is necessitated on the basis of advice by PPLs and their assistants; and

- It is desirable to carry out harvesting when the ears are nearly ripened and are still in slight green. Harvesting is made by labors using a sickle. Harvested paddy plants need to be dried on the field for 3 to 4 days.

For growing Palawija crops under the irrigated condition, advanced farming practices similar to irrigated wet paddy cultivation and high yielding varieties are to be adopted. Land preparation will require animal-draft in order to enhance efficiency and accuracy of the work. Proper fertilization matching with soil conditions and timely insect/disease control are also indispensable. These farming practices need to be applied for, following technical instructions of extension agents.

(4) Anticipated crop yield

It is anticipated that the future yield of proposed crops under the "With Project" condition increases to 4.5 ton/ha for wet paddy, 1.1 ton/ha for mungbean and 7.5 ton/ha for red onion. These targets are estimated in due consideration of the present yield level in well established irrigation areas of Kabupaten Bima as well as introduction of high yielding varieties and advanced farming practices, stable irrigation water supply and optimum use of farm inputs. As for build-up period to attain the anticipated yield, it is also prospected that crop yield level is 60% of the target in the first year, 70% in the second year, 80% in the third year, 90% in the fourth year and 100% from the fifth year and onward.

(5) Projected livestock population

The future livestock population in the Project area for the target year 2008/2009 is projected as shown below taking into account the actual growth rate of each livestock in Kabupaten Sumbawa during the Pelita V period.

Projected Population of Livestock

Unit: head

Cow	Buffalo	Horse	Goat /Sheep	Pig	Chicken/ Duck
289	13	2	130	0	0

2.5 Water Demand

(1) Irrigation water demand

In order to optimize the development scale and delineate the beneficiary area of the Project, irrigation water demand for each proposed crop is estimated for unit irrigation area of 1 ha on the semi-monthly base taking into account crop consumptive use, evapotranspiration, crop coefficient, effective rainfall and irrigation efficiency both for wet paddy and Palawija crops as well as land preparation water, layer replacement and percolation loss only for wet paddy. As described in Attachment 1, irrigation water demand in the Project area is calculated by referring to the standard quoted in "Irrigation Design Standard, KP-01" by DGWRD.

Tables 2.1 and 2.2 show the calculation results of evapotranspiration and effective rainfall, respectively, and Table 2.3 presents the unit irrigation water demands for each crop.

3. EXAMINATION OF EMBUNG DEVELOPMENT POTENTIAL

3.1 Topographic Condition

The proposed dam site is selected at a narrow gorge on the Nggembe river, about 300 m upstream from the existing intake weir. River bed elevation shows El. 27.0 m and the width of gorge is rather wide as about 400 m at El. 55m on both abutments of the dam site. Gradient of the river bed at the proposed Embung site is 1/50.

3.2 Geological Condition

The proposed Embung site is underlain by volcanic breccia of the Quaternary age. The foundation is mainly formed of volcanic breccia at the both left and right banks, and alluvium at river bed. The drilling survey shows that the average N-value of alluvium will be expected more than 8 and that of highly weathered volcanic breccia varies from 14 to 41. The coefficient of permeability of volcanic breccia varies from 9.4×10^{-5} to 2.9×10^{-5} cm/sec, while that of alluvium is assumed to be 10^{-3} cm/sec order. No ground water is present at any hole.

The reservoir area is mainly underlain by volcanic breccia, terrace deposits and alluvium . No major fault and landslide are recognized in the reservoir area. Volcanic breccia of the Quaternary age is supposed to be semi-consolidated and possible to have high permeability layer. Some water leakage may occur in the reservoir area. Geological map and profile are shown in Figures 3.1 and 3.2.

3.3 Availability of Construction Materials

In and around the proposed Ncoha-II Embung is site, there are sufficient materials suitable for constructing a zone type fill dam. The borrow area for impervious soil and the quarry site for sand and gravel materials are investigated from the technical and economical viewpoints. The following shows a summary of the selected location and the availability of the materials.

Availability of Construction Materials

Material	Location	Description
1. Impervious soil	Reservoir area and downstream of the dam site	Clayed sandy silt
2. Filter material	Nggembe river	River deposits
3. Random material	(1)Nggembe river (2)Spillway and main dam foundation	Boulders from river deposits Andestic tuff breccia in weathered rock
4 Concrete aggregates	Nggembe river	River deposits

3.4 Availability of Water Resources

(1) Catchment yield

As for the Nggole river, there is no record of discharge. Accordingly, runoff at the proposed Embung site is estimated by use of the rainfall record near the proposed site. The Sila rainfall station which is located in the south of the Ncoha II Embung catchment has rainfall record of nearly consecutive 23 years and is considered to represent catchment

rainfall. The blank data of the Sila station was supplemented by that of the Raba station. The climate is strongly influenced by altitude and the rainfall in the low elevated area is considerably low comparing to the high elevated area. Furthermore, most rainfall stations are located in the low elevated area. To convert the station rainfall to the catchment rainfall, thus, the adjustment coefficient of 1.1 is multiplied by use of isohyetal map. The generated catchment rainfall is given in Table 3.1. A runoff coefficient of 0.35 is adopted considering the characteristics of the catchment area and the previous hydrological analysis in the Sumbawa Island. Using this runoff coefficient and rainfall record at Sila, river flow of the Nggole at proposed site is estimated.

The following conditions are considered for estimation of the half monthly discharge:

- Catchment area of the proposed Embung site is 12.6 km^2; and,
- Less than 20 mm of half monthly rainfall is ignored for estimation.

This estimation is made based on the rainfall record from 1970 to 1990. The estimated half monthly discharge is given in Table 3.2 and monthly discharge is summarized below.

Mean Monthly Discharge

Unit: 1,000 m^3

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1,024	980	712	231	91	47	12	0	29	141	531	896	4,692

(2) Floods

The flood analysis is made to determine the design discharge of the structures, such as spillway, diversion tunnel, and so on. Taking availability of the flood record and size of the catchment area into account, the rational formula is adopted to estimate the flood discharge in the Study. The formula is;

$$Q = 0.2778 \, f \, r \, A$$

where, Q : Peak discharge (m^3/s)
f : Runoff coefficient
r : Average rainfall intensity within time of concentration (mm/hr)
A : Catchment area (km)

1) Design rainfall

Design rainfall is estimated by the Log Pearson Type III method, which is widely used in NTB. In this Study, 20 years rainfall data of the Sila station from 1970 to 1993 are analyzed by the method. The result of probability analysis is summarized below.

Design Rainfall

Unit : mm

Return Period	Design Rainfall
1 in 2 year	79
1 in 5 year	98
1 in 10 year	109
1 in 20 year	120
1 in 50 year	133
1 in 100 year	143
1 in 200 year	152

2) Design flood

The following is the Ruziha's formula to estimate the flood travel time:

$$T = L/V$$

$$V = 72(H/L)^{0.6}$$

where, T : Flood travel time (hr)
L : Horizontally projected length of river course (km)
H : Difference of elevation (m)
V : Velocity of flood (km/hr)

The rainfall intensity within concentration time of the flood is estimated by an empirical formula prepared by Dr. Mononobe as follows:

$$r = (R_{24}/24) \times (24/T)^{2/3}$$

where; r : Maximum average rainfall intensity within concentration time (mm/hr)
R_{24} : Daily rainfall (mm)
T : Time of concentration (hr)

The runoff coefficient is estimated at 0.8 considering the condition of the catchment area.

Based on the above condition, the peak floods in various return period are estimated. The result is shown in Table 3.3 and summarizes below.

Probable Flood

Unit : m^3/s

Return Period	Probable Flood
1 in 2 year	59
1 in 5 year	73
1 in 10 year	81
1 in 20 year	89
1 in 50 year	99
1 in 100 year	107
1 in 200 year	113

(3) Sediment load

There is no available data on sediment load on the Nggole river. The Technical Report I (Embung Study Program) in the Sumbawa Water Resources Development Planning Study Extension Phase in 1982 indicates that the sedimentation rate is 0.5 mm/year/km^2.

Taking data availability and characteristics of the catchment area into account, 0.5 mm/year/km^2 is adopted in this Study.

(4) Water quality

On October 29, 1994, water samplings were carried out at the proposed Embung site and upstream and downstream of the site for the clarification of the water quality. The result of the test is shown in Table 3.4.

4. EMBUNG DEVELOPMENT PLAN

4.1 Optimization of Development Scale

The water balance study aims to clarify the relationship among the proposed Embung scale, irrigable area and cropping pattern. According to the water demand and procedure to be described below, the water balance study of the Ncoha II Embung Project is conducted.

(1) Methodology

The simulation equation is as follows:

$$W_2 = W_1 + I - L - S_P - O_D - O_L - O_I$$

where , I : inflow to reservoir at the half monthly period (m^3)
L : water losses from the reservoir caused by evaporation during the half monthly period (m3)
SP : flow of water over the spillway during the half monthly period (m3)
OD : outflow needed for domestic water during the half monthly period (m3)
OL : outflow needed for livestock water during the half monthly period (m^3)
O_I : outflow needed for irrigation water during the half monthly period (m^3)
W_1 : volume of water in the reservoir at the beginning of the half monthly period (m^3)
W_2 : volume of water in the reservoir at the end of the half monthly period (m^3)

1) Inflow

Since there is no gauging station on the Nggole river, discharge is generated from rainfall of the Sila station.

2) Reservoir storage curve

Reservoir storage curve with surface area is shown in Figure 4.1 in relation to the elevation at the proposed Embung site.

3) Losses

Evaporation from inundation area can be estimated as "1.1 x ETo", indicating, "open water evaporation", which is employed in the Design Criteria KP-1.

4) Spill out discharge from reservoir

Spill out discharge is considered if there is any excess storage which exceeds the maximum storage capacity of dam.

5) Water Demand

The 100% dependability of the domestic water demand shall be secured by the proposed Ncoha II Embung.

As for the irrigation water demand, maximum irrigable area for wet season and dry season are as follows:

To meet 80% dependability of irrigation water, reservoir capacity will be determined.

6) Water level of reservoir

Minimum water level is estimated at El. 36.9 m considering sedimentation volume for 25 years and 1.0 m allowance. Maximum water level for the simulation is equal to the crest elevation of spillway. Probable maximum high water level according to topography is set at El. 49.0 m.

(2) Optimum development scale

With respect to the proposed Ncoha II Embung, the plan with the most sizable reservoir is selected within economically reasonable range in view of maximum exploitation of the endowed water resource. The optimum development scale of Ncoha II Embung is decided by the limitation of topography at the proposed site. The optimum development scale is thus in line with the maximum height of 25 m and effective storage capacity of 1.024 million cubic meters (MCM). The result of reservoir operation is shown in Figure 4.2.

4.2 Delineation of Beneficiary Area

(1) Delineation of Beneficiary Irrigation Area

By developing available water resources of the Nggole river through construction of the proposed Ncoha II Embung at the scale to utilize the maximum runoff, irrigation water can be supplied to wet paddy field of 157 ha in net for the both seasons. The beneficiary area of the proposed Embung comprises the presently irrigated paddy field of 40 ha and newly converted field from the existing rainfed paddy field of 117 ha. Taking such water supply condition into account, it becomes possible that the future cropping pattern under the "With - Project" condition aims to maximize rice production, sustain soil fertility and enhance cash income sources. In this regard, the proposed cropping pattern is to be the wet season irrigated paddy coupled with two cropping of irrigated mungbean and red onion as the first and second dry season Palawija crops to the full extent as shown below and illustrated in Figure 4.3.

Under the "Without-Project" condition, no new irrigation water source can be developed so that the future cropping pattern is to remain in the same condition of the present pattern.

Future Cropping Pattern

Condition	Wet season			Dry Season		
	Crop	Water Supply	Area (ha)	Crop	Water Supply	Area (ha)
With Project	Paddy	Irrigated	157	Mungbean	Irrigated	157
				Red onion	Irrigated	157
Without Project	Paddy	Irrigated	40	Mungbean	Rainfed	20
	Paddy	Rainfed	117	(Fallow)		-

(2) Delineation of beneficiary area for livestock water supply

There is no water demand for domestic and livestock use in the Project area. It is therefore to utilize reservoir water of the proposed Embung for the irrigation purpose only.

4.3 Embung Development Plan

Following the results of the geological and material surveys as well as the optimization study, the proposed development plan of Ncoha II Embung is determined. In

terms of dam type, zone earthfill type is applied in due consideration of the foundation strength and the availability of embankment materials.

The main components of Ncoha II Embung are the main dam, spillway, river diversion conduit and water supply facility as shown in Figure 4.4. In order to provide the reservoir with the optimum storage capacity of 1.024 MCM, the full supply level (F.S.L.) is set at El. 66.0 m. Taking overflow depth of spillway and freeboard into account, the dam height of Ncoha II Embung becomes 25.0 m above the river bed. In order to release the flood discharge during the construction period, an open river diversion is provided. The spillway is designed on the left bank of the main dam to release the flood discharge of 107 m ^{3}/sec from the catchment area of 12.6 km^2 . For the purpose of supplying irrigation water to the beneficiary area, such related facilities are provided as an intake structure in the reservoir, water supply pipe with a diameter of 260 mm below the dam body and valve house at the downstream of the main dam.

The principal features of Ncoha II Embung are summarized below.

(1)	Reservoir	
	- Catchment area	12.6 km^2
	- F.S.L.	El. 49.0 m
	- Minimum operating level	El. 36.9 m
	- Effective storage capacity	1,024,000 m^3
	- Dead storage capacity	196,000 m^3
	- Gross storage capacity	1,220,000 m^3
	- Sediment deposition level	E.. 35.9 m
(2)	Main dam	
	- Type	Zone-fill dam
	- Height	25.0m above river bed
	- Crest elevation	El. 52.0 m
	- Crest length	400 m
	- Crest width	7.0 m
	- Upstream slope	1 : 2.5
	- Downstream slope	1 : 2.0
	- Total embankment volume	455,000 m^3
(3)	Spillway	
	- Design flood (1/100 year)	107 m^3/sec
	- Type	Side-channel
	- Crest elevation of overflow weir	El. 49.0 m
	- Width of overflow weir	50.0 m
	- Discharge capacity	110 m^3/sec
	- Overflow depth	1.0 m
	- Length	360 m
(4)	River diversion	
	- Design flood (1/5 year)	73 m^3/sec
	- Type	Open channel
	- Diameter	10.0 m x 4 m
	- Length	250 m
(5)	Water supply system	
	- Inlet structure	1.0 x 1.0 m with trashracks
	- Pipe diameter	ϕ 260 mm pipe culvert
	- Length	130 m
	- Design discharge	160 lit/sec
	- Valve house	Right abutment of dam site

-	Type	Through valve
-	Diameter	ϕ 260 mm
-	Outlet elevation	El. 35.0 m

5. PRELIMINARY DESIGN OF FACILITIES

5.1 Preliminary Design of Embung

(1) Dam height

Resulting from the optimization study based on irrigation benefit and construction cost, the dam height is decided on the basis of "Reservoir Storage Curve" as shown Figure 4.1.

(2) Freeboard

The freeboard of main dam is designed taking into consideration the rise of the reservoir water surface due to extraordinary flood discharge and wave uprush on the slope.

The following formula is applied for the design of Ncoha II Embung.

$$Hf = 0.05h + 1.0 \text{ (m)}$$

where, Hf : freeboard
h : height from river bed to the designed flood level.

(3) River diversion tunnel during construction

During the dam construction period, river flow including floods has to be diverted to avoid inundation of the Embung construction site. This can be effectively and economically made by providing a random-filled cofferdam and an open channel river diversion with a trapezoidal shape of 10 m in width and 4 m in height. A 5-m high cofferdam with a crest level of El. 32.0 m would suffice to contain the flood inflow of 73 m^3 /sec having a return period of five years.

(4) Spillway

The spillway is located on the left abutment of the main dam, which is composed of side channel type overflow weir, throughway and chuteway. The over flow weir is designed to cope with the inflow design flood with a flood surcharge space provided above F.S.L. The inflow design flood is determined at 100 year probable flood having a peak discharge of 107 m^3/sec.

Based on comparative study on combination of overflow depth and width of the spillway, the overflow depth at 1.0 m and the width of 50 m are decided so as to minimize the costs of the spillway and the main dam.

A non-gated ogee crest would be set at El. 49.0 m to coincide with F.S.L. A bridge would be provided over the throughway of the spillway.

(5) Water supply system

In order to supply the water to the downstream irrigation area, the water supply system is provided to release the water of 160 lit/sec. The water supply system consists of intake structure, pipe line and valve house. The intake structure is located at the front of diversion tunnel above the sediment deposition level of El. 35.9 m. Fixed trash racks are provided on the intake structure. Pipe culvert with a diameter of 260 mm is connected from the intake structure to the downstream through the main dam foundation.

A value house would be constructed near the downstream toe of the dam. The guard valve and control devices with a diameter of 260 mm would be installed in the valve house.

5.2 Preliminary Design of Irrigation Facilities

(1) Basic concept

The following basic concepts are applied for the preliminary design of irrigation facilities in line with the development strategy:

- Irrigation area is defined taking into consideration the available cropped field and the effective storage capacity of Embung;
- Irrigation canals from the outlet of Embung to the head of existing cropped field is constructed in the form of open channel as much as possible from the economic viewpoint;
- Irrigation system in the existing cropped field is be developed by farmers themselves, as the irrigation system commands around 50 ha only. No consideration is taken into in terms of new land reclamation;
- Proper design of canal alignment for gravity irrigation is considered paying special attention to avoid adverse effect on environment; and,
- Drainage improvement is not required for the existing cropped field since the beneficiary area is situated on well drained land.

(2) Irrigation plan

The water taken from the reservoir is led to the valve house through the cast iron pipe provided in the right abutment of the dam.

Irrigation water is discharged to the irrigation inlet box next to the valve house to make the open flow from the pipe pressure flow. The water is divided into two flows by the turnout next to the irrigation inlet box. One is led to wet paddy field on the right bank of the Nggembe river by the newly constructed irrigation canal. The other is discharged to the river and then is taken by the existing weir situated at 500 m downstream from the dam axis to irrigate wet paddy field on the left bank of the river. Irrigation water taken from the weir is led to the downstream wet paddy field by the existing irrigation canal and newly constructed irrigation canal.

General layout is shown in Figure 5.1 including the layout of irrigation canals.

(3) Design discharge and initial water level

Design discharge for canal and related structures are decided based on the irrigation water requirement and proposed cropping pattern. Peak semi-monthly base diversion requirement for the unit irrigation area of 1.0 ha is defined as a design discharge after multiplying the irrigation area. Peak diversion requirement occurs in the first half month of January for paddy crop and its design discharge is estimated at 160 lit/sec for the net irrigation area of 145 ha. This design discharge is enough to flow design discharge for the dry season Palawija crops of net area of 145 ha at peak time.

Initial water level at the irrigation inlet box is decided taking the elevation at the box site into consideration. As a result, the initial water level is El. 35.0 m at the irrigation inlet box.

(4) Irrigation facilities

The proposed canal layout and design of irrigation facilities are made based on the 1/5,000 topographic map prepared under the Study and in accordance with the following conditions:

- Canal alignment should be straight and short as much as possible.
- The alignment should be planned so as not to pass through villages and not to give damages to public facilities.
- The types of canal related structures should be minimized as much as possible.
- The structures should be simplified as much as possible.

Irrigation canal to lead the water to the existing paddy field is constructed by the stone masonry canal with a trapezoid section taking into account the design discharge of the canal, steep topographic condition, construction method and available construction materials in the area. Canal related structures required are irrigation inlet box, turnouts, siphon, cross drain and irrigation division boxes. Required irrigation facilities are summarized below.

Irrigation Facilities Requirement

Facilities	Quantities
- Valve house (including in the facilities for Embung)	1 No.
- Irrigation inlet box	1 No.
- Masonry canal to be constructed	3.0 km
- Masonry canal to be rehabilitated	1.2 km
- Turnout	3 Nos.
- Siphon	1 No.
- Cross drain	1 No.
- Irrigation division box	29 Nos.

6. EMBUNG CONSTRUCTION PLAN

6.1 Construction Schedule

(1) Basic condition

All the construction works will be carried out by a local contractor selected by local competitive bidding.

The construction plan is based on the mode of construction and the target schedule of construction works as well as local conditions such as availability of construction labor, material and equipment, as well as weather and topographic conditions of the construction site.

It is assumed that 200 working days per year are available for conducting the earthfill embankment works, 270 days per year for the filter and rock embankment works and 300 days per year for concreting works in view of the daily rainfall distribution in the Project area. For each working day, 8-hour shift is applied.

(2) Construction schedule

The overall construction schedule is determined as shown in Figure 6.1 taking into account the necessary time of detailed design, bidding procedure including the time of tender evaluation and award of the contract. The major points of construction schedule are described below.

1) Mobilization and preparation works

Immediately after received the "Notice to Proceed", the contractor would commence the mobilization of the construction equipment and key staffs to the site from beginning of November in the first year. Following the above, preparatory works would be commenced at the Project site.

2) Setting out and excavation works

During the mobilization, setting out of all the structures would be commenced by the contractor at the Project site. Construction of temporary access roads such as access to the borrow area and access to major structural sites shall be started by using equipment available at the Project site. The excavation works for the river diversion channel and the main dam would be commenced at the beginning of March in the second year.

3) Embankment works and excavation of spillway and water supply conduit

After the river water diverts into the diversion channel around June in the second year, embankment works for the main dam shall be commenced and completed before the wet season in the third year. Excavation works for the spillway and water supply conduit shall also be commenced and completed before October in the second year.

4) Concrete works of spillway and water supply conduit

Concrete works of the spillway will be commenced in March and completed before October in the third year. Concrete works of the water supply conduit will be completed before re-starting the embankment works of the main dam in the dry season of the third year.

5) Commencement of reservoir water impounding

Commencement of the reservoir water impounding will be done at beginning of October in the third year after completion of the main dam embankment and spillway construction. Considering the rainfall in November and December in the third year, the Ncoha II reservoir would be quite full, the water can be supplied from the reservoir to the water users from January in the fourth year.

6) Water distribution system

Construction works for the water distribution system will be executed in parallel with the Embung construction works by using mainly manpower because the work quantities are not so much. These works shall be completed by the end of December in the third year before supplying the reservoir water to the beneficiary area.

6.2 Construction Plan of Embung

(1) Preparatory works

The preparatory works consist of preparation of temporary buildings, construction plant and repair shop, arrangement power and water supply systems as well as communication system, construction of access and haul roads, and so on. All of these works will be conducted from November in the first year to February in the second year.

1) Temporary buildings and yards

The temporary buildings required for the construction would include office, quarters, workshop, warehouse and storage yards. These temporary buildings will be built by the contractor.

2) Water and power supply

The water required for the construction works and the daily use in the construction camp is planned to be taken from the rivers or springs near the Embung site or the wells drilled in the contractor's yard.

The electric power for the construction camp is planned to be supplied by the contractor's diesel generators.

(2) River diversion works

The river flow will be released through the river diversion channel provided along the right bank during the second and third year.

In the dry season of the third year, the river diversion channel below the main dam will be filled by the embankment materials of the main dam. In this period, the river water shall be released to the downstream through the water supply conduit to be constructed before the dry season in the third year.

(3) Main dam works

Following the foundation excavation and completion of the river diversion channel, the dam embankment will be commenced at beginning of July in the second year. Considering a total embankment volume of 455,000 m^3 and the dry season in the second and

third year, the daily embankment volume is to be 2,000 m^3 which is quarried from the borrow area and the quarry site around the Embung construction site.

(4) Spillway construction

Excavation of the spillway will be scheduled to be performed about five months from March to September in the second year. Most of the excavated materials may be used for the main dam and saddle dam embankments so that the excavated materials will be stocked on the designated area.

After completion of the spillway excavation, concrete works for overflow weir and chuteway will be commenced. Before starting the reservoir water impounding at the beginning of October in the third year, major concrete works of the spillway shall be completed in order to release the flood discharge in the following wet season.

(5) Water supply system

Inlet structure of the water supply system is constructed above the sediment load disposition level of El. 35.9 m. Connecting with the inlet structure, pipe culvert with a diameter of 260 mm is constructed up to the downstream end of the main dam. Construction of the water supply conduit should be completed before re-starting the main dam embankment at the beginning of March in the third year.

The valve house of the water supply system will be constructed before the reservoir water reaches to F.S.L of El. 49.0 m around the end of December in the third year.

6.3 Construction Plan of Irrigation Facilities

Since the irrigation facilities to be constructed are rather small in work quantities and scattering in the beneficiary area in comparison with the Embung construction works, almost all the works except earth works for irrigation canal will be basically executed by man power. Earth works for the irrigation canal such as clearing, stripping, excavation and embankment works will be executed by using heavy construction equipment including bulldozer, excavator, compactor, and so on. All of works will be executed in parallel with the Embung construction works.

6.4 Institutional Arrangement for Project Implementation

(1) Responsible organization for Project implementation

In the course of Project implementation, DPUP of NTB, after getting approval from DGWRD, will direct the PKSA Sumbawa Project Office to commence undertaking of detailed investigation work of the Ncoha II Embung. This work will be done by the Survey Section of the said Project Office. Under the PKSA Sumbawa Project Office, the Sub Project Office in charge of East Region of Sumbawa will be responsible for carrying out detailed design work. Based on the cost estimate, DPUP of NTB will disburse budget for land acquisition and construction of Embung and related facilities to the Project Office using development budget allocated from the Central Government. Before starting construction work, land acquisition work will be carried out by the Land Acquisition Section of the Project Office. Supervision of construction works, being entrusted to a contractor through tendering, will be the responsibility of the said Sub Project Office.

(2) Technical resources input

In due consideration of the current availability of engineers and technical staff as well as the annual development target in the PKSA Sumbawa Project Office, it is necessary to

utilize technical resources outside the Project Office to the maximum extent for enabling the Project Office to realize its target. In this connection, undertaking of detailed investigation and design works for the Ncoha II Embung need to be entrusted to consultants aiming to secure smooth implementation of the Project in accordance with the implementation program made by the Project Office.

(3) Organization for O&M

After completing all of Project works for Ncoha II Embung, DPUP of NTB will submit its completion report to the Minister for Public Works through DGWRD and therefrom the notice of Project completion will be transferred to the Minister for Home Affairs. After receiving the Minister's direction, the Governor of NTB Province will order DPUP of NTB to take a necessary action for O&M of the said Project facilities. Following this, DPUP of NTB will direct its Provincial O&M Project Office to arrange O&M works and disburse the Provincial Government's budget to DPUP Kabupaten Bima Office.

(4) Water User's Association (P3A)

In the Project area, the existing P3A has been active since 1990. It is therefore necessitated to make the new beneficiary farmers become members of this P3A and to train them by using training materials and modules prepared by the Water User Training Program under DGWRD.

7. COST ESTIMATE

7.1 Basic Assumption of Cost Estimate

Project cost of the proposed works for developing the Ncoha II Embung is estimated on the basis of assumptions as follows :

- All the civil works of the Project will be executed on the contract basis. Contractor(s) will be selected through the competitive bidding;
- Project cost includes the physical contingency of 15% of the construction costs in view of the preliminary nature of the estimate. The price contingency of 20% is also included in the cost estimate taking into account the recent price escalation of construction materials in Indonesia;
- The associated costs to be financed by the Government, such as the cost for strengthening the extension services, facilities of the Water Users' Association and improvement of the social infrastructures except for those included in the proposed Project works, are not included in the cost estimate;
- The direct construction cost is estimated based on the calculated work quantities of the Project works and unit prices of the works. The unit prices of the works are estimated based on the current prices in NTB as of October 1994 and the data collected from the on-going projects in NTT and NTB. The basic prices for construction works include delivery cost of construction materials to the Project site;
- The contract tax, which is a value added tax imposed by the government at a rate of 10% against the total contract cost, is included in the estimate of the Project cost;
- Engineering service cost for the consultants in conducting detailed design and construction supervision is estimated based on such assumption as 15% of direct construction cost;
- Administration cost consists of PRWS's staff salary for construction management, vehicle running cost and other related cost only for the Project implementation. Administration cost is estimated at around 5% of the direct construction cost with reference to the recent other project costs in NTT and NTB;
- Land acquisition cost including the purchase of the Embung site, reservoir area, borrow areas, and land of pipe line, irrigation canal and permanent structures and is estimated at 0.5 % of the direct construction cost taking into consideration the present condition of the Project area based on the survey results under the Study; and,
- The currency for cost estimate is expressed in Indonesian Rupiah (Rp.) since all construction materials are available in Indonesia and the payment for construction works will be executed with Indonesian Rupiah.

7.2 Construction Cost

The Project cost, as an initial investment by the Project, is composed of direct construction cost, administration cost, engineering service cost, physical contingency, contract tax, land acquisition cost and price contingency. The total Project cost for constructing the Ncoha II Embung is estimated at Rp. 15,531 million as shown in Table 7.1. Detail of direct construction cost estimated based on the calculated work quantities of the proposed Project works and unit prices of the works is shown in Table 7.2 together with work quantities of the main work items and unit prices.

The total Project cost for constructing the Ncoha II Embung is summarized below.

Summary of Project Cost for Ncoha II Embung

Unit : Rp. Million

Item		Project cost
I.	Direct construction cost	8,526
1.1	Preparatory works	406
1.2	Embung construction	7,807
1.3	Irrigation facilities	313
1.4	Domestic water supply	0
1.5	Operation & maintenance road	0
II.	Administration cost	426
III.	Engineering services	1,279
IV.	Physical contingencies	1,535
V.	Contract tax	1,134
VI.	Land acquisition	43
VII.	Price contingency	2,588
	Grand Total	15,531

7.3 Operation and Maintenance Cost

The O&M costs consist of salaries of O&M staff, cost for maintaining the Project facilities, material and labor cost for repairing works, and running cost of Project facilities. The annual O&M costs are estimated at Rp. 77.7 million, which is equivalent to 0.5 % of the Project cost.

8. PROJECT JUSTIFICATION

8.1 Satisfaction of BHN

As no water demand for domestic and livestock use by the beneficiary inhabitants, no social impact can be expected in the Project area by the development of Ncoha II Embung at the proposed site on the Nggole river.

8.2 Economic Consideration

(1) Economic cost

The financial costs are to be converted into the economic costs by applying the economic conversion factor (ECF) established by DGWRD in 1985. The ECFs applied are: 0.71 for preparatory works and all civil works including Embung, irrigation facilities, domestic water supply system and road networks; 0.75 for unskilled on-farm labor and farm labor; 0.80 for land clearing, on-farm development and operation and maintenance cost; and tertiary irrigation system development, 0.90 for design and survey works and administration; and 1.00 for O&M equipment and replacement cost.

When the financial cost is converted to the economic cost, the contract tax, land acquisition cost and price contingency are fully excepted. In this Study, only the purchasing cost of consumables and goods appropriated in the administration cost is to be converted to the economic administration cost, as the normal payment to civil servants is principally appropriated in the operation budget of the Government. As the construction cost of dam and engineering cost estimated include some allowance to cover additional cost for expatriates, 50% of the engineering cost is to be converted to the economic cost in order to make the estimated cost equal to the level of local cost.

The economic cost converted and its annual disbursement schedule are shown in Table 8.1.

(2) Economic benefit

The irrigation benefits of the Project are principally derived from increased crop production attributable to stable irrigation water supply, full utilization of available farm land resources and optimum farm input supply. Table 8.2 gives financial and economic prices of farm inputs and outputs estimated for major islands. Based on the proposed quantity of farm inputs, anticipated crop yield and economic farm gate prices, the economic crop budget is estimated as shown in Table 8.3.

The annual net incremental benefit is thus estimated to be Rp. 555.3 million. This increment benefit will accure from the first year when irrigation water can be released from the Ncoha II Embung. Taking the present agricultural situation and farmers capability into account, it is assumed that five years are needed as the build-up period to attain the anticipated crop yield level. In the proposed reservoir area, rainfed paddy field of 3 ha will be under the reservoir water after completion of the proposed Ncoha II Embung, the total amount of production foregone is estimated to be around Rp. 1 million.

(3) Economic evaluation

The economic internal rate of return (EIRR) is examine as shown in Table 8.4 on costs and benefits as at August 1994. The result of economic analysis shows that EIRR is 4.3%, but the proposed Ncoha II Embung Project would still have a significant positive impact on the development of the economically depressed area within Sumbawa island as it can be expected to increase paddy production by 363 tons or 2.3 times and to enhance cash

income source by introducing irrigated cultivation of red onion with very high demand in local markets of urban areas.

(4) Farm budget analysis

With the implementation of Ncoha II Embung Project, the net on-farm income of farmers holding a unit farm size of 1.0 ha can be expected to increase by Rp. 5,192,600/year from Rp. 519,200/year under the "Without Project" condition with the cropping intensity of 114% to Rp. 5,711,800/year under the "With Project" condition with the cropping intensity of 300% as shown in Table 8.5 and below. Such improvement of farm budget would give much incentive for farmers to make further investment in improvement of their living standard and also could increase their payment capacity enabling beneficiary farmers to pay irrigation water charge to some extent.

Farm Budget for Unit Farm Size of 1 Ha

Crop	Watering Condition	Without Project		With Project	
		Crop Intensity (%)	Income (Rp.)	Crop Intensity (%)	Income (Rp.)
Paddy	Wet/Rainfed	72.4	300,279	-	-
	Wet/Irrigated	27.6	155,526	100.0	926,375
Mungbean	Dry/Rainfed	13.8	63,386	-	-
	Dry/Irrigated	-	-	100.0	1,074,420
Red onion	Dry/Irrigated	-	0	100.0	3,711,000
Total		113.8	519,191	300.0	5,711,795

8.3 Environmental Impact Assessment

Environmental impact assessment for the Project is carried out in consideration of the development objectives of the Project..

(1) Environmental features of the Project area

The principal features of human and physical environment in the Ncoha II Project area are summarized as below.

Environmental Features in the Ncoha II Project Area

Item	Description
1. Human Environment	
Social intention	Insufficiency of reliable water sources and facilities for irrigation water
Human use	Use of well water
Economic activities	Cultivation of rainfed paddy and Palawija, and livestock farming
Health and sanitation	Occurrence of waterborne intestinal diseases
2. Physical environment	
Geology/land	Volcanic products of the Quaternary
Surface/ground water	Surface water is not perennially observed
Endemic fauna and flora	None
3. Others	None

(2) Environmental Impact Assessment

The results of environmental impact assessment reveal that there exist no negative impacts by Embung development in this Project area. But the land of 3 ha in the proposed

reservoir area is utilized as cultivation, so that it is necessary that the land is expropriated. In Indonesia, expropriation of the land regarding development Project is usually carried out by means of recommending an alternative land. In case of this Project, it is expected that the alternative land resources are ensured in the beneficiary area of the Project. Therefore, the land users can acquire more agricultural productivity than current status by means of a stable irrigation water supply. Since most of the land users of the proposed reservoir area live in the beneficiary area, they will not be affected by social friction such as discord among inhabitants in the beneficiary area.

(3) Primary information of environmental assessment

To support environmental analysis presentation for this Project implementation on the Indonesian rule, primary information on environmental assessment is compiled in the Attachment to the Volume 4.

8.4 Contribution to Women in Development

Since housewives in the Project area manage their family budgets, an increase of the farmer's income would encourage women in investing surplus in improvement and diversification of their income sources.

9. CONCLUSION AND RECOMMENDATIONS

9.1 Conclusion

On the basis of categorization of 157 candidate schemes for the Study, the Ncoha II Embung scheme is selected representing a typical sample scheme of which potential beneficiary area has its irrigation water intake on the source river of the proposed Embung, partly irrigated farming system and inhabitants' demand for further use of irrigation water. The proposed Ncoha II Embung site has physically irrigable land resources of 145 ha in net and the annual discharge of 4.7 MCM from its catchment area of 12.6 km^2.

As there is no limitation in the topographic condition and the availability of water resources, the future water demand for irrigation use in the beneficiary area is the determining factor in the optimization of development scale. To cover the physically irrigable area by gravity method to the maximum extent, the dam height of Ncoha II Embung is thus set to be 25.0 m with the total and effective storage capacities of 1.22 and 1.02 MCM, respectively. Under such condition, it can be expected to practice irrigated cropping of the wet season paddy followed by double cropping of high-valued Palawija crops under the irrigated condition for the dry season in the beneficiary area.

The structural components are main dam, spillway and irrigation water distribution system. The zoned embankment dam is constructed with the crest length of 400 m, embankment volume of 455,000 m^3 and side-channel typed spillway having design flood discharge of 107 m^3 /sec and overflow weir width of 50 m. The required investment cost amounts to Rp. 15.5 billion of which direct construction cost is estimated to be 8.5 billion.

The results of feasibility study reveal that construction of the candidate Embung at the proposed site is technically sound but economically marginal because no more availability of irrigable land coupled with requirement of a large embankment volume. Therefore, such type of Embung is worth implementing from the technical viewpoint but needs further socio-economic justification paying special attention to policy issues to reduce the economic gap and to eradicate poverty both predominant in NTB.

9.2 Recommendations

In the intensification of the farming system to the target level with the cropping intensity of 300%, it is recommended to improve farming practices and on-farm irrigation water management skills of the beneficiary farmers through strengthening of agricultural extension services and water management training programs.

The Study on The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara

Feasibility Study on Ncoha II Embung Development Project

Tables

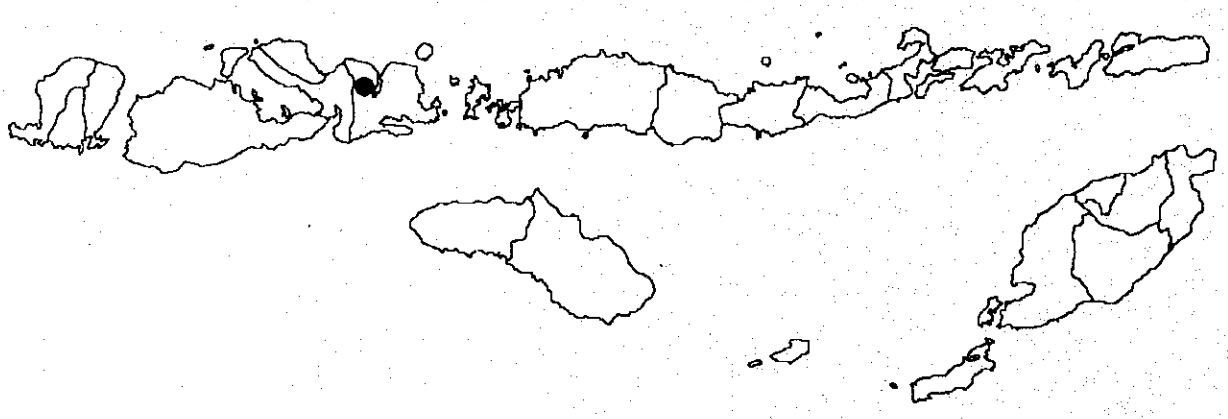

Table 1.1 Rainfall Record in Sila

Station : Sila
Kec./Kab. : Bolo/Bima
Elevation : + 20 m
Location : BT 118 37 55
LS 08 28 00

Year	Jan.		Feb.		Mar.		Apr.		Mei		Jun.		Jul.		Ags.		Sep.		Okt.		Nop.		Des.		Annual	Daily Max.
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II		
1970	80	121	138	156	66	10	6	74	13	12	15	0	0	0	0	0	5	2	5	0	158	100	63	60	1,084	53
1971	86	214	93	93	55	214	12	23	14	14	5	7	7	0	0	0	0	0	0	32	92	108	137	132	1,338	110
1972	50	13	36	24	125	33	26	4	0	0	0	0	0	0	0	0	0	0	0	0	0	15	234	48	608	98
1973	99	82	120	89	90	72	40	22	50	64	0	6	6	0	0	0	2	8	0	6	140	75	48	95	1,114	68
1974	64	40	80	220	62	10	41	10	10	4	0	0	0	6	0	0	2	0	3	32	54	148	82	103	971	61
1975	69	49	64	17	41	134	143	43	42	15	0	0	0	0	0	0	18	3	17	138	26	78	135	55	1,087	107
1976	125	5	117	31	149	37	11	0	0	0	0	0	0	0	0	0	0	0	0	78	5	78	175	116	927	108
1977	135	218	93	179	94	84	55	0	12	0	0	0	0	0	0	0	0	0	0	0	0	26	122	112	1,130	84
1978	190	63	88	169	49	172	49	6	2	18	24	17	27	3	7	10	13	10	20	33	47	16	40	83	1,156	87
1979	98	130	21	108	101	2	0	0	53	31	16	0	0	0	0	0	0	0	0	0	0	0	0	0	560	41
1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	3	85	138	101	-	-
1981	107	51	224	68	89	48	13	0	40	11	46	0	0	0	0	0	25	23	8	0	89	95	79	32	1,048	57
1982	140	70	79	132	113	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	26	-	-
1983	208	0	43	36	66	35	66	13	10	2	1	0	0	0	0	0	0	0	17	80	27	237	8	41	890	64
1984	69	91	296	108	73	115	59	53	45	8	0	13	0	0	4	0	27	48	12	2	32	52	100	0	1,207	85
1985	0	247	57	179	248	9	1	41	0	13	19	0	0	0	0	0	0	0	0	9	1	106	135	14	1,079	107
1986	282	54	129	141	65	51	94	53	0	0	13	31	0	0	0	0	14	0	0	76	27	50	116	13	1,209	58
1987	138	150	109	116	3	34	4	44	0	0	9	4	3	0	0	3	0	0	0	0	12	104	435	154	1,322	97
1988	46	203	84	15	41	194	35	3	26	3	7	0	0	0	0	0	4	0	58	13	33	157	67	98	1,087	73
1989	63	76	60	124	28	84	12	15	13	23	26	55	2	24	0	0	0	0	0	42	31	39	178	17	912	60
1990	194	222	149	118	139	24	0	7	20	0	3	0	6	0	0	0	0	0	2	20	0	7	128	210	-	-
1991	272	153	116	96	6	5	152	48	0	0	0	0	21	4	0	0	0	0	0	0	26	84	27	28	1,038	60
1992	166	60	25	122	110	15	12	67	3	20	0	0	0	0	0	0	0	0	0	0	46	83	238	103	1,070	88
1993	0	67	55	32	82	67	28	11	7	4	0	26	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rata-rata	117	104	99	103	82	64	39	24	16	11	8	7	3	2	1	1	5	4	6	26	39	79	122	73	1,036	-

note. : x => data not available

Table 1.2 Climate in Godo

Station : Godo
Kec./Kab : Woha / Bima
Elevation : + 5 m
Location : BT. 118 38' 30"
LS. 08 32'00"

Description	Unit	Jan.	Feb.	Mar.	Apr.	Mei	Jun.	Jul	Ags.	Sep.	Okt.	Nop.	Des.	Annual Mean	Year
Mean Temperature	C	28.1	28.0	28.0	28.1	27.9	26.9	26.3	26.5	27.7	29.0	29.2	28.4	27.8	1976 - 1985
Mean Maximum Temperature	C	32.6	32.3	32.6	33.4	33.1	32.1	28.2	32.7	34.0	35.6	35.4	33.7	33.0	1976 - 1985
Mean Minimum Temperature	C	23.8	23.6	23.5	22.8	22.4	21.5	20.8	20.4	21.1	22.1	23.6	23.3	22.4	1976 - 1985
Mean Relative Humidity	%	88.0	89.0	88.0	86.0	86.0	85.0	84.0	81.0	80.0	82.0	83.0	86.0	84.8	1976 - 1985
Mean Maximum Relative Humidity	%	94.0	94.0	95.0	95.0	93.0	91.0	90.0	89.0	88.0	87.0	89.0	92.0	91.4	1976 - 1985
Mean Minimum Relative Humidity	%	78.0	80.0	78.0	73.0	72.0	73.0	73.0	68.0	66.0	67.0	71.0	74.0	72.8	1976 - 1985
Mean Dew Point	C	25.2	24.8	25.1	24.8	24.4	23.5	22.9	22.5	23.4	24.8	25.5	25.2	24.3	1976 - 1985
Mean Sunshine Hours	%	33.0	36.0	47.0	60.0	62.0	60.0	65.0	70.0	69.0	66.0	53.0	40.0	55.1	1976 - 1985
Mean Solar Radiation	Cal/Cm2	294.0	295.0	316.0	312.0	288.0	281.0	291.0	309.0	351.0	345.0	338.0	310.0	310.8	1976 - 1982
Mean Wind Velocity	Km/hr	3.7	3.2	3.0	3.1	4.5	5.9	6.9	6.4	6.7	6.4	5.0	3.3	4.8	1976 - 1985
Mean Evaporation	mm/day	5.3	4.8	5.5	6.3	6.8	6.8	7.4	8.2	8.9	9.8	8.6	6.1	7.0	1976 - 1985
Mean Monthly Rainfall	mm	187.0	171.0	137.0	60.0	51.0	16.0	17.0	8.0	12.0	19.0	119.0	188.0	985.0	1977 - 1985

Table 1.3 Typical Soil Profile in the Ncoha II Project Area

Profile No.:	3
Soil Classification:	Ustic Endoaquerts
Physiography:	Alluvial fan
Topography:	Flat (1 - 3%)
Land Use/Vegetation:	Paddy field
Parent material:	Basaltic/Calcitic rock
Drainage:	Moderate
Groundwater Table:	
Permeability:	Slightly slow (1.80 cm/hr)
Land Morphology:	

Horizon	Depth (cm)	Description
Ap	0 - 22	Dark gray (10YR 4/1, dry); clay; storong, prismatic, coarse structure; very sticky, very plastic consistency; many, fine root; many organic matter; many CaCO3; clear, smooth horizon boundary
Bw1	22 - 86	Black (10YR 2/1, dry); clay; strong, prismatic, medium structure; very sticky, very plastic consistency; many organic matter; many CaCO3; gradual, smooth horizon boundary
Bw2	86 - 110	Black (10YR 1.7/1, dry); clay; weak, prismatic, medium structure; very sticky, plastic consistency; few organic matter; many CaCO3

Source: Soil survey carried out by the local consultant under supervision of the JICA Study Team

Table 1.4 Results of Soil Laboratory Test in the Ncoha II Project Area

Soil Pit	Layer	Texture			Permeability	pH	pH	Organic	Total N	Ava. P	CEC	Ex. Na	Ex. Ca	Ex. K	Ex. Mg	Base	EC
		Sand (%)	Silt (%)	Clay (%)	(cm/hr)	(H2O)	(KCl)	matter	(%)	(ppm)	(me/100g)	(me/100g)	(me/100g)	(me/100g)	(me/100g)	Saturation (%)	(mS/cm)
3	A	53.7	21.3	35.0	1.8	7.5	6.7	2.36	0.04	4.06	32.19	1.70	11.05	0.85	3.56	53	0.52
	Bw1	56.4	11.3	32.3	1.5	7.7	6.6	1.75	0.04	2.15	33.22	2.14	10.86	0.59	4.04	53	0.56
	Bw2	57.5	27.4	35.0		7.3	6.6	1.50	0.03	3.76	30.63	1.54	16.28	1.08	3.62	74	0.66
4	A	22.4	55.3	22.3	6.0	7.1	5.7	2.04	0.06	2.17	24.58	0.43	9.00	0.75	1.96	49	0.18
	Bw1	44.7	30.3	25.0	3.5	7.4	5.7	0.51	0.06	2.84	21.40	0.34	8.08	0.72	1.89	52	0.06
	Bw2	46.9	32.1	21.0		7.5	6.9	0.37	0.05	2.50	16.23	0.37	7.90	0.90	1.54	66	0.06
6	A	33.9	53.1	13.0	7.0	7.0	6.9	7.60	0.06	3.47	17.03	5.92	5.16	0.82	3.34	89	3.38
	Bw	46.8	40.2	13.0	3.5	7.3	6.9	1.06	0.04	3.16	14.51	1.80	5.95	1.25	3.32	85	0.52
	2A	70.4	13.3	16.3		6.8	6.5	11.15	0.02	3.50	15.80	1.46	8.98	0.24	3.43	89	1.96

Source: Soil survey carried out by the local contractor under supervision of the JICA Team

Table 1.5 Soil Classification in the Ncoha II Project Area

Land Unit	Description	Physiography	Topography	Potential Suitability			Area	
				Paddy	Soybean	Maize	(ha)	(%)
I	Typic Ustifluvents deep; coarse loamy; moderate CEC; neutral; moderate permeability; well drainage	Mountain foot slope	Undulating (5%)	S3	S2	S2	75	14%
II	Typic Ustropepts deep, coarse loamy; neutral; moderate CEC; moderate permeability; well drainage	Alluvial fan	Flat-undulating (1-4%)	S1	S1	S2	78	15%
III	Estic Endoaquerts deep; fine clay; neutral; high CEC; slightly slow permeability; poor-moderate drainage	Alluvial fan	Flat (1-3%)	S2	S3	S3	8	1%
IV	Typic Tropaquepts deep; coarse loamy, neutral; moderate CEC; slightly rapid permeability; moderate drainage	Alluvial fan	Flat (0-2%)	S2	S1	S2	12	2%
#	Unclassified						362	68%
	Total						535	100%

Source: Soil survey carried out by the local consultant under supervision of the JICA Team

Table 1. 6 Summary of Farm Household Economic Survey in the Ncoha II Project Area

	Item	Unit	Respond't No. 1	Respond't No. 2	Respond't No. 3	Respond't No. 4	Respond't No. 5	Respond't No. 6	Respond't No. 7	Respond't No. 8	Respond't No. 9	Respond't No. 10	Respond't No. 11	Respond't No. 12	Respond't No. 13	Respond't No. 14	Respond't No. 15	Average
1	Sex and Age		Male 56	Male 35	Male 43	Male 32	Male 37	Male 51	Male 35	Male 40	Male 26	Male 33	Male 55	Male 70	Male 52	Male 45	Male 40	Male 43
2	No. of Family Member		M-1/F-3	M-1/F-3	M-2/F-3	M-1/F-3	M-2/F-2	M-1/F-5	M-1/F-4	M-2/F-2	M-1/F-2	M-2/F-3	M-1/F-3	M-1/F-1	M-4/F-3	M-3/F-4	M-8/F-1	M-2/F-3
3	Type of Side Job		Civil Sv.	HC Driver	Entrepren.	Worker	Tailor	Civil Sv.	Seller	None	Entrepren.	Fishermen	None	Seller	Fishermen	Fishermen	Crafman	
4	Own Farmland	ha	4.32	1.35	1.08	0.32	3.13	4.32	1.34	1.32	1.14	0.42	6.03	2.73	0.27	1.77	2.02	2.10
	Rented Farmland	ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Yield Division	ha	1.35	0.00	0.00	0.00	0.00	1.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18
	(Paddy field)	ha	2.10	0.55	0.55	0.00	2.00	2.10	0.30	0.30	0.00	0.40	6.00	0.61	0.25	0.35	1.50	1.13
5	Cropped Area	ha	3.50	2.00	2.10	0.30	1.80	3.50	1.60	1.60	1.00	1.20	6.00	2.82	0.75	1.50	3.50	2.21
	(Paddy)	ha	0.75	0.50	0.80	0.00	0.40	0.75	0.30	0.30	0.00	0.40	2.00	0.61	0.25	0.35	1.50	0.59
	(Palawija)	ha	2.75	1.50	1.30	0.30	1.40	2.75	1.30	1.30	1.00	0.80	4.00	2.21	0.50	1.15	2.00	1.62
	(Others)	ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	Cow/Buffalo	head	2	3	2	0	0	10	10	5	0	0	5	19	7	5	10	5
	Horse	head	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Goat/Sheep	head	3	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Pig	head	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Chicken/Duck	head	7	20	5	9	27	0	0	0	0	10	0	21	9	10	0	8
7	Gross Income	Rp.'000/yr	3,582.0	2,040.0	2,149.0	846.0	4,578.5	3,582.0	1,505.0	1,488.0	1,320.0	1,423.0	6,590.0	3,735.4	870.5	2,140.0	2,141.0	2,532.7
	(Crop)	Rp.'000/yr	3,052.0	885.0	1,744.0	126.0	738.5	3,052.0	585.0	1,488.0	360.0	708.0	6,440.0	2,265.4	254.5	1,040.0	1,531.0	1,618.0
	(Livestock)	Rp.'000/yr	230.0	75.0	0.0	0.0	0.0	230.0	200.0	0.0	0.0	0.0	150.0	750.0	0.0	200.0	250.0	139.0
	(Side job)	Rp.'000/yr	300.0	1,080.0	405.0	720.0	3,840.0	300.0	720.0	0.0	960.0	715.0	0.0	720.0	616.0	900.0	360.0	775.7
	(Miscellaneous)	Rp.'000/yr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	Expenditure	Rp.'000/yr	3,610.3	2,500.3	2,283.5	862.7	2,269.3	3,610.3	2,551.1	2,628.5	1,805.3	1,718.8	4,641.5	2,861.3	2,893.7	2,471.3	3,555.6	2,684.2
	(Food/drink)	Rp.'000/yr	1,000.8	864.0	1,170.0	660.0	1,152.0	1,000.8	972.0	1,188.0	774.0	960.0	1,260.0	648.0	1,296.0	1,242.0	1,818.0	1,067.0
	(Living)	Rp.'000/yr	693.4	607.5	358.5	107.0	360.0	693.4	934.0	812.0	794.0	355.0	585.0	518.0	1,234.0	539.0	384.0	598.3
	(Education)	Rp.'000/yr	700.0	600.0	112.0	48.0	230.0	700.0	166.5	24.0	0.0	24.0	1,400.0	900.0	120.0	200.0	50.5	351.7
	(Production)	Rp.'000/yr	1,216.1	428.8	643.0	47.7	527.3	1,216.1	478.6	604.5	237.3	379.8	1,396.5	795.3	243.7	490.3	1,303.1	667.2
9	Surplus/Deficit	Rp.'000/yr	-28.3	-460.3	-134.5	-16.7	2,309.2	-28.3	-1,046.1	-1,140.5	-485.3	-295.8	1,948.5	874.1	-2,023.2	-331.3	-1,414.6	-151.5
10	Saving	Rp.'000/yr	120.0	0.0	0.0	0.0	90.0	120.0	120.0	0.0	120.0	0.0	1,500.0	180.0	72.0	0.0	60.0	158.8

Source : JICA Agro-economy Survey

Table 2.1 Estimated Evapotranspiration in Ncoha II Project

Site : Ncoha II
Meteorological Station : Godo

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
T mean	C	28.10	28.00	28.00	28.10	27.90	26.90	26.30	26.50	27.70	29.00	29.20	28.40
RH mean	%	88.00	89.00	88.00	86.00	86.00	85.00	84.00	81.00	80.00	82.00	83.00	86.00
U km/day	km/day	88.80	76.80	72.00	74.40	108.00	141.60	165.60	153.60	160.80	153.60	120.00	79.20
ea	mbar	37.80	37.59	37.59	37.80	37.38	35.28	34.02	34.44	36.96	39.87	40.33	38.49
RH/100		0.88	0.89	0.88	0.86	0.86	0.85	0.84	0.81	0.80	0.82	0.83	0.86
ed	mbar	33.26	33.46	33.08	32.51	32.15	29.99	28.58	27.90	29.57	32.69	33.47	33.10
(ea-ed)	mbar	4.54	4.13	4.51	5.29	5.23	5.29	5.44	6.54	7.39	7.18	6.86	5.39
f(u)		0.51	0.48	0.46	0.47	0.56	0.65	0.72	0.68	0.70	0.68	0.59	0.48
(1-W)		0.23	0.23	0.23	0.23	0.23	0.24	0.25	0.25	0.23	0.23	0.22	0.23
(1-W)f(u)(ea-ed)	mm/day	0.53	0.46	0.48	0.57	0.68	0.84	0.97	1.10	1.22	1.11	0.91	0.60
Ra	mm/day	16.40	16.30	15.50	14.20	12.80	12.00	12.40	13.50	14.80	15.90	16.20	16.20
n	hr/day	2.64	2.88	3.76	4.80	4.96	4.80	5.20	5.60	5.52	5.28	4.24	3.20
N	hr/day	12.60	12.40	12.10	11.80	11.60	11.50	11.60	11.80	12.00	12.30	12.60	12.70
(0.25+0.50n/N)		0.35	0.37	0.41	0.45	0.46	0.46	0.47	0.49	0.48	0.46	0.42	0.38
Rs	mm/day	5.82	5.97	6.28	6.44	5.94	5.50	5.88	6.58	7.10	7.39	6.78	6.09
Rns	mm/day	4.65	4.77	5.03	5.15	4.75	4.40	4.70	5.26	5.68	5.91	5.42	4.87
f(T)		16.30	16.30	16.30	16.30	16.26	16.06	15.94	15.98	16.22	16.50	16.54	16.38
f(ed)		0.08	0.08	0.08	0.08	0.09	0.09	0.10	0.10	0.10	0.08	0.08	0.08
f(n/N)		0.29	0.31	0.38	0.47	0.48	0.48	0.50	0.53	0.51	0.49	0.40	0.33
Rnl=f(T)f(ed)f(n/N)	mm/day	0.38	0.41	0.51	0.64	0.68	0.72	0.81	0.87	0.80	0.67	0.54	0.44
Rn =Rns-Rnl		4.27	4.37	4.52	4.51	4.07	3.68	3.90	4.39	4.88	5.24	4.88	4.43
W		0.77	0.77	0.77	0.77	0.77	0.76	0.75	0.75	0.77	0.77	0.78	0.77
W Rn		3.29	3.36	3.47	3.47	3.13	2.79	2.93	3.31	3.74	4.06	3.79	3.42
c		1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Eto	mm/day	4.20	4.20	4.35	4.45	4.19	3.99	4.29	4.86	5.45	5.68	5.17	4.42

Source : JICA Study Team estimation by Modified Penman Method based on the meteorological data at the Godo staiton.

Table 2.2 Effective Rainfall in Ncoha II Project

Site : Ncoha II
Meteorological Station : Sila

Month	Evapotrans-piration (ETo)	Average Rainfall		Annual-base Dependable Rainfall	Effective Rainfall	
					Paddy	Palawija
	[1] (mm)	[2] (mm)	[3] (%)	[4] (mm)	[5] (mm)	[6] (mm)
January	130	221	21.4%	188	132	121
February	117	202	19.5%	172	120	108
March	135	146	14.1%	124	87	85
April	133	63	6.1%	54	38	40
May	130	27	2.6%	23	16	18
June	120	15	1.4%	13	9	10
July	133	5	0.5%	4	3	0
August	151	2	0.2%	2	1	0
September	164	9	0.9%	8	5	0
October	176	32	3.1%	27	19	23
November	155	118	11.4%	100	70	75
December	137	195	18.8%	166	116	111
Total	1,681	1,035	100.0%	881	617	591

Note ;

[1] : Estimated by Modified Penman Method based on Godo station
[2] : Rainfall data in station compiled by P3SA (1970-1992)
[3] : Percentage of monthly rainfall to annual rainfall, calculated from column [2]
[4] : 881 mm (Calculated 80 % dependable annual rainfall) x [3]
[5] : [4] x 0.70
[6] : Derived by USDA SCS Method introduced by Design Criteria KP-01, where effective storage is assumed 75 mm

Source ; JICA Study Team estiamtin based on the rainfall data at the Sila statin