Japan International Cooperation Agency (JICA)

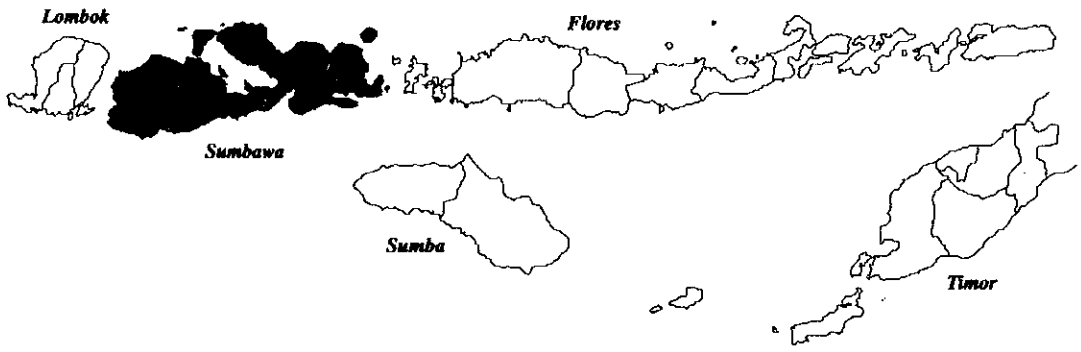
Directorate General of Water Resources Development, Ministry of Public Works

No. 52

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)

Feasibility Study Report
on
Four Embung Development Projects
in
Sumbawa Island in West Nusa Tenggara



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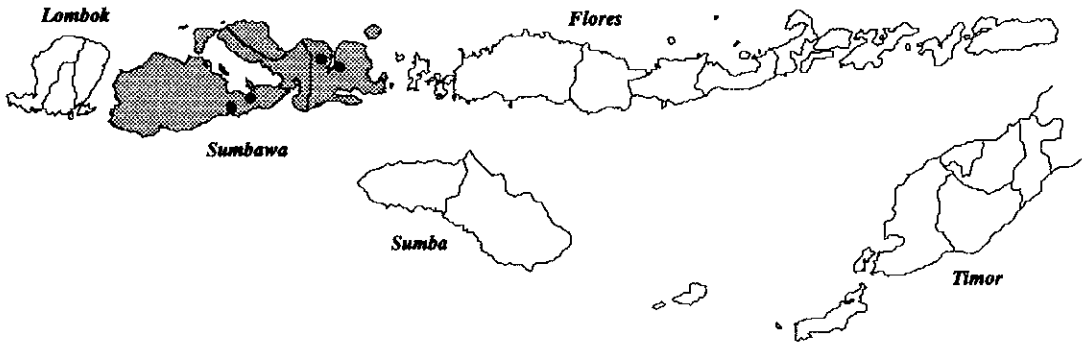

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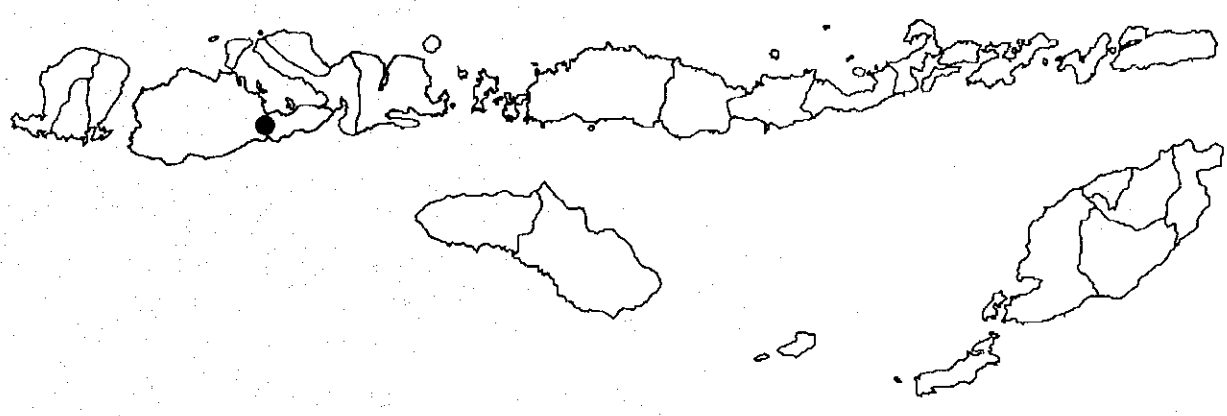

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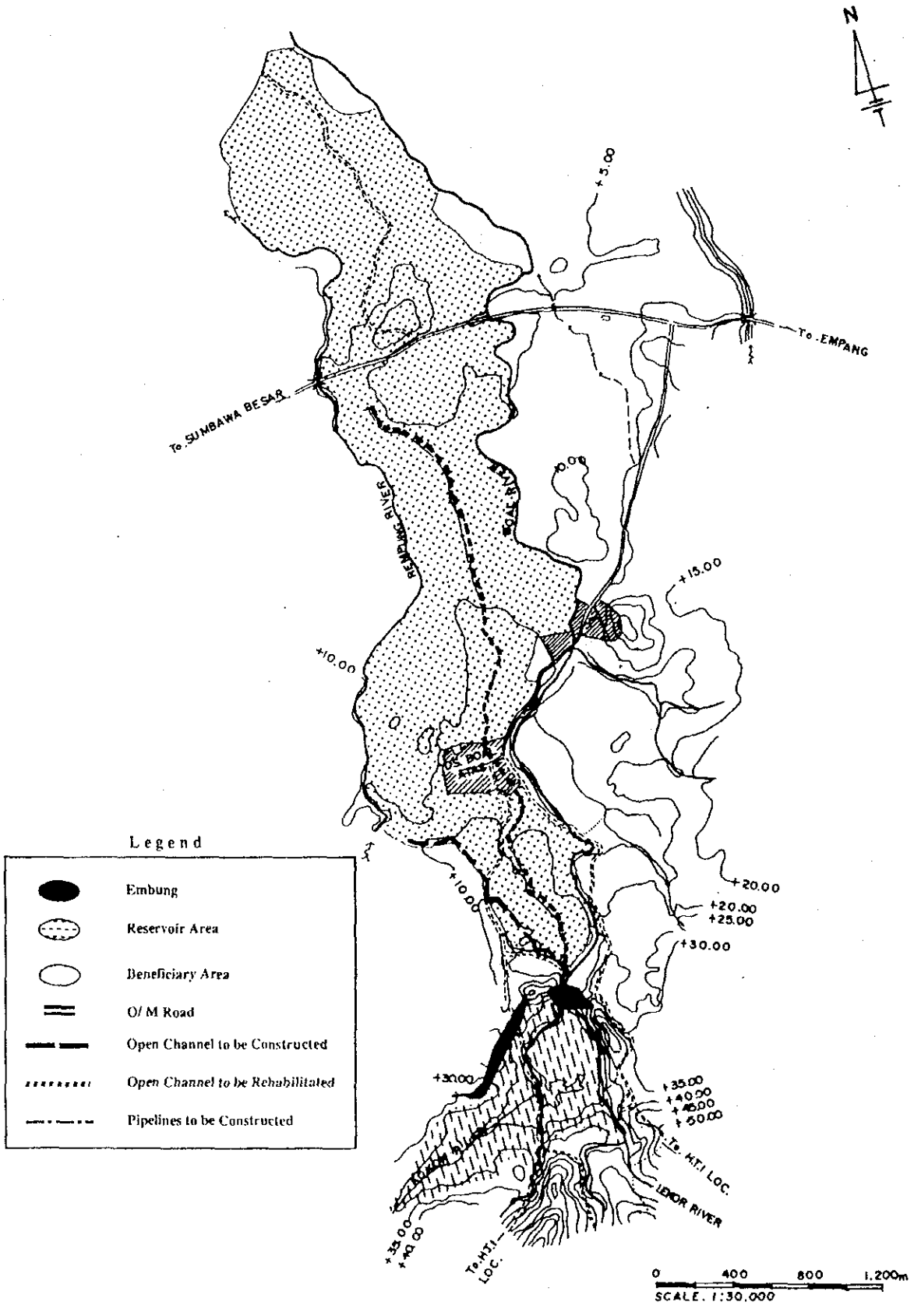

Location Map: TIU TUI

THE STUDY
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(SMALL SCALE IMPOUNDING POND DEVELOPMENT PROJECT)
IN
EAST NUSA TENGGARA AND WEST NUSA TENGGARA
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FINAL REPORT

VOLUME 9-1

FEASIBILITY STUDY
ON
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1. PRESENT SITUATION OF THE PROJECT AREA

1.1 Location and Topography

The Project area is located in Boal Village in Kecamatan Empang of Kabupaten Sumbawa. The proposed Embung site is located upstream of the Boal river, about 100 km east from Sumbawa Besar of Nusa Tenggara Barat (NTB).

Topographical condition of the reservoir area is very gentle having agricultural land and paddy field along the Boal river and its tributaries. Mountainous zone is covered by rough forest up to the watershed area.

Beneficiary area is located on the both sides of the Boal river until coastal zone of Kecamatan Empang.

1.2 Climate and Hydrology

The nearest climate station from the proposed Embung site is the Plampang station while there are another two rainfall stations near the proposed Embung site; Empang and Plampang. The wet season usually starts from late November and ends early April in the Project area with the average annual rainfall of 1,217 mm in Empang. Mean annual temperature is 27.8 °C with the average maximum temperature of 32.8°C and the average minimum temperature of 22.9 °C. Mean relative humidity is 85.1%. 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 5.8 km/hr. Tables 1.1 and 1.2 show monthly rainfall record at the Empang station and climate data at the Plampang station, respectively.

The Brang Tiu Tui rises near Mt. Oro Saranger where the altitude is approximately 600 m and follows a northeasterly course. Then it discharges into the Saleh Bay. The surface of the catchment area is mostly covered with forest. The catchment area at the proposed Embung site is 21.2 km^2. There is no gauging station on this river.

1.3 Geology

The proposed Embung site is underlain by volcanic rock of the Tertiary age and unconsolidated deposits of the Quaternary age. The geological formation is: andesitic tuff breccia composed of andesitic tuff breccia of the Tertiary age, moderately soft to hard rock.; terrace deposits composed of mainly sand and gravel forming terrace with flat to gentle slope; alluvium composed of sand, silt and gravel forming lowland; alluvium with a thickness of probably 0.5 to 2.5 m; and,. river deposits composed of sand, silt, gravel and boulder distributed along the existing river bed.

1.4 Soils and Land Use

The Project area of Tiu Tui lies on alluvial fan to alluvial plain of the Boal river. The west border of the Project area is the Rempung river and the east border is rolling hill and the Lamenta river. The land slope is about 1% along the river but the land is partly undulating or rolling.

Soils of the Project area extend on basaltic rock and mixed alluvial materials. Soil drainage of farmland is well and soil permeability is moderate to well. Soil depth is very deep recording more than 100 cm. Soil texture of surface soil is clay to sandy clay loam.

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

Relative low land is used as wet paddy fields with the coverage 453 ha or 57% of the Project area. Irrigation water is taken by the existing weir at the 100 m downstream of the proposed Embung site. The irrigation water supply is still unstable, and the area commanded is estimated at only 27 ha in the upper left bank area of the Boal river and 10 ha in the middle right bank area of the tributary. More than 400 ha of the paddy field are under the rainfed condition.

Upland and bush/scrub lie on relative high land because insufficient water is available for paddy even in the wet season. The area of upland field is 170 ha or 22% of the Project area.

Tree crops, mostly coconut are planted in only 8 ha of the coastal plain.

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

Present Land Use on the Project Area of Tiu Tui

Unit: ha

Land Use	Irrigated	Rainfed	Others	Total
Paddy field	37	416		453
Upland	0	170		170
Tree crops	0	8		8
Bush/Scrub/Grassland			140	140
Residential			15	15
Cemetery			4	4
Others			0	0
Total	37	594	159	790

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 3,477 and a total number of households of 782 including farm households of 721 as shown below. The average family size is 4.4 persons. Dominant ethnic is original Sumbawanese 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.)
Boal	Boal Atas	396	86	4.6	82
	Boal Bawah	405	99	4.1	99
	Gapit	1,308	207	6.3	200
	Nyarinying	219	40	5.5	40
	Lamenta	1,149	350	3.3	300
Total		3,477	782	4.4	721

Source : JICA Water Use Survey

1.6 Domestic Water Use

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

- In Boal Atas Sub-Village, all the inhabitants take their drinking water from 39 hand pump wells nearby their houses and livestock water from the Boal river 50 to 100 m away. The length of prevailing water shortage period is six months between June and November for drinking water and three months from September to November for livestock water;

- In Boal Bawah, Gapit and Lamenta Sub-Villages, all the inhabitants depend their drinking water on five hand pump wells nearby their houses. Livestock water sources are the Boal river 50 m away from Bola Bawah Sub Village, dug wells in Gapit Sub-Village and the Lemanta river 10 m away from Lamenta Sub Village. The length of water shortage problem is on the same level of Boal Atas Sub Village; and,

- In Nyarinyin Sub-Village, people get their drinking and livestock water from three hand pump wells at the maximum distance of 30 m. They are suffering from water shortage problem during the same period of Boal Atas Sub Village.

1.7 Social Infrastructures

The access from Mataram 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 private toilets outside their houses or the river bed for defecating purposes. There are an auxiliary hospital and an integrated health service center within the Project area.

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	25.0	33.0	5.9	130
(2) Paddy - Fallow	374.0	374.0	66.8	100
(3) Upland crop - Fallow	153.0	153.0	27.3	100
Total / Average	552.0	560.0	100.0	102

Source : The JICA Land Use Survey and Inventory Survey

(2) Farming practice and farm inputs

About one third of the irrigated paddy field, farmers practice two cropping of the irrigated wet season paddy and the rainfed dry season soybean as Palawija crop. Single cropping of the wet season paddy predominates on the remaining irrigated and rainfed paddy field. Major crops grown on dry upland are soybean and mungbean.

As for paddy, most farmers carry out land preparation with an animal-drawn plough and harrow their paddy field once or twice at the beginning of the wet season, while this work done by other marginal farmers depends on their own man power. High yielding rice varieties such as IR36, IR64 and Krueng Aceh are grown. 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 farming practices of Palawija and upland crops are very primitive and local varieties are broadly used. Land preparation, planting, weeding and harvesting are done by hand.

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

Present Farm Inputs and Labor Requirements

Description	Unit	Wet Paddy	Soybean	Mungbean
Farm Inputs				
Seed	kg/ha	50	50	35
Fertilizer				
Urea	kg/ha	300	50	25
TPS	kg/ha	100	100	-
KCl	kg/ha	50	25	-
Agro-chemicals	lit/ha	-	-	-
Labor Requirements				
Nursery	md/ha	4	-	-
Land preparation	md/ha	2	3	2
	ad/ha	5	-	-
Planting	md/ha	3	3	2
Transplanting	md/ha	15	-	-
Weeding	md/ha	10	4	4
Pest & disease control	md/ha	2	2	2
Farm management	md/ha	2	2	1
Harvesting	md/ha	15	10	8
Transportation	md/ha	5	5	4
Others	md/ha	4	2	2
Total	md/ha	62	31	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 yield of major crops remains extremely low due to the shortage of irrigation water, 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	33	3.00	99
Rainfed			
Wet season paddy	274	2.00	548
Dry season Palawija			
Soybean	10	0.60	6
Upland Field			
Soybean	53	0.90	48
Mungbean	100	0.80	80

Source: The JICA Inventory Survey

(4) Livestock population

Various kinds of livestock are raised in the Project area and their numbers are given below. Cows and buffaloes play important roles in land preparation and horses are fed for draft power source as well as transportation means. Chicken and duck are raised for self - consumption.

Current Population of Livestock

Unit: head

Breeding Household	Cow	Buffalo	Horse	Goat /Sheep	Pig	Chicken/ Duck
970	988	3,811	1,219	0	0	1,192

Source: The JICA Water Use Survey

1.9 Irrigation Facilities

In the Project area, there exists paddy field of 332 ha in gross on the left bank of the Boal river. Among these, the paddy field of 27 ha has been irrigated and the remaining of 305 ha have been rainfed. The paddy field has been irrigated by the existing weir situated at around 100 m downstream of the proposed Embung site. The weir has been rehabilitated in recent years. So it is functioning well now. Irrigation water taken by the weir is led by the existing canal to wet paddy field with a distance of about 300 m. Though this canal had been an earth-lined originally, it has been lined by the stone masonry in recent years. It is functioning well. Due to the shortage of surface water of the river and poor conditions of the existing facilities, wet paddy field has been irrigated only in 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. No farmers have yet established Water Users' Association (P3A/HIPPA) for the purpose of maintaining on-farm irrigation service facilities and managing 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 Empang. 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 assigned to a district center for agricultural extension. 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. 2.47 million and Rp. 3.09 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 3,477 persons as at 1993 to 3,715 persons in 1998, 3,945 persons in 2003, 4,159 persons in 2008, 4,347 persons in 2013 and 4,519 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 can meet drinking and livestock water requirements during half the year. Although inhabitants get hardly their drinking water because of decrease in water table of their dug wells during the dry season, the pressing need is to solve water shortage problems for their livestock resulting from that the water source rivers dry up for three months from September to November.

(3) Economic development needs

All of 721 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. Those who are suffering from livestock water shortage problems from September to November have to bring their cattle to far places where water is available because cattle are the staff of life for the Sumbawanese. They also intend to utilize the time presently spent to remove cattle for productive purposes. In this connection, they need permanent water source facilities which enable them to secure stable livestock water throughout a year. Although water tables of all the inhabitants' dug wells decrease during the dry season, they are satisfied with water quantity and quality so that they have no intention to obtain new sources of drinking water.

(5) Development constraints

The present constraints against social upgrade and 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 Brang Tiu Tui river can divert only the wet season discharge, because the water level at the intake site becomes very lower during the dry season and also the intake itself has no function of storing water. Due to such situation of limited use of surface runoff, no more utilization of the Brang

Tiu Tui river can be expected unless countermeasures to regulate the wet season runoff are practiced.

In order to supplement insufficient livestock water during the dry season, breeding households bring their cattle to far places where perennial water is available. Such limited water resources have acted as the barrier to meet BHN and to promote development of intensive agriculture.

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 irrigation and livestock water shortage problems originated from insufficient use of potential water resources in the Brang Tiu Tui 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 Brang Tiu Tui river. Approach to development planning of the potential Embung is as follows:

- To put the first priority to supply irrigation water and the second to livestock water taking into account inhabitants' needs and intention;
- To project the future water demand for irrigation and livestock use at the target year of 2008 being the last year of Pelita VIII;
- To examine development potential of the Tiu Tui 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

Land use in the future is firstly planned as extension of irrigation on the presently rainfed paddy field of more than 400 ha. From a viewpoint of the topographic conditions, the left bank area is considered to be more suitable for irrigation development. Supposing that all of the rainfed paddy field on the left bank could be irrigated, 305 ha of the rainfed paddy field will be changed to the irrigated paddy field by constructing the proposed Embung.

Then, the dry upland of 31 ha on the upper left bank is planned to be transformed into the irrigated paddy field as an alternative land resource for wet paddy field of about 15 ha to be impounded by the Embung. Other upland and bush/scrub land are in low representative for land and irrigation development due to relatively higher elevation.

Total irrigated paddy field in the future is expected to be 363 ha by constructing the proposed Embung and 10 ha of the existing weir of the farmers themselves.

The following two kinds of changes on land use are expected by constructing the proposed Embung.

Rainfed paddy field	->	Irrigated paddy field	305 ha
Rainfed upland	->	Irrigated paddy field	31 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 Tiu Tui

Unit: ha

Land Use	Irrigated	Rainfed	Others	Total
Paddy field	373	111		484
Upland	0	139		139
Tree crops	0	8		8
Bush/Scrub/Grassland			140	140
Residential			15	15
Cemetery			4	4
Others			0	0
Total	373	258	159	790

Source : The JICA Study Team

There is the rainfed paddy field of about 15 ha in the impounding area of the proposed Embung. The alternative land for it is available in the dry upland of 31 ha on the upper left bank which is proposed to be transformed into the irrigated paddy field after the construction of the proposed Embung.

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 A-12	Paddy	100	Paddy	100	-	-
With Project A-21	Paddy	100	Soybean*	100	-	-
With Project A-22	Paddy	100	Soybean*	100	Mungbean	50
					Red onion	50
With Project C-23	Paddy	100	Paddy	100	Mungbean	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 input 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 Requirement

Item	Unit	Wet Paddy	Soybean	Mungbean	Red Onion
Farm Inputs					
Seed	kg/ha	25	40	30	2,000
Fertilizer					
Urea	kg/ha	300	50	75	300
TPS	kg/ha	100	100	100	200
KCl	kg/ha	50	50	50	100
Agro-chemicals	lit/ha	2	2	2	10
Rodenticide	kg/ha	2	1	1	3
Labor	md/ha	185	70	80	250
Draft Animal	ad/ha	20	10	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 PPLs.

(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, 1.4 ton/ha for soybean, 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 Sumbawa 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
1,820	3,999	1,281	0	0	2,999

2.5 Water Demand

(1) Livestock water demand

The future livestock water consumption level in NTB is set to be 40 lit/day/head for cow, buffalo and horse, 5 lit/day/head for sheep and goat, 6 lit/day/head for pig and 0.6 lit/day/head for poultry according to "The Study for Formulation of Irrigation Development Program in the Republic of Indonesia". Additional water demand for buffalo's bathing is considered to be 20 lit/day/head.

Following the projected livestock population, the future livestock water demand is estimated to be 133,500 m^3. The breakdown of this livestock water demand is 26,600 m^3 for 1,820 cows, 58,400 m^3 for 3,999 buffaloes, 18,700 m^3 for 1,281 horses and 600 m^3 for 2,999 chickens as well as 29,200 m^3 for bathing water of buffaloes.

(2) 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 one hectare 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 valley of the Boal river so as to store the river water as much as possible. However, topographic condition of the left portion of the dam site is not sufficient in elevation, so that a 770-m long saddle dam is planned in order to maximize the reservoir storage capacity up to the possible crest elevation of 36.0 m.

An intake weir exists just downstream of the proposed Embung site, which is still supply the river water effectively for the downstream irrigation area.

3.2 Geological Condition

The proposed Embung site is underlain by andesitic breccia of the Tertiary 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 varies from 7 to 47. The coefficient of permeability of andesitic breccia varies from 1.8×10^{-4} to 3.3×10^{-6} cm/sec. Ground water is present at low land and right bank except bore hole No. 1 on left bank.

The reservoir area is mainly underlain by and esitic breccia, terrace deposits and alluvium. No major fault and landslide are recognized in the reservoir area. Major problem for water leakage through saddles is assumed to occur at the both left and right banks in the reservoir area. Some measures like saddle dams will be required at several low saddles. Geological map and profile are shown in Figures 3.1 and 3.2.

3.3 Availability of Construction Materials

In and around the proposed Tiu Tui Embung site, there are sufficient materials suitable for 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	Sandy clayed silt reddish brown
2. Filter material	Boal river	River deposits
3. Random material	Spillway/ main dam foundation	Excavated rock or weathered rock of Andestic breccia
4. Concrete aggregates	Boal river	River deposits

3.4 Availability of Water Resources

(1) Catchment yield

As for the Brang Tiu Tui 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 Empang rainfall station which is located in the east of the Tiu Tui Embung catchment has rainfall record of nearly consecutive 30 years and is considered to represent catchment

rainfall. The blank data of the Empang station was supplemented by that of the Plampang 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 1.30 is multiplied by use of isohyetal map. The generated catchment rainfall is given in Table 3.1. A runoff coefficient of 0.40 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 Empang, river flow of the Tiu Tui at proposed site is estimated.

Following conditions are considered for estimation of the half monthly discharge:

- Catchment area of the proposed Embung site is 21.2 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 1966 to 1991. 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
3,545	2,998	2,163	763	312	175	128	46	165	258	863	2,369	13,694

(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, 32 years rainfall data of the Empang station from 1955 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	84
1 in 5 year	115
1 in 10 year	136
1 in 20 year	155
1 in 50 year	182
1 in 100 year	202
1 in 200 year	222

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	134
1 in 5 year	184
1 in 10 year	218
1 in 20 year	248
1 in 50 year	291
1 in 100 year	323
1 in 200 year	355

(3) Sediment load

There is no available data on sediment load on the Brang Tiu Tui 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, 0.4 mm/year/km^2 is adopted in this Study.

(4) Water quality

On October 27, 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 Tiu Tui 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 (m^3)
S_P : flow of water over the spillway during the half monthly period (m3)
OD : outflow needed for domestic water during the half monthly period (m3)
O_L : 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 Brang Tiu Tui, discharge is generated from rainfall of the Empang 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 Tiu Tui Embung.

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

6) Water level of reservoir

Minimum water level is estimated at El. 22.1 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. 32.2 m.

(2) Optimum development scale

With respect to the proposed Tiu Tui 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 Tiu Tui 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 19.5 m and effective storage capacity of 3.962 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 Tiu Tui river through construction of the proposed Tiu Tui Embung at the maximum scale, irrigation water can be supplied to wet paddy field of 331 ha in net for the both seasons. The beneficiary area of the proposed Embung comprises the presently irrigated paddy field of 33 ha and newly converted field from the existing rainfed paddy field of 274 ha and dry upland of 24 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 the wet season irrigated paddy coupled with two cropping of the dry season irrigated Palawija crops to the full extent as shown below and illustrated in Figure 4.3. Soybean and mungbean are planted as the first crop and mungbean and red onion as the second crop.

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	331	Soybean	Irrigated	165.5
				Mungbean	Irrigated	331
				Red onion	Irrigated	165.5
Without Project	Paddy	Irrigated	33	Soybean	Rainfed	10
	Paddy	Rainfed	274	(Fallow)		-
	Soybean	Rainfed	24	(Fallow)		-

(2) Delineation of beneficiary area for livestock water supply

With regard to livestock water demand in the Project area, it is possible to meet the whole amount by using reservoir water of the proposed Embung. Thus, the livestock water for 7,145 equivalent heads of cow is to be distributed by installing new water pipeline networks.

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 Tiu Tui 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.

The main components of Tiu Tui Embung are the main dam, saddle dam, spillway, river diversion conduit and water supply facility as shown in Figure 4.4. In order to provide the optimum storage capacity of 3.962 MCM, the full supply level (F.S.L.) is set at El. 32.2 m. Taking overflow depth of spillway and freeboard into account, the dam height of Tiu Tui Embung becomes 19.5 m above the river bed. In order to release the flood discharge during the construction period, the open river diversion is provided. The spillway is designed on the left bank of the main dam to release the flood discharge of 323 m^3 /sec from the catchment area of 21.2 km^2. For the purpose of supplying domestic water to the beneficiary area, such related facilities are provided as an intake structure in the reservoir, water supply pipe with a diameter of 400 mm below the dam body and valve house at the downstream of the main dam.

The principal features of Tiu Tui Embung are summarized below.

(1)	Reservoir	
	- Catchment area	21.2 km^2
	- F.S.L.	El. 32.2 m
	- Minimum operating level	El. 22.1 m
	- Effective storage capacity	3,962,000 m^3
	- Dead storage capacity	338,000 m^3
	- Gross storage capacity	4,300,000 m^3
	- Sediment deposition level	El. 21.1 m
(2)	Main dam	
	- Type	Zone-fill dam
	- Height	19.5 m above river bed
	- Crest elevation	El. 36.0 m
	- Crest length	230 m
	- Crest width	7.0 m
	- Upstream slope	1 : 2.5
	- Downstream slope	1 : 2.0
	- Total embankment volume	
(3)	Spillway	
	- Design flood (1/100 year)	323 m^3/sec
	- Type	Side-channel
	- Crest elevation of overflow weir	El. 32.2 m
	- Width of overflow weir	52.0 m
	- Discharge capacity	330 m^3/sec
	- Overflow depth	2.0 m
(4)	River diversion	
	- Design flood (1/5 year)	184 m^3/sec
	- Type	Open channel
	- Diameter	15.0 x 4 m
	- Length	200 m
(5)	Water supply system	
	- Inlet structure	1.2 x 1.2 m with trashracks
	- Pipe diameter	D 400 m pipe culvert

-	Length	95 m
-	Design discharge	350 lit/sec
-	Valve house	left abutment of dam site
-	Type	Through Valve
-	Diameter	ϕ280 mm x 2 units
-	Outlet elevation	El. 21.0 m

5. PRELIMINARY DESIGN OF FACILITIES

5.1 Preliminary Design of Embung

(1) Main dam

Considering the geological condition and available construction materials around the dam site, zone fill dam is applied for constructing the Tiu Tui 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 reservoir water surface due to extraordinary flood discharge and wave uprush on the slope.

The following formula is applied for the design of the Tiu Tui Embung.

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

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

(2) Saddle dam

In order to keep the crest elevation of main dam, a saddle dam is designated on the saddle portion with the maximum length of 770 m at the left side of dam site. Homogeneous earthfill dam is selected for the saddle dam with the maximum height of 12.0 m above the original ground.

(3) River diversion 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 trapezoidal shape of 15.0 m in width and 4.0 m in height, a 5-m high cofferdam with a crest level of El. 21.5 m would suffice to contain the flood inflow of 184 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 323m^3/sec.

Based on comparative study on combination of overflow depth and width of the spillway, the overflow depth at 2.0 m and the width of 52.0 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. 32.2 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 350 lit/sec. The water supply system consists of intake structure, pipe line and valve house. The intake structure is located in the reservoir area above the sediment deposition level of El 21.1m. Fixed trashracks are provided on the intake structure. Pipe culvert with a diameter of 400 mm is connected from the intake structure to the downstream through the main dam foundation.

A valve house would be constructed near the downstream toe of the dam. In the valve house, two units of the guard valve and control devices with a diameter of 280 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 is carried out by using the remaining impounded water after satisfying of full requirements of domestic/livestock water supply in the beneficiary area;
- 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 outlet works of the Embung are planned to be used for dual purposes of supplying irrigation water. The water taken from the reservoir is led to the valve house through the cast iron pipe provided in 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. From the irrigation inlet box, irrigation water is led to the existing irrigation canal by an open channel with a distance of around 100 m. Irrigation water is divided at the turnout of open channel into newly constructed irrigation canal. Irrigation

water is diverted from the irrigation canal to diversion boxes for livestock use is delivered to the wet paddy field by using the existing and newly constructed irrigation canal.

General layout for this scheme 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 requirements and cropping patterns mentioned in the previous section. 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 is on the first half month of January for paddy crop and design discharge is estimated at 350 liters per second for the net irrigation area of 324 ha. This design discharge is an enough discharge to flow for dry season Palawija crops of net area of 324 ha at peak time.

Initial water level at the irrigation inlet box is decided taking the topographic elevation at the box into consideration. As a result, initial water level is El. 21.0 m at the irrigation inlet box.

(4) Irrigation facilities

The proposed canal layout and design of irrigation facilities are made based on the 1/5000 topographic map prepared during this Study and in accordance with the following considerations:

- 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 canal from the Embung is constructed by the stone masonry canal with trapezoid section taking steep topographic condition, construction method and available construction materials in the area into account. Canal related structures required are irrigation inlet box to make open flow from the pressure flow of pipe line, turnout, aqueduct and irrigation division boxes. Required irrigation facilities for this scheme are summarized below :

Irrigation Facilities Requirement

Facilities	Quantities
- Valve house (included in the facilities for Embung)	1 No.
- Irrigation inlet box	1 No.
- Masonry canal to be constructed	1.2 km
- Masonry canal to be rehabilitated	3.5 km
- Turnout	1 No.
- Aqueduct	1 No.
- Irrigation division box	22 Nos.
- Division Box for Livestock	5 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. 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 diversion of the river water into the diversion channel around June in the second year, embankment works for the main and saddle dams 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 work of the spillway will be commenced in March and completed before October in the third year. Concrete work of the water supply conduit will be completed before re-starting the embankment works of the main dam in 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 and saddle dam embankment and spillway construction. Considering the rainfall in November and December in the third year, the Tiu Tui reservoir would be full reservoir water condition, accordingly 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 construction works of the Embung by using mainly manpower because of the work quantities for them 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 channel during the second and third year, and therefore the river diversion channel would be provided along the right bank of the Boal river.

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 works will be commenced at the beginning of July in the second year. Considering a total embankment volume of 252,000 m^3 and the dry season period in the second and third year, the daily embankment volume is to be 1,000 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 for about five months from March to September in the second year. Most of the excavated materials may be used for the main and saddle dam embankments 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 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. 21.1 m. Connecting with the inlet structure, pipe culvert with a diameter of 400 mm is constructed up to the downstream end of the main dam. Construction of the pipe culvert should be completed before re-starting of the main dam embankment at the beginning of May in the third year.

The valve house of the water supply system will be constructed before the reservoir water reaches to F.S.L. 46.0 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, earth works for irrigation canal will be executed by using heavy construction equipment and other works are conducted by manpower in parallel with the Embung construction works. Works of the irrigation canal such as clearing, stripping, excavation and embankment works. Heavy construction equipment such as bulldozer, excavator, compactor, and so on are used for earth 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 Tiu Tui 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 Tiu Tui 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 the Project works for Tiu Tui 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, no P3A has been established. It is therefore necessitated to organize the beneficiary farmers for establishing 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 Tiu Tui 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 Tiu Tui Embung is estimated at Rp. 10,919 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 Tiu Tui Embung is summarized below.

Summary of Project Cost for Tiu Tui Scheme

Unit : Rp. Million

Item		Project cost
I.	Direct construction cost	5,994
1.1	Preparatory works	285
1.2	Embung construction	5,480
1.3	Irrigation facilities	229
1.4	Domestic water supply	0
1.5	Operation & maintenance road	0
II.	Administration cost	300
III.	Engineering services	899
IV.	Physical contingencies	1,079
V.	Contract tax	797
VI.	Land acquisition	30
VII.	Price contingency	1,820
	Grand Total	10,919

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. 54.6 million, which is equivalent to 0.5 % of the Project cost.

8. PROJECT JUSTIFICATION

8.1 Satisfaction of BHN

The benefit of livestock water supply to 7,145 equivalent heads of cow fed by beneficiary breeding households in Boal Village could be indicated as the net value of additionally increasing cattle weight, either cow or buffalo, attributable to stabilized livestock water supply condition. In order to estimate this net value, it is assumed that a cow or buffalo aged 1.5 to 2 years old and with the initial weight of 200 kg will get an additional increase of 0.6 kg/day in weight during four months of the dry season as a result of stable supply of livestock water. Further assumptions made for other unit values are Rp. 2,500/kg for the both initial and increasing weights, Rp. 490,000/head for the overall feeding cost and Rp. 24,000/head for by-products.

The direct construction cost is broken down into the cost for Embung construction and preparatory works of Rp. 5,765 million and irrigation facilities of Rp. 300 million. The annual water demand is 0.1304 MCM for livestock use and 5.04 MCM for irrigation use, totaling 5.15 MCM. The direct construction cost is allocated as shown below.

Allocation of Direct Construction Cost

Item	Unit	Total demand	Domestic water	Livestock water	Irrigation water
Annual water demand	'000 m^3	5,170	0	130	5,040
Direct construction cost	Million Rp.	5,994	0	145	5,849

Thus, the value of livestock water is estimated to be Rp. 1,115/m^3 . As the unit net value of additionally increasing cattle weight is estimated to be Rp. 180,000/head, the total net value can be expected to be Rp. 1,286 million by supplying stable livestock water being worth Rp. 145 million in total to 7,145 equivalent heads of cow fed by beneficiary breeding households.

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. 956.1 million. This increment benefit will accure from the first year when irrigation water can be released from the Tiu Tui 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 13.5 ha will be under the reservoir water after completion of the proposed Tiu Tui Embung, the total amount of production foregone is estimated to be around Rp. 14 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 14.4%. Accordingly, the proposed Tiu Tui Embung Project would 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 843 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. Furthermore, the cattle feeding in Desa Boal can be stabilized by constant supply of livestock water to 7,145 equivalent heads of cow throughout the year.

(4) Farm budget analysis

With implementation of the Tiu Tui 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. 3,972,200/year from Rp. 456,400/year under the "Without Project" condition with the cropping intensity of 100% to Rp. 4,428,600/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	82.8	343,413	-	-
	Wet/Irrigated	10.0	56,350	100.0	926,375
Soybean	Wet/Rainfed	7.2	55,086	-	-
	Dry/Rainfed	0.3	1,508	-	-
	Dry/Irrigated	-	-	50.0	572,330
Mungbean	Dry/Irrigated	-	-	100.0	1,074,420
Red onion	Dry/Irrigated	-	-	50.0	1,855,500
Total		100.3	456,357	300.0	4,428,625

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 Tiu Tui Project area are summarized as below.

Environmental Features in the Tiu Tui Project Area

Item	Description
1. Human Environment	
Social intention	Insufficiency of reliable water sources and facilities for irrigation and livestock water use
Human use	Use of well water (shortage in the dry season)
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 rocks of Tertiary
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 Tiu Tui Embung development in this Project area. But the land of 13.5 ha in the proposed reservoir area is utilized for 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 by the Indonesian side, primary information on environmental assessment is compiled in the Attachment to the Main Text of Vol. 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 Tiu Tui 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, mainly rainfed and partly irrigated farming system, and inhabitants' demand for further use of irrigation and livestock water. The proposed Tiu Tui Embung site has physically irrigable land resources of 331 ha in net and the annual discharge of 13.7 MCM from its catchment area of 21.2 km^2 . Breeding households with a total of 7,145 equivalent heads of cow projected for the year of 2008 need to solve livestock water shortage problem during the dry season.

As there is no limitation in the topographic condition and the availability of water resources, the future water demand for irrigation and livestock use in the beneficiary area is the determining factor in the optimization of development scale. To cover the physically irrigable area by gravity method and the livestock water demand to the maximum extent, the dam height of Tiu Tui Embung is thus set to be 19.5 m with the total and effective storage capacities of 4.30 and 3.96 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 during the dry season and to meet increasing livestock water demand of 7,145 equivalent heads of cow in the beneficiary area.

The structural components are main dam, saddle dam, and spillway as well as irrigation water distribution system. The zoned embankment dam is constructed with the crest length of 230 m, embankment volume of 251,700 m^3 and side-channel typed spillway having design flood discharge of 323 m^3/sec and overflow weir width of 52 m. The required investment cost amounts to Rp. 11.0 billion of which direct construction cost is estimated to be 6.0 billion.

The results of feasibility study reveal that construction of the candidate Embung at the proposed site is technically sound and economically possible because the proposed site has a large pocket and requires smaller dam volume. The increasing livestock water demand of 7,145 equivalent heads of cow in the Project area could be fully met by creating a new water source through construction of the proposed Tiu Tui Embung. Therefore, such type of Embung is worth implementing from the technical, economic and social viewpoints.

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 Tiu Tui Embung Development Project

Tables

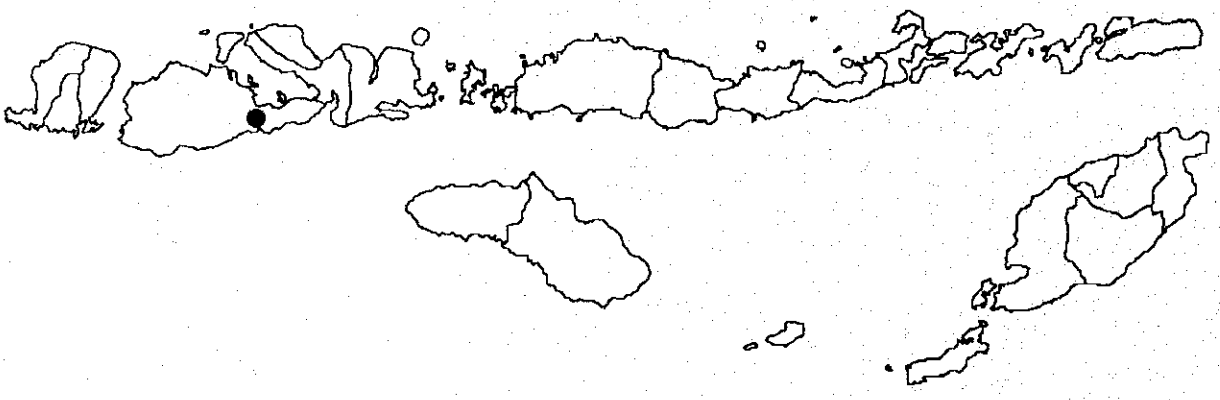


Table 1.1 Rainfall Record in Empang

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	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	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 Tiu Tui Project Area

Profile No.:		4
Soil Classification:		Typic haplusterts
Physiography:		Alluvial fan
Topography:		Flat (1 %)
Land Use/Vegetation:		Rainfed paddy field
Parent material:		Alluvium material
Drainage:		> 5 m
Groundwater Table:		Slow (0.5 cm/hr)
Permeability:		Cracking 2 - 5 m width, 50 cm depth
Land Morphology:		
Horizon	**Depth (cm)**	**Description**
Ap	0 - 37	Dark brown (7.5YR 3/3, dry); clay loam; strong, angular blocky, very fine structure; very sticky, very plastic, very firm, very hard consistency; fine, medium root; diffuse, broken horizon boundary
Bw1	37 - 88	Dark grayish brown (7.5YR 4/2, moist); clay; strong, angular blocky, very fine structure; very sticky, very plastic, very firm, very hard consistency; diffuse, smooth horizon boundary
Bw2	88 - 100+	Very dark grayish brown (7.5YR 3/2, moist); sandy clay; strong, angular blocky, very fine structure; very sticky, very plastic, very firm, very 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 Tiu Tui 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)
1	Ap	41.9	23.0	35.0	0.5	7.4	6.6	1.50	0.06	4.26	39.31	11.00	14.65	1.85	2.73	77	7.08
	Bw1	57.5	5.4	37.0	0.4	7.1	6.4	1.91	0.04	3.77	42.63	10.95	18.59	1.79	4.41	84	9.32
	Bw2	60.4	5.3	34.3		7.3	6.2	1.28	0.04	2.07	48.81	11.07	22.57	1.48	5.08	82	7.26
4	Ap	44.0	23.0	33.0	0.5	7.3	6.2	1.62	0.07	2.00	37.84	2.48	15.15	1.83	4.17	62	0.44
	Bw1	46.0	13.0	41.0	0.1	8.0	6.7	0.96	0.04	3.55	47.09	6.75	13.90	1.31	4.29	56	1.04
	Bw2	54.4	12.1	42.3		7.5	5.6	0.74	0.02	3.34	42.47	6.90	8.92	1.63	4.23	51	1.40
7	Ap	67.7	15.3	27.0	2.0	7.3	6.6	1.69	0.04	2.05	20.87	2.71	9.47	1.83	2.22	78	0.52
	2A	72.4	15.3	12.3	1.9	7.6	6.8	0.42	0.03	1.85	7.06	1.71	3.44	0.78	0.72	94	0.22
	3A	54.4	5.3	40.3		7.2	6.6	1.38	0.03	2.07	34.69	7.83	10.78	1.20	1.47	61	2.76

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

Table 1.5 Soil Classification in the Tiu Tui Project Area

Land Unit	Description	Physiography	Topography	Potential Suitability			Area	
				Paddy	Soybean	Maize	(ha)	(%)
I	Typic Ustifluvents deep; fine sand; neutral; high-low CEC; slightly slow permeability; well drainage	Alluvial fan	Flat (0-2%)	S1	S1	S2	50	6%
II	Typic Ustropepts deep; fine silty; neutral; moderate CEC; slightly slow permeability; well drainage	Alluvial fan	Flat (0-2%)	S2	S1	S2	57	7%
III	Typic Haplusterts deep; fine-very fine clay; slow-very slow permeability; well drainage	Alluvial fan	Undulating (4-8%)	S1/S2	S1	S2	325	41%
IV	Oxyaquic Ustifluvents deep; fine silty-fine clayey; neutral; slightly slow permeability; well drainage	Alluvial fan	Flat (0-2%)	S1	S1	S2	67	8%
V	Udic Salaquerts deep; fine clayey; alkaline; slow permeability; well drainage	Alluvial fan	Flat (0-2%)	S1	S1	S2	28	4%
#	Unclassified						263	33%
	Total						790	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 Tiu Tui 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 52	Male 62	Male 45	Male 70	Male 55	Male 46	Male 42	Male 50	Male 55	Male 57	Male 60	Male 37	Male 50	Male 40	Male 45	Male 51
2	No. of Family Member		M-1/F-3	M-1/F-0	M-2/F-2	M-2/F-1	M-1/F-3	M-4/F-3	M-2/F-2	M-2/F-4	M-1/F-2	M-1/F-1	M-1/F-1	M-1/F-4	M-2/F-2	M-2/F-3	M-2/F-2	M-2/F-2
3	Type of Side Job		None	None	Craftman	Craftman	Worker	None	None	None	None	Entrepren.	None	Entrepren.	None	Worker	Worker	
4	Own Farmland	ha	4.21	1.05	3.01	5.03	15.00	8.02	3.13	4.12	3.02	4.02	4.52	8.71	6.01	1.61	5.78	5.15
	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	0.68	1.00	1.00	3.00	4.75	6.00	1.10	2.10	1.00	2.00	2.50	4.75	4.00	1.00	1.75	2.44
5	Cropped Area	ha	3.86	1.50	4.00	5.00	19.00	5.50	3.10	4.10	3.00	2.00	4.50	6.70	6.00	1.60	5.00	4.99
	(Paddy)	ha	1.18	1.00	1.00	3.00	4.25	3.50	1.10	2.10	1.00	2.00	2.50	2.75	4.00	1.00	1.00	2.09
	(Palawija)	ha	2.68	0.50	3.00	2.00	14.75	2.00	2.00	2.00	2.00	0.00	2.00	3.50	2.00	0.60	4.00	2.87
	(Others)	ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.00	0.00	0.00	0.03
6	Cow/Buffalo	head	7	9	14	8	9	4	1	10	3	40	14	36	4	6	4	11
	Horse	head	4	3	4	2	2	3	4	0	0	10	1	0	0	0	0	2
	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	1	0	0	0	0	17	0	2	0	0	3	3	0	2
7	Gross Income	Rp.'000/yr	3,411.9	800.0	3,320.0	2,810.0	7,200.0	5,660.0	2,057.5	4,500.0	1,975.0	4,785.0	4,400.0	11,950.0	2,520.0	2,880.0	2,320.0	4,039.3
	(Crop)	Rp.'000/yr	3,036.9	800.0	2,770.0	2,260.0	6,100.0	5,560.0	2,057.5	3,000.0	1,975.0	3885.00	3,500.0	10,350.0	1,920.0	2,260.0	2,195.0	3,444.6
	(Livestock)	Rp.'000/yr	0.0	0.0	300.0	300.0	800.0	100.0	0.0	1,500.0	0.0	0.0	0.0	1,200.0	600.0	500.0	0.0	353.3
	(Side job)	Rp.'000/yr	375.0	0.0	250.0	250.0	300.0	0.0	0.0	0.0	0.0	900.0	900.0	400.0	0.0	120.0	125.0	241.3
	(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	5,000.3	1,267.7	3,204.8	2,354.5	5,783.5	5,429.0	2,277.6	3,360.5	1,666.9	1,733.8	3,173.0	6,683.5	1,809.8	2,863.9	2,034.0	3,242.9
	(Food/drink)	Rp.'000/yr	1,044.0	676.8	1,118.4	990.0	2,400.0	1,620.0	696.0	997.2	903.6	504.0	1,572.0	1,452.0	576.0	1,622.4	698.4	1,124.7
	(Living)	Rp.'000/yr	994.0	264.4	625.4	402.0	1,608.0	710.0	826.0	634.8	455.0	522.4	664.0	1,524.0	264.8	475.0	573.2	702.9
	(Education)	Rp.'000/yr	540.0	0.0	600.0	0.0	0.0	1,200.0	180.0	100.0	0.0	0.0	0.0	1,500.0	100.0	100.0	45.0	291.0
	(Production)	Rp.'000/yr	2,422.3	326.5	861.0	962.5	1,775.5	1,899.0	575.6	1,628.5	308.3	707.4	937.0	2,207.5	869.0	666.5	717.4	1,124.3
9	Surplus/Deficit	Rp.'000/yr	-1,588.4	-467.7	115.2	455.5	1,416.5	231.0	-220.1	1,139.5	308.1	3,051.2	1,227.0	5,266.5	710.2	16.1	286.0	796.4
10	Saving	Rp.'000/yr	0.0	0.0	0.0	0.0	400.0	150.0	200.0	0.0	0.0	120.0	300.0	0.0	0.0	0.0	0.0	78.0

Source : JICA Agro-economy Survey

Table 2.1 Estimated Evapotransiration in Tiu Tui Project

Site : Tiu Tui
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 Tiu Tui Project

Site : Tiu Tui
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 Tiu Tui Project (1/3)

Site : Tiu Tui
Crops : Wet 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. 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 Tiu Tui Project (2/3)

Site : Tiu Tui
Crops : Dry Season Paddy

Item		Month (days)	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. Dry Season Paddy																											
(1) Proposed cropping pattern / Crop coefficient																											
- DP-1										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 Tiu Tui Project (3/3)

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

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. 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 Tiu Tui Embung Site

Unit : mm

	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	147	153	143	103	230	307	44	8	0	20	21	0	0	0	18	3	0	66	3	26	12	57	237	281	1,879
1967	269	542	81	77	212	66	10	18	0	1	0	0	0	5	0	1	8	1	47	0	66	18	209	176	1,807
1968	204	148	153	398	36	96	109	0	92	87	7	7	44	140	0	0	0	0	14	17	0	9	131	126	1,818
1969	29	56	38	130	14	164	0	0	0	0	0	0	0	0	0	0	0	0	36	0	0	10	25	59	561
1970	82	161	237	260	107	73	7	61	0	0	7	4	0	0	0	0	0	30	0	29	65	65	94	191	1,473
1971	86	221	311	117	190	170	0	66	16	94	0	0	0	0	0	0	0	30	1	138	92	69	255	49	1,905
1972	311	5	129	208	140	146	3	57	0	0	0	0	0	0	0	0	0	0	0	0	0	13	112	52	1,176
1973	142	191	211	20	191	79	72	83	21	29	0	0	0	0	0	0	31	26	0	27	13	22	70	86	1,314
1974	239	18	121	371	286	134	47	0	25	0	0	0	0	0	0	10	16	64	7	87	144	174	85	85	1,913
1975	140	120	237	382	286	186	330	267	212	0	0	0	0	59	0	0	174	0	91	39	59	0	213	221	3,016
1976	220	204	104	200	161	0	62	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	16	33	1,009
1977	311	159	231	117	268	208	52	0	47	0	0	0	0	0	0	0	0	0	0	0	0	0	137	139	1,669
1978	263	178	256	252	125	237	126	70	0	65	355	51	53	0	53	0	0	0	0	0	74	65	124	241	2,588
1979	293	172	83	143	241	53	0	0	62	57	65	0	0	0	0	0	0	0	0	0	0	0	168	72	1,409
1980	304	296	293	87	109	0	0	131	0	0	0	0	0	0	0	0	0	0	0	0	20	127	235	291	1,893
1981	547	233	386	286	36	0	9	226	20	26	12	9	0	0	1	30	1	0	3	0	69	114	134	44	2,186
1982	234	124	78	257	229	55	5	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59	386	1,445
1983	499	49	111	17	3	0	4	20	0	0	0	0	0	0	0	0	0	0	5	0	56	229	29	153	1,175
1984	134	211	147	339	277	5	127	81	1	0	0	0	0	0	0	0	53	7	130	13	21	92	112	52	1,802
1985	47	64	196	241	303	0	31	42	0	75	16	0	65	0	0	0	0	0	0	3	4	153	33	51	1,324
1986	226	117	85	127	109	112	0	12	0	0	0	5	0	3	0	0	0	0	17	40	22	14	125	55	1,069
1987	248	230	83	376	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	139	312	380	499	2,298
1988	17	125	44	13	92	298	0	0	0	0	0	0	0	0	0	0	0	0	0	0	105	81	125	131	1,031
1989	55	618	114	194	57	203	26	16	0	0	12	46	1	31	0	57	0	0	0	100	39	13	231	30	1,843
1990	283	386	195	57	251	4	9	64	22	43	0	0	0	0	0	0	31	4	0	0	0	4	209	172	1,734
1991	307	212	234	170	36	42	101	65	0	0	0	0	8	17	0	0	7	0	0	0	40	96	22	35	1,392
Mean	217	192	165	190	155	101	45	50	20	19	19	5	7	10	3	4	12	9	14	20	40	67	137	143	1,643

Table 3.2 Estimated Discharge at Tiu Tui Embung Site

Unit : 1000 m3

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	1,247	1,297	1,213	873	1,950	2,603	373	0	0	0	178	0	0	0	0	0	0	560	0	220	0	483	2,010	2,383	15,390
1967	2,281	4,596	687	653	1,798	560	0	0	0	0	0	0	0	0	0	0	0	0	399	0	560	0	1,772	1,492	14,798
1968	1,730	1,255	1,297	3,375	305	814	924	0	780	738	0	0	373	1,187	0	0	0	0	0	0	0	0	1,111	1,068	14,957
1969	246	475	322	1,102	0	1,391	0	0	0	0	0	0	0	0	0	0	0	0	305	0	0	0	212	500	4,553
1970	695	1,365	2,010	2,205	907	619	0	517	0	0	0	0	0	0	0	0	0	254	0	246	551	551	797	1,620	12,337
1971	729	1,874	2,637	992	1,611	1,442	0	560	0	797	0	0	0	0	0	0	0	254	0	1,170	780	585	2,162	416	16,009
1972	2,637	0	1,094	1,764	1,187	1,238	0	483	0	0	0	0	0	0	0	0	0	0	0	0	0	0	950	441	9,794
1973	1,204	1,620	1,789	0	1,620	670	611	704	178	246	0	0	0	0	0	0	263	220	0	229	0	187	594	729	10,864
1974	2,027	0	1,026	3,146	2,425	1,136	399	0	212	0	0	0	0	0	0	0	0	543	0	738	1,221	1,476	721	721	15,791
1975	1,187	1,018	2,010	3,239	2,425	1,577	2,798	2,264	1,798	0	0	0	0	500	0	0	1,476	0	772	331	500	0	1,806	1,874	25,575
1976	1,866	1,730	882	1,696	1,365	0	526	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	280	8,345
1977	2,637	1,348	1,959	992	2,273	1,764	441	0	399	0	0	0	0	0	0	0	0	0	0	0	0	0	1,162	1,179	14,154
1978	2,230	1,509	2,171	2,137	1,060	2,010	1,068	594	0	551	3,010	432	449	0	449	0	0	0	0	0	628	551	1,052	2,044	21,945
1979	2,485	1,459	704	1,213	2,044	449	0	0	526	483	551	0	0	0	0	0	0	0	0	0	0	0	1,425	611	11,950
1980	2,578	2,510	2,485	738	924	0	0	1,111	0	0	0	0	0	0	0	0	0	0	0	0	0	1,077	1,993	2,468	15,884
1981	4,639	1,976	3,273	2,425	305	0	0	1,916	0	220	0	0	0	0	0	254	0	0	0	0	585	967	1,136	373	18,069
1982	1,984	1,052	661	2,179	1,942	466	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	500	3,273	12,057
1983	4,232	416	941	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	475	1,942	246	1,297	9,549
1984	1,136	1,789	1,247	2,875	2,349	0	1,077	687	0	0	0	0	0	0	0	0	449	0	1,102	0	178	780	950	441	15,060
1985	399	543	1,662	2,044	2,569	0	263	356	0	636	0	0	551	0	0	0	0	0	0	0	0	1,297	280	432	11,032
1986	1,916	992	721	1,077	924	950	0	0	0	0	0	0	0	0	0	0	0	0	0	339	187	0	1,060	466	8,632
1987	2,103	1,950	704	3,188	263	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,179	2,646	3,222	4,232	19,487
1988	0	1,060	373	0	780	2,527	0	0	0	0	0	0	0	0	0	0	0	0	0	0	890	687	1,060	1,111	8,488
1989	466	5,241	967	1,645	483	1,721	220	0	0	0	0	390	0	263	0	483	0	0	0	848	331	0	1,959	254	15,271
1990	2,400	3,273	1,654	483	2,128	0	0	543	187	365	0	0	0	0	0	0	263	0	0	0	0	0	1,772	1,459	14,527
1991	2,603	1,798	1,984	1,442	305	356	856	551	0	0	0	0	0	0	0	0	0	0	0	0	339	814	187	297	11,532
Mean	1,833	1,621	1,403	1,596	1,305	857	368	396	157	155	144	32	53	75	17	28	94	70	99	159	323	540	1,159	1,210	13,694
	3,454		2,998		2,163		763		312		175		128		46		165		258		863		2,369		

Table 3.3 Probable Flood Discharge at Tiu Tui Embung Site

Characteristics of the catchment area								
Catchment Area	(km2)	21.20						
Eelevation at Dam Site (1)	(m)	80						
Maximum elevation in the catchment area (2)	(m)	600						
Height (3)=(2)-(1)	(h)	520						
Length of Catchment Area (l)	(m)	6.000						
Flow velocity	W2 (km/hr)	16.60						
Time of concentration	T2 (hrs)	0.36						
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)	29	39	46	53	62	69	75
Probable Flood Discharge	(m3/s)	134	184	218	248	291	323	355
Specific Discharge	(m3/s/km2)	6	9	10	12	14	15	17

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 Tiu Tui 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	27.00	27.00	28.00	28.50	Normal water temperature
2 Dissolved solid matter	mg/liter	593.00	594.00	364.00	656.00	1000
3 Electric Conductivety	umhos/cm	807.00	812.00	491.00	893.00	-
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 Aroenic	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	0.13	0.11	0.11	0.53	1.5
7 Cadmium	mg/liter	0.00	0.00	0.00	0.00	0.005
8 Chloride	mg/liter	106.00	99.40	98.70	142.00	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	0.17	0.00	10
12 Nitric, N	mg/liter	0.43	0.05	0.05	0.00	1
13 Dissolved Oxygen	mg/liter	2.63	4.39	7.00	6.00	*
14 pH	-	7.60	7.60	7.70	7.80	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	18.80	19.60	20.80	25.30	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	0.01	0.01	0.00	0.01	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	17,000	11,000	13,000	9,400	2,000
2 Total Coliform	per 100 ml	28,000	22,000	24,000	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 Tiu Tui Project

Item	Amount (Rp. million)
I. Direct Construction Cost	
1.1 Preparatory Works	285
1.2 Embung Construction	
1) Main dam	2,836
2) Spillway	2,146
3) Diversion Tunnel	0
4) Seepage protection works	0
5) Miscellaneous	498
Sub-total of 1.2	5,480
1.3 Irrigation Facilities	229
1.4 Domestic Water Supply	0
1.5 Embung Operation and Maintenance Road	0
Sub-total of I.	5,994
II. Administration Cost	300
III. Engineering Services	899
Sub-total of I, II & III	7,193
IV. Physical Contingency	1,079
Sub-total of I, II, II, & IV	8,272
V. Contract Tax	797
VI. Land Acquisition Cost	30
Sub-total I, II, III, IV, V & VI	9,100
VII. Price Contingency	1,820
GRAND TOTAL	10,919

Table 7.2 Direct Construction Cost in Tiu Tui 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	49,800	19,920
2) Excavation, common	m3	3,500	112,100	392,350
, weathered rock	m3	7,500	37,400	280,500
, rock	m3	11,500	0	0
3) Embankment, impervious soil	m3	8,000	181,600	1,452,800
, filter	m3	12,000	18,000	216,000
, transition	m3	12,000	0	0
, random material	m3	6,000	52,100	312,600
4) Stone masonry	m3	80,000	0	0
5) Rip-rap protection	m3	15,000	1,800	27,000
1.2 Grouting	m	71,000	0	0
1.3 Other miscellaneous works				135,059
Sub-total of 1.				2,836,229
2. Spillway				
2.1 Earth works				
1) Clearing	m2	400	4,900	1,960
2) Excavation, common soil	m3	3,500	9,000	31,500
, weathered rock	m3	7,500	18,000	135,000
, rock	m3	11,500	3,000	34,500
3) Backfill	m3	5,200	2,200	11,440
2.2 Concrete works				
1) Concrete - A	m3	250,000	360	90,000
2) Concrete - B	m3	170,000	6,880	1,169,600
3) Reinforcement bar	ton	1,500,000	18	27,000
4) Form	m2	15,000	36,200	543,000
2.3 Other miscellaneous works	L.S			102,200
Sub-total of 2.				2,146,200
3. Miscellaneous & Others				498,243
Total - I.				5,480,671
II. Irrigation Facilities				
1. Canal works (including the rehabilitation works)				
1.1 Earth works				
1) Clearing	m2	400	14,900	5,960
2) Excavation	m3	5,000	2,100	10,500
3) Embankment	m3	6,300	3,100	19,530
1.2 Stone masonry	m3	80,000	1,800	144,000
Sub-total of 1.				179,990

Table 7.2 Direct Construction Cost in Tiu Tui Project (2/2)

Item	Unit	Unit Price Rp.	Quantity	Total 1000 Rp.
2. Related structures				
2.1 Turnout	nos.	2,600,000	1	2,600
2.2 Syphon	nos.	5,500,000	0	0
2.3 Aqueduct	nos.	6,000,000	1	6,000
2.3 Cross drain	nos.	4,700,000	0	0
2.4 Irrigation division box	nos.	900,000	22	19,800
2.5 Division box for livestock	nos.	1,200,000	5	
Sub-total of 2.				28,400
3. Miscellaneous & Others	L.S			20,839
Total - II				229,229
GRAND TOTAL				5,709,900

Table 8.1 Economic Construction Costs and Annual Disburement Schedule

Tiu Tui Project (Unit : Rp. million)

Item	SCF	Total cost	1st year	2nd year	3rd year
1 Direct Construction Cost		3,902	101	1,647	2,154
1) Preparatory Works	0.71	202	101	101	0
2) Dam Construction					
- Main dam	0.71	2,013	0	1,007	1,006
- Spillway	0.71	1,524	0	457	1,067
- Diversion tunnel	0.71	0	0	0	0
- Seepage protection works	0.71	0	0	0	0
Sub-total		3,537	0	1,464	2,073
3) Irrigation Facilities	0.71	163	0	82	81
4) Domestic Water Supply System	0.71	0	0	0	0
5) Dam O & M Road	0.71	0	0	0	0
2 Administration Cost	0.90	270	7	114	149
3 Engineering Services	0.90	371	149	111	111
4 Physical Contingency		585	15	247	323
Total		5,128	272	2,119	2,737

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		Sumbawa	
			Financial Price *1	Economic Price *2	Financial Price *1	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

Tiu Tui Project

Item		Q'ty of Unit	Value (Rp.)	Without Project: Paddy (Irrigated) Q'ty	Paddy (Irrigated) Am't (Rp.)	Paddy (Rainfed) Q'ty	Paddy (Rainfed) Am't (Rp.)	Soybean (1st crop) (Rainfed) Q'ty	Soybean (1st crop) (Rainfed) Am't (Rp.)	Soybean (2nd crop) (Rainfed) Q'ty	Soybean (2nd crop) (Rainfed) Am't (Rp.)	With Project: Paddy (Irrigated) Q'ty	Paddy (Irrigated) Am't (Rp.)	Soybean (Irrigated) Q'ty	Soybean (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	0	0	0	0	4,500	1,773,000	0	0	0	0	0	0
Soybean		kg	642	0	0	0	0	900	577,800	600	385,200	0	0	1,400	898,800	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	0	0	0	0	0	0
	Own	kg	325	0	0	50	16,250	0	0	0	0	0	0	0	0	0	0	0	0
Soybean	Certified	kg	617	0	0	0	0	10	6,170	10	6,170	0	0	20	12,340	0	0	0	0
	Own	kg	606	0	0	0	0	30	18,180	30	18,180	0	0	20	12,120	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	25	10,475	20	8,380	300	125,700	50	20,950	75	31,425	300	125,700
TSP		kg	491	75	36,825	50	24,550	50	24,550	40	19,640	100	49,100	100	49,100	100	49,100	200	98,200
KCl		kg	421	35	14,735	0	0	25	10,525	20	8,420	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	0.0	0	0.0	0	2.0	20,000	2.0	20,000	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	0.0	0	0.0	0	2.0	11,000	1.0	5,500	1.0	5,500	3.0	16,500
Labor																			
Family		md	1,875	127	238,125	65	121,875	25	46,875	20	37,500	172	322,500	70	131,250	80	150,000	151	283,125
Hired		md	1,875	13	24,375	10	18,750	0	0	0	0	13	24,375	0	0	0	0	99	185,625
Draft Animal																			
Family		ad	5,000	20	100,000	10	50,000	10	50,000	0	0	20	100,000	10	50,000	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		166,775		98,290		688,850		322,310		358,765		2,651,250
3 Net Production Value					612,415		485,975		411,025		286,910		1,084,150		576,490		722,435		2,591,250

Table 8.4 Economic Costs and Benefits Flow

Tiu Tui Project Unit : Million Rp.

Year	Cost				Benefit			Increment
	Capital	Replace	O&M	Total	Irrigation	Negative	Total	
1.	272	0	0	272	0	-7	-7	-279
2.	2,119	0	0	2,119	0	-7	-7	-2,126
3.	2,737	0	0	2,737	0	-7	-7	-2,744
4.	0	0	21	21	574	-3	571	550
5.	0	0	21	21	669	-2	667	646
6.	0	0	21	21	765	-1	764	743
7.	0	0	21	21	860	0	860	839
8.	0	0	21	21	956	0	956	935
9.	0	0	21	21	956	0	956	935
10.	0	0	21	21	956	0	956	935
11.	0	0	21	21	956	0	956	935
12.	0	0	21	21	956	0	956	935
13.	0	0	21	21	956	0	956	935
14.	0	0	21	21	956	0	956	935
15.	0	0	21	21	956	0	956	935
16.	0	0	21	21	956	0	956	935
17.	0	0	21	21	956	0	956	935
18.	0	0	21	21	956	0	956	935
19.	0	0	21	21	956	0	956	935
20.	0	0	21	21	956	0	956	935
21.	0	0	21	21	956	0	956	935
22.	0	0	21	21	956	0	956	935
23.	0	0	21	21	956	0	956	935
24.	0	0	21	21	956	0	956	935
25.	0	0	21	21	956	0	956	935
26.	0	0	21	21	956	0	956	935
27.	0	0	21	21	956	0	956	935
28.	0	0	21	21	956	0	956	935

EIRR = 14.4 %

Table 8.5 Financial Crop Budget per Ha

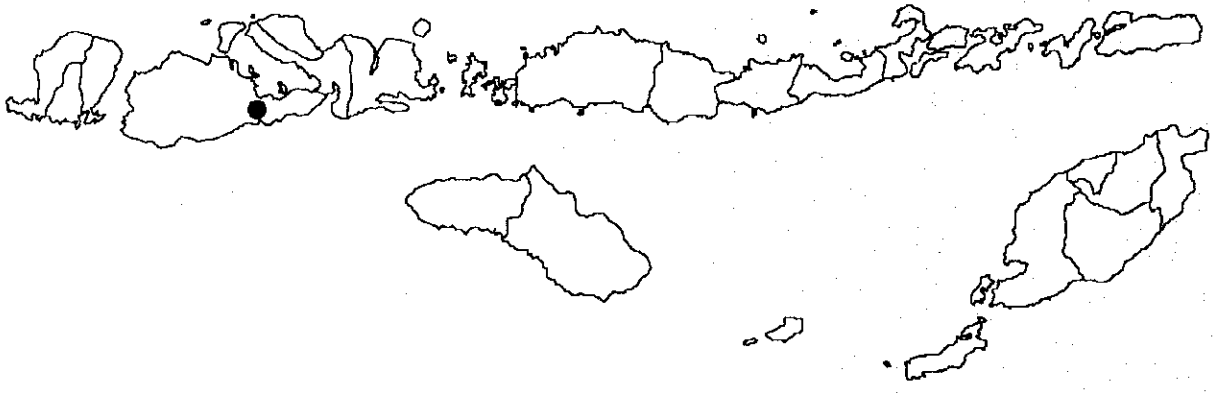
Tiu Tui Project

Item		Q'ty of Unit	Value (Rp.)	Without Project: Paddy (Irrigated) Q'ty	Am't (Rp.)	Paddy (Rainfed) Q'ty	Am't (Rp.)	Soybean (1st crop) (Rainfed) Q'ty	Am't (Rp.)	Soybean (2nd crop) (Rainfed) Q'ty	Am't (Rp.)	With Project: Paddy (Irrigated) Q'ty	Am't (Rp.)	Soybean (Irrigated) Q'ty	Am't (Rp.)	Mungbean (Irrigated) Q'ty	Am't (Rp.)	Red Onion (Irrigated) Q'ty	Am't (Rp.)
1 Gross Production Value																			
Paddy		kg	260	3,000	780,000	2,000	520,000	0	0	0	0	4,500	1,170,000	0	0	0	0	0	0
Soybean		kg	900	0	0	0	0	900	810,000	600	540,000	0	0	1,400	1,260,000	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	0	0	0	0	0	0
	Own	kg	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0
Soybean	Certified	kg	617	0	0	0	0	10	6,170	10	6,170	0	0	20	12,340	0	0	0	0
	Own	kg	0	0	0	0	0	30	0	30	0	0	0	20	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	25	8,750	20	7,000	300	105,000	50	17,500	75	26,250	300	105,000
TSP		kg	400	75	30,000	50	20,000	50	20,000	40	16,000	100	40,000	100	40,000	100	40,000	200	80,000
KCl		kg	400	35	14,000	0	0	25	10,000	20	8,000	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	0.0	0	0.0	0	2.0	20,000	2.0	20,000	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	0.0	0	0.0	0	2.0	11,000	1.0	5,500	1.0	5,500	3.0	16,500
Labor																			
Family		md	0	127	0	65	0	25	0	20	0	172	0	70	0	80	0	151	0
Hired		md	2,500	13	32,500	10	25,000	0	0	0	0	13	32,500	0	0	0	0	99	247,500
Draft Animal																			
Family		ad	0	20	0	10	0	10	0	0	0	20	0	10	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		44,920		37,170		243,625		115,340		125,580		2,289,000
3 Net Production Value					563,500		414,750		765,080		502,830		926,375		1,144,660		1,074,420		3,711,000

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

Feasibility Study on Tiu Tui Embung Development Project

Figures



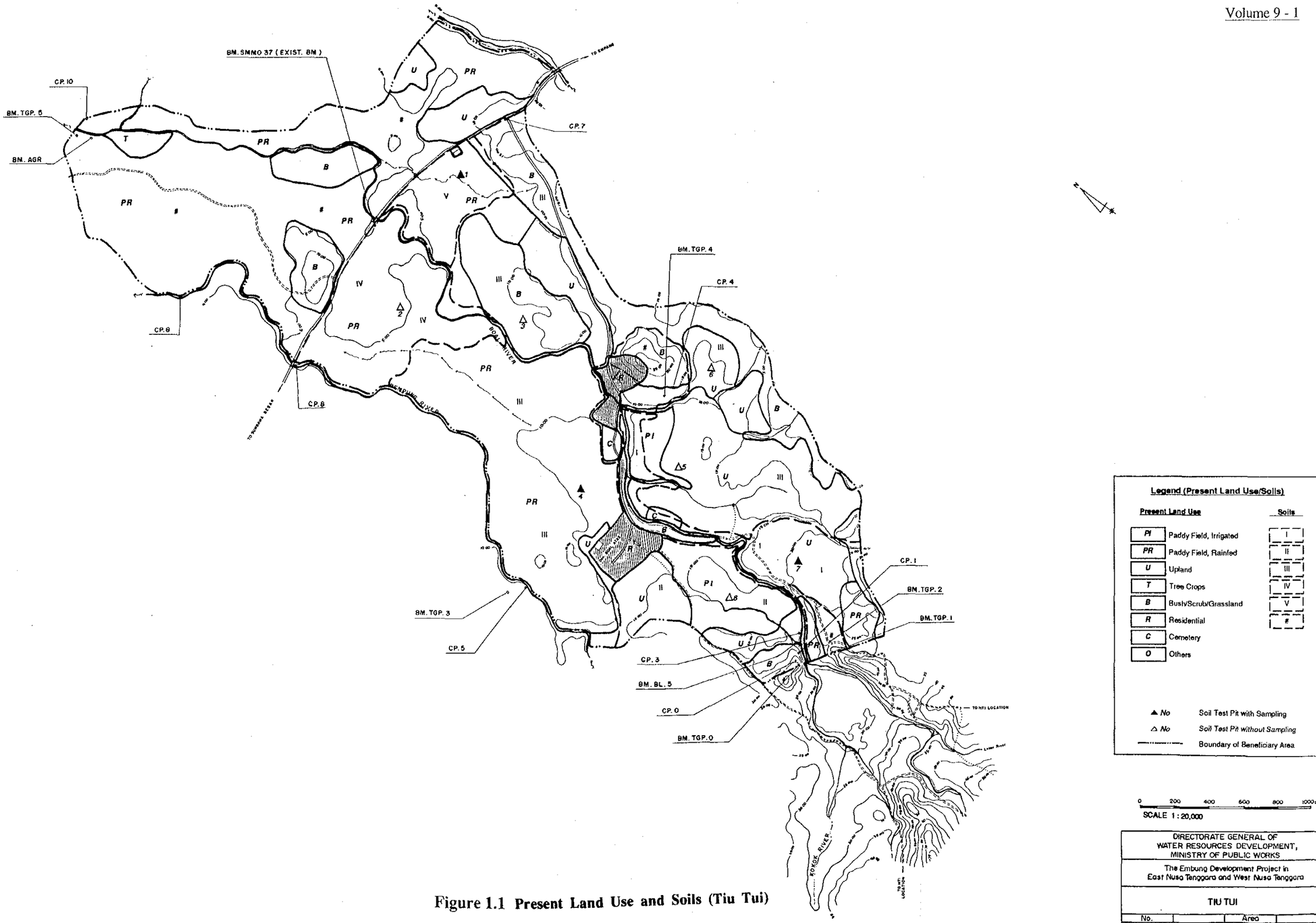


Figure 1.1 Present Land Use and Soils (Tiu Tui)

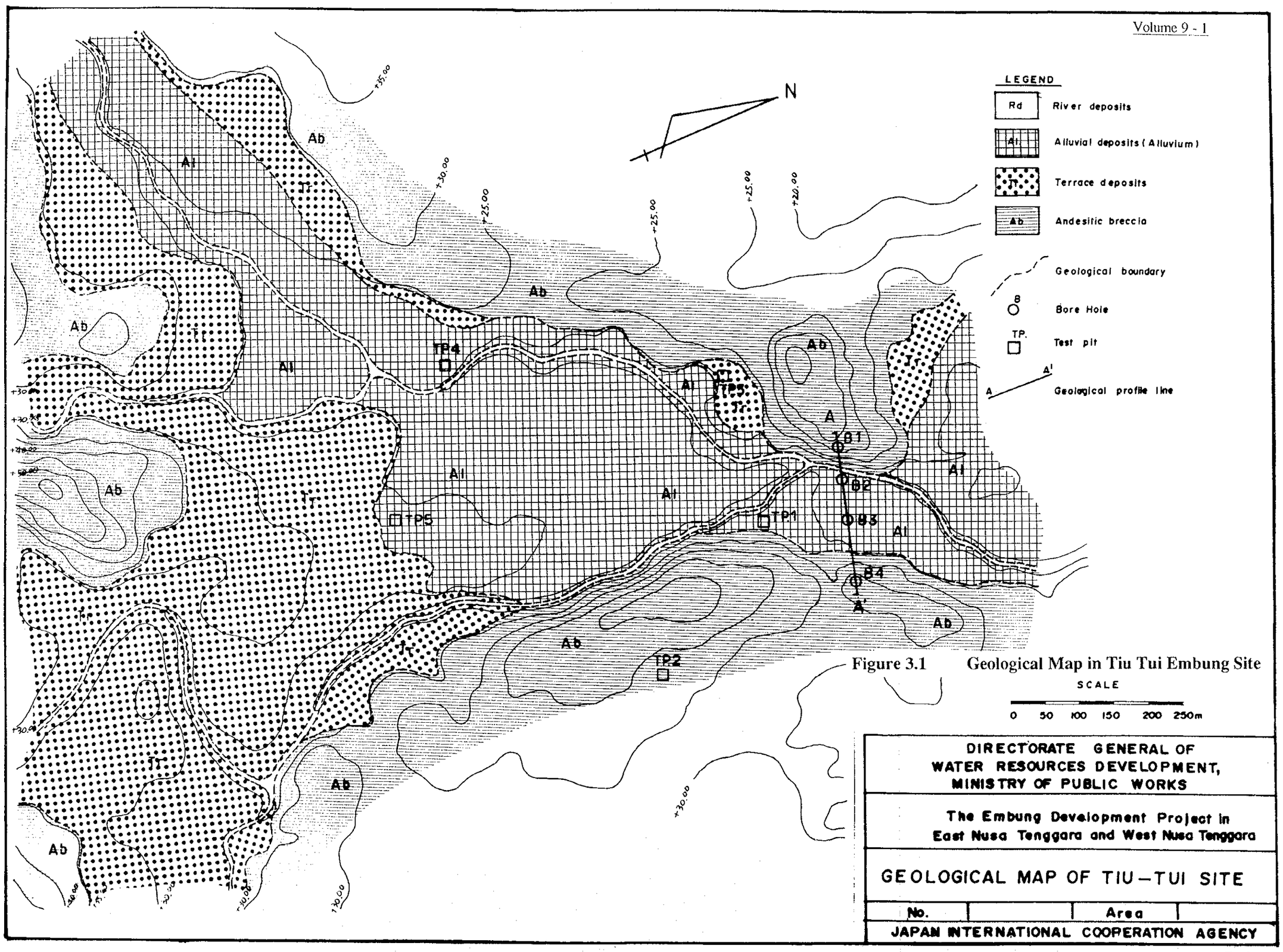


Figure 3.1 Geological Map in Tiu Tui Embung Site

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT, MINISTRY OF PUBLIC WORKS			
The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara			
GEOLOGICAL MAP OF TIU–TUI SITE			
No.		Area	
JAPAN INTERNATIONAL COOPERATION AGENCY			

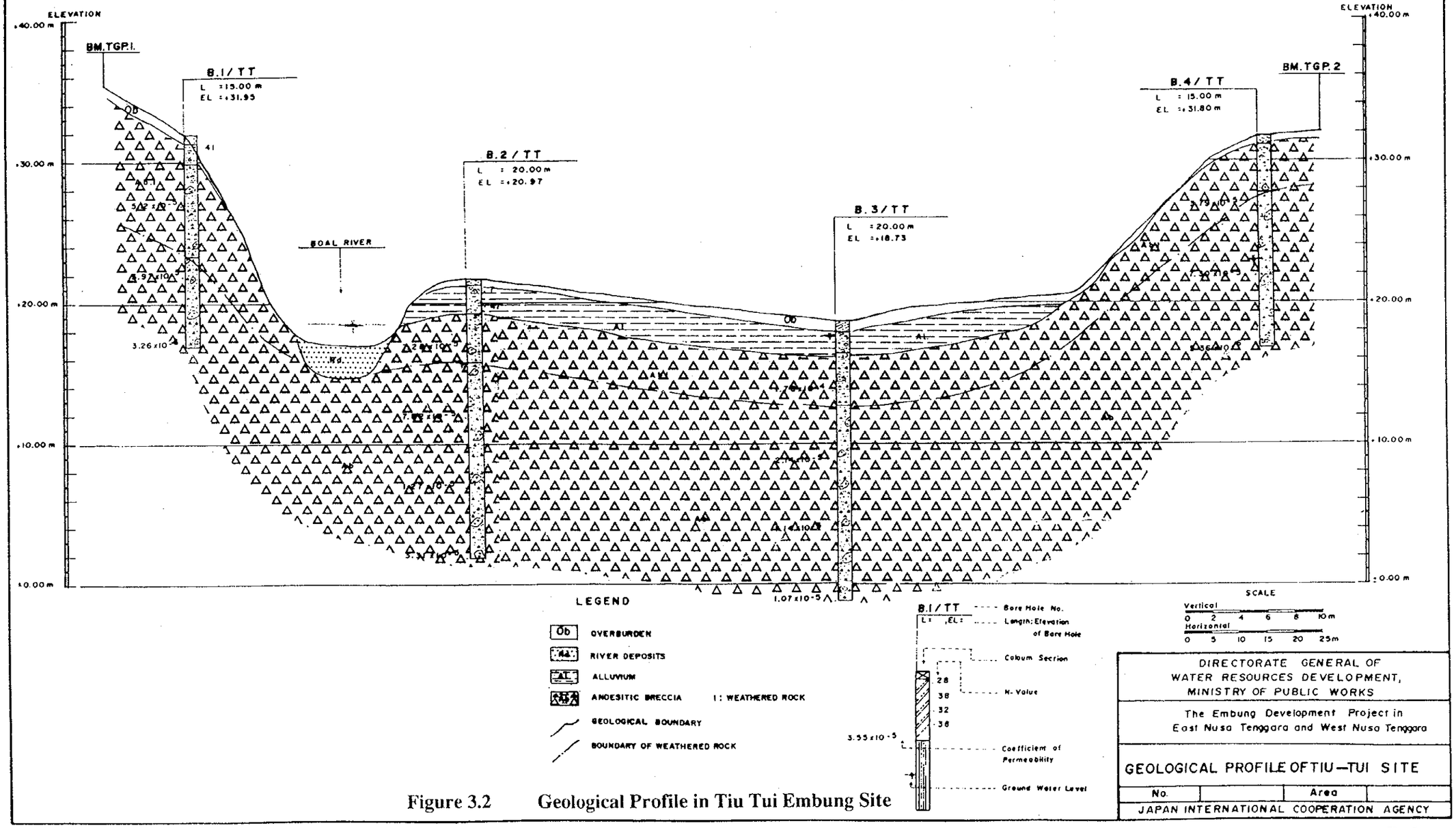


Figure 3.2 Geological Profile in Tiu Tui Embung Site

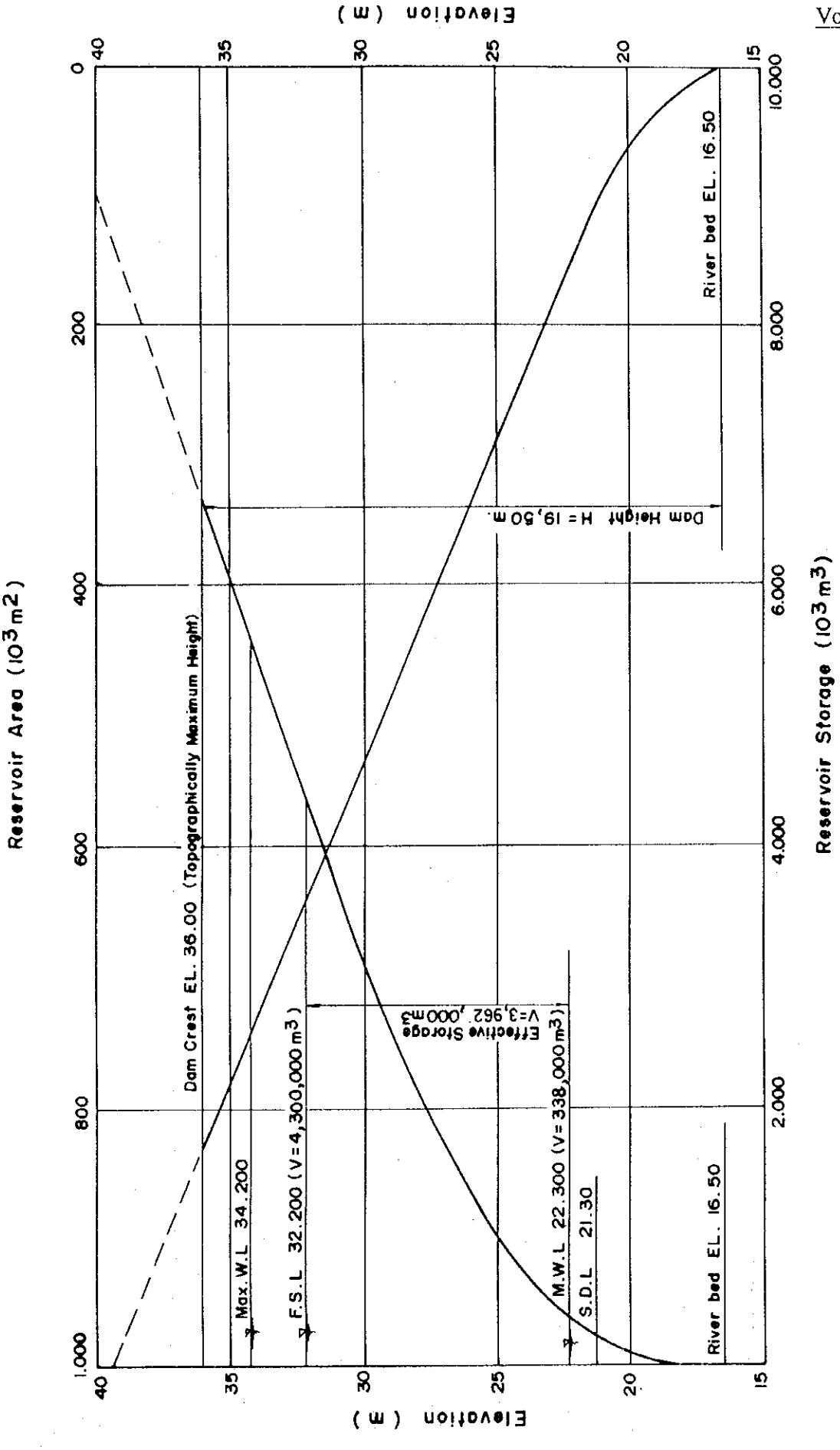


Figure 4.1 Reservoir Storage Curve in Tiu Tui Embung

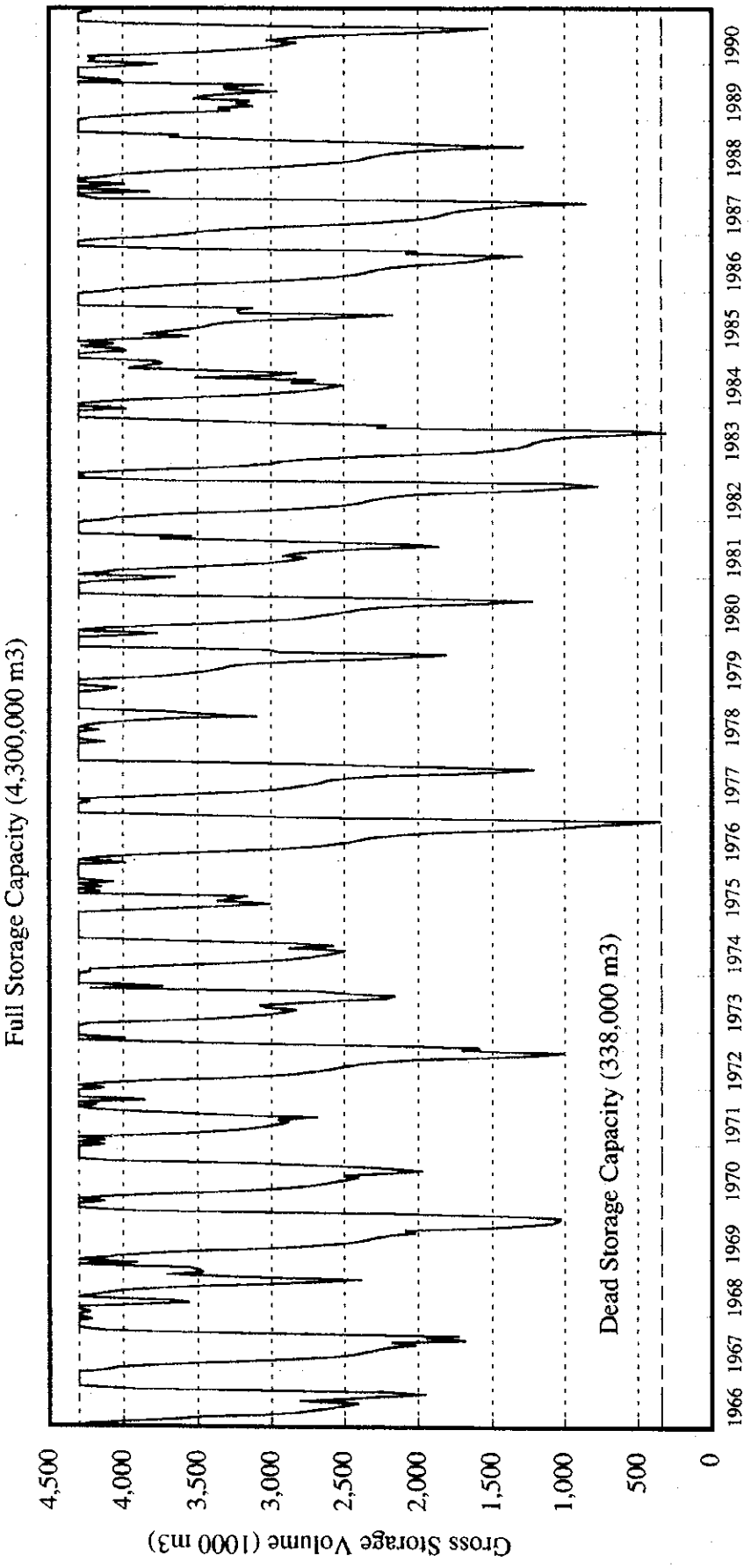
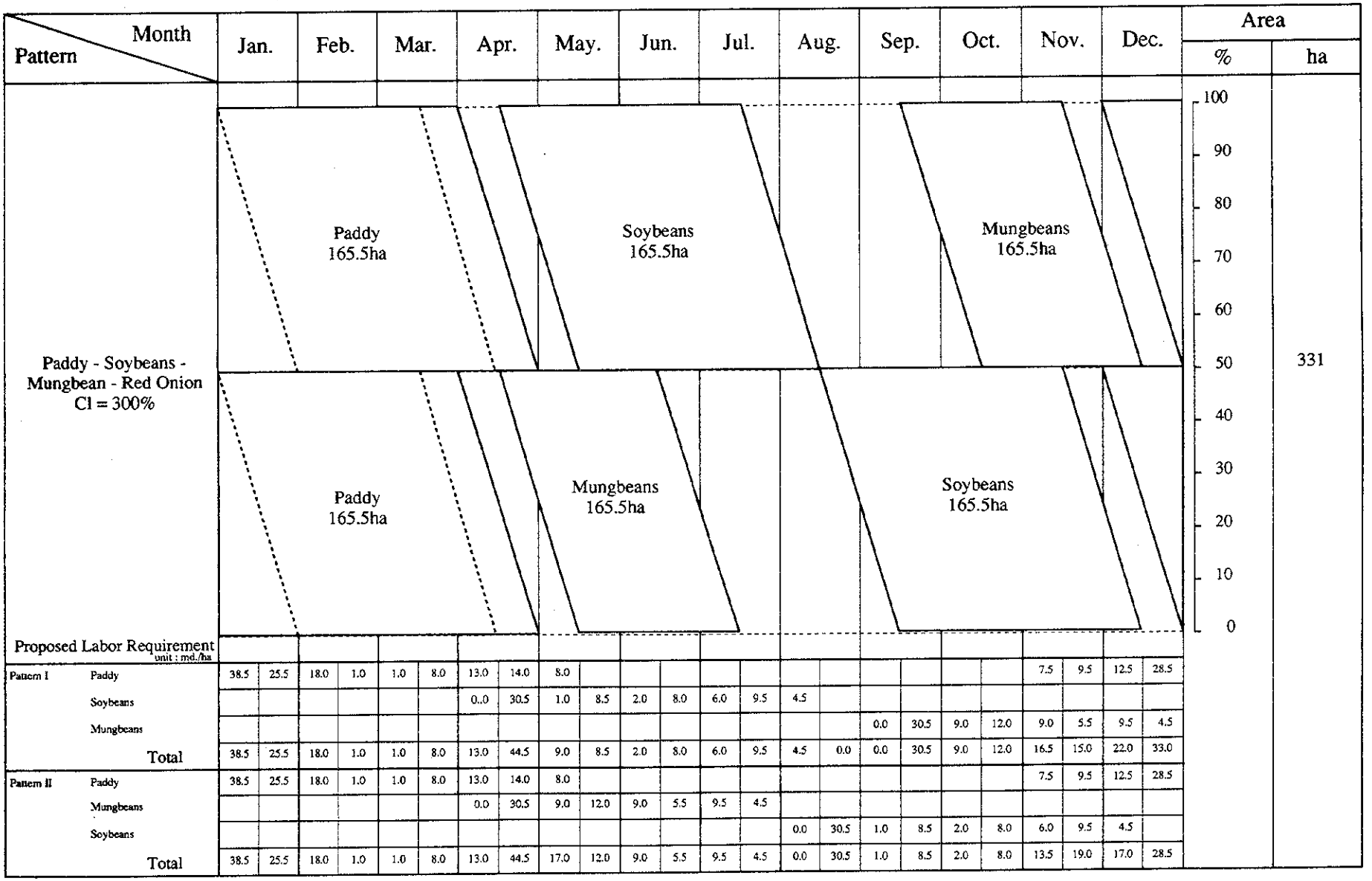


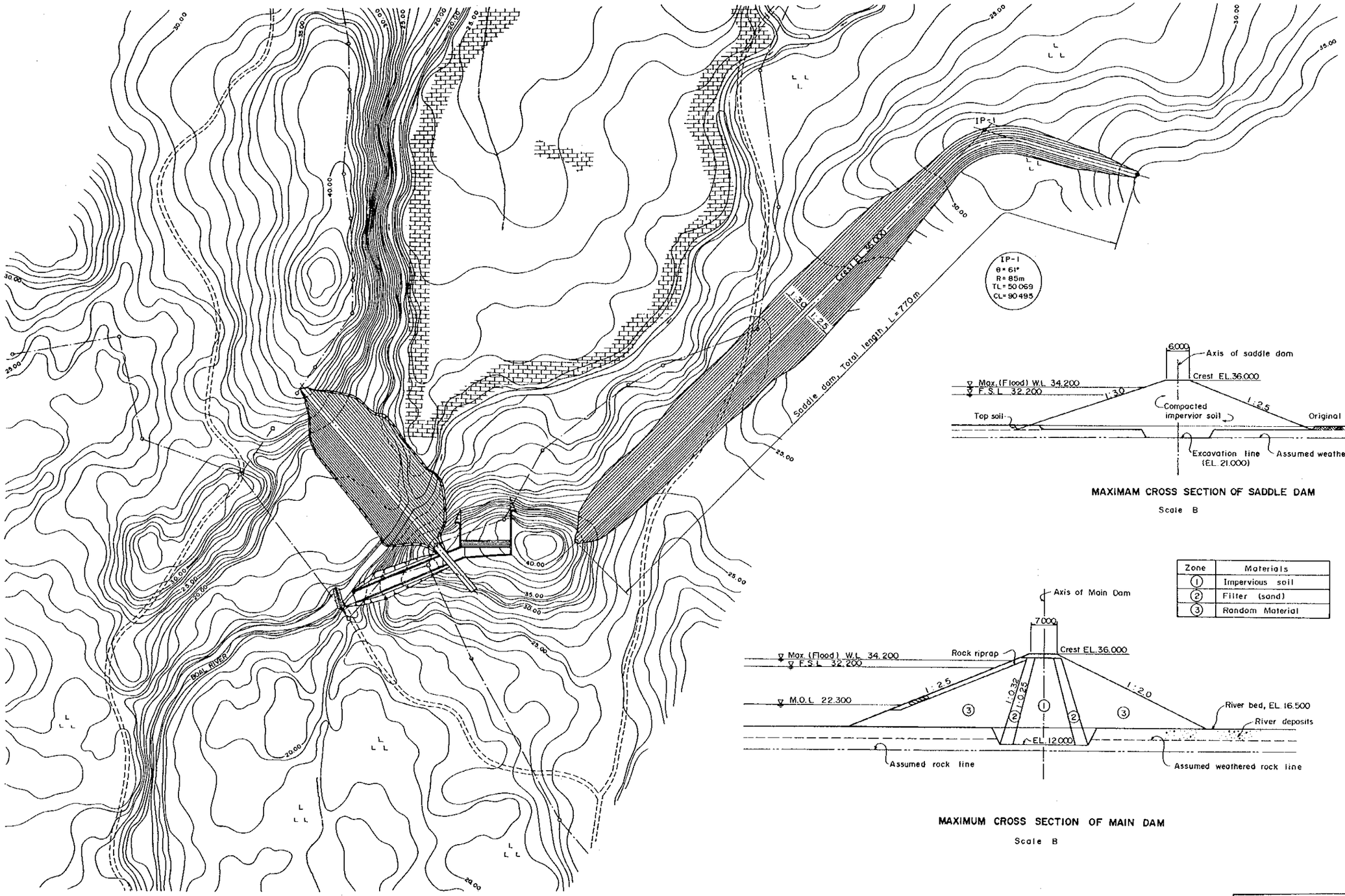
Figure 4.2 Result of Reservoir Operation in Tiu Tui Embung



Proposed Labor Requirement
unit : md./ha

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
	Soybeans							0..0	30.5	1.0	8.5	2.0	8.0	6.0	9.5	4.5							
	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	8.0	13.0	44.5	9.0	8.5	2.0	8.0	6.0	9.5	4.5	0.0	0.0	30.5	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
	Mungbeans							0.0	30.5	9.0	12.0	9.0	5.5	9.5	4.5								
	Soybeans															0.0	30.5	1.0	8.5	2.0	8.0	6.0	9.5	4.5	
	Total	38.5	25.5	18.0	1.0	1.0	8.0	13.0	44.5	17.0	12.0	9.0	5.5	9.5	4.5	0.0	30.5	1.0	8.5	2.0	8.0	13.5	19.0	17.0	28.5

Figure 4.3 Proposed Cropping Pattern for Tiu Tui Project



GENERAL PLAN OF MAIN DAM & SADDLE DAM

Scale A

MAXIMAM CROSS SECTION OF SADDLE DAM

Scale B

Zone	Materials
①	Impervious soil
②	Filter (sand)
③	Random Material

MAXIMUM CROSS SECTION OF MAIN DAM

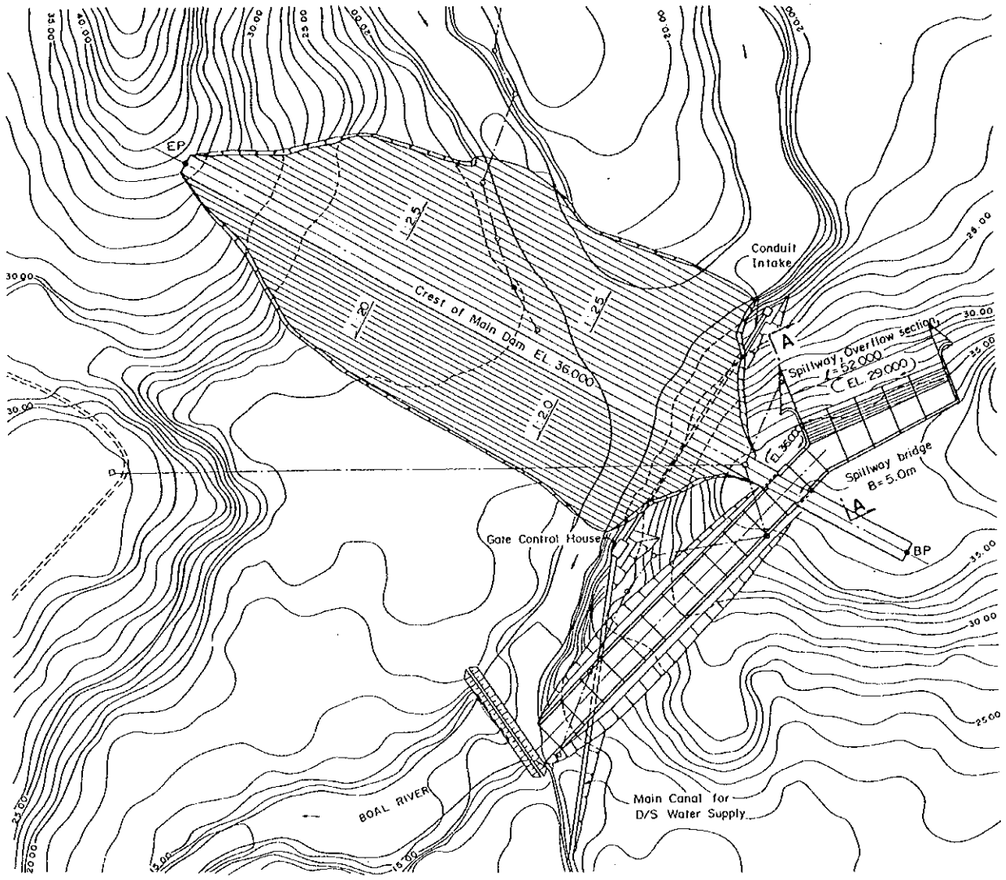
Scale B

Scale A 0 50 100 150 200m

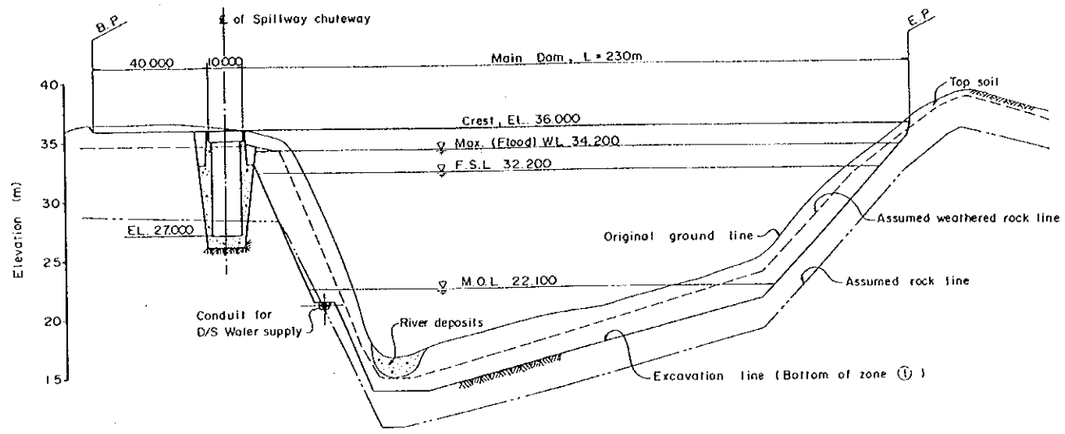
Scale B 0 10 20 30 40 50m

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 TIU TUI EMBUNG (1)	
No.	Area
JAPAN INTERNATIONAL COOPERATION AGENCY	

Figure 4.4 General Plan of Tiu Tui Embung (1/2)

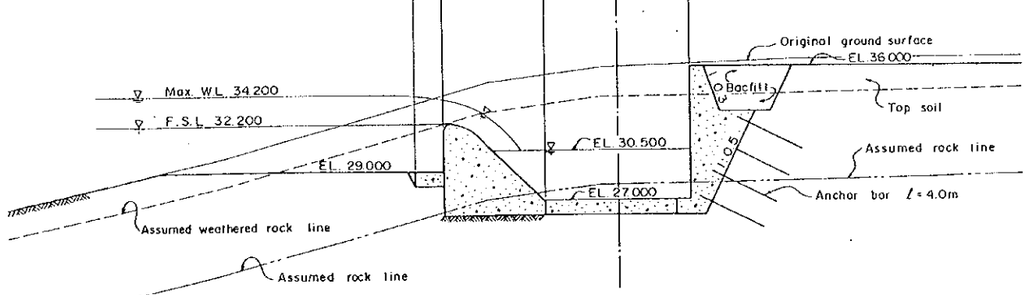


PLAN Scale A



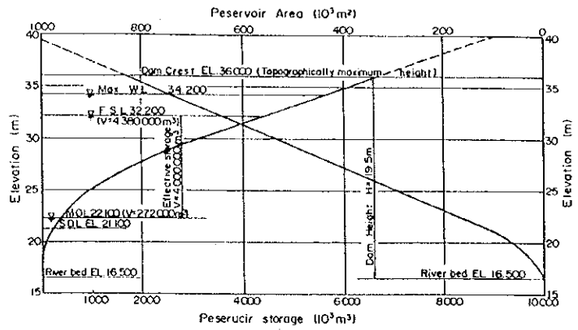
PROFILE OF MAIN DAM

Scale H = 1 : 1 000
V = 1 : 250



SECTION A – A

Scale B



RESERVOIR STORAGE CURVE AT TIU TUI

Scale A 0 20 40 60 80 100m

Scale B 0 5 10 15 20m

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 TIU TUI EMBUNG (2)	
No.	Area
JAPAN INTERNATIONAL COOPERATION AGENCY	

Figure 4.4 General Plan of Tiu Tui Embung (2/2)

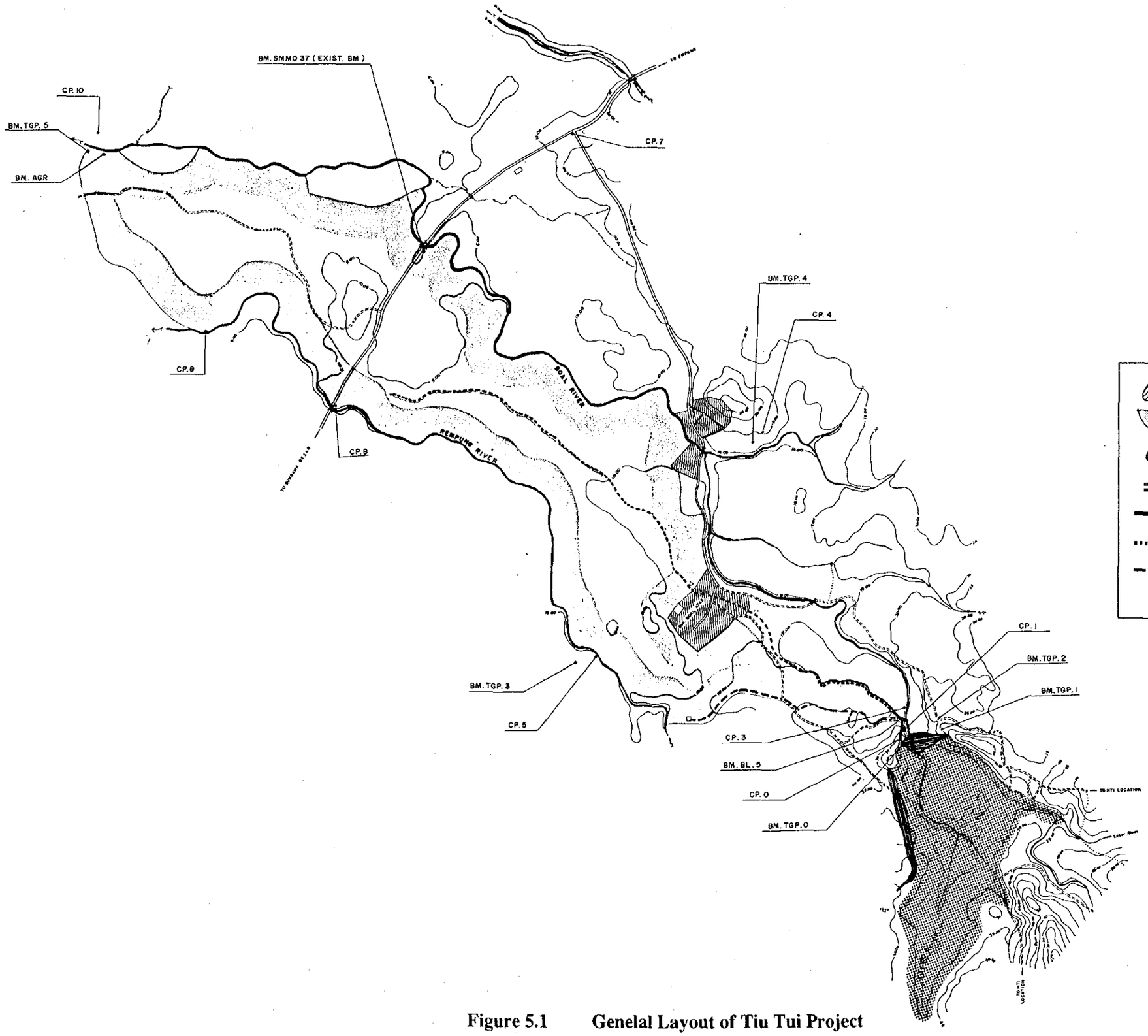


Figure 5.1 Genelal Layout of Tiu Tui Project

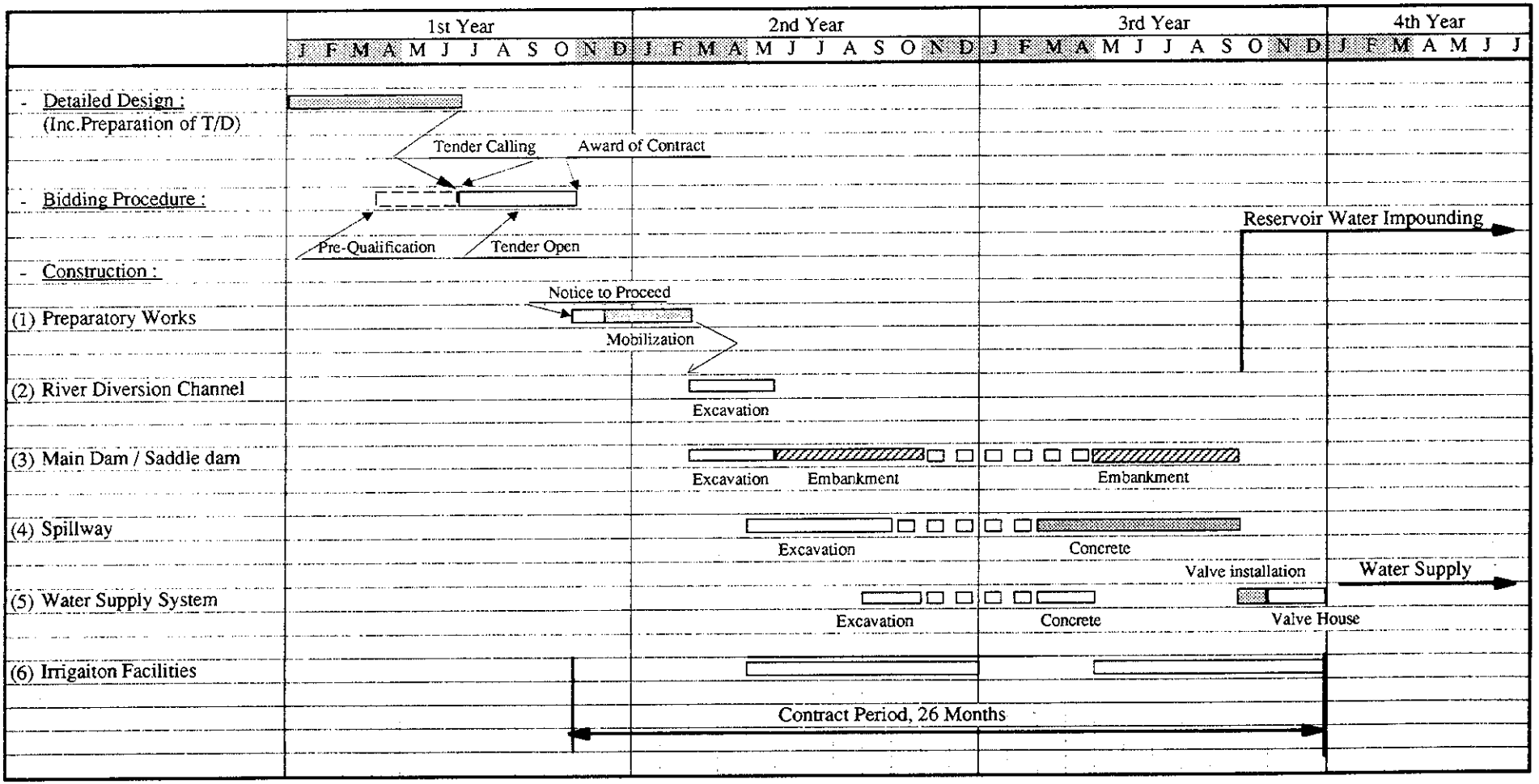


Figure 6.1 Construction Time Schedule for Tiu Tui Project

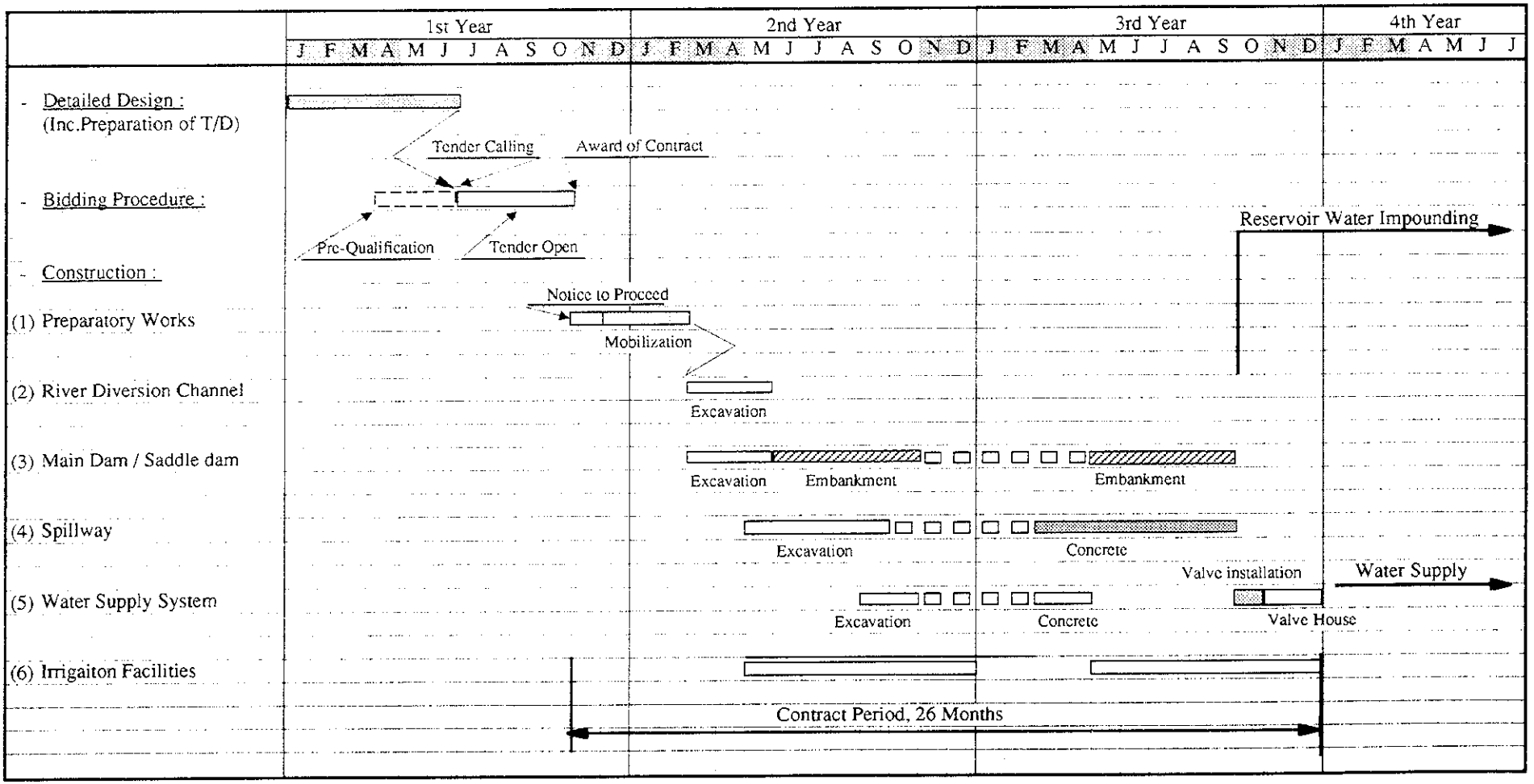


Figure 6.1 Construction Time Schedule for Tiu Tui Project

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

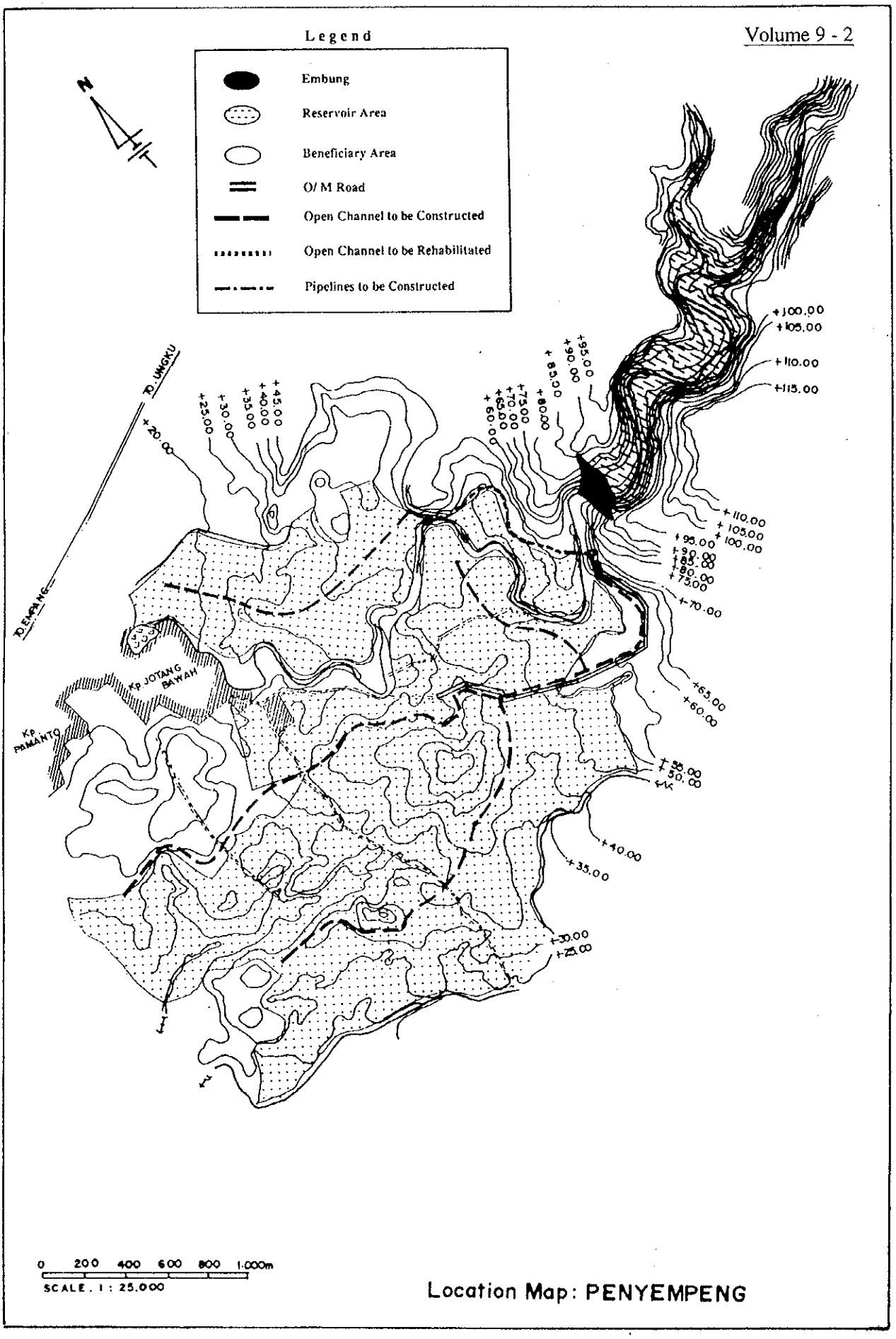
Final Report

Volume 9-2

Feasibility Study
on
Penyempeng Embung Development Project

May 1995

Nippon Koei Co., Ltd.



Location Map: PENYEMPENG

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 9-2

FEASIBILITY STUDY
ON
PENYEMPENG 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 Jotang Village in Kecamatan Empang of Kabupaten Sumbawa. The proposed Embung site is located upstream of the Jotang river about 100 km east from Sumbawa Besar of Nusa Tenggara Barat (NTB).

Topographical condition of the catchment area is fairly steep slope up to the mountain peak, from which V-shaped valley is formed along the Penyempeng river. Mountainous zone is covered by rough forest above the reservoir area.

Beneficiary area is located on the both side of the Penyempeng river from the dam site until the downstream residential zone.

1.2 Climate and Hydrology

The nearest climate station from the proposed Embung site is the Plampang station while there are another two rainfall stations near the proposed Embung site; Empang and Plampang. The wet season usually starts from late November and ends early April in the Project area with the average annual rainfall of 1,217 mm in Empang. Mean annual temperature is 27.8 °C with the average maximum temperature of 32.8 °C and the average minimum temperature of 22.9 °C. Mean relative humidity is 85.1 %. 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 5.8 km/hr. Table 1.1 and 1.2 show monthly rainfall record at the Empang station and climate data at the Plampang station, respectively.

The Brang Penyempeng river rises near Mt. Doro Tanahmerah where the altitude is approximately 600 m and follows a southwesterly course until it reaches Empang Village. Then it turns northwestwards and discharges into Saleh Bay. The surface of the catchment area is mostly covered with forest. The catchment area at the proposed Embung site is 41.1 km^2. There is the Empang gauging station on this river at the downstream site of the proposed Embung although its measurement is intermittent.

1.3 Geology

The proposed Embung site is underlain by mainly volcanic rock of the Tertiary age and unconsolidated deposits of the Quaternary age. The geological formation is: andesitic breccia composed of andesitic tuff breccia of the Tertiary age, moderately soft to hard rock.; terrace deposits composed of mainly sand and gravel forming terrace with flat to gentle slope; alluvium composed of sand, silt and gravel forming lowland; detritus composed of soil with rock fragments, and distributed at foot of slope or gentle valley; 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 Penyempeng lies on the alluvial fan and undulating plain. The right bank area of the Semangi river is relatively flat with an average slope of 1%, while the left bank is steeper and undulating.

Soils of the Project area extend on basaltic rocks and mixed alluvial materials. Soil drainage on farmland is moderate to well and soil permeability is slow to moderate. Soil

depth is shallow to very deep ranging from 20 cm to more than 110 cm. Soil texture of surface soil varies from clay to sandy loam.

The results of the soil survey are shown in Table 1.3 on a typical soil profile out of 14 soil test pits, Table 1.4 on soil laboratory tests for soil samples taken from three representative pits out of 14 pits and Table 1.5 on the soil classification.

The wet paddy field of 247 ha lies on the right bank area of the Semangi and Terara rivers, the upper left bank area of the Semangi river and the southern part of Jotang Bawah Village. The paddy field of 96 ha between the Semangi and Terara rivers is irrigated by the existing intake weir at 150 m downstream from the proposed Embung site. The remaining 151 ha of the wet paddy field are still under the rainfed cultivation.

The dry upland widely extends on the left bank area of the Semangi river, occupying 328 ha in total which include the fields mixed with grassland or bush.

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

Present Land Use on the Project Area of Penyempeng

Unit: ha

Land Use	Irrigated	Rainfed	Others	Total
Paddy field	96	151		247
Upland	0	328		328
Tree crops	0	0		0
Bush/Scrub/Grassland			62	62
Residential			26	26
Cemetery			1	1
Others			0	0
Total	96	479	89	664

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 3,258 and a total number of households of 761 including farm households of 662 as shown below. The average family size is 4.3 persons. Dominant ethnic is original Sumbawanese 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.)
Jotang	Jotang Bawah	1,189	309	3.8	240
	Jotang Atas	1,504	343	4.4	317
	Jotang Bru	565	109	5.2	105
Total		3,258	761	4.3	662

Source : JICA Water Use Survey

1.6 Domestic Water Use

The existing water source facilities for supplying domestic water are hand pump wells and a public water basin in the Project area. Another water source of drinking and livestock water is perennial flow of the Brang Bru river. No water shortage problems occur in the Project area. The present water use in each sub village clarified under the Study is summarized below:

- In Jotang Bawah Sub Village, 274 households take their drinking water from the Brang Bru river, 20 families from hand pump wells and 15 households from a public water basin. The average distance from the river is 100 m, while other source facilities are available nearby their houses;

- In Jotang Atas Sub Villages, 263 households take their drinking water from the Brang Bru river and 40 families each from hand pump wells and a public water basin. The average distance from the river is 125 m, while other source facilities are available nearby their houses; and

- In Jotang Bru Sub Village, 38 households take their drinking water from the Brang Bru river, 22 families from hand pump wells and 49 households from a public water basin. The average distance from the river is 150 m, while other source facilities are available nearby their houses.

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 private toilets outside their houses or the river bed for defecating purposes. There are an auxiliary hospital and an integrated health service center within the Project area.

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 - Paddy	43.0	86.0	16.7	200
(2) Paddy - Fallow	135.0	135.0	26.2	100
(3) Upland crop - Fallow	295.0	295.0	57.1	100
Total / Average	473.0	516.0	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 paddy are cultivated, while on the rainfed paddy field single cropping of the wet season paddy is common. Soybean 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 primitive 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	Soybean
Farm Inputs			
Seed	kg/ha	50	50
Fertilizer			
Urea	kg/ha	300	50
TPS	kg/ha	100	100
KCl	kg/ha	50	25
Agro-chemicals	lit/ha	-	-
Labor Requirements			
Nursery	md/ha	4	-
Land preparation	md/ha	2	3
	ad/ha	5	-
Planting	md/ha	3	3
Transplanting	md/ha	15	-
Weeding	md/ha	10	4
Pest & disease control	md/ha	2	2
Farm management	md/ha	2	2
Harvesting	md/ha	15	10
Transportation	md/ha	5	5
Others	md/ha	4	2
Total	md/ha	62	31
	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 yield of major crops remains 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	86	3.00	258
Rainfed			
Wet season paddy	135	2.00	270
Dry season paddy	86	1.80	155
Upland Field			
Soybean	295	0.90	266

Source: The JICA Inventory Survey

(4) Livestock population

Various kinds of livestock are raised in the Project area and their population is given below. Buffaloes and horses play important roles in land preparation and transportation 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
608	15	293	153	55	0	640

Source: The JICA Water Use Survey

1.9 Irrigation Facilities

In the Project area, there exist paddy field of 96 ha in gross on the right bank and 71 ha on the left bank of the Buas river. Water source of this river is a spring situated at the upstream not so far from the proposed Embung site. The right area bank has been irrigated by the existing weir situated at around 100 m downstream of the proposed Embung site. The weir was built by the Government. It is functioning well. Irrigation water taken by the weir is led by the existing canal to wet paddy field with a distance of about 800 m. This canal is an earth-lined. It is functioning well. Wetpaddy field on the left bank is rainfed. As the Buas river is perennial, the irrigated paddy field on the right bank is also provided with irrigation water in the dry 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 70% of farmers benefited by the existing irrigation scheme are involved in Water Users' Association (P3A/HIPPA), established in 1988, 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 Empang. 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 assigned to a district center for agricultural extension. 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. 1.52 million and Rp. 2.20 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 3,258 persons as at 1993 to 3,479 persons in 1998, 3,695 persons in 2003, 3,895 persons in 2008, 4,071 persons in 2013 and 4,232 persons in 2018.

(2) Basic human needs (BHN)

The inhabitants in the Project area are satisfied with the present condition of rural infrastructures because the existing domestic water supply sources can meet drinking and livestock water requirements throughout a year. Therefore, no pressing BHN are left in the Project area at moment.

(3) Economic development needs

All of 662 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 as much as possible.

(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 Brang Penyempeng river can divert the wet season discharge at the designed level but the dry season discharge below the said level, because the water level at the intake site becomes lower than the expected level during the dry season and also the intake itself has no function of storing water. Due to such situation of limited use of surface runoff, no more utilization of the Brang Penyempeng river can be expected unless countermeasures to regulate the wet season runoff are practiced.

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 increase irrigation water for the dry season cropping by utilizing potential water resources in the Brang Penyempeng river basin to the maximum extent.

(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 Brang Penyempeng 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 Penyempeng 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 land use on the right bank area would not be changed in the future, because the land is already developed as irrigated paddy field as much as possible. Only irrigation water source for the paddy field of 96 ha could be changed from the existing weir to the proposed Embung.

On the other hand, the left bank area has large development potential for irrigation and land reclamation. The irrigation water could be conveyed in the presently rainfed paddy field of 71 ha where elevation of the field is lower, enough for water supply. Further, the upland field could be transformed into the irrigated paddy field from the viewpoint of land suitability. The new wet paddy field should be a terraced form because of the steep slope of 1 to 10%. The maximum land reclamation area is roughly estimated at 250 ha, while the reclamation scale depends on the irrigation water availability.

Rainfed paddy field	->	Irrigated paddy field	71 ha
Rainfed upland	->	Irrigated paddy field	250 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 Penyempeng

Unit: ha

Land Use	Irrigated	Rainfed	Others	Total
Paddy field	417	80		497
Upland	0	78		78
Tree crops	0	0		0
Bush/Scrub/Grassland			62	62
Residential			26	26
Cemetery			1	1
Others			0	0
Total	417	158	89	664

Source : The JICA Study Team

The impounding area of the proposed Embung is covered by only the grassland and river escarpment. There is no intensive farmland in the reservoir area. Therefore, the land compensation is not necessary for this Project.

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 C-12	Paddy	100	Paddy	100	-	-
With Project C-21	Paddy	100	Soybean*	100	-	-
With Project C-22	Paddy	100	Soybean*	100	Mungbean	50
					Red onion	50
With Project C-23	Paddy	100	Paddy	100	Mungbean	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 input 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	Soybean	Mungbean	Red Onion
Farm Inputs					
Seed	kg/ha	25	40	30	2,000
Fertilizer					
Urea	kg/ha	300	50	75	300
TPS	kg/ha	100	100	100	200
KCl	kg/ha	50	50	50	100
Agro-chemicals	lit/ha	2	2	2	10
Rodenticide	kg/ha	2	1	1	3
Labor	md/ha	185	70	80	250
Draft Animal	ad/ha	20	10	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 application 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 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 PPLs.

(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, 1.4 ton/ha for soybean, 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 Sumbawa 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
27	307	161	16	0	1,605

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 Penyempeng Embung site is selected at a narrow gorge on the Penyempeng river, immediately upstream of the existing irrigation intake weir. A reservoir tank for domestic water supply to Empang is located just left abutment of the dam site. The river bed is El. 48.5 m and the width of gorge is about 400m at El. 90m on the both abutments of the dam site.

3.2 Geological Condition

The dam site is mainly underlain by andesitic breccia. The foundation is mainly formed of andesitic breccia at the left bank and andesitic breccia and alluvium at the right bank . The drilling survey shows that the average N-value of alluvium will be expected more than 11. The coefficient of permeability of andesitic breccia varies from 9.3×10^{-5} to 9.8×10^{-6} cm/sec. Groundwater table is present around El. 52 m at the both banks and the bottom of alluvium. Spring water occurs at bore hole No. 2 from 3 m in depth.

The reservoir area is mainly underlain by andesitic breccia, terrace deposits and alluvium. No major fault and landslide are recognized in the area. No major problem for water leakage is assumed to occur in the reservoir area. Geological map and profiles are shown in Figures 3.1 and 3.2.

3.3 Availability of Construction Materials

In and around the proposed dam site, there are sufficient construction materials suitable for constructing a zone type fill dam for the proposed Embung. The borrow area for impervious soil and 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	Clayed silty sand or clayed sandy silt
2. Filter material	Downstream of Penyempeng river	River deposits
3. Transition material	Penyempeng river	River deposits
4. Random material	Spillway/ main dam foundation	Excavated materials of Andestic breccia, weathered rock
5. Concrete aggregates	Downstream of Penyempeng river	River deposits

3.4 Availability of Water Resources

(1) Catchment yield

As for the Brang Penyempeng river, there are discharge records in Empang at the downstream site but its recording period is not sufficient to make relationship between

rainfall and discharge. Accordingly, runoff at the proposed Embung site is estimated by use of the rainfall record near the proposed site. The Empang rainfall station which is located in the east of the Tiu Tui Embung catchment has rainfall records of nearly consecutive 30 years and is considered to represent catchment rainfall. The blank data of the Empang station is supplemented by that of the Plampang station. The climate is strongly influenced by altitude and 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 1.20 is multiplied by use of isohyetal map. The generated catchment rainfall is given in Table 3.1. A runoff coefficient of 0.40 is adopted considering the characteristics of the catchment area and the previous hydrological analysis in the Sumbawa Island. Using this runoff coefficient and the rainfall record at Empang station, river flow of the Brang Penyempeng at proposed Embung site is estimated.

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

- Catchment area of the proposed Embung site is 41.1 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 1966 to 1991. 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
6,179	5,366	3,870	1,367	534	302	230	82	296	460	1,509	4,221	24,415

(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, 32 years rainfall data of the Empang station from 1955 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	84
1 in 5 year	115
1 in 10 year	136
1 in 20 year	155
1 in 50 year	182
1 in 100 year	202
1 in 200 year	222

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	171
1 in 5 year	234
1 in 10 year	277
1 in 20 year	316
1 in 50 year	371
1 in 100 year	411
1 in 200 year	452

(3) Sediment load

There is no available data on sediment load on the Brang Penyempeng 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, 0.4 mm/year/km^2 is adopted in this Study.

(4) Water quality

On October 27, 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 Penyempeng 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 (m3)
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)
O_L : 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 Brang Penyempeng, discharge is generated from rainfall of the Empang 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 Penyempeng Embung.

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