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Japan International
Cooperation Agency
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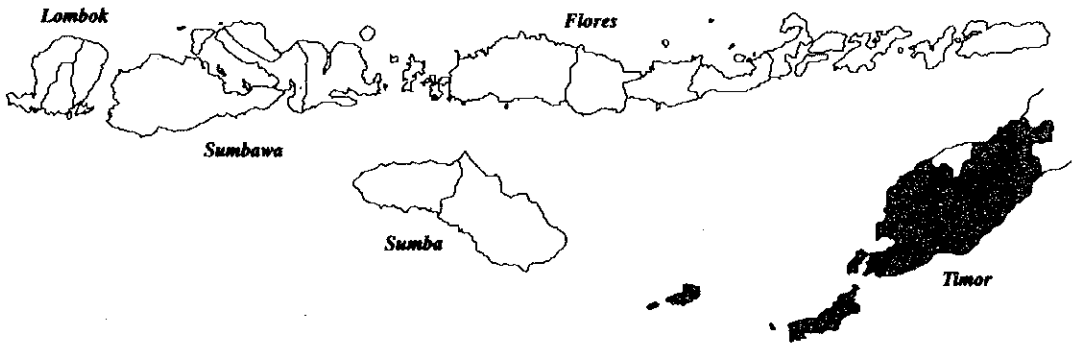
Directorate General of
Water Resources Development,
Ministry of Public Works

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 6)

Feasibility Study Report
on
Six Embung Development Projects
in
Timor Island in East Nusa Tenggara

ANNEXES



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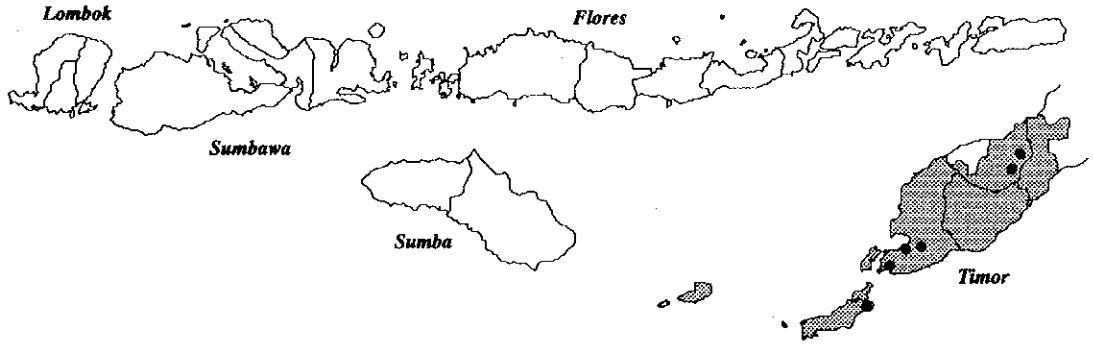

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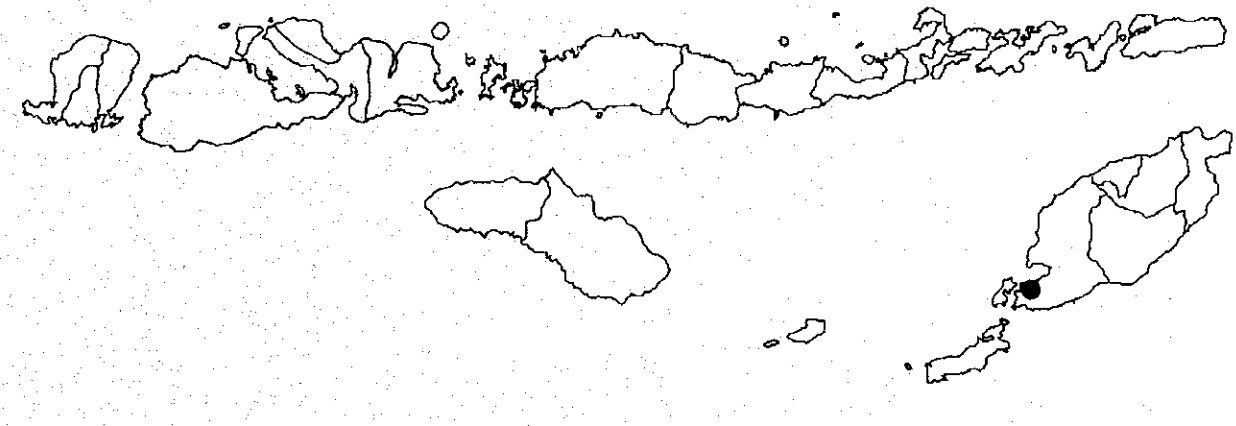
Feasibility Study
on
Bimoku Embung Development Project



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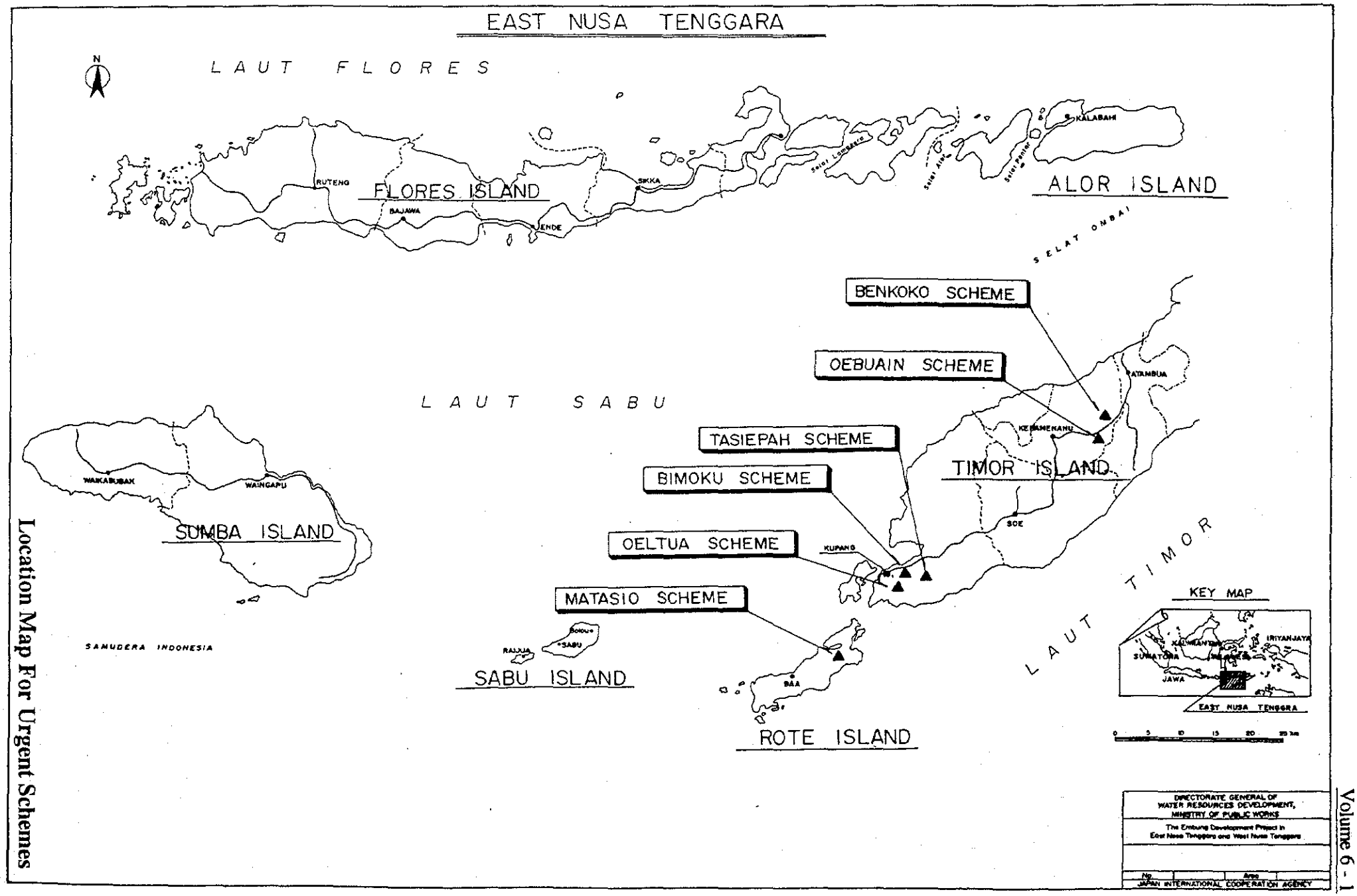
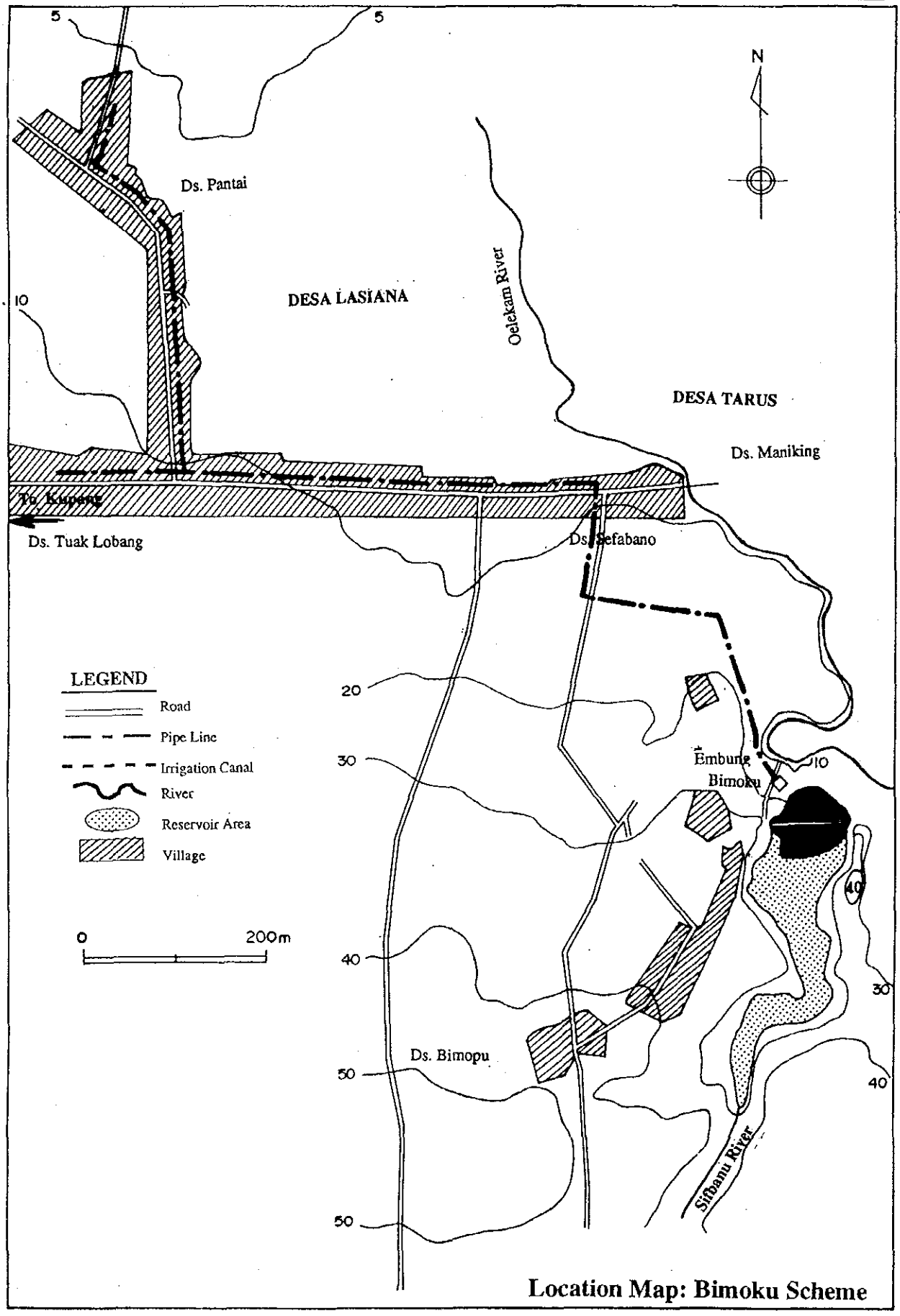


Location Map For Urgent Schemes



Location Map: Bimoku Scheme

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

FINAL REPORT

VOLUME 6-1

FEASIBILITY STUDY
ON
BIMOKU EMBUNG DEVELOPMENT PROJECT

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Location of Bimoku 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 about 12 km of east of Kupang, the capital of East Nusa Tenggara (NTT) Province, in the western part of Timor island. The proposed site of Bimoku Embung has coordinates of 123°41'43" east longitude and 10° 08' 50" south latitude.

The Project area extends along the both sides of the Sifbanu river, a tributary of the Oelekam river, and covers coastal plain. It is bounded on the south by terrace and lower hill and the north by Kupang bay. A hill with flat plateau shape is distributed along the Sifbanu river and, at the proposed Embung site, forms a narrow valley. The Project area ranges from 4 to 48 m in elevation. The potential area for irrigated agriculture is flat.

Main residential zones in the Project area are Lasiana Village (Desa) and a part of Tarus Village in the Sub-district (Kecamatan) of Kupang Tengah of the District (Kabupaten) of Kupang. These two villages within the Project area consist of five sub-villages (Dusun); Sefabano, Tuak Lobang, Pantai, and Bimopu in Lasiana Village and Maniking in Tarus Village.

1.2 Climate and Hydrology

The wet season usually starts from late November and ends early April in the Project area with the average annual rainfall of 1,470 mm. Rainfall pattern is featured by concentrated heavy rains occurring two or three times during the wet season with the maximum 24 hours rainfall record of 120 mm. Mean annual temperature is 27.4°C with the average maximum temperature of 31.0°C and the average minimum temperature of 22.9°C. Mean relative humidity is 72.8%. Average sunshine hours are 4 to 5 hr/day during the wet season and increase to 7 to 8 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 0.4 km/hr. Tables 1.1 and 1.2 show monthly rainfall record at the Penfui station and climate data at the Penfui station, respectively.

The Sifbanu river as a potential water resource is a perennial stream with a catchment area of 0.20 km^2 at the proposed Embung site. There is no gauging station on this river. Usually, the river resume reflects the monthly rainfall pattern. Due mainly to deforestration in the catchment area, sedimentation on the river bed is common along the river stretch.

1.3 Geology

The Project area is underlain by the Tertiary and the Quaternary. The Tertiary is mainly composed of siltstone called the Noele Formation. The Quaternary is formed by coral limestone, alluvial terrace deposits, detertus and recent river deposits. With regard to geological formation, the Noele Formation consists of sandy marl interbedded with sandstone, conglomerate and tuff layers. Coral limestone and sandy limestone form Coralline Limestone. Alluvial terrace deposits comprise gravel, sand and some clay, being unconsolidated sediments. Detritus is composed of soil with gravel and distributed on gentle slopes at the foot of hill. Recent river deposits are derived from river sediments consisting of gravel of coral limestone, sand and clay.

1.4 Soils and Land Use

Soils in the cultivated and cultivable land in the Project area are structured with silty to sandy clay. As presence of exchangeable cations is high, soil reaction is slightly alkaline. Response to fertilizer application is high because of poor soil fertility caused by lack of organic matters in the top soil.

At present, a total land of 286 ha is used for agriculture activities comprising wet paddy field of 10 ha and upland of 276 ha. The wet paddy field is used under rainfed condition. In addition, inhabitants in the Project area possess a small piece of home yard growing vegetables and tree crops mainly for their home consumption.

1.5 Demography

The total population in the Project area as of 1993 was 2,392 and the number of households was 576 in total. The breakdown of population and household by sub-village is shown in Table 1.3. The average family size is 4.2 persons. Heterogeneous ethnics are originated from the native Timor. The majority of inhabitants are Protestant and engaged in agriculture. Their average education attainment is primary to junior high school grade.

1.6 Domestic Water Use

There exist one public water basin, five public water tanks, one water faucet, five public wells and 213 private wells in the Project area. The Maniking river is used as supplemental water source for domestic use. About 80% of users of these water supply sources are suffering from water shortage problem for at least two months every year because these go almost completely dry from October to December. The present water use in each sub-village clarified under the Study is summarized as follows:

- In Sefabano Sub-village with 85 families and 380 persons, there are one public water tank at a distance of 150 m on an average from 12 family users, one water faucet for one family and two private wells at the average distance of 10 m from ten families. These water sources except for the water faucet dry up from October to December. Together with the remaining 62 families without any specific water source, all inhabitants are provided with the minimum volume of water by public water tankers during the period of no water. The total number of livestock is equivalent to 48 heads of cow and water for these livestock use is taken from these water sources;

- In Tuak Lobang Sub-village with 141 families and 575 persons, there are one public water basin at a distance of 210 m on an average from eight families, one small public water tank next to two families' houses, four public wells at the average distance of 25 m from 10 families and 41 private wells at a distance of 10 to 15 m from 94 families. Of these water sources, no water becomes available in the small public water tank from October to January, in 35 private wells from October to November and in another six private wells from September to December. Inhabitants depending on these water sources are provided with the minimum volume of water by public water tankers during the period of no water. The total number of livestock is equivalent to 126 heads of cow and water for these livestock use is taken from the same water sources;

- In Pantai Sub-village with 106 families and 491 persons, there are one private wells at a distance of 75 m from eight family users and 50 private wells at the average distance of 10 m from 95 families. These wells dry up in October and November. All inhabitants including the remaining three families without any specific water source, the minimum volume of water is supplied by public water tankers. The total number of livestock is equivalent to 77 heads of cow and water for these livestock use is taken from the same wells;

- In Bimopu Sub-village with 101 families and 474 persons, there are two public water tanks at a distance of 20 m from 101 family users. The total number of livestock is equivalent to 108 heads of cow and water for these livestock use is taken from the same water tanks; and,

- In Maniking Sub-village with 143 families and 472 persons, there are 121 private wells of which 10 wells are broken and 111 wells are contaminated by mud water from December to February. The average distance between these wells and 111 users' houses is about 25 m. The remaining 32 families carry water for their own use from the Maniking river being 100 m distant from their houses. The number of livestock is equivalent to 132 heads of cow and water for these livestock use is taken from the Maniking river.

1.7 Social Infrastructures

The access from Kupang to the Project area is a paved road maintained well as it is the trans-Timor road leading to Dili from Kupang. The proposed Embung site and sub-villages are connected by unpaved gravel road to this main road. All the sub-villages in the Project area are served by rural electricity supply network. In the Project area, there is no hospital but one community health sub-center and two health integrated posts.

Most of 576 families have facilities for bathing and defecating inside their houses, but they are using public water basin and wells for washing purposes. Under such circumstances, inhabitants in the Project area are often suffering from diseases like vomiting and diarrhoea, dysentery and trachoma, and so on.

1.8 Agriculture and Livestock

In the Project area, there exists farm land of 286 ha all of which are currently cultivable and extend over coastal plain on the left bank of the Oelekam river. It consists of wet paddy field of 10 ha and dry upland of 276 ha. Rainfed rice cultivation is practiced on the wet paddy field during the wet season. Maize is the sole crop grown on upland field under the rainfed condition. The present cropping pattern is single cropping of paddy on the wet paddy field and maize on the dry upland for the wet season . The cropping intensity is thus 100% for the both cases.

In the Project area, the wet paddy field is prepared by an animal-drawn plough and harrow. The high yielding rice variety of IR 64 is commonly used, while fertilizers are not applied as usual. No serious plant pests are reported under the hot and dry weather condition, and farmers put insecticide if necessary. Harvesting is principally done by family labor force with an additional input of hired labors. Farming practices for growing dry upland crops are very simple and primitive with direct sowing on harrowed field and no fertilizer application. The average yield level at present is 1.5 ton/ha for paddy and 0.4 ton/ha for maize. Annual crop production is 15 tons for paddy and 110 tons for maize.

As of 1993, a total of 350 cows/buffaloes, 27 horses, 257 goats/sheep, 471 pigs and 719 chickens/ducks were raised in the Project area. The breakdown of livestock population by sub-village is shown in Table 1.4. The majority of cows and pigs are marketed to and slaughtered in Kupang, while some live cows are directly shipped to markets in Jakarta and Surabaya.

1.9 Agro-economy

In terms of agricultural extension services, two rural extension centers (BPP) are established in Lasiana and Tarus Villages directly under the District Agricultural Office (Dinas Pertanian Kabupaten) covering its own working area with field extension workers (PPL). In the Project area, however, most of the farmers have no frequent access to the PPL's extension activity at present due mainly to limited number of transportation means and amount of budget in BPP.

Farmers are organized as memberships of Agricultural Cooperative (KUD). As KUD's branch shop in the Project area is not active at present, farmers buy necessary farm inputs from local markets or merchant shops. Agricultural credits are available in the service network of the

Indonesian People's Bank (Bank Rakyat Indonesia), consisting of short-term credits to cover one crop season and a mid-term credit of five years to support farmers' small investment.

Food production in the Project area is used for home consumption of farmers themselves. They sell farm products in local markets in the Project area or middlemen for markets in Kupang when farmers need cash. The results of agro-economy survey carried out under the Study reveal that farmers in the Project area usually have some deficit in their home economy with the average annual income of Rp. 1,564,000 and expenditure of Rp. 1,883,000 as, shown in Table 1.5.

2. DEVELOPMENT NEEDS AND CONCEPTS

2.1 Development Needs

In the Project area, it is common for 2,392 inhabitants to carry water from available water sources to their homes at the average distance of 36 m during the wet season and to receive the minimum volume of water from public tankers for their own use during the dry season when all water sources dry up every year. Such water shortage condition has caused infectious diseases and damaged their health. Further, it has prevented farmers' willingness to introduce improved crop production system and to introduce irrigation facilities.

The pressing necessity of inhabitants in the Project area is to meet basic human needs (BHN) aiming at improvement of their living conditions through solution of water shortage problems derived from lack of perennial water sources. In addition, the inhabitants are eager to get sufficient water for maintaining their livestock which are their sources of nutrition and cash income.

The available land resources suitable for agricultural use amount to 286 ha in the Project area. Rainfed wet paddy field occupies 10 ha and dry upland covers the remaining 276 ha. From the topographic viewpoints, both the rainfed paddy field and dry upland are irrigable if irrigation water source is created. In the Project area, however, there is no water resource potential with the large scale development possibility so that no attention is paid to develop new water source for irrigation purpose.

2.2 Water Demand

The estimated per capita domestic water consumption in the Project area is about 25 lit/day being far below the regional levels, 123 lit/day for NTT and 144 lit/day for Kabupaten Kupang. The future water demand in the Project area comprises domestic water for inhabitants, livestock water and irrigation water. In the draft Repelita VI (1993/94 to 1998/99), the Provincial Government of NTT has set the goals of meeting BHN by 1998. In terms of domestic and livestock water supply, the target is 60 lit/day/capita for rural people and 40 lit/day/head for cow.

In comparison with the present level of water consumption and taking into consideration limited availability of water resources in the Project area, the target year to reach the above water supply levels is to be set 2003/04, the last year of Repelita VII, under the Study. Also, the above per capita water supply target of 60 lit/day is to include drinking, bathing, defecating, washing, gardening and unaccounted-for water. The future population of inhabitant and livestock in the target year is estimated by the Study referring the projected population growth rates made by the Provincial Statistic and Livestock Offices.

(1) Domestic water demand

The future population in the target year of 2003/04 is projected for each sub-village located in the Project area as shown in Table 1.3 based on the projection of population growth rate mentioned in the above. The total population projected is 3,019 in the Project area. The future water demand is calculated by multiplying the target per capita water supply amount by the projected population.

The projected water demand in the Project area for the target year of 2003/04 amounts to 66,116 m^3 and the breakdown by each sub-village is shown in Table 2.1.

(2) Livestock water demand

The future livestock population in the target year of 2003/04 is projected for each sub-village located in the Project area as shown in Table 1.4 based on the projection of livestock population growth rate mentioned in the above. The livestock population projected is 455

cows/water buffaloes, 31 horses, 376 sheep/goats, 756 pigs and 1,361 chickens/ducks as a whole in the Project area.

Regarding daily water consumption of livestock other than cow, unit water requirement assumed in "The Study for Formulation of Irrigation Development Program in the Republic of Indonesia" is employed; 40 lit/head/day for buffalo, 5 lit/head/day for sheep/goat, 6 lit/head/day for pig and 0.6 lit/head/day for poultry. That for horse is assumed to be 40 lit/head/day. The future water demand is calculated by multiplying the target unit water supply requirement by the projected livestock population.

The projected water demand in the Project area for the target year of 2003/04 amounts to 9,735 m^3 and the breakdown by each sub-village is shown in Table 2.1.

2.3 Development Constraints

In and around the Project area, there are no perennial spring and groundwater resources which can constantly meet BHN throughout a year. The only one potential water resource in the Project area is thus the Sifbanu river with the possibility of developing Embung as water reservoir.

In developing water resource potential of the Sifbanu river, it is said that there are not so much serious limitations in terms of topography, hydrology, environment and socio-economy, while there are some weak points in geological conditions derived from presence of coral limestone. In the western part of Timor island, 92 small Embungs have already been developed for domestic and livestock water supply, and another 11 Embungs in Sumba and Rote islands for domestic and irrigation water supply. The average height of these Embungs is 7.15 m for the case of domestic water supply and 8.75 m for the case of irrigation water supply. Under such situation, therefore, technical know-how to construct higher Embung with geological weak points has not been accumulated yet in both the public and private sectors in NTT.

2.4 Development Concepts and Approach

In order to correct economic imbalance between NTT and other provinces in harmony with the national policy, it is prerequisite to give the highest priority over improvement of infrastructures related to BHN and the second priority to betterment of agricultural production base in rural areas of NTT. Among others, special attention should be paid to how to solve chronic water shortage problem under the dry weather condition being characteristic of NTT.

The objective of the Project is a part of the strategies of the Government to improve BHN, to alleviate poverty of rural areas and to achieve a balanced regional development throughout the country. The aim of water resources development through construction of Embung is to supply domestic and livestock water to rural people for meeting their BHN as well as to utilize the existing farm land resources to the fullest extent by providing with irrigation water.

Through the previous identification study undertaken by the NTT Provincial Irrigation Service (PRIS) in 1986, a possible site to construct higher Embung was found on the Sifbanu river nearby Lasiana Village. In the course of the Study, therefore, it is firstly to examine water resources development potential at this site called Bimoku Embung from the viewpoints of topography, geology, soil engineering and hydrology. If the examination results reveal that there is a possibility of creating new permanent water source facility, development strategies of the Bimoku Embung are to be worked out including the optimization of development scale and then technical feasibility of Embung development is to be confirmed. In the end, development impacts are to be assessed from social and environmental viewpoints as well as from an economic consideration if necessary.

3. EXAMINATION OF EMBUNG DEVELOPMENT POTENTIAL

3.1 Topographic Condition

The original site of Bimoku Embung was identified by PRIS, through its identification study done in 1986. Under the present Study, the original site as shown in Figure 3.1 is reviewed from topographical and geological points of view including mapping and geological investigations. As a result, it is reconfirmed that selection of the original site by PRIS is topographically appropriate. Thus, the original site is taken up as the proposed Embung site for the Study. At the proposed site, the Sifbanu river flows through rather deep and narrow valley among hills. The width of valley is around 90 m and the elevation of riverbed is El. 13.0 m . The left bank shapes gentle slope of about 13° up to the top of flat terrace of El. 32.0 m, while the right bank is of rather steep slope of about 18° up to the top of ridge of El. 31.0 m. Elevation of hills surrounding the proposed reservoir area ranges from about El. 30.0 to El. 47.0 m.

3.2 Geological Condition

Under the Study, geological investigation including core drilling works have been conducted in the proposed Embung site. The results of core drilling, standard penetration test and field permeability test are presented as Attachment 1. Figures 3.2 and 3.3 depict geological map and profile of the proposed Bimoku Embung, respectively.

The proposed site of Bimoku Embung is underlain by the Tertiary mainly composed of siltstone called the Noele Formation and the Quaternary consisting mainly of Coralline limestone, terrace deposits and recent river deposits. The foundation rock of the proposed site is composed of sandy limestone found in lower part of Coralline limestone. The terrace deposits with a thickness of 3 m are confirmed on the river bed portion.

The result of field permeability test reveals that the coefficient of permeability is almost 5×10^{-5} cm/sec for the both sandy limestone and siltstone and also constant in the vertical direction. In the design of the foundation treatment, therefore, ordinary care against for seepage or leaking the water from the reservoir through dam foundation or the abutments is taken into consideration. According to the standard penetration test, the average N-value of sandy limestone will be expected to be more than 15. The result of unconfined compression test on recovered core samples of drilling works shows that the unconfined compression strength varies from 150 to 275 kg/cm^2 and the foundation rock strength is not so high for the dam construction. In this connection, special consideration is required for determination of dam type.

The reservoir area is underlain by mainly Coralline limestone, Noele Formation and terrace deposits. No major fault and landslide are recognized in the field. It is prospected that water leakage through coral limestone distributed on the right bank occurs in the reservoir area because of its high permeability. Special attention is therefore needed to introduce practical countermeasures for water leakage.

3.3 Availability of Embankment Materials

In 1992, PRIS carried out construction material survey to check embankment and concrete aggregate materials in and around the proposed Bimoku Embung site. In addition, the second material survey is performed under the Study, comprising field test pitting and laboratory tests. In due consideration of the results of the second material survey and the required quantity of the embankment materials, two borrow areas are selected; one in the reservoir area and the other in hills on the left bank upstream of the reservoir as shown in Figure 3.1. The location of test pits is shown in Figure 3.1 and the results of laboratory tests are presented as Attachment 2.

(1) Embankment materials

In general, earth materials in the borrow areas are composed of relatively fine grained soils. The result of gradation analysis in the borrow area is shown below.

Result of Gradation Analysis

Test Pit No.	Passing sieves (%) No. 4	No. 200	Classification
TP. 1	88	54	CL
TP. 2	87	50	CL
TP. 3	100	92	CH
TP. 4	100	93	CH
TP. 5	84	44	CL

As physical property to oppose piping, mean value of Plastic Index (PI) is 39, being satisfied with the quality level which enables the materials to prevent the piping phenomena.

The result of compaction test of the materials in the borrow area are as follows:

- Maximum dry density (γd max.) ranges from 1.44 to 1.81 ton/m^3 and 1.64 ton/m^3 on an average, which are slightly low in comparison with 1.73 ton/m^3 as an average of CL;
- Optimum moisture content (OMC) ranges from 16 to 26% and 20% on an average;
- The discrepancy between OMC and the natural moisture content (NMC) is approximately 8%, wetter side from OMC. Considering the sampling time of May 1994, NMC is more favorable in respect of the moisture control which is required for the embankment works because other borrow materials are slightly drier than those OMC. Accordingly, the moisture control needs to be considered at the borrow area during the construction period; and,
- According to the shear strength test carried out by using unconsolidated-undrained tri-axial compaction test (U-U test) apparatus under the OMC condition, the average values of internal friction angle and cohesion are 25° and 1.31 kg/cm^2, respectively. The test method is however based on U-U test which is applied to get a design value for the case of just after completion of a dam.

For a design value under the full supply level (F.S.L.) and earthquake conditions, the shearing strength at consolidated-undrained test under the effective stress condition is provisionally estimated at 30° for friction angle and 0.13 kg/cm^2 for cohesion by using the standard values of the soil classified as "CL" of ASTM Unified Soil Classification.

(2) Sand and gravel materials

Sand and gravel materials to be used as filter materials for the dam embankment and concrete aggregates are investigated in the Kasmuti river, 25 km south from the proposed Embung site. Quantity and quality of sand and gravel materials are sufficient. Quarry site for rock materials is investigated in Tablolong, 28 km south from Bimoku. Quantity and quality of rock materials are enough for riprap protection of the proposed Embung.

3.4 Availability of Water Resources

(1) Catchment yield

As for the Sifbanu river, there has been no record of discharge. Accordingly, runoff at the proposed Embung site is estimated by use of the rainfall record near the proposed site. The Penfui rainfall station which is located in the east of the Bimoku Embung catchment has rainfall record of nearly consecutive 28 years and is considered to represent catchment rainfall. A runoff coefficient of 0.30 is adopted considering the characteristics of the catchment area and previous hydrological analysis in the Timor Island. Using this runoff coefficient and rainfall record of Penfui, river flow of the Sifbanu river 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 0.20 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 1993. The estimated half monthly discharge is given in Table 3.1 and summarized below.

Mean Monthly Discharge

Unit: 1,000 m^3

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
24	22	13	4	1	1	1	0	0	0	6	14	86

(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 NTT. In this Study, 25 years rainfall data of the Penfui station from 1966 to 1992 are analyzed by the above method. The result of probability analysis is summarized below.

Design Rainfall

Unit : mm

Return Period	Design Rainfall
1 in 2 year	103
1 in 5 year	160
1 in 10 year	205
1 in 20 year	253
1 in 50 year	327
1 in 100 year	390
1 in 200 year	459

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:

$$r = (R24/24) \times (24/T)2/3$$

where; r : Maximum average rainfall intensity within concentration time (mm/hr)
R24 : 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 3.2 and summarizes below.

Probable Flood

Unit : m^3/s

Return Period	Probable Flood
1 in 2 year	5
1 in 5 year	7
1 in 10 year	9
1 in 20 year	11
1 in 50 year	15
1 in 100 year	18
1 in 200 year	21

(3) Sediment load

There is no available data on sediment load on the Sifbanu 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, the same value is adopted in this Study.

(4) Water Quality

On June 4, 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 3.3.

4. EMBUNG DEVELOPMENT PLAN

4.1 Optimization of Development Scale

(1) Cases for comparison

The optimum development scale of Bimoku Embung coincides with the maximum scale which can be decided by the available run-off from the catchment area and the limitation of topography at the proposed Embung site. Therefore, only one case with the dam height of 14.0 m is taken up for the optimization study.

(2) 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 (m^3)
O_D : outflow needed for domestic water during the half monthly period (m^3)
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 Sifbanu river, discharge is generated from Penfui 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. The probability that the spill out comes in the wet season is set at about 80%.

5) Water demand

The annual water demand for the domestic water and livestock are outlined below.

Annual Domestic and Livestock Water Demand

Description	Unit	Numbers	Demand (m^3/year)
Beneficiaries	Nos.	1,825	39,968
Livestock (equivalent to cow)	Nos.	343	5,006

The 100% dependability of the above demand shall be secured by the proposed Bimoku Embung.

The priority of water supply is to be given firstly to domestic use and secondly to livestock use.

6) Water level of reservoir

Minimum water level is estimated at El.16.50 m considering sedimentation volume for 25 years and 0.50 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. 30.0 m.

(3) Optimum development scale

From the topographic and hydrological points of view, there is no alternative choice to develop Bimoku Embung. The optimum development scale is thus in line with the maximum height of 14.0 m and effective storage capacity of 0.05125 million cubic meters (MCM). The result of the reservoir operation is shown in Figure 4.2.

4.2 Delineation of Beneficiary Area

Even though the proposed Bimoku Embung is developed at the maximum scale, its effective storage capacity will be unable to meet water demand for domestic and livestock use to the fullest extent. Therefore, the priority of water supply is to be given to domestic use. The beneficiary area of water supply from the Bimoku Embung is thus limited to Sefabano, Tuak Lobang and Pantai Sub-villages of Lasiana Village, with 1,825 inhabitants in total, located in the downstream of the proposed site. The beneficiary area of the Bimoku Embung is shown in Dwg. - 101 to - 102.

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 Bimoku Embung is determined. In terms of dam type, homogeneous earthfill type is applied in due consideration of the foundation strength and the availability of embankment materials. As for the proposed countermeasures for water leakage in the reservoir, it is proposed to adopt earth blanket to cover the reservoir area up to El. 24.0 m so as to keep the water tightness of the sandy limestone layer in the reservoir.

The main components of Bimoku Embung are the main dam, spillway, river diversion conduit and water supply facility as shown Dwg. - 103. In order to provide the reservoir with the optimum storage capacity of 0.055 MCM, FSL is set at El. 24.0 m. Taking overflow depth of spillway and freeboard into account, the dam hight of Bimoku Embung becomes 14 m above the river bed. In order to release the flood discharge during the construction period, a river diversion conduit with a concrete pipe of 0.9 m in diameter is provided below the dam body. The spillway is designed on the left bank of the main dam to release the flood discharge of 20 m^3/sec from the catchment area of 0.2 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 40 mm below the dam body and valve house at the downstream of the main dam.

The principal features of Bimoku Embung are summarized below.

(1)	Reservoir	
	- Catchment area	0.2 km^2
	- F.S.L.	El. 24.0 m
	- Minimum operating level	El. 16.5 m
	- Effective storage capacity	51,250 m^3
	- Dead storage capacity	3,750 m^3
	- Gross storage capacity	55,000 m^3
	- Sediment deposition level	El. 16.0 m
(2)	Main dam	
	- Type	Homogeneous earthfill
	- Height	14 m above river bed
	- Crest elevation	El. 27.0 m
	- Crest length	90 m
	- Crest width	7.0 m
	- Upstream slope	1:3.5
	- Downstream slope	1:3.0
	- Total embankment volume	31,000 m^3
(3)	Spillway	
	- Design flood (1/100 year)	20 m^3/sec
	- Type	Non gated overflow
	- Crest elevation of overflow weir	El. 24 m
	- Width of overflow weir	6.2 m
	- Discharge capacity	20 m^3/sec
	- Length	89 m
(4)	River diversion	
	- Design flood (1/5 year)	2 m^3/sec
	- Type	Pipe culvert
	- Diameter	900 mm
	- Length	98 m
(5)	Water supply system	
	- Inlet structure	1.0 x 1.0 m with trashracks
	- Pipe diameter	75 mm
(6)	Blanket in the reservoir	
	- Type	Earth blanket
	- Covering area	El. 24.0 m and 13,000 m^2
	- Thickness	2.0 m

5. PRELIMINARY DESIGN OF FACILITIES

5.1 Preliminary Design of Embung

(1) Freeboard

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

The following formula is applied for the design of the dam in the Bimoku Embung;

$Hf = 0.05h + 1.0$ (m)

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

(2) Stability of dam slopes

1) Design criteria

The design criteria adopted for evaluating the stability of the dam body comprises:

- Stability of a dam embankment as a whole and safety against surface sliding of the embankment slopes; and,
- Hydraulic stability of embankment materials and safety and serviceability against leakage.

The reservoir condition to be considered here is at F.S.L. of 24.0 m under seismic condition. The dam slopes for upstream and downstream are determined using the stability calculation.

The required minimum safety factor for the stability of the embankment is 1.2 for all cases. Seismic coefficient of 0.15 is applied for the stability calculation taking into consideration design seismic coefficient applied for dam and irrigation projects.

2) Design value

Considering the result of laboratory tests, the design values of the embankment materials for the stability calculation are as shown in Table 5.1.

3) Slope stability against sliding

A slip circle method is used for the stability analysis. The basic concept of the method is to check if the resisting moment of the force along a presumed slip circle line exceeds the driving moment caused by gravity and seismic forces. The ratio of those two moment gives the safety factor for sliding.

The result of the numerical calculations is summarized in Figure 5.1.

(3) Horizontal filter drain and toe rock drain

In order to reduce the seepage line within the dam body under full reservoir water condition, horizontal filter drain (drainage mattress) and toe rock drain are provided below body and at toe portion of the main dam as shown in Dwg. - 103.

(4) River diversion during construction

During the dam embankment period, river flow including floods has to be diverted to avoid inundation of the Embung site. This can be effectively and economically made by providing a random-filled cofferdam and utilizing the concrete pipe culvert with a diameter of 0.9 m as a diversion facility as shown in Dwg. - 105. Since the volume of flood inflows from 0.2-km^2 catchment will be quite small as compared to the storage created by constructing low cofferdams, a 2 m high cofferdam with a crest level of El. 15.0 m would suffice to contain the dry season flood inflow of 2.0 m^3/sec having a return period of five years.

(5) Spillway

The spillway is located on the left abutment of the Embung, which is composed of side channel type overflow weir, throughway, chuteway and downstream channel. The overflow 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 20 m^3/sec.

Based on the result of comparative study on combination of overflow depth and width of the spillway, overflow depth at 1.3 m and width of 6.2 m are decided so as to minimize the costs of spillway and the main dam.

A non-gated ogee crest would be set at El. 24.0 m to coincide with F.S.L. A bridge would be provided over the throughway of the spillway.

The profile and sections of spillway are shown in Dwg. - 104.

(6) Water supply system

In order to meet BHN to the downstream water users, the water supply system is provided to release the water of 1.43 lit/sec throughout the year, which consists of intake structure, pipe line and valve house. The intake structure is located in the reservoir area just above the sediment deposition level of El 16.0 m. Fixed trashracks are provided on the intake structure. Cast iron pipe with diameter of 40 mm is connected from the intake structure to the downstream through the main dam. The detail of water supply inlet is given in Dwg. - 105

The value house would be constructed near the downstream toe of the dam. The guard valve and control devices would be installed in the valve house. The detail of the valve house is shown in Dwg. - 106.

5.2 Preliminary Design of Water Distribution Facilities

(1) Basic concept

The following basic concepts are applied for executing the preliminary design of water distribution facilities for inhabitants and livestock in the beneficiary area :

- Distribution facilities to the beneficiary area are selected taking into consideration the effective storage capacity of Embung, topographic condition of the Project area, village boundary and the existing water supply facilities;
- Water demand for inhabitants and livestock are fully referred to the preliminary design of pipeline and the arrangement of division boxes in the beneficiary area;
- The system of pipelines with pressure flow is used for the water distribution system from the Embung to the beneficiary area. Pipes are arranged along the existing roads as much as possible from the viewpoint of easiness of the operation

and maintenance of the pipe lines. Pipes are set at around 50 cm below the ground surface;

- Division boxes for inhabitants, of which capacity is estimated at 6,000 lit/100 persons, are arranged based on the water demand, the water conveyance distance by inhabitants from the proposed division boxes to their houses and the topographic condition at sites division box sites;

- Division boxes for livestock, of which capacity is estimated at 900 lit per 22 heads of cow /buffalo, are arranged based on the water demand and taking into consideration the locations not affecting the division boxes for inhabitants;

- Related structures of pipelines such as check valves, air valves and blow offs are planed to be set taking into considerations the locations of pipelines and their topographic conditions in the Project area; and,

- The High Density PVC pipe is used for the water supply taking the safety against the unexpected high pressure to the pipe, the steep and undulating topographic condition in the area and the easiness to get the materials in Indonesia into account.

(2) Beneficiary area and design discharge for pipelines

The beneficiary area of the domestic water supply from the Bimoku Embung covers three villages along the existing paved road located at around 500 m downstream of the proposed Embung site. Due to insufficiency of the effective storage capacity of Bimoku Embung, it is not able to supply the impounded water to the livestock in the area. The total beneficiary to be supplied is with domestic water defined at 1,825 persons based on the results of population projection and the optimization of development scale.

Design discharge of pipelines is estimated at 1.27 lit/sec taking the projected population and the domestic water demand of 60 lit per day into account.

(3) Preliminary design

In due consideration of the above basic concepts and the design discharge, the locations of pipelines and related facilities are planed to be set as shown in the Dwgs. - 101 to - 102. Design of pipelines is executed by using the Hazen Williams formula. Typical designs for related facilities such as check valves, air valves, blow offs and division boxes for domestic water supply are shown in Dwg. - 108. Required water distribution facilities for domestic water supply are summarized below.

Water Distribution Facilities Requirement

Facilities	Quantities
Pipe Line	
- Dia. 75 mm	1.3 km
- Dia. 65 mm	0.13 km
Related Facilities	
- Check valve	2 Nos.
- Air valve	2 Nos.
- Blow off	1 No.
- Division box for domestic water	19 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. Some construction equipment will be purchased through international competitive bidding, if necessary.

The construction plan is based on the mode of construction and the target schedule of construction works as well as taking into consideration the construction conditions such as availability of construction labor, material and equipment as well as weather and the topographic conditions of the construction site. Generally, the mechanized construction method is assumed to be adopted although other construction methods may be practiced.

It is assumed that 200 working days per year are available for conducting the earthfill embankment works, 270 days per year for the filter drain and toe 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, one 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 Project site from the beginning of November in the first year. Following the above, preparatory works would be commenced at the Project site.

2) Setting out and excavation works

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

3) Concrete works embankment works

After completion of the concrete placing into the river diversion culvert, embankment works for the main dam shall be commenced and completed before the wet season in the second year. Concrete works for the spillway shall also be concentrated and completed before October in the second year.

4) Commencement of reservoir water impounding

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

5) 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 since those work quantities are not so much. The construction works shall be completed by the end of December in the second year before supplying the impounded 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 of 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 during four months from November in the first year to February in the second year.

1) Temporary buildings and yards

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

The temporary buildings will require a total floor area of 1,200 m^2 for an anticipated staff strength of 15 persons and labor force of 80 persons. The land required for the temporary buildings and construction facilities is estimated at 2,500 m^2. The temporary buildings and yards may be located near the construction site.

2) Water and power supply

The water required for the construction works and the daily use of 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 constructor's diesel generators with installed capacity of 200 kW to meet the requirements as shown below.

Power Requirement

Place / works	Power Requirement (kW)
Office and quarters	30
Construction plant	50
Repair shop	60
Dam site	20
Water supply	20
Others	20
Total	200

(2) River diversion works

The river flow will be released through the river diversion conduit during the dry season in the second year. The river diversion culvert would be provided along the right bank of the Sifbanu river. In order to avoid the leakage or seepage water from the reservoir along the river diversion conduit across the dam body, the river diversion conduit is planned to be

installed in the excavated rock foundation so as to contact the concrete surface smoothly to the homogeneous earth materials as seen in Dwg. - 105.

Considering very short construction period as four months from the beginning of March to the end of June in the second year, concrete pipe culvert with diameter of 0.9 m is used, and therefore the concrete placing will be made without inside-forms nor reinforcement bars in the conduit.

After completion of the main dam embankment around the end of September in the second year, the river diversion conduit shall be plugged by the concrete using concrete pump with a capacity of 20 m^3/hr for the whole length from the reservoir-side to the downstream outlet.

(3) Main dam works

Following the foundation excavation and completion of the river diversion conduit, the dam embankment will be commenced at the beginning of July in the second year. Considering a embankment volume of 31,000 m^3 and remaining dry season period of three months until the end of September in the second year, the daily embankment volume is to be 520 m^3 which is quarried from the borrow area at a distance of about 700 m distance from the Embung site.

Excavation of the embankment materials at the borrow area will be done with D-7 class (21 ton) bulldozers and the excavated materials will be loaded with 1.2-m^3 wheel loader and be hauled to the dam site by 11-ton dump trucks. The embankment materials will be spread at the dam site will be spread with 21-ton bulldozer and compacted with 10-ton class tire roller in layers of 20 cm thickness before compassion.

The filter embankment is planned as a horizontal drainage mattress with a thickness of 1.0 m, which is scheduled to be placed immediately after completion of the river diversion culvert, at the beginning of June in the second year. Before placing the drainage mattress, the main dam foundation should be graded and trimmed smoothly. The filter material will be spread by 21-ton bulldozer and be compacted by 21-ton bulldozer or 10-ton tire roller. This filter material will be hauled with 11-ton dump trucks from the Kasmuti river, about 25 km south from the construction site.

Riprap placement is scheduled to be made simultaneously as the homogeneous earth embankment of the main dam. The riprap volume is estimated to be 1,700 m^3 and the rock material will be quarried from at Tablolong, 28 km south of the Embung site. The rock material will be placed by 0.6 m^3-backhoe and large voids should be filled with smaller rock fragments. The riprap protection should be finished manually to the design slope and thickness.

(4) Spillway construction

Excavation of the spillway will be scheduled to be performed about three months from March to May in the second year. As the total volume of common and weathered rocks is estimated to be 16,200 m^3, 21-ton bulldozer and 1.2-m^3 backhoe will be used for flat portion and steep slope chuteway portion of spillway, respectively. Most of the excavated materials may be used as the main dam embankment materials so that the excavated materials will be stocked in the designated area. For loading the excavated materials to 11-ton dump trucks, 1.2 m^3 wheel loaders is used.

After completion of the spillway excavation, preparation for foundation of chuteway will be commenced. For concrete placing into side-walls and shuteway slope portion, 20-ton class truck crane with concrete bucket (1.0 m^3) and concrete pump with a capacity of 20 m^3/hr will be used. Before starting the reservoir water impounding at the beginning of October in the

second year, major concrete works of the spillway should 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 (El. 16.0 m). Connecting the inlet structure, a cast iron pipe with diameter of 40 mm is installed up to the downstream end of the main dam. Construction of the river diversion conduit and water supply pipe should be completed before commencement of the main dam embankment at the beginning of July in the second year.

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

(6) Earth blanket in reservoir

After excavation of the embankment materials for the main dam in the reservoir area, the foundation of the earth blanket should be provided considering the smooth grading and trimming by using 11-ton bulldozer and a 3.7-m wide motor grader.

As shown in Dwg. - 107, the earth blanket will be provided in the reservoir area up to the F.S.L. under the condition that the blanket material should be the same material of the original ground of the reservoir area. Accordingly the original ground should be loosened by 21-ton bulldozer and 3.7-m wide motor grader, then compacted by 21-ton bulldozer or 10-ton tire roller which is subject to the result of trial embankment at the construction site.

The construction period of the earth blanket is about six months from April to September in the second year as seen in Figure 6.1.

(7) Construction materials

Quantities of the major construction materials required for constructing the Bimoku Embung are summarized below,

Construction Material Requirement

Item	Quantity	
Earthfill materials		
Main dam	30,000	m^3
Blanket in reservoir	34,000	m^3
Filter materials		
Horizontal drain	1,500	m^3
Riprap portion	800	m^3
Rock materials		
Riprap protection	1,700	m^3
Toe rockfill	1,000	m^3
Concrete		
Cement	600	tons
Reinforcement bars	50	tons
Aggregates	1,500	m^3

(8) Construction equipment

The minimum number of major construction equipment and plants to be used for the Bimoku Embung construction works are summarized in Table 6.1.

6.3 Construction Plan of Water Distribution Facilities

Construction works required for the water distribution system are summarized below:

- Pipe setting works with a diameter of 65 and 75 mm amount to 1.6 km; and,
- Construction works of the related facilities such as check valves, air valves, blow off and division boxes for inhabitants are 14 in number as a whole.

Since the facilities to be constructed for the water distribution system are rather small in work quantity and scattering in the beneficiary area in comparison with the Embung construction works, almost all of the works will be basically executed by man-power in parallel with the Embung construction works.

6.4 Institutional Arrangement for Project Implementation

(1) Organization for implementation

After the reorganization enforced in August 1994, the Directorate General of Water Resources Development (DGWRD) of the Ministry of Public Works (PU) is responsible for managing overall water resources development and conservation in the whole country. At the provincial level, the Provincial Water Resources Services (PRWS) of the Provincial Public Works Service (DPUP) under the direct control of the Governor is the principal organization which is responsible for planning, design, and implementation aspects regarding water resources development, operation and maintenance of water source, irrigation and flood control facilities, and watershed management. The Regional Office of PU (Kanwil PU) is established in each Province bearing the responsibility of maintaining coordination between PU and DPUP, and providing support and assistance to the DPUP as well as planning and implementing projects of a national nature.

In NTT, there are four provincial service offices; Water Resources (Pengairan), Road/Bridge (Bina Marga), Water Supply/Building (Cipta Karya) and Technical Quality Management (Tata Laksana Teknik). In terms of domestic water supply to urban and rural areas in NTT, PRWS is responsible for creating and supplying raw water and Cipta Karya has to treat and distribute clean water to end-users in urban areas.

The organizational structure of PRWS consists of a general administrative unit and four technical sections for design, construction, and operation and maintenance (O&M), and project benefit promotion. Under the chief of DPUP, there are nine functional project offices established for the specific purposes. Of these, Embung development is handled by the both Timor Water Resource Construction and Conservation Project Office (Proyek PKSA Timor) and Flores-Sumba Water Resources Construction and Conservation Project Office (Proyek PKSA Flores-Sumba) in case of the Central Government's financing projects and the Provincial Embung Development Project Office (Embung APBD) in case of the Provincial Government's financing projects. After completion of Embungs, O&M works are transferred to the O&M Section according to the direction from the Minister for Home Affairs to the Governor in response to the request by the Minister for PU. The present organization chart of PRWS and two PKSAs are shown in the Volume 4.

In implementing Bimoku Embung Project as one component of the package development program, it is proposed that PRWS is in charge of overall arrangement and the PKSA Timor Project Office is responsible for all of the actual management works. Under the Project Office, one special section or sub-project office needs to be established to represent the following functions:

- Design and construction supervision of all the Project works including water distribution system; and

- Accounting and management of construction works.

(2) Expatriate assistance

In NTT, accumulation of technical know-hows to construct a larger Embung are still insufficient resulting in that the implementation of Bimoku Embung requires experienced professional manpower, especially management of supervision on the construction works. For the successful prosecution of the Project, therefore, it is proposed to introduce appropriate expatriate assistance.

A vital part of the functions of expatriate assistance will be the training of the local professional and sub-professional staff on effective management to supervise the earth and construction works and further to provide substantial experience and techniques to the PKSA Timor Project Office.

(3) Organization for O&M

After completion of the proposed Bimoku Embung, the O&M Section of PRWS is responsible for operating and maintaining Embung as well as water intake and distribution facilities. Among various O&M works to be done by this Section, the reservoir operation is the main function and needs to be conducted on the basis of operation rule to be established. In order to operate and maintain the Project facilities effectively according to the said rule, it is prerequisite to upgrade the capability of O&M staff and the level of O&M equipment.

As for maintenance works of water distribution facilities, it is proposed for PRWS to organize the beneficiary people aiming at their participation in routine works such as cleaning of water division boxes, clearing of animal excreta around water division boxes, repairing of fence along the reservoir and so on.

7. COST ESTIMATE

7.1 Basic Assumption of Cost Estimate

Project cost of the proposed works for development of the Bimoku 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 10% 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 NTT area as of June 1994 and the data collected from the on-going projects in NTT. 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 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 recent other project costs in NTT;
- Land acquisition cost including the purchase of the Embung site, reservoir area, borrow area and land for pipe line and other permanent structure is estimated at 0.5% of the direct construction cost taking into considerations 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 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 Bimoku Embung is estimated at Rp. 3,393 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 for this scheme 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 Bimoku Embung is summarized below.

Summary of the Project Cost for Bimoku Embung

Unit : Rp. million

Item		Project cost
I.	Direct construction cost	2,032
1.1	Preparatory works	97
1.2	Embung construction	1,754
1.3	Domestic water supply	181
1.4	Operation & maintenance road	-
1.5	Irrigation facilities	-
II.	Administration cost	102
III.	Engineering services	305
IV.	Physical contingencies	366
V.	Contract tax	270
VI.	Land acquisition	10
VII.	Price contingency	308
	Grand Total	3,393

7.3 Operation and Maintenance Cost

The O&M costs consist of salaries for O&M staff, cost for maintaining the Project facilities, materials and labor cost for repairing works, and running cost of Project facilities. The annual O&M costs are assumed at Rp. 16.97 million, which is equivalent to 0.5% of the Project cost.

8. PROJECT JUSTIFICATION

8.1 Satisfaction of BHN

In general, it is impossible to quantify benefits attributable to improvement of the existing water supply system for the domestic use in rural areas of NTT. The water supply benefits anticipated in the beneficiary area of Bimoku Embung comprise two main portions: increased water quantity for domestic use during the dry season and reduced health problems or morbidity especially caused from inflow of muddy water to wells during the wet season. It is also hard to evaluate the values of decreased incidence of water borne diseases in quantitative manner.

Under the Study, thus, the benefits to be born from satisfaction of BHN by creating a new water source facility are to be indicated as the value of water and the investment amount to each beneficiary inhabitant. The investment amount is given by deducting the administration and land acquisition costs from the Project cost, because these could not be defined as the direct construction cost due to the mode of payment. The value of effective storage water is obtained by dividing the investment amount by the effective storage capacity, while that of supplied water is given by dividing the investment amount by the annual supply amount of domestic water.

The total Project cost for constructing the Bimoku Embung with the effective storage capacity of 0.05125 MCM is estimated to be Rp. 3,393 million. The total number of beneficiary water users is 1,825 inhabitants with the annual water demand of 0.03997 MCM. The investment amount estimated is Rp. 3,254 million. The value of effective storage water to be created by the Bimoku Embung is estimated to be Rp. 63,493/m3, while that of supplied water is estimated to be Rp. 81,411/m^3. The estimated investment amount to the respective beneficiary people is Rp. 1.78 million.

8.2 Economic Consideration

With provision of permanent water source facilities, no economic activities can be expected in the beneficiary area of Bimoku Embung due to insufficient storage capacity derived from the limitation of topographic condition and available run-off from the catchment area. As a result, there is no economic benefit attributable to water supply from the Bimoku Embung. Taking such situation into account, economic evaluation is skipped over in this case.

8.3 Environment Impact Assessment

(1) Environmental features of Project area

Principal human and physical environment features in the Project area are summarized below.

Human and Physical Environmental Features

Items		Descriptions
Human environment		
Social	:	Insufficiency of reliable water sources and facilities for domestic use
Human use	:	Use of ground water (not useful in the dry season)
Health and sanitation	:	Prevalence of waterborne intestinal diseases
Physical environment		
Geology/land	:	Noele formation/coral limestone
Surface/ground water	:	Surface water is not perennially observed
Endemic fauna and flora	:	none
Others	:	none

(2) Environmental impact assessment

In the Project area, environmental issues assessed as negative environmental problems are only human use of trees in the catchment area and excavation works to be done in the borrow area located on the left bank upstream of the reservoir. Trees in both the reservoir and catchment areas have been utilized by inhabitants for their economic activities producing water-carriers and other baskets, firewood, timber, alcoholic beverage, the sap of sugar and so on. Decrease of vegetation caused by logging has severely incurred a deterioration of water conservation and acceleration of soil erosion in the catchment area. Of two borrow area, the one is sited on the left bank of the reservoir nearby Bimopu Sub-village. During the construction period, some atmosphere aspects represented dust and exhaust gas will occur as a result of excavation and transportation works using heavy machines.

The countermeasures to eliminate this environmental impact is to establish an effective watershed management rule and conduct a campaign for participation of inhabitants in forest conservation activities. Additional incentives are required to encourage inhabitants to diversify their economic activities on on-forest basis. Around the borrow area and along the construction road, it is proposed to station watchmen aiming at daily safety control, proper transportation management of excavated materials, and so on.

(3) Primary information of environmental assessment

To support undertaking of environmental analysis presentation for the proposed Project on the Indonesian rule, primary information on environmental assessment is compiled in Attachment 3.

8.4 Contribution to Women in Development

With provision of permanent water source facilities, women and children of 419 families can be free from waterborne diseases. As a result, women will be able to utilize the saved expense and time for improving their activities in relation to not only agriculture and livestock but also small business and cottage industry. Since housewives in the Project area manage their family budgets, increasing family income would encourage women in investing surplus in improvement and diversification of their economic activities.

9. CONCLUSION AND RECOMMENDATIONS

9.1 Conclusion

The Bimoku Embung development plan has been formulated as one of the six urgent water resource development schemes in NTT aiming to meet BHN for upgrading the living standard of the Project area. The present Study is made to confirm technical feasibility and socio-economic impact of the Project in conformity with this concept.

The Project consists of such structural components as main dam, water leakage protection measure and domestic water distribution system. All of these components have to be implemented without any missing components for the purpose of achieving the development concept.

As the results of the Study, it is clarified that each of the Project components are technically possible and the Project is socially desirable for enabling 1,825 inhabitants of 419 families to get permanent water source and to decrease frequency of waterborne disease.

It is therefore concluded that construction of Bimoku Embung is worthy of urgent implementation.

9.2 Recommendations

As the conclusion of the Study is aforementioned, it is recommended that necessary steps for the implementation of the Bimoku Embung Project are to be taken. Such steps will be composed of administrative issues and technical matters.

Main issues of the administrative matters to be taken up will be the determination of executing agency, the procurement of necessary fund in foreign currency and the preparation of budget in domestic currency as a counterparts fund.

Necessary technical matters to be made are composed of introduction of advanced technology and management know-hows in terms of smooth construction of higher Embung on permeable foundation for shorter period. As the development of Bimoku Embung aims to supply raw water for domestic use, it is recommended to take necessary action for appropriate watershed management including afforestation and for no entry of inhabitants and livestock to the reservoir area so as to keep proper water quality.

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Feasibility Study on Bimoku Embung Development Project

Tables

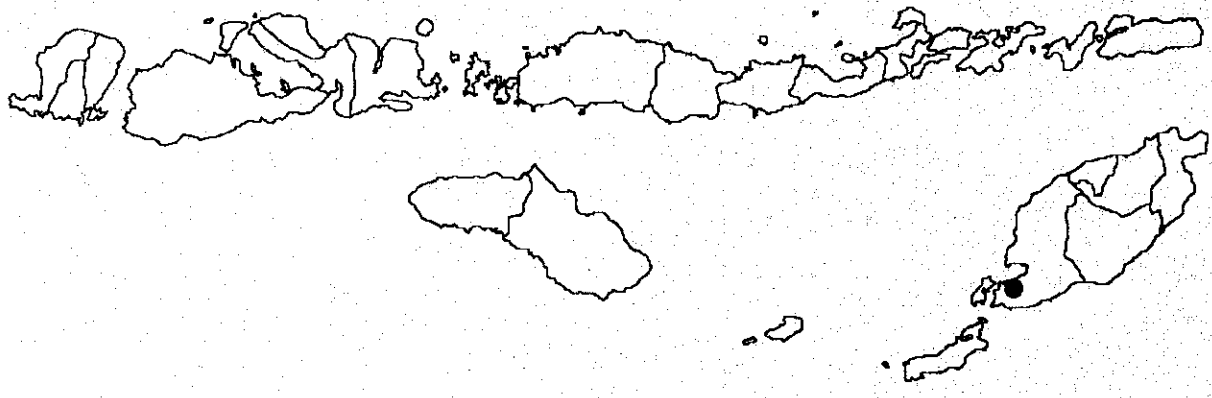


Table 1.1 Monthly Rainfall Record

Station : Penfui Unit : mm

Year	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul		Aug		Sep.		Oct.		Nov.		Dec.		Annual
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
1966	76	158	129	208	39	27	2	0	5	3	54	0	0	0	0	0	0	0	25	0	8	16	144	127	1.020
1967	110	305	252	230	284	38	14	1	0	0	8	0	0	0	0	0	0	0	19	10	5	24	104	52	1.455
1968	44	237	313	162	61	21	31	26	88	3	20	1	3	4	0	1	0	0	0	0	3	20	52	49	1.139
1969	105	146	243	133	17	63	0	0	10	3	22	0	3	1	2	0	0	0	0	4	6	4	113	41	915
1970	42	89	27	93	40	7	0	47	21	9	0	0	0	0	0	0	0	13	5	0	80	72	147	35	724
1971	31	280	248	216	293	88	15	28	12	10	1	0	2	0	0	0	0	1	5	4	56	76	97	42	1.506
1972	9	0	2	7	4	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	24	94	22	163
1973	56	286	81	11	58	75	7	9	45	0	0	10	1	0	0	10	0	1	0	0	34	85	93	144	1.006
1974	701	48	318	319	228	209	89	15	26	0	54	2	38	1	12	0	33	0	2	3	93	94	15	22	2.318
1975	121	127	146	161	144	21	87	23	0	16	0	11	0	10	0	0	0	0	14	168	59	118	312	145	1.683
1976	364	137	93	205	415	142	29	10	0	0	1	0	6	0	0	0	0	0	0	14	76	3	185	43	1.722
1977	415	37	306	256	188	62	23	11	0	0	0	0	1	0	0	0	0	0	0	0	6	11	142	92	1.550
1978	127	111	208	559	50	51	85	1	38	124	54	2	38	1	12	0	0	0	0	0	7	233	25	237	1.960
1979	248	177	33	140	380	46	6	58	2	47	22	0	0	0	0	0	0	0	0	5	0	157	148	111	1.579
1980	142	467	580	39	31	37	0	93	0	18	0	6	0	0	0	0	0	0	0	19	12	73	135	222	1.874
1981	248	319	211	225	175	6	4	11	4	40	5	24	101	12	0	0	15	27	0	4	125	149	438	237	2.380
1982	71	380	226	226	313	80	1	38	0	7	0	4	14	0	0	0	0	0	0	0	0	77	38	123	1.597
1983	356	92	158	196	215	22	139	57	20	30	0	0	0	0	0	0	0	0	9	49	8	83	16	91	1.540
1984	307	296	209	272	29	230	19	2	12	0	4	1	0	3	0	0	29	0	0	34	20	30	172	243	1.910
1985	18	176	71	112	122	2	23	30	0	0	6	0	15	0	0	0	0	0	0	13	11	120	95	115	928
1986	265	401	130	172	62	71	40	2	0	15	10	39	0	82	0	0	0	0	0	8	3	76	89	164	1.629
1987	156	533	206	180	0	53	24	1	6	32	1	0	12	0	0	0	0	0	0	0	2	118	198	99	1.621
1988	168	245	306	26	147	142	25	0	4	0	0	0	0	0	0	0	9	0	0	5	127	208	155	127	1.695
1989	88	203	96	83	353	103	10	86	42	3	0	36	1	13	0	0	0	0	0	7	20	6	113	122	1.385
1990	281	123	122	220	280	0	7	114	4	3	0	0	0	0	0	11	0	0	0	0	56	9	209	78	1.517
1991	190	303	245	257	43	32	424	9	0	1	0	2	0	0	0	0	0	0	0	0	61	131	47	28	1.773
1992	22	106	232	66	78	153	74	29	0	29	0	0	0	0	0	1	0	12	20	10	30	58	128	0	1.047
1993	135	625	161	108	101	84	14	4	0	2	0	30	0	2	0	0	0	0	3	1	0	20	90	274	1.651
1994	161	81																							
Average	174	224	191	174	148	67	43	25	12	14	9	6	8	5	1	1	3	2	4	13	32	75	128	110	1.469

Source : Data Klimatologi di Nusa Tenggara Timur, Tahun - 1992, Bagian Proyek Hidrologi, Kantor Wilayah Propinsi NTT

Table 1.2 Climate Data

Station: Penfui **Latitude : 10.1833S**
Island : Timor **Longitude : 123.6667E**
Kabupaten : Kupang **Elevation : 115 m**

Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Year	Average
Temperature (mean)	26.9	26.6	27.1	27.9	27.8	26.8	26.4	26.9	27.8	28.6	28.8	27.7	1966-1992	27.4
Temperature (max)	29.9	29.4	30.4	31.1	30.6	31.2	30.1	29.8	33.1	32.5	32.6	31.4	1966-1992	31.0
Temperature (min)	22.9	22.9	23.8	24.2	22.7	23.0	22.8	22.7	21.0	22.7	23.4	23.2	1966-1992	22.9
Relative Humidity (mean)	84.7	86.2	84.1	74.9	69.6	67.6	65.2	63.5	62.4	64.0	70.8	80.4	1966-1992	72.8
Relative Humidity (max)	100.0	100.0	100.0	6.0	95.0	95.0	96.0	88.0	84.0	94.0	96.0	100.0	1966-1992	87.8
Relative Humidity (min)	57.0	69.0	61.0	56.0	47.0	46.0	45.0	43.0	40.0	40.0	42.0	58.0	1966-1992	50.3
Sunshine Hours (hr/day)	6.5	6.3	7.3	9.3	9.7	9.5	9.4	10.2	10.0	10.4	8.8	6.8	1966-1992	8.7
Wind Velocity (km/day)	8.2	8.2	6.9	8.9	11.6	12.0	13.2	12.3	11.2	9.9	8.0	6.5	1966-1992	9.7

Source : Data Klimatologi di Nusa Tenggara Timur, Tahun - 1992, Bagian Proyek Hidrologi, Kantor Wilayah Propinsi NTT

Table 1.3 Present and Projected Demographic Condition

Village	Sub-village	Population			Household		
		1994	1999	2004	1994	1999	2004
Lasiana	Sefabano	380	428	480	85	96	107
	Tuak Lobang	575	647	725	141	159	178
	Pantai	491	553	620	106	120	134
	Beneficial Area Total	1,446	1,628	1,825	332	375	419
Lasiana	Bimopu	474	534	599	101	114	128
Tarus	Manikin	472	531	595	143	161	180
	Total	2,392	2,693	3,019	576	650	727

Source : Provincial Statistic Office, NTT

Table 1.4 Present and Projected Livestock Population

Year and Village	Sub-villaga	Cow & Buffalo	Horse	Sheep & Goat	Pig	Chicken & Duck	Equiv't Total
1994							
Lasiana	Sefabano	39	3	21	23	0	48
	Tuak Lobang	108	0	26	82	186	126
	Pantai	40	7	12	162	259	77
Beneficial Area Total		187	10	59	267	445	251
Lasiana	Bimopu	76	6	107	78	31	108
Tarus	Manikin	87	11	91	126	243	132
	Total	350	27	257	471	719	491
1999							
Lasiana	Sefabano	45	3	25	29	0	55
	Tuak Lobang	123	0	32	104	256	146
	Pantai	47	7	15	205	356	92
Beneficial Area Total		215	10	72	338	612	293
Lasiana	Bimopu	88	6	129	99	43	126
Tarus	Manikin	99	12	110	160	334	154
	Total	402	28	311	597	989	573
2004							
Lasiana	Sefabano	52	3	31	37	0	64
	Tuak Lobang	140	0	38	132	352	170
	Pantai	52	8	18	260	490	109
Beneficial Area Total		244	11	87	429	842	343
Lasiana	Bimopu	98	7	156	125	59	144
Tarus	Manikin	113	13	133	202	460	180
	Total	455	31	376	756	1,361	667

Source : Provincial Livestock Office, NTT and JICA Study Team

Table 1. 5 Summary of Farm Economic Survey

	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	Average
1	Sex and Age		Male 42	Male 38	Male 26	Male 54	Male 44	Male 31	Male 30	Male 24	Male 38	Male 72	40
2	No. of Family Member		M-2/F-4	M-2/F-4	M-2/F-1	M-4/F-2	M-2/F-4	M-1/F-4	M-3/F-2	M-2/F-2	M-1/F-1	M-3/F-4	M-2/F-3
3	Type of Side Job		None	Enterprneur	Enterprneur	None	Civil Servant	Civil Servant	C.S./Enter.	None	Civil Servant	None	
4	Own Farmland	ha	2.09	0.90	0.50	1.20	0.70	2.30	0.40	1.00	0.90	0.90	1.09
	(Paddy field)	ha	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.70	0.00	0.00	0.27
5	Cropped Area	ha	2.00	0.90	0.50	2.30	0.58	2.45	0.40	1.40	0.50	0.18	1.12
	(Paddy)	ha	0.00	0.00	0.00	2.00	0.00	1.00	0.00	1.20	0.00	0.00	0.42
	(Palawija)	ha	1.50	0.90	0.50	0.30	0.58	1.45	0.40	0.20	0.50	0.18	0.65
	(Others)	ha	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
6	Cow/Buffalo	head	0	1	2	0	0	0	0	4	3	4	1.4
	Horse	head	0	0	0	0	0	0	0	0	0	0	0.0
	Goat/Sheep	head	0	0	0	0	6	0	0	0	0	0	0.6
	Pig	head	2	0	6	4	2	7	2	2	3	12	4.0
	Chicken/Dug	head	6	6	6	30	9	22	6	9	11	18	12.3
7	Gross Income	Rp/yr	726,250	1,700,000	1,395,000	1,849,000	1,646,600	4,420,000	565,000	1,236,500	1,150,000	955,000	1,564,335
	(Crop)	Rp/yr	626,250	100,000	70,000	1,599,000	81,600	2,020,000	0	861,500	0	0	535,835
	(Livestock)	Rp/yr	100,000	0	325,000	250,000	65,000	600,000	25,000	375,000	550,000	955,000	324,500
	(Side job)	Rp/yr	0	1,600,000	1,000,000	0	1,500,000	1,800,000	540,000	0	600,000	0	704,000
8	Expenditure	Rp/yr	1,401,900	2,310,150	1,201,900	3,167,050	1,570,000	2,678,850	1,044,000	2,203,000	1,560,500	1,501,750	1,883,480
	(Food/Drink)	Rp/yr	822,000	1,188,000	743,400	1,596,000	846,000	1,158,000	564,000	1,020,000	894,000	1,164,000	999,540
	(Living)	Rp/yr	527,900	1,087,900	457,000	205,000	412,000	985,650	646,000	694,500	518,000	141,750	567,570
	(Education)	Rp/yr	18,000	24,000	0	1,000,000	300,000	50,000	25,000	100,000	24,000	180,000	172,100
	(Production)	Rp/yr	34,000	10,250	1,500	366,050	12,000	485,200	4,700	388,500	124,500	16,000	144,270
9	Surplus/Deficit	Rp/yr	-675,650	-610,150	193,100	-1,318,050	76,600	1,741,150	-479,000	-966,500	-410,500	-546,750	-319,145

Source : JICA's Agro-economy Survey

Table 2.1 Projected Domestic and Livestock water Demand

Unit : m3

Village	Sub-village	1999			2004		
		Domestic	Livestock	Total	Domestic	Livestock	Total
Lasiana	Sefabano	9,373	810	10,183	10,512	941	11,453
	Tuak Lobang	14,169	2,138	16,307	15,878	2,480	18,358
	Pantai	12,111	1,343	13,454	13,578	1,586	15,164
	Beneficial area Total	35,653	4,291	39,944	39,968	5,007	44,975
Lasiana	Bimopu	11,695	1,834	13,529	13,118	2,104	15,222
Tarus	Manikin	11,629	2,245	13,874	13,031	2,625	15,656
	Total	58,977	8,370	67,347	66,117	9,736	75,853

Source : JICA Study Team

Table 3.1 Estimated Half Monthly Discharge at Proposed Embung Site

Embung Bimoku

Unit : 1000 m3

	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	5.00	9.00	8.00	12.00	2.00	2.00	0.00	0.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	9.00	8.00	60.00
1967	7.00	18.00	15.00	14.00	17.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	6.00	3.00	83.00
1968	3.00	14.00	19.00	10.00	4.00	1.00	2.00	2.00	5.00	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	3.00	3.00	66.00
1969	6.00	9.00	15.00	8.00	0.00	4.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	2.00	52.00
1970	3.00	5.00	2.00	6.00	2.00	0.00	0.00	3.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	4.00	9.00	2.00	42.00
1971	2.00	17.00	15.00	13.00	18.00	5.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	5.00	6.00	3.00	89.00
1972	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	6.00	1.00	8.00
1973	3.00	17.00	5.00	0.00	3.00	5.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	5.00	6.00	9.00	58.00
1974	42.00	3.00	19.00	19.00	14.00	13.00	5.00	0.00	2.00	0.00	3.00	0.00	2.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	6.00	6.00	0.00	1.00	137.00
1975	7.00	8.00	9.00	10.00	9.00	1.00	5.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	4.00	7.00	19.00	9.00	99.00
1976	22.00	8.00	6.00	12.00	25.00	9.00	2.00	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	5.00	0.00	11.00	3.00	103.00
1977	25.00	2.00	18.00	15.00	11.00	4.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.00	6.00	91.00
1978	8.00	7.00	12.00	34.00	3.00	3.00	5.00	0.00	2.00	7.00	3.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.00	1.00	14.00	115.00
1979	15.00	11.00	2.00	8.00	23.00	3.00	0.00	3.00	0.00	3.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.00	9.00	7.00	94.00
1980	9.00	28.00	35.00	2.00	2.00	2.00	0.00	6.00	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	4.00	8.00	13.00	109.00
1981	15.00	19.00	13.00	13.00	11.00	0.00	0.00	0.00	0.00	2.00	0.00	1.00	6.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	7.00	9.00	26.00	14.00	138.00
1982	4.00	23.00	14.00	14.00	19.00	5.00	0.00	2.00	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	5.00	2.00	7.00	95.00
1983	21.00	5.00	9.00	12.00	13.00	1.00	8.00	3.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00	5.00	0.00	5.00	87.00
1984	18.00	18.00	13.00	16.00	2.00	14.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	2.00	0.00	2.00	10.00	15.00	112.00
1985	0.00	11.00	4.00	7.00	7.00	0.00	1.00	2.00	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	7.00	6.00	7.00	52.00
1986	16.00	24.00	8.00	10.00	4.00	4.00	2.00	0.00	0.00	0.00	0.00	2.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	5.00	10.00	95.00
1987	9.00	32.00	12.00	11.00	0.00	3.00	1.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	12.00	6.00	95.00
1988	10.00	15.00	18.00	2.00	9.00	9.00	2.00	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	8.00	12.00	9.00	8.00	102.00
1989	5.00	12.00	6.00	5.00	21.00	6.00	0.00	5.00	3.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	7.00	7.00	80.00
1990	17.00	7.00	7.00	13.00	17.00	0.00	0.00	7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00	13.00	5.00	89.00
1991	11.00	18.00	15.00	15.00	3.00	2.00	25.00	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	4.00	8.00	3.00	2.00	106.00
1992	1.00	6.00	14.00	4.00	5.00	9.00	4.00	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	3.00	8.00	0.00	60.00
1993	8.00	37.00	10.00	6.00	6.00	5.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	16.00	95.00
Average	10.43	13.68	11.54	10.39	8.93	4.00	2.25	1.36	0.57	0.64	0.39	0.25	0.36	0.18	0.00	0.00	0.14	0.07	0.07	0.54	1.79	4.25	7.68	6.64	86.14

Table 3.2 Estimated Flood Discherge

Bimoku Scheme

Characteristics of the catchment area								
Catchment Area	(km2)	0.20						
Eelevation at Dam Site (1)	(m)	13						
Maximum elevation in the catchment area (2)	(m)	40						
Height (3)=(2)-(1)	(h)	27						
Length of Catchment Area (l)	(m)	500						
Flow velocity	W2 (km/hr)	12.50						
Time of concentration	T2 (hrs)	0.04						
Estimate of the Design Flood Discherge								
Return Period	(years)	2	5	10	20	50	100	200
Rainfall	(mm/day)	103	160	205	253	327	390	459
Rainfall intensity within the time of concentration	(mm)	105	163	209	258	334	398	469
Designed Flood	(m3/s)	5	7	9	11	15	18	21
Specific Discharge	(m3/s/km2)	23	36	46	57	74	88	104

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 3.3 Result of Water Quality Test

Bimoku Scheme

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	28.50	31.00	31.00	26.00	Normal water temperature
2 Dissolved solid matter	mg/liter	617.00	468.00	546.00	368.00	1000
3 Electric Conductivety	umhos/cm	845.00	637.00	742.00	501.00	-
II. CHEMISTRY						
a. Unorganic chemistry						
1 Mercury	mg/liter	0.00	0.00	0.00	0.00	0.001
2 Ammonia	mg/liter	0.40	0.00	0.00	0.00	0.5
3 Aroenic	mg/liter	-	-	-	-	0.05
4 Barium	mg/liter	-	-	-	-	5
5 Ferro	mg/liter	0.08	0.09	0.04	0.09	1
6 Fluoride	mg/liter	1.70	1.00	0.90	0.80	1.5
7 Cadmium	mg/liter	0.00	0.00	0.00	0.00	0.005
8 Chloride	mg/liter	46.80	32.60	32.60	23.00	600
9 Chronium, valense-6	mg/liter	0.00	0.00	0.00	0.00	0.05
10 Manganese	mg/liter	0.13	0.00	0.00	0.00	0.5
11 Nitrate, N	mg/liter	0.00	0.00	0.00	1.10	10
12 Nitric, N	mg/liter	0.06	0.01	0.01	0.01	1
13 Dissolved Oxygen	mg/liter	0.35	6.14	6.14	0.69	*
14 pH	-	6.90	7.60	7.20	7.60	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	11.00	8.80	8.00	9.00	400
19 Sulfide, H2S	mg/liter	0.00	0.00	0.00	0.00	0.1
20 Copper	mg/liter	0.00	0.00	0.00	0.00	1
21 Lead	mg/liter	0.00	0.00	0.00	0.00	0.1
b. Organic Chemistry						
1 Aldrin and Dieldrin	mg/liter	0.00	0.00	0.00	0.00	0.017
2 Chlordane	mg/liter	0.00	0.00	0.00	0.00	0.003
3 DDT	mg/liter	0.00	0.00	0.00	0.00	0.042
4 Endrine	mg/liter	0.00	0.00	0.00	0.00	0.001
5 Fenol	mg/liter	0.00	0.00	0.00	0.00	0.001
6 Heptachlor and Heptachlor Epoxide	mg/liter	-	-	-	-	0.018
7 Carbon Cloroform Ektract	mg/liter	-	-	-	-	0.5
8 Lindane	mg/liter	0.00	0.00	0.00	0.00	0.056
9 Methoxychlor	mg/liter	-	-	-	-	0.035
10 Oil and Fat	mg/liter	0.00	0.00	0.00	0.00	Nil
11 Organofosphate and Carbomate	mg/liter	0.00	0.00	0.00	0.00	0.1
12 PCB	mg/liter	-	-	-	-	Nil
13 Senyawa atife biru (Sulfaktan)	mg/liter	0.00	0.00	0.00	0.00	0.5
14 Toxaphene	mg/liter	0.00	0.00	0.00	0.00	0.005
III MICRO BIOLOGY						
1 Coliform tinja	per 100 ml	17,000	13,000	13,000	49,000	2,000
2 Total Coliform	per 100 ml	22,000	17,000	18,000	49,000	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 5.1 Design Value of Embankment Materials

Bimoku Scheme

Item		Unit	Design Value
Natural Water Content	(NWC)	%	21.6
Bulk Density	(γ d max)	g/cm3	1.932
Maximum Dry Density	(γ t)	g/cm3	1.80
Saturated Density	(σ sat)	g/cm3	2.090
Optimum Moisture Content	(Wopt)	%	20
Specific Gravity	(Gs)	-	2.60
Liquid Limit	(LL)	%	40.0
Plastic Limit	(PL)	%	17.0
Plastic Index	(PI)	%	23.0
Shrinkage Limit	-	%	22.0
Angle of Internal Friction	(ϕ)	°	30.0
Cohesion (UU/CU)	(C)	kg/cm2	1.3
Permeability	(K)	cm/sec	2.30E-06
Classification of Soil	-	-	CL

Table 6.1 Summary of Construction Equipment

Bimoku Scheme

No.	Equipment	Capacity	Munimum Number
1	Bulldozer	21 ton	2
2	Wheel loder	1.2 m3	1
3	Backhoe	1.2 m3	2
4	Backhoe	0.6 m3	3
5	Dump Truck	11 ton	12
6	Dump Truck	7 ton	3
7	Type roller	10 ton	1
8	Motor grader	3.7 m	1
9	Water Tanker(Sprinkler)	6 kl	1
10	Leg drill	2.8 m3/min	2
11	Sinker	3.3 m3/min	2
12	Air compressor	14 m3/min	1
13	Batching plant	0.75 m3	1
14	Agitator (Trunk mixer)	3.0 m3	2
15	Concrete bucket	1.0 m3	2
16	Concrete vibrator	-	3
17	Truck crane	20 ton	1
18	Water pump	3,7 kw	2
19	Welder	300 A	2
20	Diesel generator	80 KVA	2
21	Truck	7 ton	4
22	Truck with crane	6 ton	1
23	Pickup car	-	4
24	Jeep	-	4
25	Concrete pump	20 m3/hr	1

Table 7.1 Summary of Project Cost

Scheme : BIMOKU

Item	Amount (Rp. million)
I. Direct Construction Cost	
1.1 Preparatory Works	97
1.2 Embung Construction	
1) Main dam	330
2) Spillway	868
3) Intake, outlet & diversion channel	118
4) Leakage protection works	279
5) Miscellaneous	159
Sub-total of 1.2	1,754
1.3 Domestic Water Supply	
1) Pipe line	32
2) Division boxes	133
3) Miscellaneous	16
Sub-total of 1.3	181
1.4 Embung Operation and Maitenace Road	0
1.5 Irrigation Facilities	0
Sub-toal of I.	2,032
II. Administration Cost	102
III. Engineering Services	305
Sub-total of I, II & III	2,438
IV. Physical Contingency	366
Sub-total of I, II, II, & IV	2,804
V. Contract Tax	270
VI. Land Aquisition Cost	10
Sub-total I, II, III, IV, V & VI	3,084
VII. Price Contingency	308
GRAND TOTAL	3,393

Table 7.2 Direct Construction Cost (1/3)

Scheme : BIMOKU

Item	Unit	Unit Price Rp.	Quantity	Total 1000 Rp.
I. Embung				
1. Main Dam				
1.1 Earth/stone works				
1) Clearing	m2	400	4,400	1,760
2) Excavation	m3	5,500	4,400	24,200
3) Embankment	m3	8,000	31,000	248,000
4) Rip-rap protection	m3	15,000	1,700	25,500
1.2 Other miscellaneous works				29,946
Sub-total of 1.				329,406
2. Spillway				
2.1 Earth works				
1) Clearing	m2	400	1,100	440
2) Excavation	m3	5,500	16,200	89,100
3) Backfill	m3	5,200	3,900	20,280
2.2 Concrete works				
1) Concrete - A	m3	250,000	200	50,000
2) Concrete - B	m3	170,000	2,200	374,000
3) Reinforcement bar	ton	1,500,000	50	75,000
4) Form	m2	15,000	12,000	180,000
2.3 Other miscellaneous works	L.S			78,882
Sub-total of 2.				867,702
3. Intake, Outlet & Diversion Channel				
3.1 Earth works				
1) Clearing	m2	400		0
2) Excavation	m3	5,500	1,000	5,500
3) Backfill	m3	15,000		0
3.2 Concrete works				
1) Concrete - A	m3	250,000		0
2) Concrete - B	m3	170,000	600	102,000
3) Reinforcement bar	ton	1,500,000		0
4) Form	m2	15,000		0
3.3 Other miscellaneous works	L.S			10,750
Sub-total of 3.				118,250
4. Leakage Protection Works				
4.1 Earth works				
1) Clearing	m2	400	17,000	6,800
2) Earth blanket works	m3	8,000	34,000	272,000
4.2 Concrete lining works	m2	170,000		0
Sub-total of 4.				278,800
5. Miscellaneous & Others				159,416
Total of I.				1,753,574

Table 7.2 Direct Construction Cost (2/3)

Scheme : BIMOKU

Item	Unit	Unit Price Rp.	Quantity	Total 1000 Rp.
II. Domestic Water Supply				
1. Pipe line				
1.1 Earth works				
1) Clearing	m2	400	3,300	1,320
2) Excavation	m3	5,000	540	2,700
3) Backfill	m3	5,200	530	2,756
1.2 Pipe line setting works				
1) Dia 40 mm	m	5,300		0
2) Dia 50 mm	m	7,400		0
3) Dia 65 mm	m	9,200	130	1,196
5) Dia 75 mm	m	13,300	1,500	19,950
6) Dia. 400 mm	m	218,000		0
1.3 Pipe line related structures				
1) Check valve	nos.	624,000	3	1,872
2) Air valve	nos.	506,000	2	1,012
3) Drainage valve	nos.	1,036,000	1	1,036
Sub-total of 1.				31,842
2. Division Boxes				
1) Division box for inhabitants	nos.	6,990,000	19	132,810
2) Division box for livestock	nos.	1,130,000		0
Sub-total of 2.				132,810
3. Miscellaneous & Others	L.S			16,465
Total of II.				181,117
III. Embung Operation and Maintenance Road				
1. Road Works				
1.1 Earth works				
1) Clearing	m2	400		0
2) Excavation	m3	5,000		0
3) Embankment	m3	6,300		0
4) Pavement (lime stone)	m3	15,000		0
2. Related structures				
2.1 Cross drain	nos.	4,700,000		0
3. Miscellaneous and others	L.S			0
Total of III				0

Table 7.2 Direct Construction Cost (3/3)

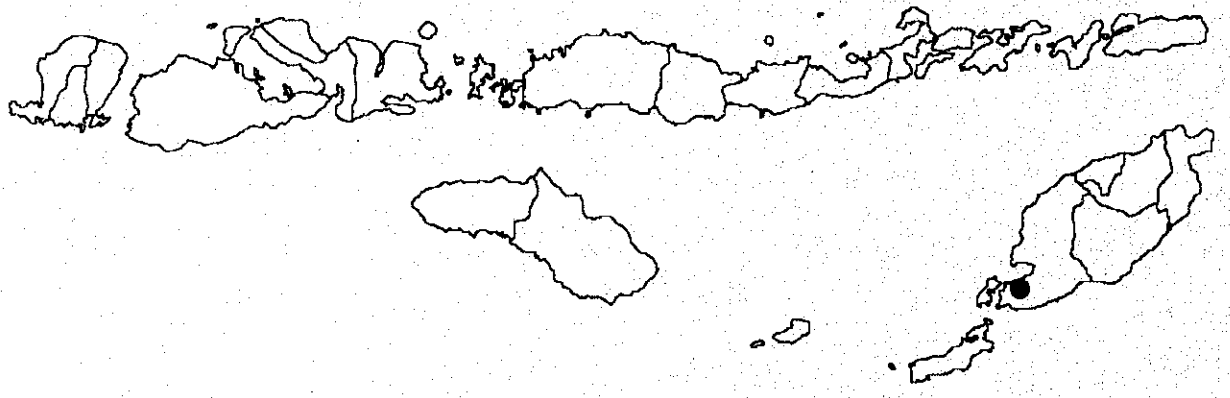
Scheme : BIMOKU

Item	Unit	Unit Price Rp.	Quantity	Total 1000 Rp.
IV. Irrigation Facilities				
1. Canal works				
1.1 Earth works				
1) Clearing	m2	400		0
2) Excavation	m3	5,000		0
3) Embankment	m3	6,300		0
1.2 Concrete works				
1) Concrete - A	m3	250,000		0
2) Concrete - B	m3	170,000		0
3) Reinforcement bar	ton	1,500,000		0
4) Form	m2	15,000		0
2. Related structures				
2.1 Irrigation inlet box	nos.	1,600,000		0
2.2 Aqueduct	nos.	2,750,000		0
2.3 Cross drain	nos.	4,700,000		0
2.4 Irrigation division box	nos.	600,000		0
3. Rehabilitation of existing canal				
3.1 Weir rehabilitation	L.S			0
3.2 Canal rehabilitation	L.S			0
4. Miscellaneous & Others	L.S			0
Total - IV				0
GRAND TOTAL				1,934,691

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

Feasibility Study on Bimoku Embung Development Project

Figures



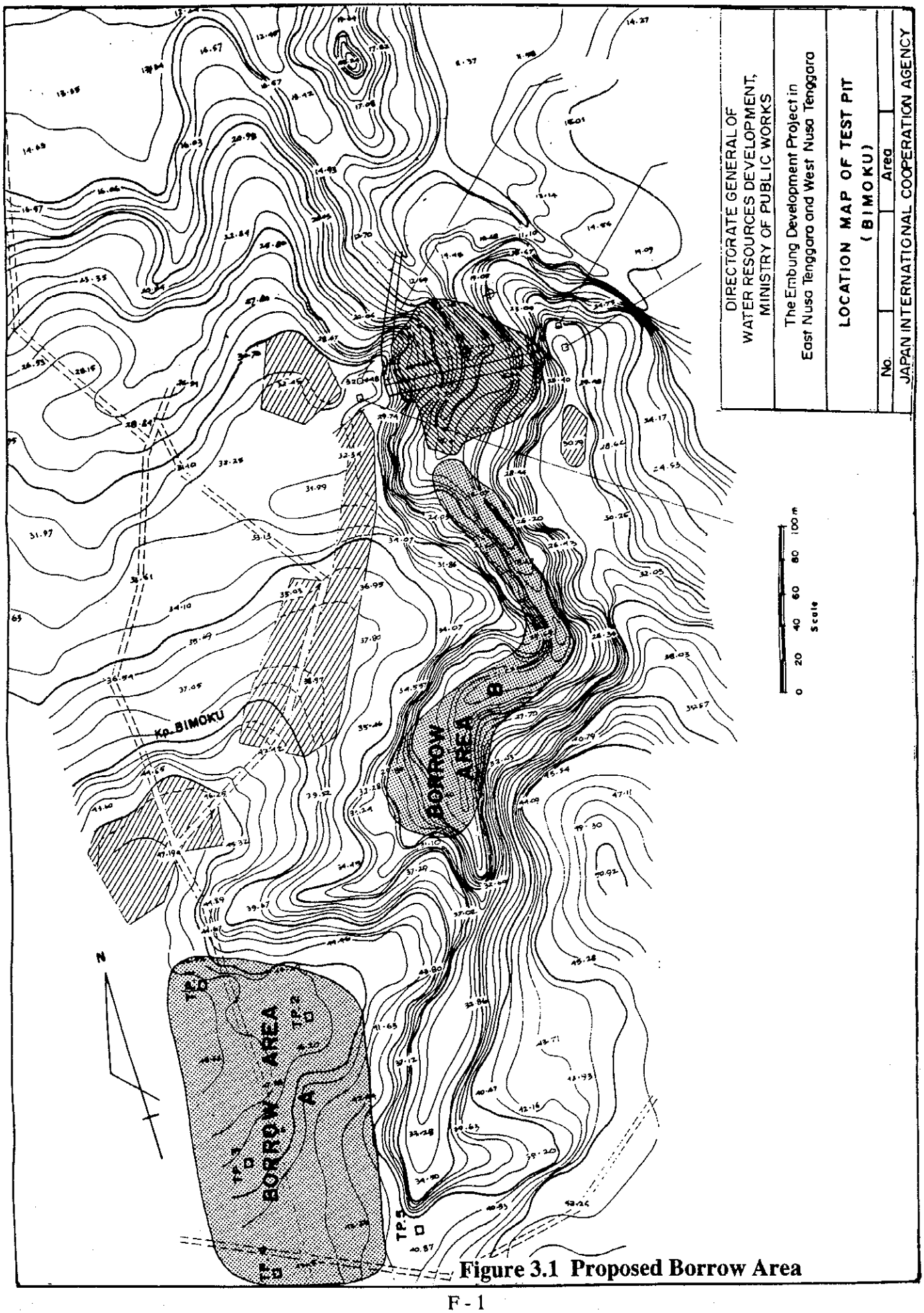


Figure 3.1 Proposed Borrow Area

KP BIMOKU

N

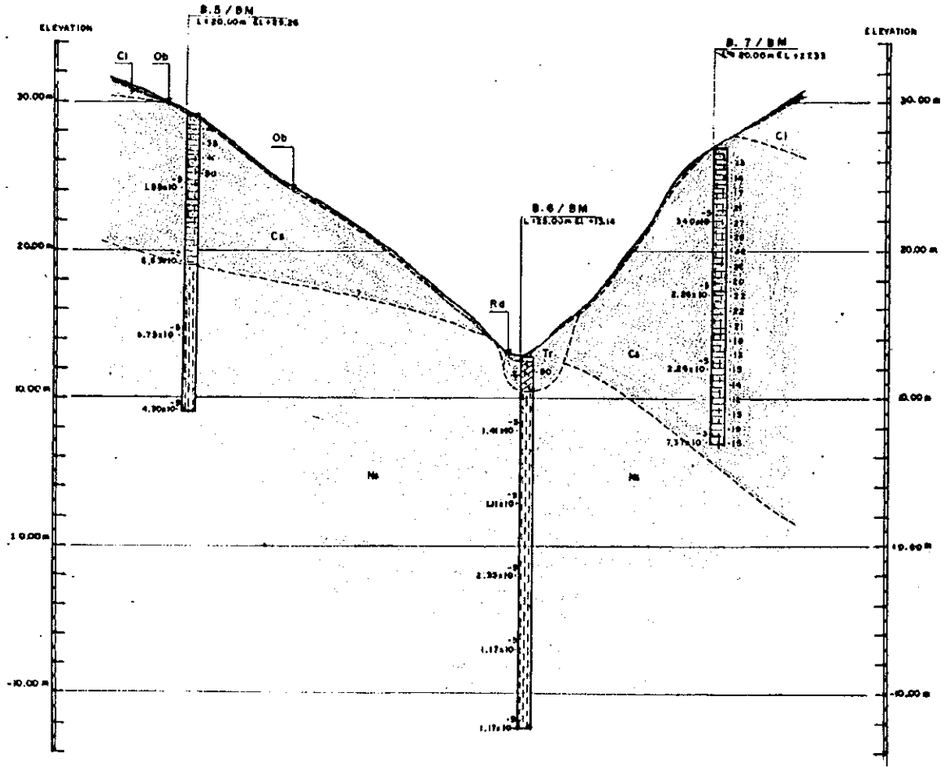
LEGEND

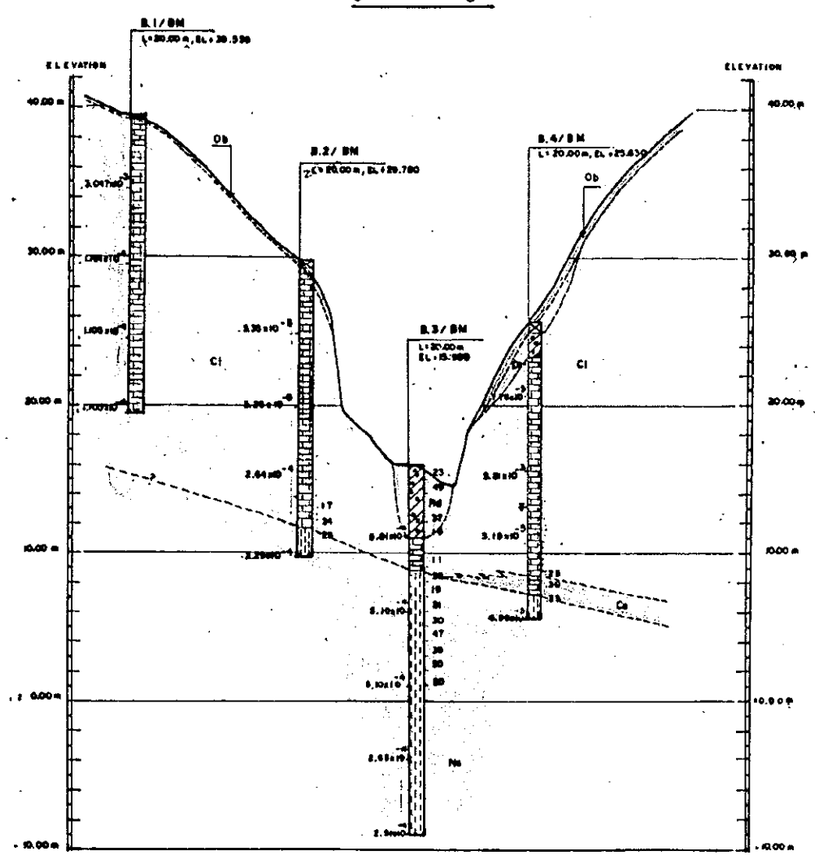
Rd	River deposits		Geological boundary
Dt	Detritus		
At	Alluvial terrace deposits	●	Bore Hole
Cl	Coral limestone } Coralline limestone	A — A'	Geologic profile line
Cs	Sandy limestone }		
Ns	Siltstone : Noele Formation		

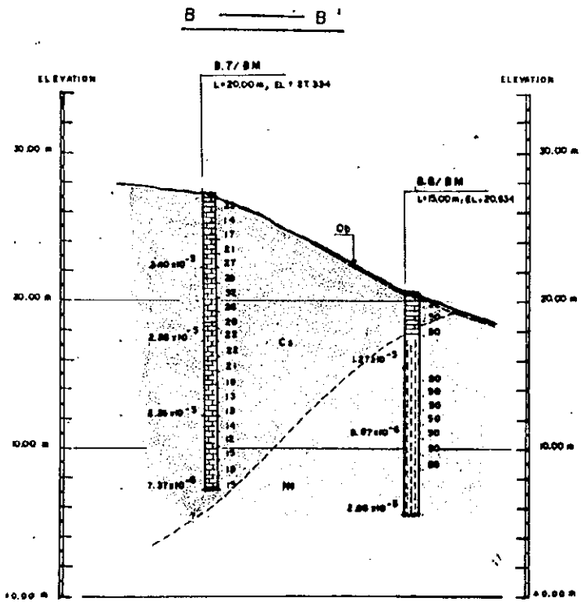
0 20 40 60 80 100 m
Scale

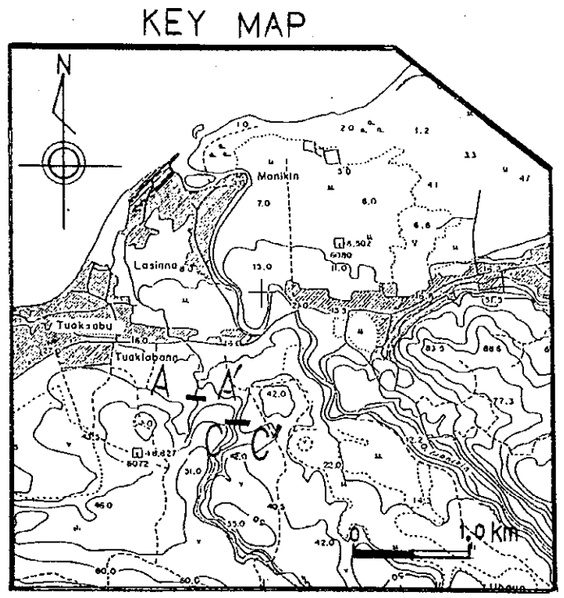
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT, MINISTRY OF PUBLIC WORKS			
The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara			
GEOLOGICAL MAP OF BIMOKU SITE			
No.		Area	
JAPAN INTERNATIONAL COOPERATION AGENCY			

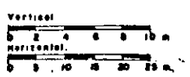
Figure 3.2 Geological Map and Profile (1/2)





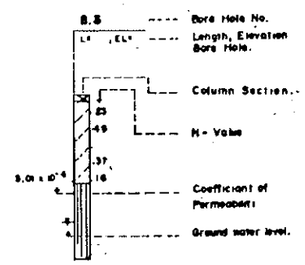






LEGEND

- Ob — Overburden
- Rd — River deposits.
- Dt — Detritus.
- Tr — Terrace deposits.
- Cl — Coral limestone
- Cs — Sandy limestone
- } Coralline limestone
- Ns — Siltstone : Noele Formation
- Geologic boundary



DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT, MINISTRY OF PUBLIC WORKS

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

GEOLOGICAL PROFILE OF BIMOKU SITE

No | Area

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 3.3 Geological Map and Profile (2/2)

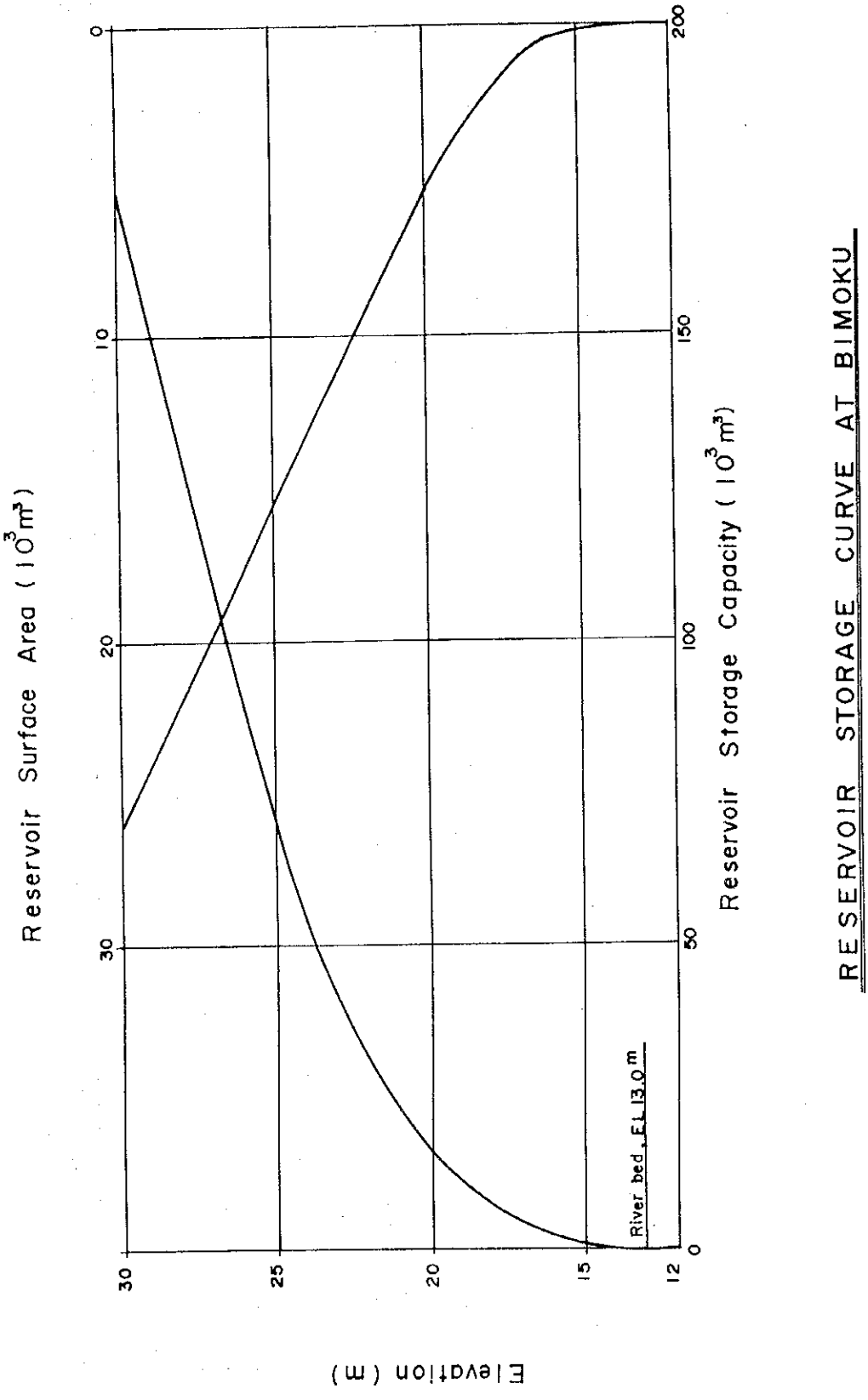


Figure 4.1 Reservoir Storage Curve

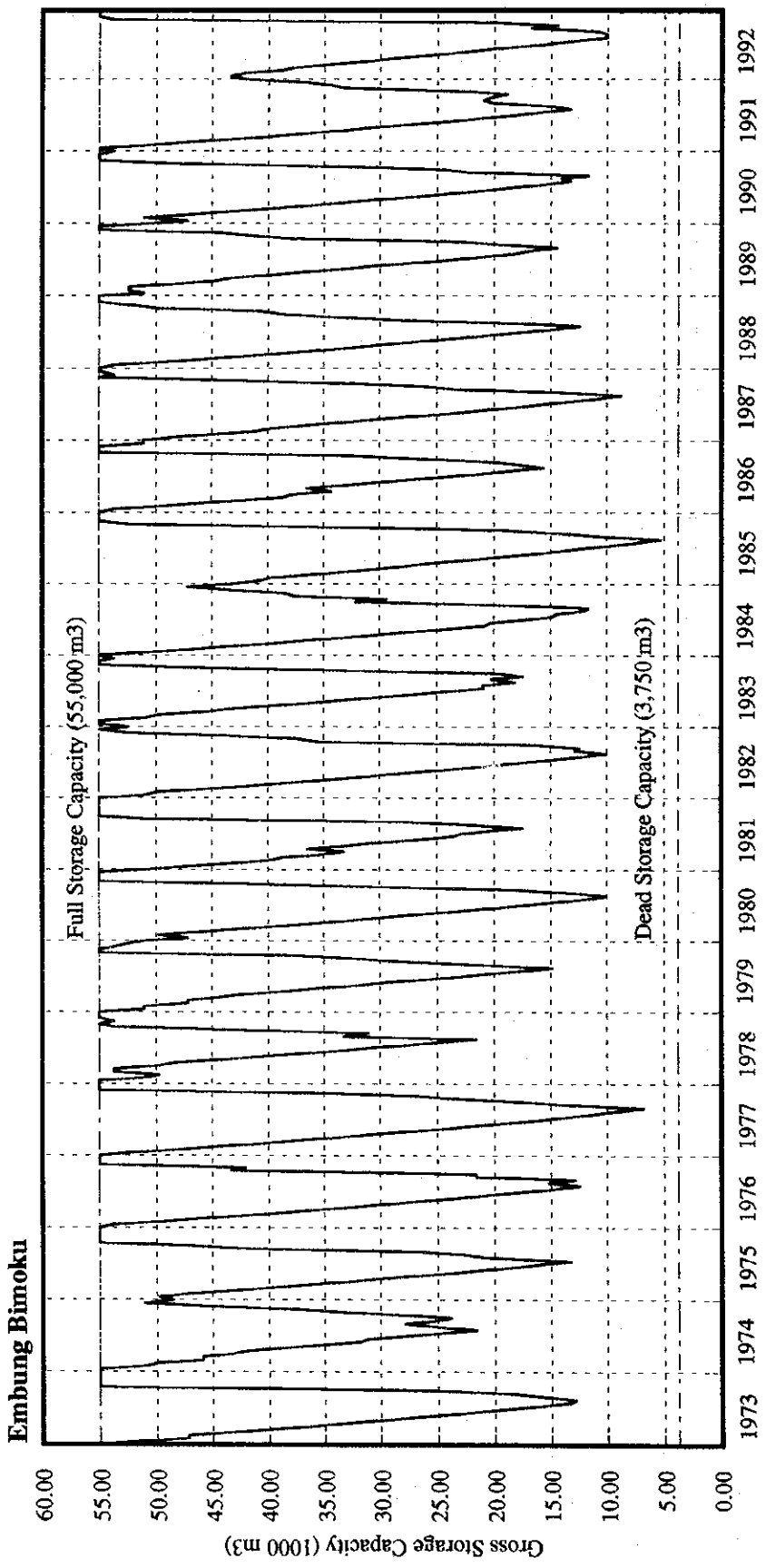
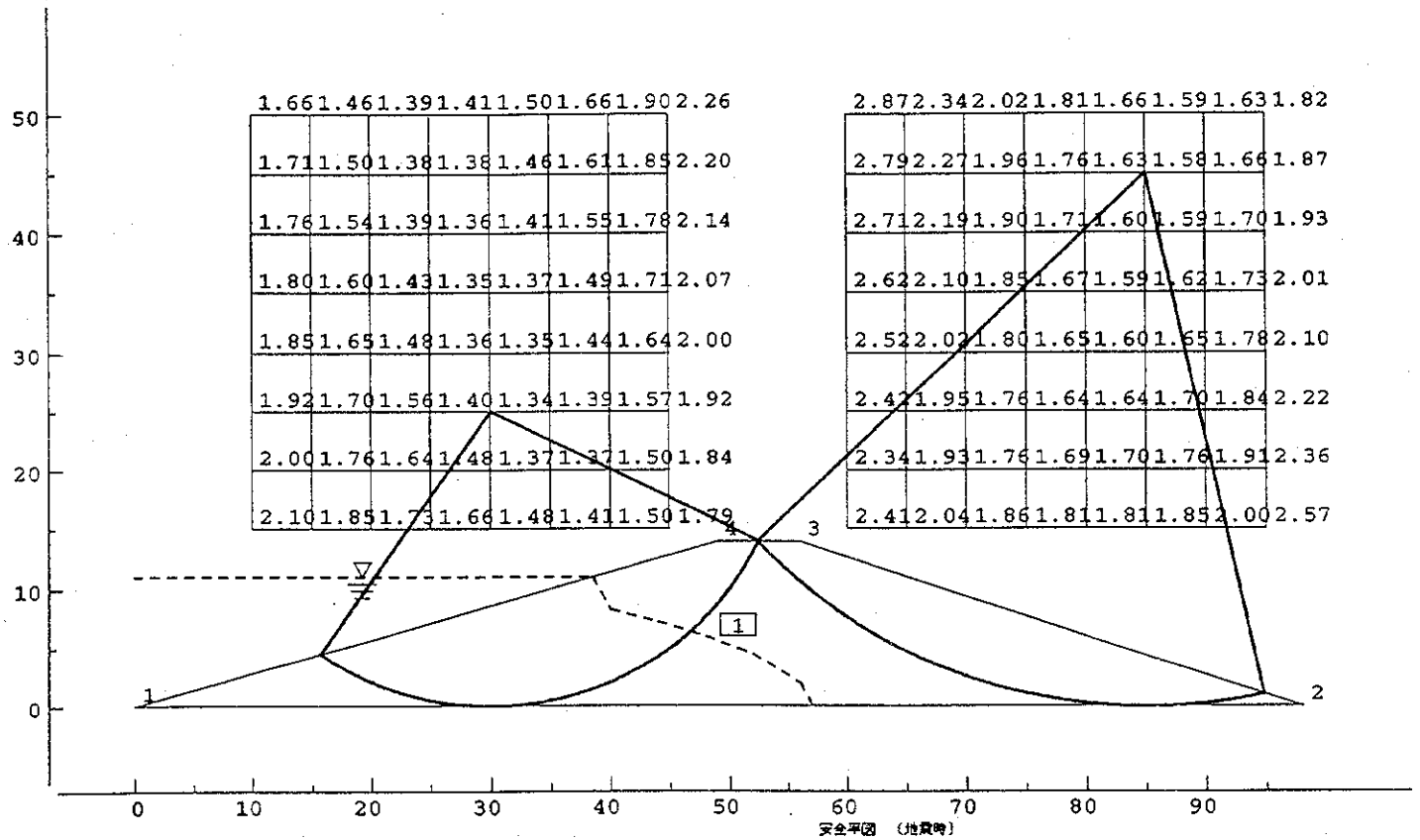


Figure 4.2 Result of Reservoir Operation



	Slope	Safety factor
Upstream	1: 3.5	1.34
Downstream	1: 3	1.58

Figure 5.1 Stability Analysis

Bimoku Scheme

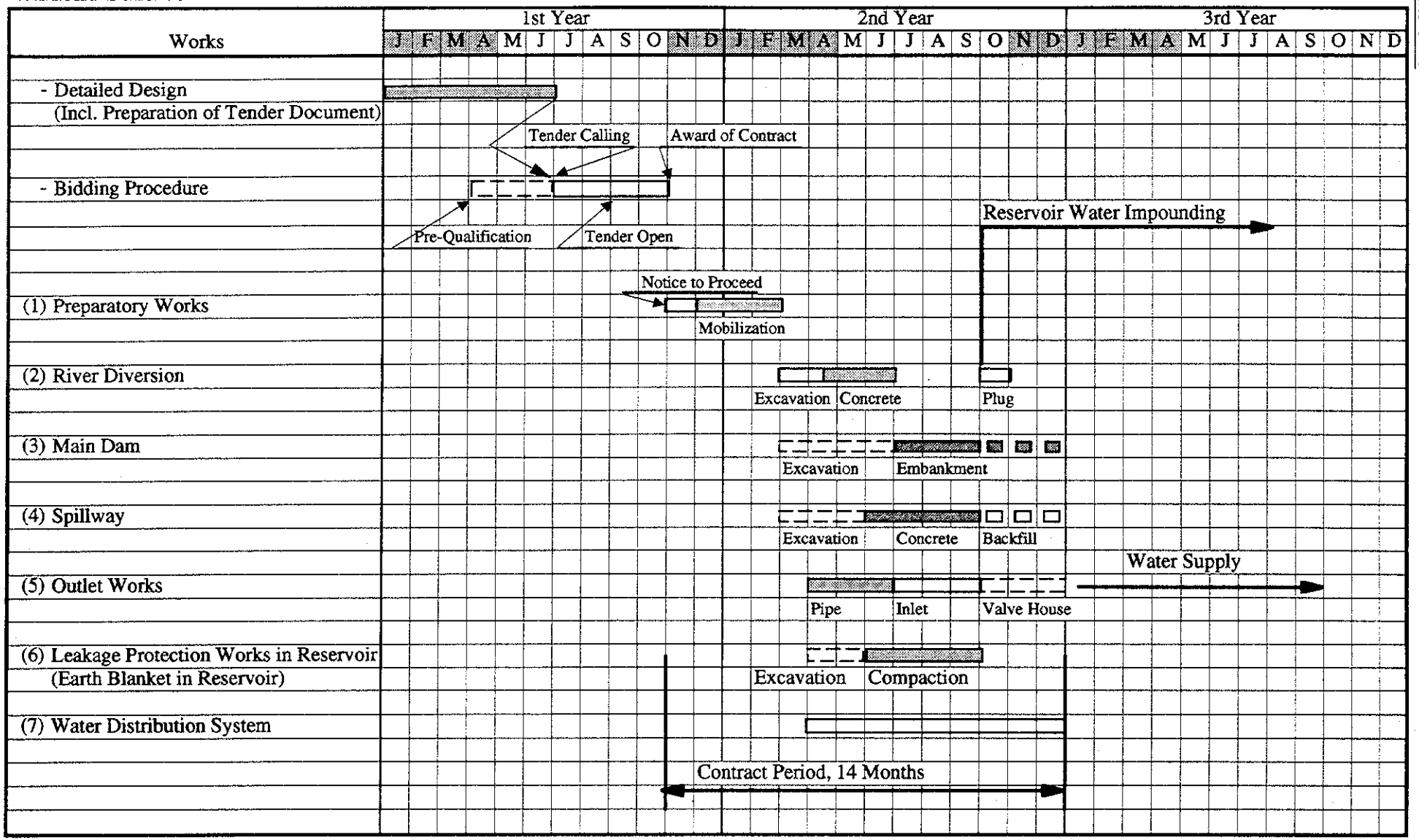


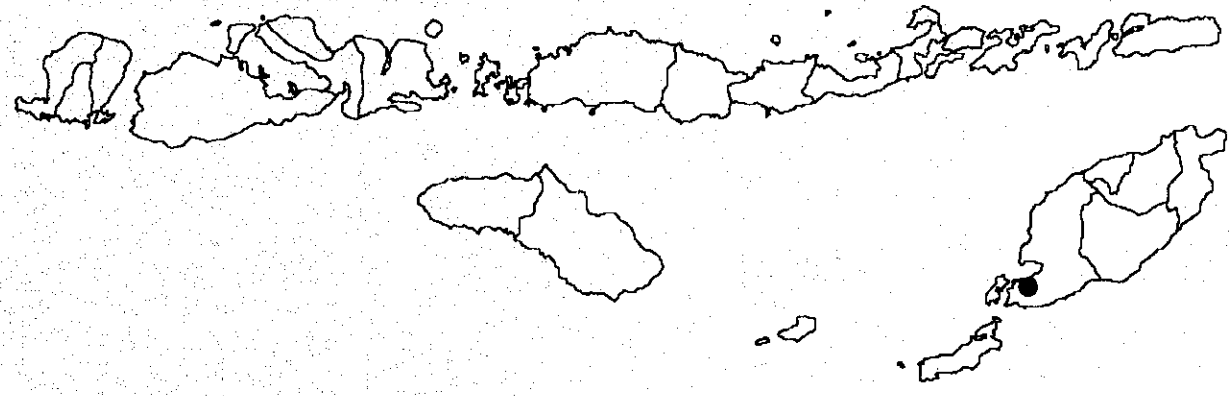
Figure 6.1 Construction Time Schedule

Volume 6 - 1

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

Feasibility Study on Bimoku Embung Development Project

Attachments



Attachment - 1

Result of Soil Laboratory Test in Bimoku

Bor.No. (Depth)	Formation Classification	Unified Soil Content(%)	Water (g/cm3)	Unit Weight	Specific Gravity
B2(6.0m)	Coral limestone	CL	22.6	-	2.71
B3(12.0m)	Noele siltstone	CL	34	1.83	2.52
B5(3.0m)	Sandy limestone	CL	30.3	1.59	2.66
B6(11.0m)	Noele siltstone	CH	58.1	1.44	2.79
B6(16.0m)	Noele siltstone	CH	57.1	-	2.65
B7(3.0m)	Sandy limestone	OL-ML	29.4	1.62	2.64

Result of Rock Test in Bimoku

Sample	Formation	Unit Weight (g/cm3)	Specific Gravity	Unconfined Compression (kg/cm3)
B2(5.0m)	Coral limestone	2.34	2.73	275.27
B6(12.0m)	Noele siltstone	2.43	2.72	150.05

Attachment-2

SUMMARY OF LABORATORY TEST

PROJECT : Embung Bimoku
LOCATION OF PROJECT : Ds. Lasania, Kec. Kupang Tengah
DISTRICT : Kupang
PROVINCE : Nusa Tenggara Timur
DATE : Jun-94

			TP.1	TP.2	TP.3	TP.4	TP.5	Average
Depth of Sample		m						
Water Content	(Wn)	%	22.41	23.43	30.32	20.49	12.95	21.92
Unit Weight	(γ w)	g/cm3						
Maximum Dry Density	(γ d max)	g/cm3	1.710	1.720	1.520	1.440	1.805	1.64
Optimum Moisture Content	(Wopt)	%	18.45	17.50	24.40	25.70	15.85	20.38
Specific Gravity	(Gs)	-	2.52	2.60	2.61	2.58	2.56	2.57
Liquid Limit	(LL)	%	39.85	39.40	59.00	64.35	40.20	48.56
Plastic Limit	(PL)	%	17.17	17.89	16.24	21.44	14.68	17.48
Plastic Index	(PI)	%	22.68	21.51	42.76	42.91	25.52	31.08
Shrinkage Limit	-	%	18.02	27.76	28.32	27.05	20.49	24.33
Angle of Internal Friction	(ϕ)	°	31	23	22	22	27	25.00
Cohesion (UU/CU)	(C)	kg/cm2	2.500	0.800	0.845	1.680	0.700	1.31
Permeability	(K)	cm/sec	1.94E-06	2.63E-06	2.48E-06	2.53E-06	2.50E-06	
Passing of # 200 Sieve	-	%	54.03	49.87	92.13	93.13	43.55	
Clasification of Soil			CL	CL	CH	CH	CL	

1. Physical Environmental Impacts

Place I : Catchment area
Place II : Embung and reservoir area planned
Place III : River and riverbed
Place IV : Riverside
Place V : Beneficial area
Place VI : Downstream area other than beneficial area

Embung Site: 1: T101 : Bimoku
2: T102 : Oeltua
3: T103 : Tasiepah
4: T108 : Benkoko
5: T109 : Oebuain
6: RO13: Matasio

Positive Impact with Project

Negative Impact with Project

Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur I II III IV V VI	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur I II III IV V VI	Embung Site 1 2 3 4 5 6	Mitigatory Measures
LAND	Land use	Actual	I	not available					
		Potential	I	not available					
	Soil erosion	Actual	I	not available					
		Potential	I	not available					
	Soil fertility	Actual	I	not available					
		Potential	I	not available					
	Soil contamination	Actual	I	not available					
		Potential	I	not available					
WATER	River hydrology	Actual	III	available	· Flush floods in short duration are observed during the wet season	· no impact		1 2	
		Actual	III	available	· -ditto-	· It causes scour and erosion of river bed	III	5	
		Potential	III	available	· River run-off is reduced by storage function of the reservoir	· no impact		1 2 5	
		Actual	III	available	· River flow discharge rapidly increase during the wet season	· It causes scour and erosion of riverbed · Sedimentation and erosion of riverbed induce reduction of flow area of the river	III	3	
		Actual	III	available	· -ditto-	· It causes scour and erosion of riverbed	III	4 6	
		Potential	III	available	· River run-off is reduced by storage function of the reservoir	· -ditto-	III	3 4 6	

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Positive Impact with Project

Negative Impact with Project

Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur I II III IV V VI	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur I II III IV V VI	Embung Site 1 2 3 4 5 6	Mitigatory Measures
	River morphology	Actual	IV	available	· River section is stable because it composed of lime stone	· no impact		1 2	
		Potential	IV	available	· not applicable	· no impact		1 2	
		Actual	IV	available	· Erosion and collapse of river banks caused by floods and excess grazing are observed	· Sedimentation in the river reduces flow area of the river	III	3 5 6	
		Potential	IV	available	· Grazing is slightly controlled by means of the water supply for livestock	Decrease of sedimentation is expected	III	3 5 6	
		Actual	IV	available	· Erosion and slope collapse are not observed owing to the slope protection by dense vegetation along the river	· no impact		4	
		Potential	IV	available	· no applicable	· no impact		4	
	Flooding	Actual	III	IV available	· Overflow from river banks is not observed during floods	· no impact		1	
		Actual	III	IV available	· Intensive flow induces flood occurrence during the wet season.	· no impact		2 4	
		Actual	III	IV available	· Intensive flow induces flood occurrence during the wet season	· Erosion along the river banks is accelerated by floods	III	3 5 6	
		Potential	III	IV available	· Flood discharge is not reduced because the dam has not flood control purpose	· no impact		1 2 3 4 5 6	

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Positive Impact with Project

Negative Impact with Project

Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur I II III IV V VI	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur I II III IV V VI	Embung Site 1 2 3 4 5 6	Mitigatory Measures
	Surface water availability	Actual	V	available	· Surface water is utilized in the wet season	· Surface water is utilized for livestock during the wet season	V	1	
		Potential	V	available	· Surface water is stored in the reservoir during the wet season	· Stored water is utilized as a water source for domestic water supply	V	1	
		Actual	V	available	· Surface water is utilized in the wet season	· Surface water is utilized for livestock during the wet season	V	2	
		Actual	V	available	· -ditto-	· Surface water is utilized for livestock during the wet season	V	5	
		Potential	V	available	· Surface water is stored in the reservoir during the wet season	· Stored water is constantly utilized for the uses of domestic water and livestock	V	2 5	
		Actual	V	available	· Surface water is utilized throughout the year	· Stored water is utilized as a water source for domestic water supply throughout the year · Stored water is supplementarily utilized for irrigation purpose during the wet season	V	3	
		Actual	V	available	· Surface water is utilized in the wet season	· Stored water is supplementarily utilized for irrigation purpose during the wet season	V	4	
		Actual	V	available	· -ditto-	· Stored water is supplementarily utilized for irrigation purpose during the wet season	V	6	
		Potential	V	available	· Surface water is stored in the reservoir	· Stored water is utilized as a water source for domestic water supply throughout the year · Stored water is supplementarily utilized for irrigation purpose	V	3 4 6	
	Surface water quality	Actual	III	not available					
		Potential	III	not available					
	Groundwater levels	Actual	V	not available					
		Potential	V	not available					
	Groundwater quality	Actual	V	not available					
		Potential	V	not available					

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Positive Impact with Project

Negative Impact with Project

Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur I II III IV V VI	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur I II III IV V VI	Embung Site 1 2 3 4 5 6	Mitigatory Measures
ATMOSPHERE	Dust, Odor, Noise	Actual	II	available	–	–			
		Potential	II	available	• Air contamination is generated by the construction works in the vicinity area	• Inhabitants and livestock in the vicinity area are affected by air contamination	V	1 2 3 4 5 6	• Proper supervisory works, e.g. education of laborer, construction schedule, safety control shall be performed.

2. Biotic Environmental Impacts

Place I : Catchment area
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Positive Impact with Project

Negative Impact with Project

Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur (I II III IV V VI)	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur (I II III IV V VI)	Embung Site (1 2 3 4 5 6)	Mitigatory Measures
FAUNA	FAUNA	Actual	II	available	· There is not any inhabitant and its migration	· no impact		1 2 3 4 5 6	
		Potential	II	available	· not applicable	· no impact		1 2 3 4 5 6	
FLORA	Forests/trees	Actual	II	available	· There exist savanna and evergreen trees	· Logging by inhabitants is observed	II	1 2 3 4 5 6	
		Potential	II	available	· Logging in the reservoir area caused by dam construction is required	· Limitation of logging area by dam construction accelerate logging activities in the catchment area of the reservoir	I	1 2 3 4 5 6	· Vegetations in the catchment area should be protected by means of artificial remedy

3. Human Environmental Impacts

Place I : Catchment area
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Place IV : Riverside
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5: T109 : Oebuain
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Positive Impact with Project

Negative Impact with Project

Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur I II III IV V VI	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur I II III IV V VI	Embung Site 1 2 3 4 5 6	Mitigatory Measures
SOCIAL	Human carrying capacity	Actual	V	available	· Human carrying capacity, which is attributed to low farm productivity due to unstable irrigation during the wet season, is still in low level	· Low employment opportunity in the dry season accelerate outflow of labor force from rural area to urban area · Low economic growth is not afford to satisfy the social demand derived from constant population growth	V	3 4	
		Potential	V	available	· Increase of human carrying capacity is expected by means of the provision of sufficient irrigation water supply in the wet/dry seasons	· Control of labor force outflow · Proper economic growth contributes to the social demand derived from constant population growth	V	3 4	
		Actual	V	available	· Human carrying capacity, which is attributed to low farm productivity due to unstable irrigation during the wet season, is still in low level	· Low economic growth is not afford to satisfy the social demand derived from constant population growth	V	6	
		Potential	V	available	· Increase of human carrying capacity is expected by means of the provision of sufficient irrigation water supply in the wet/dry seasons	· Proper economic growth contributes to the social demand derived from constant population growth		6	
	Settlement	Actual	V	available	· Settlement is not recommended to avoid conflict among indigenous social communities	· no impact		1 2 3 4 5 6	
		Potential	V	available	· Settlement is not composed of the project components	· no impact		1 2 3 4 5 6	
	Resettlement	Actual		available	—	—		1 2 3 4 5 6	
		Potential	II	available	· Involuntary resettlement is not applicable because any residence does not exist there	· not applicable		1 2 3 4 5 6	

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Positive Impact with Project

Negative Impact with Project

Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur I	II	III	IV	V	VI	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur I	II	III	IV	V	VI	Embung Site 1	2	3	4	5	6	Mitigatory Measures
	Population growth	Actual					V		available	· Population is growing as same rate as nation's average	· Increase of water demand due to population growth causes the shortage of the water supply in coming year					V		1	2			5	6	
		Actual					V		available	· Twice of rapid annual population increase were observed due to implementation of irrigation project in latest 5 years	· Rapid increase of population causes the shortage of domestic water supply					V				3				
		Potential					V		available	· Constant population growth is maintained due to stable domestic water supply and medical and sanitary improvement of living condition	· Sufficient domestic water supply in proportion to the population growth is inevitable to maintain rural living condition in view points of health and sanitation					V		1	2	3		5	6	
		Actual					V		available	· Rapid annual population decreases caused by starvation from drought, and increases by implementation of irrigation project were observed due to in latest 5 years	· Decrease of population was occurred · Deterioration of a sense of social cohesion in their communities					V					4			
		Potential					V		available	· Improvement of living condition is attained through stable farm activities	· Mitigate a decrease of population · Retrieve a sense of social cohesion in their communities					V					4			
	Demographic structure	Actual					V		available	· Poor employment opportunity induces seasonal laborer movement to the urban area	· no impact					V		1						
		Potential					V		available	· not applicable	· no impact					V		1						
		Actual					V		availabie	· Composition of population ranges in national average by age and sex	· no impact								2				6	
		Potential					V		available	· not applicable	· no impact								2				6	
		Actual					V		available	· Young generation is likely to outflow to urban area	· no impact					V				3	4	5		
		Potential					V		available	· Labor force requirement due to increase of employment opportunity slightly reduces an outflow of young generation to the urban area	· no impact					V				3	4	5		

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Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur I II III IV V VI	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur I II III IV V VI	Embung Site 1 2 3 4 5 6	Mitigatory Measures
	Social equity	Actual	V	available	· Indigenous practice regarding domestic water utilization, such as water right and distribution methods might incur inconvenience among them	· Restriction of water use might confuse their general concept on water use especially in the dry season	V	1 2 3 4 5 6	
		Potential	V	available	· Social equity regarding water utilization is realized through unification of water distribution system	· Achievement of effective water distribution system is acceptable for inhabitants and it improves social cohesion among them	V	1 2 3 4 5 6	
	Health	Actual	V	available	· Lacking of acknowledge about disease prevention, i.e. excretion in the field is social problem in the health and sanitary points of view	· It causes prevailing oral contagious and rising of waterborne intestinal disease among infant	V	1 2 3 4 5 6	
		Potential	V	available	· Prevention of disease infection is expected by means of stable domestic water supply	· Decrease of contagious disease and infant mortality rate are expected	V	1 2 3 4 5 6	

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Positive Impact with Project

Negative Impact with Project

Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur I II III IV V VI	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur I II III IV V VI	Embung Site 1 2 3 4 5 6	Mitigatory Measures
HUMAN USE	Cultivation	Actual	V	available	· Insufficient irrigation water, poor maintenance of irrigation facilities and water distribution management cause low productivity and cultivated area	· Unstable farm management causes low farm income, investment and increase unemployment rate	V	3 4 6	
		Potential	V	available	· High farm productivity and increase of cultivated area are attained by adequate irrigation water supply	· High farm income, investment and employment opportunity are realized by improvement of irrigation system	V	3 4 6	
	Livestock	Actual	V	available	· Surface water is used for livestock during the wet season · Ground water or spring yield are used in the dry season	· Shortage of domestic water is occurred in the dry season · Women are compelled to heavy duties, such as water conveyance	V	2	
		Actual	V	available	· Ground water and spring yield are available during the wet season · Ground water is principally utilized in the dry season	· -ditto-	V	4	
		Actual	V	available	· Spring yield is available	· -ditto-	V	6	
		Potential	V	available	· It is possible to supply stable water for livestock · Effective water distribution system is planned	· Water supply quantity for livestock is kept · Heavy duties of women, e.g. water conveyance, is mitigated	V	2 4 6	
		Actual	V	available	· Majority of water supply for livestock uses surface water throughout the year, the rest uses ground water	· Insufficiency of water supply for livestock is occurred during the dry season due to a shortage of surface flow · Over grazing induces erosion and slope collapse at the riverside	IV V	3 5	
		Potential	V	available	· Stable water supply is required · Effective water distribution system is required	· Water supply quantity for livestock is kept · Restriction of grazing in the river to control riverside erosion	IV V	3 5	
	Fisheries	Actual	IV	available	· Fisheries activities are not conducted at downstream of reservoir and at a mouth of river	· no impact		1 2 3 4 5 6	
		Potential	IV	available	· no impact	· no impact		1 2 3 4 5 6	
	Afforestation	Actual I		available	· Reforestation project is not implemented · Logging is conducted to maintain inhabitants' daily life	· Deterioration of recharge of ground water is observed in the reservoir catchment area · Logging accelerate soil erosion	I	1 2 3 4 5 6	
		Potential I		available	· Limitation of logging area contributes excess logging in the reservoir catchment area	· Excess logging accelerate soil erosion and results in deterioration of ground water recharge capacity and increase of inflow of sediment into the reservoir	I II III IV	1 2 3 4 5 6	· Increase of recharge capacity of ground water and effect of erosion control are expected by reforestation in the catchment area.

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Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur I II III IV V VI	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur I II III IV V VI	Embung Site 1 2 3 4 5 6	Mitigatory Measures
	Domestic water supply	Actual	V	available	· Ground water is utilized for the domestic water supply · Private shallow wells are not useful during the dry season because of the decline of water level Public deep wells are useful during the dry season	· Shortage of domestic water supply is observed · Women are compelled to water conveyance	V	1	
		Potential	V	available	· Stable and sufficient domestic water supply shall be attained · Improvement of water system, e.g. distribution tank construction is planned	· Shortage of domestic water supply is reduced at a part of area · Heavy duties of women are mitigated	V	1	
		Actual	V	available	· Ground water or spring yield are available for the domestic water supply · Spring yield is perennially available in the case that well water is dried up in the dry season	· Shortage of domestic water supply is observed · Women are compelled to water conveyance	V	2	
		Actual	V	available	· Ground water or river water are available for the domestic water supply · Water shortage is occurred during the dry season	· -ditto-	V	3 5	
		Actual	V	available	· Ground water (including by pump lifting) and spring yield transmitted by pipeline are available for domestic water supply	· -ditto-	V	4	
		Actual	V	available	· Spring yield and ground water by pump lifting are used for domestic water supply · Shortage of water supply is occurred in a part of service area in the dry season in both water sources	· -ditto-	V	6	
		Potential	V	available	· Reliable water sources and distribution system are to be facilitated · Water distribution plan shall be established to attain stable water distribution	· Shortage of domestic water supply is reduced at a part of area · Heavy duties of women are mitigated	V	2 3 4 5 6	

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Negative Impact with Project

Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur I	II	III	IV	V	VI	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur I	II	III	IV	V	VI	Embung Site 1	2	3	4	5	6	Mitigatory Measures
ECONOMIC	Income	Actual					V		available	· Farm income by single cropping in the wet season remains farmers in low income level	· Increase of farm productivity is not expected owing to the deficiency of investment (farm inputs)					V				3			6	
		Actual					V		available	· Increase of disposable income is not expected owing to a low productivity	· Increase of farm productivity is not expected owing to insufficiency of disposable income					V					4			
		Potential					V		available	· Slightly increase of farm income with improvement of farm productivity is expected by means of stable irrigation water supply	· Increase of investment incentive and improvement of living standard are expected with increase of farm income					V				3	4		6	
	Employment	Actual					V		available	· Employment opportunity remains in a low level due to a stagnation of agro-economy	· Outflow of labor force is incurred due to low employment opportunity in the rural area					V				3	4			
		Potential					V		available	· Increase of farm income with improvement of farm productivity is expected by means of stable irrigation water supply	· Outflow of labor force is controlled					V				3	4			
		Actual					V		available	· Employment opportunity remains in a low level because cultivation in the dry season is not enforced	· It causes unemployment					V							6	
		Potential					V		available	· Employment opportunity is created by activation of farming practice with irrigation water supply	· It affects decrease of unemployment					V							6	

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Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur I II III IV V VI	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur I II III IV V VI	Embung Site 1 2 3 4 5 6	Mitigatory Measures
CULTURAL	Historic/ archaeological sites	Actual	II	available	· Historic/archaeological remains and cultural assets do not exist	· no impact		1 2 3 4 5 6	
		Potential	II	available	· not applicable	· no impact		1 2 3 4 5 6	
	Lifestyle (quality of life)	Actual	V	available	· Women are imposed in heavy duties, e.g. water conveyance	· Physical disorder is observed in women	V	1	
		Potential	V	available	· Alleviation of women's heavy duties by means of stable supply of domestic water, etc.	· Release women from physical disorder	V	1	
		Actual	V	available	· Women are imposed in heavy duties, e.g. water conveyance for domestic use	· Physical disorder is observed in women · Indifference on education	V	2 5	
		Potential	V	available	· Alleviation of women's heavy duties by means of stable supply of domestic water, etc.	· Release women from physical disorder · Interest and spreading in education	V	2 5	
		Actual	V	available	· Women are imposed in heavy duties, e.g. water conveyance for domestic use · Living condition is still in low level	· Physical disorder is observed in women · Living condition is subjected to being distracted by natural disasters	V	3 4 6	
		Potential	V	available	· Alleviation of women's heavy duties by means of stable supply of domestic water, etc. · Living condition is upgraded by increase of farm income and employment opportunities	· Release women from physical disorder · Interest and spreading in education · Inhabitants live in affluent circumstances	V	3 4 6	

Japan International
Cooperation Agency
(JICA)

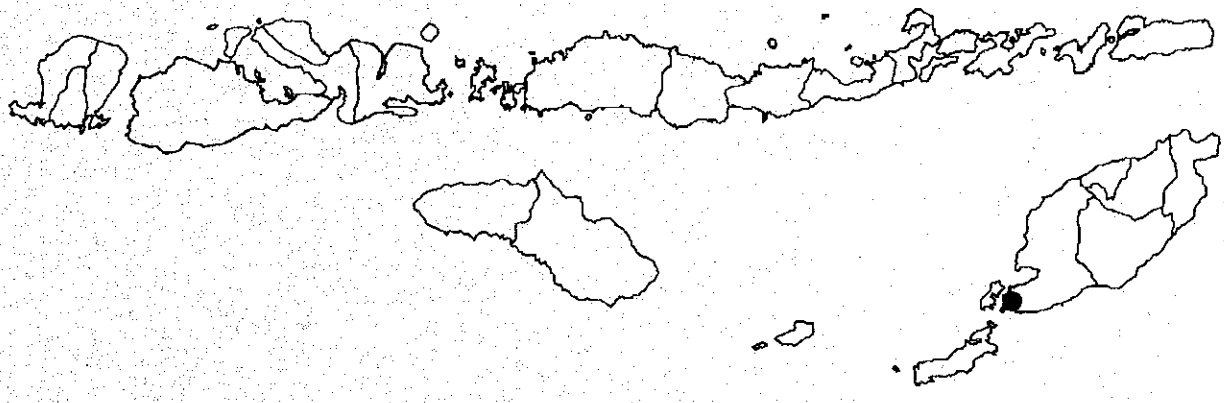
Directorate General of
Water Resources Development,
Ministry of Public Works

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

Final Report

Voleme 6-2

Feasibility Study
on
Oeltua Embung Development Project



May 1995

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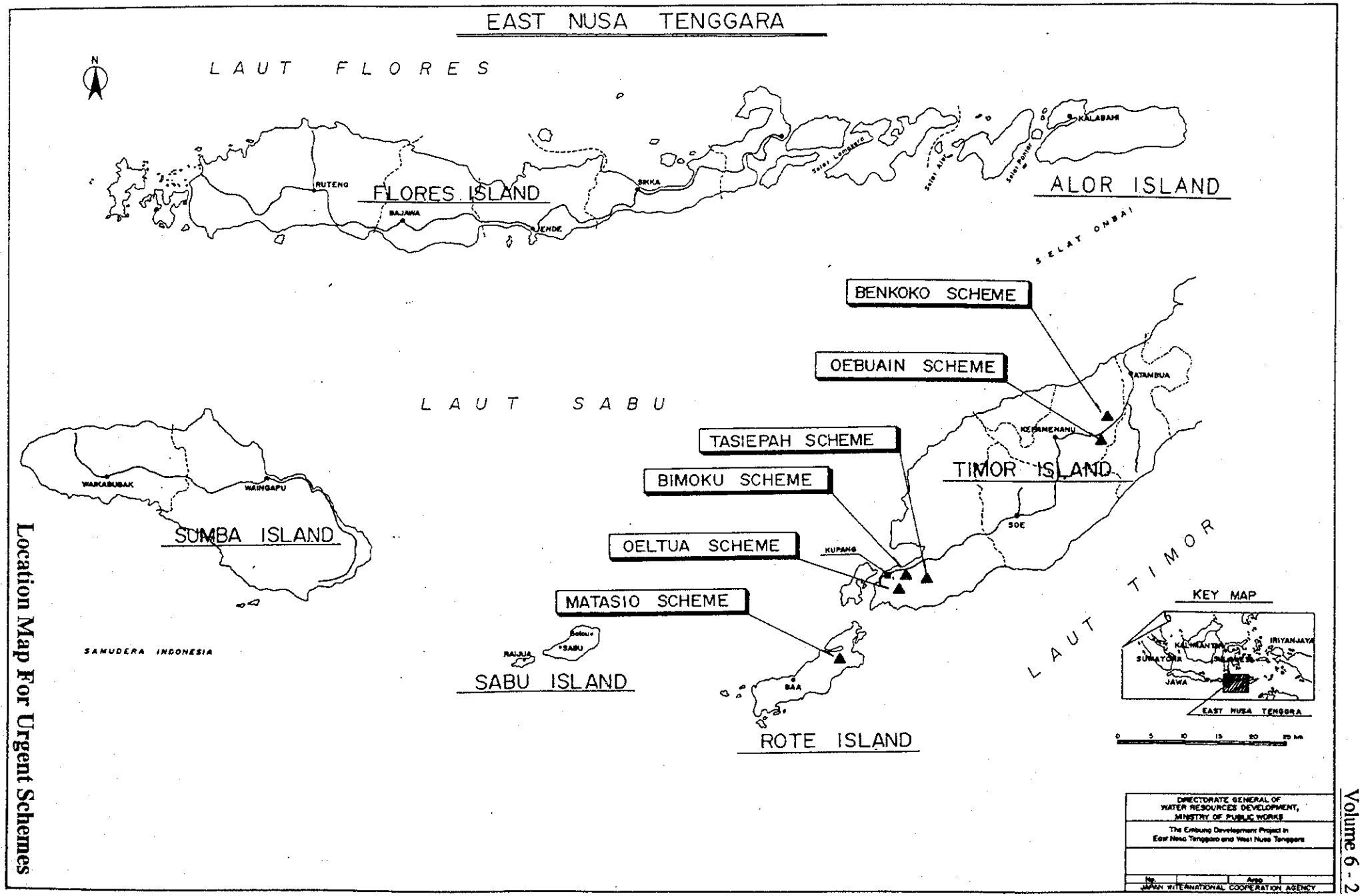
EAST NUSA TENGGARA



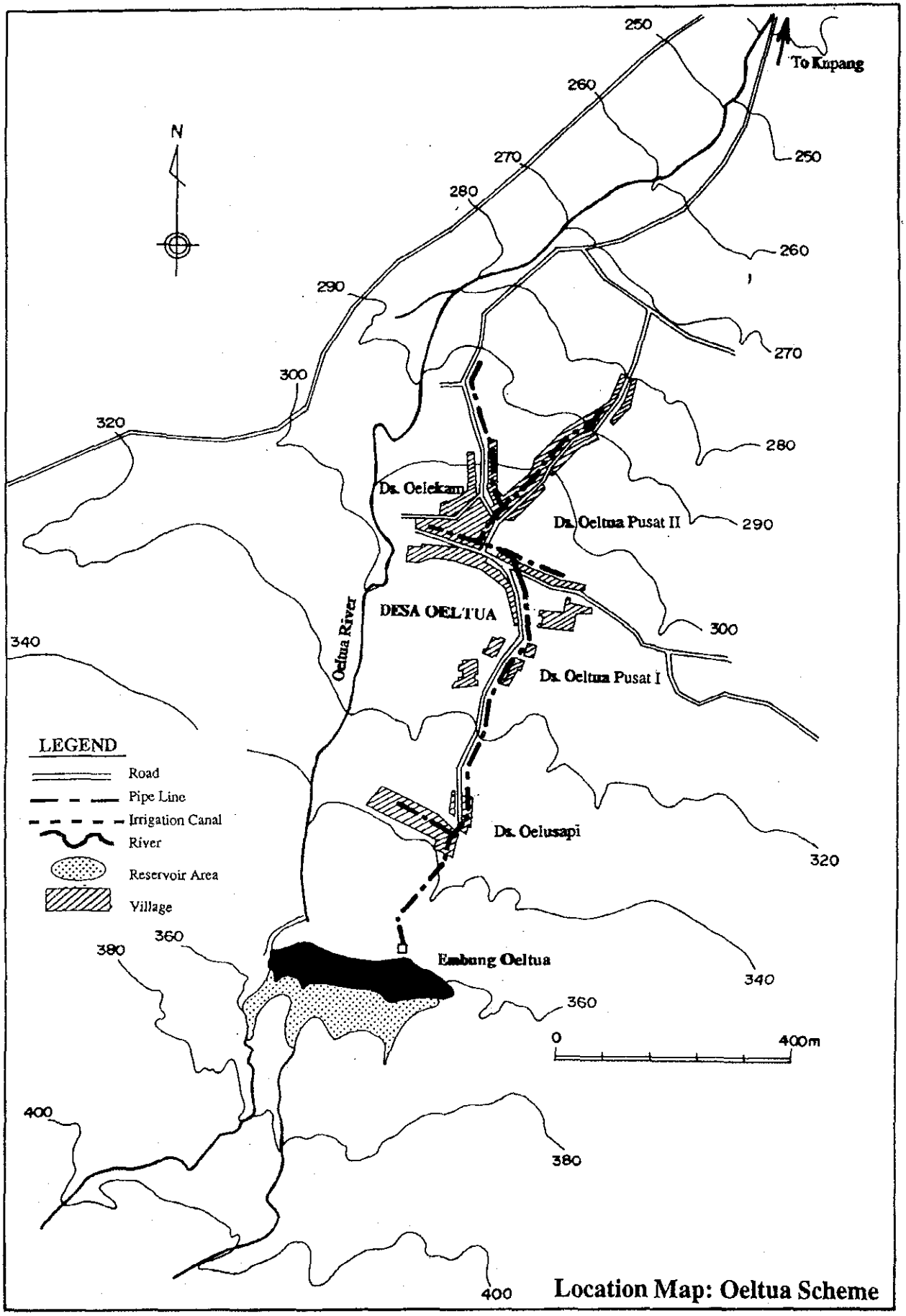
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT, MINISTRY OF PUBLIC WORKS

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

No. | Area

JAPAN INTERNATIONAL COOPERATION AGENCY

Location Map For Urgent Schemes



Location Map: Oeltua Scheme

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 6-2

FEASIBILITY STUDY
ON
OELTUA 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 around 20 km of east of Kupang, the capital of East Nusa Tenggara (NTT) Province, in the western part of Timor island. The proposed site of Oeltua Embung has coordinates of 123°40'51" east longitude and 10° 13' 56" south latitude.

The Project area extends on the right bank of the Oeltua river, a tributary of the Oelekam river. It is located on gentle hill slope down toward the north. A hill with gentle slope is distributed along the Oeltua river and, at the proposed Embung site, forms wide and narrow valley. The Project area ranges from 240 to 365 m in elevation. The potential area for irrigated agriculture is flat to gently rolling.

Main residential zone in the Project area is Oeltua Village (Desa) in the Sub-district (Kecamatan) of Kupang Timur of the District (Kabupaten) of Kupang. This village within the Project area consists of four sub-villages (Dusun); Oelusapi, Oeltua Pusat I, Oeltua Pusat II and Oelekam in Oeltua Village.

1.2 Climate and Hydrology

The wet season usually starts from late November and ends early April in the Project area with the average annual rainfall of 1,470 mm. Rainfall pattern is featured by concentrated heavy rains occurring two or three times during the wet season with the maximum 24 hours rainfall record of 120 mm. Mean annual temperature is 27.4°C with the average maximum temperature of 31.0°C and the average minimum temperature of 22.9°C. Mean relative humidity is 72.8%. Average sunshine hours are 4 to 5 hr/day during the wet season and increase to 7 to 8 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 0.4 km/hr. Tables 1.1 and 1.2 show monthly rainfall record and climate data, respectively, at the Penfui station.

The Oeltua river as a potential water resource is a perennial stream with a catchment area of 0.82 km^2 at the proposed Embung site. There is no gauging station on this river. Usually, the river resume reflects the monthly rainfall pattern. Due mainly to deforestration in the catchment area, sedimentation on the river bed is common along the river stretch.

1.3 Geology

The Project area is underlain by the Quaternary which is formed by coral limestone and recent river deposits. With regard to geological formation, coral limestone and sandy limestone form Coralline Limestone. Recent river deposits on the river bed are derived from river sediments consisting of gravel, sand and clay.

1.4 Soils and Land Use

Soils in the cultivated and cultivable land in the Project area are structured with silty to sandy clay. As less presence of exchangeable cations is common, soil reaction is slightly acid. Response to fertilizer application is high because of poor soil fertility caused by lack of organic matters in the top soil.

At present, a total land of 382 ha is used for agriculture activities comprising wet paddy field of 7 ha, dry upland of 95 ha, estate crop field of 175 ha, and grass land and idle field of 105 ha. The wet paddy fields is used under the rainfed condition. In addition, inhabitants in the Project area possess a small piece of home yard growing vegetables and tree crops mainly for their home consumption.

1.5 Demography

The total population in the Project area as of 1993 was 1,645 and the number of households was 332 in total. The breakdown of population and household by sub-village is shown in Table 1.3. The average family size is 4.9 persons. Dominant ethnics are originated from Timor with a few people from Rote, Sabu and Belu. The majority of inhabitants are Protestant and engaged in agriculture. Their average education attainment is primary school grade.

1.6 Domestic Water Use

There exist 15 wells and one spring in the Project area. Users of these water supply sources are suffering from water shortage and long distance water carriage problems for seven months from June to December every year because all wells go almost completely dry during this period. The present water use in each sub-village clarified under the Study is summarized as follows:

- In Oelusapi Sub-village with 76 families and 382 persons, there are one public well at the average distance of 250 m from 15 family users and six private wells at the average distance of 10 m from 14 families. Another 19 families carry their domestic water from a public water basin using Oelekam spring water at the average distance of 1,000 m. These wells dry up from June to December. Together with the remaining 28 families without any specific water source, all inhabitants are provided with the minimum volume of water by public water tankers during the period of no water. The total number of livestock is equivalent to 88 heads of cow and water for these livestock use is taken from two public wells in Oelusapi and Oeltua Pusat II Sub-village;

- In Oeltua Pusat I Sub-village with 119 families and 593 persons, there are four private wells at the average distance of 5 m from four family users. Another 115 families carry their domestic water from the public water basin using Oelekam spring water at the average distance of 650 m. These wells go dry from June to December. All inhabitants are provided with the minimum volume of water by public water tankers during the period of no water. The total number of livestock is equivalent to 137 heads of cow and water for these livestock use is taken from the Oelekam river when river flow is available between January and April;

- In Oeltua Pusat II Sub-village with 72 families and 357 persons, there are one public well at the average distance of 250 m from 27 family users and four private wells at the average distance of 15 m from nine families. Another 63 families carry their domestic water from the public water basin using Oelekam spring water at the average distance of 500 m. These wells go dry from June to December. During this period, the minimum volume of water is supplied to all inhabitants by public water tankers. The total number of livestock is equivalent to 161 heads of cow and water for these livestock use is taken from the Oelekam river when river flow is available between January and April; and,

- In Oelekam Sub-village with 65 families and 313 persons, all inhabitants depend their domestic water on the public water basin using Oelekam spring water at the average distance of 450 m. The total number of livestock is equivalent to 254 heads of cow and water for these livestock use is taken from the Oelekam river when river flow is available between January and April.

1.7 Social Infrastructures

The access from Kupang to the southern part of the Project area is a paved road maintained well as it is the trans-Timor road leading to Dili from Kupang. The proposed Embung site and sub-villages are connected by unpaved gravel road to this main road. All the

sub-villages in the Project area are served by rural electricity supply network. In the Project area, there is no hospital but one community health sub-center and two health integrated posts.

More than two-thirds of 278 families have no facilities for bathing, defecating and washing at inside of their houses. Instead, they are using river bed and water of the Oeltua for these purposes. Under such circumstances, inhabitants in the Project area are often suffering from various diseases like vomiting and diarrhea, malaria, dysentery and trachoma, roundworm, and so on.

1.8 Agriculture and Livestock

In the Project area, there exists farm land of 382 ha in which currently cultivable land of 277 ha is included. The present cropped area amounts to 102 ha comprising irrigated wet season paddy of 7 ha, maize of 75 ha, groundnut of 15 ha and cassava of 5 ha. Irrigated rice cultivation is practiced on the wet paddy field of using spring water during the wet season. Maize is the main crop grown on upland field under the rainfed condition. Other common crops are cassava and groundnuts. The present cropping pattern is single cropping of paddy on irrigated wet paddy field, and single cropping of maize, cassava or groundnuts on dry upland for the wet season. The overall cropping intensity is thus 37 % for the currently cultivable land.

In the Project area, the wet paddy field is prepared by an animal-drawn plough and harrow. The high yielding rice variety of IR 64 is commonly used, while fertilizers are not applied as usual. No serious plant pests are reported under the hot and dry weather condition, and farmers put insecticide if necessary. Harvesting is principally done by family labor force with additional input of hired labors. Farming practices for growing dry upland crops are very simple and primitive with direct sowing on harrowed field and no fertilizer application. The average yield level at present is 1.7 ton/ha for paddy, 1.4 ton/ha for maize, 4.0 ton/ha for cassava and 1.0 ton/ha for groundnuts. Annual crop production is 12 tons for paddy, 105 tons for maize, 20 tons for cassava and 15 ton for groundnuts.

As of 1993, a total of 484 cows/buffaloes, 7 horses, 14 goats/sheep, 469 pigs and 1,260 chickens/ducks were raised in the Project area. The breakdown of livestock population by sub-village is shown in Table 1.4. The majority of cows and pigs are marketed to and slaughtered in Kupang, while some live cows are directly shipped to markets in Jakarta and Surabaya.

1.9 Agro-economy

In terms of agricultural extension services, one rural extension center (BPP) is established in Oeltua Villages directly under the District Agricultural Office (Dinas Pertanian Kabupaten) covering its own working area with field extension workers (PPL). In the Project area, however, most of the farmers have no frequent access to the PPL's extension activity at present due mainly to limited number of transportation means and amount of budget in BPP.

Farmers are organized as memberships of Agricultural Cooperative (KUD). As KUD's branch shop in the Project area is not active at present, farmers buy necessary farm inputs from local markets or merchant shops. Agricultural credits are available in the service network of the Indonesian People's Bank (Bank Rakyat Indonesia), consisting of short-term credits to cover one crop season and a mid-term credit of five years to support farmers' small investment.

Food production in the Project area is used for home consumption of farmers themselves. They sell farm products in local markets in the Project area or middlemen for markets in Kupang when farmers need cash. The results of agro-economy survey carried out under the Study reveal that farmers in the Project area usually have some deficit in their home economy with the average annual income of Rp. 876,000 and expenditure of Rp. 1,220,000 as shown in Table 1.5.

2. DEVELOPMENT NEEDS AND CONCEPTS

2.1 Development Needs

In the Project area, it is common for 1,645 inhabitants to carry water from available water sources to their homes at the average distance of 500 m during the wet season and to receive the minimum volume of water from public tankers for their own use during the dry season when all water sources dry up every year. Such water shortage condition has caused infectious diseases and damaged their health. Further, it has prevented farmers' willingness to introduce improved crop production system and to expand irrigation facilities.

The pressing necessity of inhabitants in the Project area is to meet basic human needs (BHN) aiming at improvement of their living conditions through solution of the water shortage problems derived from lack of perennial water sources. In addition, the inhabitants are eager to get sufficient water for maintaining their livestock which are their sources of nutrition and cash income.

The available land resources suitable for agricultural use amount to 277 ha in the Project area. Wet paddy field occupies only 7 ha with irrigation facilities. From the topographic viewpoints, dry upland of 95 ha is suitable for introducing upland irrigation system if irrigation water source is created. However, the dry upland is distributed in the shape of small pieces throughout the village and there is no possibility of putting these pieces together for least-costly development of upland irrigation system. Taking such condition into account, no priority is given to develop a new irrigation water supply system in the Project area under the Study.

2.2 Water Demand

The estimated per capita domestic water consumption in the Project area is about 25 lit/day being far below the regional levels of 123 lit/day for NTT and 144 lit/day for Kabupaten Kupang. The future water demand in the Project area comprises domestic water for inhabitants and livestock water. In the draft Repelita VI (1993/94 to 1998/99), the Provincial Government of NTT has set the goals of meeting BHN by 1998. In terms of domestic and livestock water supply, the target is set at 60 lit/day/capita for rural people and 40 lit/day/head for cow.

In comparison with the present level of water consumption and taking into consideration limited availability of water resources in the Project area, the target year to reach the above water supply levels is to set in 2003/04, the last year of Repelita VII, under the Study. Also, the above per capita water supply target of 60 lit/day is to include drinking, bathing, defecating, washing, gardening and unaccounted-for water. The future population of inhabitant and livestock in the target year is estimated by the Study referring to the projected population growth rates made by the Provincial Statistic and Livestock Offices.

(1) Domestic water demand

The future population in the target year of 2003/04 is projected for each sub-village located in the Project area as shown in Table 1.3 based on the projection of population growth rate mentioned in the above. The total population projected is 2,077 in the Project area. The future water demand is calculated by multiplying the target per capita water supply amount by the projected population.

The projected water demand in the Project area for the target year of 2003/04 amounts to 45,486 m^3 and the breakdown by each sub-village is shown in Table 2.1.

(2) Livestock water demand

The future livestock population in the target year of 2003/04 is projected for each sub-village located in the Project area as shown in Table 1.4 based on the projection of livestock population growth rate mentioned in the above. The livestock population projected is 455

cows/water buffaloes, 31 horses, 376 sheep/goats, 756 pigs and 1,361 chickens/ducks as a whole in the Project area.

Regarding daily water consumption of livestock other than cow, unit water requirement assumed in "The Study for Formulation of Irrigation Development Program in the Republic of Indonesia" is employed; 40 lit/head/day for cow/buffalo, 5 lit/head/day for sheep/goat, 6 lit/head/day for pig and 0.6 lit/head/day for poultry. That for horse is assumed to be 40 lit/head/day. The future water demand is calculated by multiplying the target unit water supply requirement by the projected livestock population.

The projected water demand in the Project area for the target year of 2003/04 amounts to 11,464 m^3 and the breakdown by each sub-village is shown in Table 2.1.

2.3 Development Constraints

In and around the Project area, there are one perennial spring and seasonal groundwater resources both of which are insufficient to meet BHN throughout a year. The only one potential water resource in the Project area is the Oeltua river with the possibility of developing Embung as water reservoir.

In developing water resource potential of the Oeltua river, it is said that there are not so much serious limitations in terms of topography, hydrology, environment and socio-economy, while there are some weak points in geological conditions derived from presence of coral limestone. In the western part of Timor island, 92 small Embungs have already been developed for domestic and livestock water supply, and another 11 Embungs in Sumba and Rote islands for domestic and irrigation water supply. The average height of these Embungs is 7.15 m for the case of domestic water supply and 8.75 m for the case of irrigation water supply. Under such situation, therefore, technical know-hows to construct higher Embung at a site with geological weak points has not been accumulated yet in both the public and private sectors in NTT.

2.4 Development Concepts and Approach

In order to correct economic imbalance between NTT and other Provinces in harmony with the national policy, it is prerequisite to give the highest priority over improvement of infrastructures related to BHN and the second priority to betterment of agricultural production basis in rural areas of NTT. Among others, special attention should be paid to how to solve chronic water shortage problem under the dry weather condition peculiar to NTT.

The objective of the Project is a part of the strategies of the Government to improve BHN, to alleviate poverty of rural areas and to achieve a balanced regional development throughout the country. The objective of water resources development through construction of Embung is to supply domestic and livestock water to rural people for meeting their BHN as well as to utilize the existing farm land resources to the fullest extent by providing with irrigation water.

Through the previous identification study undertaken by the NTT Provincial Irrigation Service (PRIS) in 1986, a possible site to construct higher Embung was found on the Oeltua river nearby Oeltua Village. In the course of the Study, therefore, water resources development potential at this site called Oeltua Embung has to be examined from the viewpoints of topography, geology, soil engineering and hydrology. If the examination results reveal that there is a possibility of creating new permanent water source facility, then development strategies of the Oeltua Embung are to be worked out based on optimization of development scale and confirmation of technical feasibility on Embung development. In the end, development impacts are to be assessed from social and environmental viewpoints as well as from an economic consideration if necessary.

3. EXAMINATION OF EMBUNG DEVELOPMENT POTENTIAL

3.1 Topographic Condition

The original site of Oeltua Embung was identified by PRIS through its identification study done in 1986. Under the present Study, the original site as shown in Figure 3.1 is reviewed from topographical and geological points of view including mapping and geological investigations. As a result, it is reconfirmed that selection of the original site by PRIS is topographically appropriate. Thus, the original site is taken up as the proposed Embung site for the Study. At the proposed site, the Oeltua river and its small tributary flow through shallow and wide valley on the gentle slope of hill. The width of valley is around 350 m and the elevation of riverbed is El. 354.0 m. The left bank shapes gentle slope of about 20° up to around El. 366.0 m and then becomes very gentle slope of about 5° up to about El. 367.0 m. The right bank is of very gentle slope of about 10° up to around El. 362.5 m and then becomes gentle slope of about 30° up to about El. 368.0 m. Elevation of hills surrounding the Embung reservoir ranges about El. 354.0 m to El. 370.0 m above sea level.

3.2 Geological Condition

Under the Study, geological investigations including core drilling works have been conducted in the proposed Embung site. The results of core drilling, standard penetration test and field permeability test are presented as Attachment 2. Figures 3.2 and 3.3 depict geological map and profile of the proposed Oeltua Embung, respectively.

The proposed site of Oeltua Embung is underlain by the Quaternary consisting mainly of Coralline limestone and sandy recent river deposits. The foundation rock of the proposed site is composed of sandy limestone found in lower part of Coralline limestone. Some of terrace deposits with a thickness of 3 to 5 m and small amount of alluvial deposits are confirmed on the river bed portion.

The result of field permeability test reveals that the coefficient of permeability ranges from 4.3×10^{-4} to 3.8×10^{-6} cm/sec and bedded sandy limestone is not homogeneous in permeability. In the design of the foundation treatment, therefore, ordinary care against for seepage or leaking the water from the reservoir through dam foundation or the abutments is taken into consideration. According to the standard penetration test, the average N-value of bedded sandy limestone will be expected to be more than 17. The result of unconfined compression test on recovered core samples of drilling works shows that the unconfined compression strength is only 11 kg/cm^2 and the geological formation of the sandy limestone is not so hard for the dam construction. In this connection, special consideration is required for determination of dam type.

The reservoir area is underlain by Coralline limestone. No major fault and landslide are recognized in the field. It is prospected that water leakage through sandy limestone occurs in the reservoir area because bedding rock is heterogeneous in permeability. Special attention is therefore needed to introduce practical countermeasures for water leakage.

3.3 Availability of Embankment Materials

In 1992, PRIS carried out construction material survey to check embankment and concrete aggregate materials in and around the proposed Oeltua Embung site. In addition, the second material survey is performed under the Study, comprising field test pitting and laboratory tests. In due consideration of the results of the second material survey and the required quantity of embankment materials, the borrow area is selected in the reservoir area as shown in Figure 3.1. The location of test pits is shown in Figure 3.1 and the results of laboratory tests are presented as Attachment 2.

(1) Embankment materials

In general, earth materials in the borrow areas are composed of relatively fine grained soils. The result of gradation analysis in the borrow area is shown below.

Result of Gradation Analysis

Test Pit No.	Passing sieves (%)		Classification
	No. 4	No. 200	
TP. 1	93	54	CL
TP. 2	96	59	CH
TP. 3	99	93	CH
TP. 4	97	77	CH
TP. 5	99	94	CH

As physical property to oppose piping, mean value of Plastic Index (PI) is 29, being satisfied with the quality level which enables the materials to prevent the piping phenomena.

The result of compaction test of the materials in the borrow area are as follows:

- Maximum dry density (γd max.) ranges from 1.31 to 1.64 ton/m^3 and 1.48 ton/m^3 on an average, which are slightly low in comparison with 1.53 as an average of CH;
- Optimum moisture content (OMC) ranges from 20 to 34% and 28% on an average;
- The discrepancy between OMC and the natural moisture content (NMC) is approximately 8%, wetter side from OMC. Considering the sampling time of early May 1994, NMC is more favorable in respect of the moisture control which is required for the embankment works because other borrow materials are slightly drier than those OMC. Accordingly, the moisture control needs to be considered at the borrow area during the construction period; and,
- According to the shear strength test carried out by using unconsolidated-undrained tri-axial compaction test (U-U test) apparatus under the OMC condition, the average values of internal friction angle and cohesion are 28° and 0.98 kg/cm^2, respectively. The test method is however based on U-U test which is applied to get a design value for the case of just after completion of a dam.

For a design value under the full supply level (F.S.L) and earthquake conditions, the shearing strength at consolidated-undrained test under the effective stress condition is provisionally estimated at 24° for friction angle and 0.11 kg/cm^2 for cohesion by using the standard values of the soil classification as "CH" of Unified Soil Classification, ASTM.

(2) Sand and gravel materials

Sand and gravel materials to be used for the filter of the dam embankment and concrete aggregates are investigated in the Kasmiti river in especially for sand and in the Baun river especially for gravel. Quantity and quality of gravel materials in the both rivers (each 20 km from the proposed site) are sufficient for the filter drain and the concrete aggregates.

3.4 Availability of Water Resources

(1) Catchment yield

As for the Oeltua river, there has been no record of discharge. Accordingly, runoff at the proposed Embung site is estimated by use of the rainfall record near the proposed site. The

Penfui rainfall station which is located in the east of the Oeltua Embung catchment has rainfall record of nearly consecutive 28 years and is considered to represent catchment rainfall. A runoff coefficient of 0.30 is adopted considering the characteristics of the catchment area and previous hydrological analysis in the Timor Island. Using this runoff coefficient and rainfall record of the Penfui station, river flow of the Oeltua river at the 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 0.82 km^2; and,
- Less than 20 mm of half monthly rainfall is ignored for estimation.

This estimation was made based on the rainfall record from 1966 to 1993. The estimated half monthly discharge is given in Table 3.1 and summarized below.

Mean Monthly Discharge

Unit: 1,000 m^3

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
99	90	53	15	5	3	2	0	1	2	25	58	353

(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 NTT. In this Study, 25 years rainfall data of the Penfui station from 1966 to 1992 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	103
1 in 5 year	160
1 in 10 year	205
1 in 20 year	253
1 in 50 year	327
1 in 100 year	390
1 in 200 year	459

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 3.2 and summarizes below.

Probable Flood

Unit : m^3/s

Return Period	Probable Flood
1 in 2 year	13
1 in 5 year	20
1 in 10 year	25
1 in 20 year	31
1 in 50 year	40
1 in 100 year	48
1 in 200 year	57

(3) Sediment load

There is no available data on sediment load on the Oeltua 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, the same value is adopted in this Study.

(4) Water Quality

On June 4, 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 3.3.

4. EMBUNG DEVELOPMENT PLAN

4.1 Optimization of Development Scale

(1) Cases for comparison

The optimum development scale of Oeltua Embung coincides with the maximum scale which can be decided by the available run-off from the catchment area and the limitation of topography at the proposed Embung site. Therefore, only one case with the dam height of 11.5 m is taken up for the optimization study.

(2) 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 (m^3)
O_D : outflow needed for domestic water during the half monthly period (m^3)
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 Oeltua river, discharge is generated from rainfall of the Penfui 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. The probability that the spill out comes in the wet season is set at about 80%.

5) Water demand

The annual water demand for the domestic water and livestock are outlined below.