Annual Domestic and Livestock Water Demand

Description	Unit	Numbers	Demand (m^3/year)
Beneficiaries	Nos.	2,077	45,486
Livestock (equivalent to cow)	Nos.	785	11,464

The 100% dependability of the above demand shall be secured by the proposed Oeltua 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. 357.80 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. 370.0 m.

(3) Optimum development scale

From the topographic and hydrological points of view, there is no alternative choice to develop the Oeltua Embung. The optimum development scale is thus in line with the maximum height of 11.5 m and effective storage capacity of 0.0812 million cubic meters (MCM). The result of reservoir operation is shown in Figure 4.2.

4.2 Delineation of Beneficiary Area

By developing the proposed Oeltua Embung at the maximum scale, water demand for domestic and livestock use can be met to the fullest extent. The beneficiary area of water supply from the Oeltua Embung covers Oelusapi, Oeltua Pusat I, Oeltua Pusat II and Oelekam Sub-villages of Oeltua Village with 2,077 inhabitants and 785 heads of cows in total. The beneficiary area of Oeltua Embung is shown in Dwgs. - 201 to - 202.

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 Oeltua 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.362.5 m so as to keep the water tightness of the sandy limestone layer in the reservoir.

The main components of Oeltua Embung are the main dam, spillway, river diversion conduit and water supply facility as shown Dwg. - 203. In order to provide the reservoir with the optimum storage capacity of 0.0812 MCM, F.S.L is set at El. 362.5 m. Taking overflow depth of spillway and freeboard into account, the dam height of Oeltua Embung becomes 12 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 1.1 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 50 m^3/sec from the catchment area of 0.82 km^2. For the purpose of supplying domestic and livestock water to the beneficiary area, such related facilities are provided as an intake structure in the reservoir, water supply pipe with a diameter of 50 mm below the dam body and valve house at the downstream of the main dam.

The principal features of Oeltua Embung are summarized Below.

(1)	Reservoir	
	- Catchment area	0.82 km^2
	- F.S.L.	El. 362.5 m
	- Minimum operating level	El. 357.8 m
	- Effective storage capacity	81,200 m^3
	- Dead storage capacity	12,800 m^3
	- Gross storage capacity	94,000 m^3
	- Sediment deposition level	El. 357.2 m
(2)	Main dam	
	- Type	Homogeneous earthfill
	- Height	12 m above river bed
	- Crest elevation	El. 366.0 m
	- Crest length	340 m
	- Crest width	6.0 m
	- Upstream slope	1:4.0
	- Downstream slope	1:3.0
	- Total embankment volume	200,000 m^3
(3)	Spillway	
	- Design flood (1/100 year)	50 m^3/sec
	- Type	Non gated overflow
	- Crest elevation of overflow weir	El. 362.5 m
	- Width of overflow weir	8.7 m
	- Discharge capacity	20 m^3/sec
	- Length	107 m
(4)	River diversion	
	- Design flood (1/5 year)	5.5 m^3/sec
	- Type	Pipe culvert
	- Diameter	1100 mm
	- Length	100 m
(5)	Water supply system	
	- Inlet structure	1.0 x 1.0 m with trashracks
	- Pipe diameter	50 mm
(6)	Blanket in the reservoir	
	- Type	Earth blanket
	- Covering area	Upto El. 362.5 m and 25,000 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 Oeltua 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 362.5 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. - 203.

(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 diameter of 1.1 m as a diversion facility as shown in Dwg. - 205. Since the volume of flood inflows from 0.82-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. 356.0 m would suffice to contain the dry season flood inflow of 5.5 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 50 m^3/sec.

Based on the result of comparative study on combination of overflow depth and width of the spillway, overflow depth at 1.9 m and width of 8.7 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. 362.5 m to coincide with F.S.L. Spillway bridge is not provided across the crest portion of the spillway because of no access road from the right to the left abutment of the main dam.

The profile and sections of spillway are shown in Dwg. - 204.

(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 1.80 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 357.2 m. Fixed trashracks are provided on the intake structure. Cast iron pipe with diameter of 50 mm is connected from the intake structure to the downstream through the main dam. The detail of water supply inlet is given in Dwg. - 205.

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. - 206.

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 the 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; 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

Beneficiary area of the domestic water and livestock water supply from the Oeltua Embung covers four villages located at around 700 m downstream of the proposed Embung site. The total beneficiary inhabitants to be supplied with domestic water is estimated at 2,077 persons based on the population projection. Further, the projected livestock population in the beneficiary area is estimated as shown below with unit water demand.

Projected Livestock Population in the beneficiary area of Oeltua Embung

Livestock	Numbers (heads)	Water demand (lit/head/day)
Cattle/Buffalo	634	40
Sheep/Goat	21	5
Pig	752	6
Poultry	2,384	0.6

Design discharge of pipelines is estimated at 1.80 lit/sec adding the design discharge of domestic water supply estimated at 1.44 lit/sec taking the above population and the domestic water demand of 60 lit/sec/day and livestock water supply estimated at 0.36 lit/sec taking the above numbers and water demands.

(3) Preliminary design

In due consideration of the above basic concept and the design discharge, the locations of pipelines and related facilities are planed to be set as shown in the Dwgs. - 201 to - 203. 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 and livestock water supply and livestock water supply are shown in Dwg. - 208. Required water distribution facilities for domestic and livestock water supply are summarized below :

Water Distribution Facilities Requirement

Facilities	Quantities
Pipe Line	
- Dia. 50 mm	0.8 km
- Dia. 40 mm	0.8 km
Related Facilities	
- Check valve	6 Nos.
- Air valve	2 Nos.
- Division box for domestic water	21 Nos.
- Division box for livestock	29 Nos.

6. EMBUNG CONSTRUCTION PLAN

6.1 Construction Schedule

(1) Basic condition

All the construction works will be carried out by a local contractor selected by local competitive bidding. 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 Oeltua 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. -. 205.

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 1.1 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 200,000 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 2,700 m^3 which is quarried from the borrow area in the reservoir.

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 20 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 7,500 m^3 and the rock material will be quarried from at Tablolong, 32 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 24,000 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. 357.2 m). Connecting the inlet structure, a cast iron pipe with diameter of 50 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. - 207, 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 Oeltua Embung are summarized below,

Construction Material Requirement

Item	Quantity	
Earthfill materials		
Main dam	200,000	m^3
Blanket in reservoir	68,000	m^3
Filter materials		
Horizontal drain	11,500	m^3
Riprap portion	2,500	m^3
Rock materials		
Riprap protection	5,500	m^3
Toe rockfill	2,500	m^3
Concrete		
Cement	760	tons
Reinforcement bars	65	tons
Aggregates	2,000	m^3

(8) Construction equipment

The minimum number of major construction equipment and plants to be used for the Oeltua 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 50 mm amount to 1.5 km; and,
- Construction works of the related facilities such as check valves, air valves, blow off and division boxes for inhabitants and livestock are 58 numbers a whole.

Since the facilities to be constructed for the water distribution system are rather small in work quantities and scattering in the beneficiary area in comparison with the Embung construction works, almost all 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 Oeltua 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 Oeltua 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 Oeltua 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 Oeltua 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 Oeltua Embung is estimated at Rp. 7,757 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 Oeltua Embung is summarized below.

Summary of the Project Cost for Oeltua Embung

Unit : Rp. million

Item		Project cost
I.	Direct construction cost	4,645
1.1	Preparatory works	221
1.2	Embung construction	4,203
1.3	Domestic water supply	221
1.4	Operation & maintenance road	-
1.5	Irrigation facilities	-
II.	Administration cost	232
III.	Engineering services	697
IV.	Physical contingencies	836
V.	Contract tax	618
VI.	Land acquisition	23
VII.	Price contingency	705
	Grand Total	7,757

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. 3.88 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 and livestock use in rural areas of NTT. The water supply benefits anticipated in the beneficiary area of Oeltua Embung comprise two main portions: reduced time fetching water from distant sources and reduced health problems or morbidity. It is also hard to evaluate the values of gains prospected in newly available working time and those 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 and livestock water.

The total Project cost for constructing the Oeltua Embung with the effective storage capacity of 0.0812 MCM is estimated to be Rp. 7,757 million. The total number of beneficiary water users is 2,077 inhabitants and 785 heads of cows with the annual water demand of 0.05695 MCM. The investment amount estimated is Rp. 7,437 million. The value of effective storage water to be created by the Oeltua Embung is estimated to be Rp. 91,587/m3, while that of supplied water is estimated to be Rp. 130,588/m3. The estimated investment amount to the respective beneficiary people is Rp. 3.58 million. As the prospected unit water consumption rate of cow is equivalent to that of 0.67 inhabitant, the estimated investment amount to the respective people and livestock is Rp. 2.86 million.

8.2 Economic Consideration

With provision of permanent water source facilities, no economic activities can be expected in the beneficiary area of Oeltua 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 Oeltua Embung. Taking such situation into account, economic evaluation is skipped over in this case.

8.3 Environment Impact Assessment

(1) Environmental features of the Project area

Principal human and physical environmental 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 spring water and well water (not useful in the dry season)
Health and sanitation	:	Prevalence of waterborne diseases
Physical environment		
Geology/land	:	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 activities of using trees in the catchment area. Trees in both the reservoir and the catchment areas have been utilized by inhabitants for their economic activities producing water-carriers and other baskets, firewood, timber, alcoholic beverage, 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.

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.

(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 quite free from their daily hard job to carry their domestic water at the average distance of 500 m. As a result, women will be able to utilize the saved 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 Oeltua 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 and livestock 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 and socio-economically desirable for enabling 2,077 inhabitants of 419 families and 785 heads of cow to get permanent water source, to be quite free from daily hard job to carry their domestic water at the average distance of 500 m and to decrease frequency of water born disease.

It is therefore concluded that the the construction of Oeltua Embung Project 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 Oeltua 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 Oeltua Embung aims to supply raw water for domestic and livestock 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 water quality.

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

Feasibility Study on Oeltua Embung Development Project

Tables

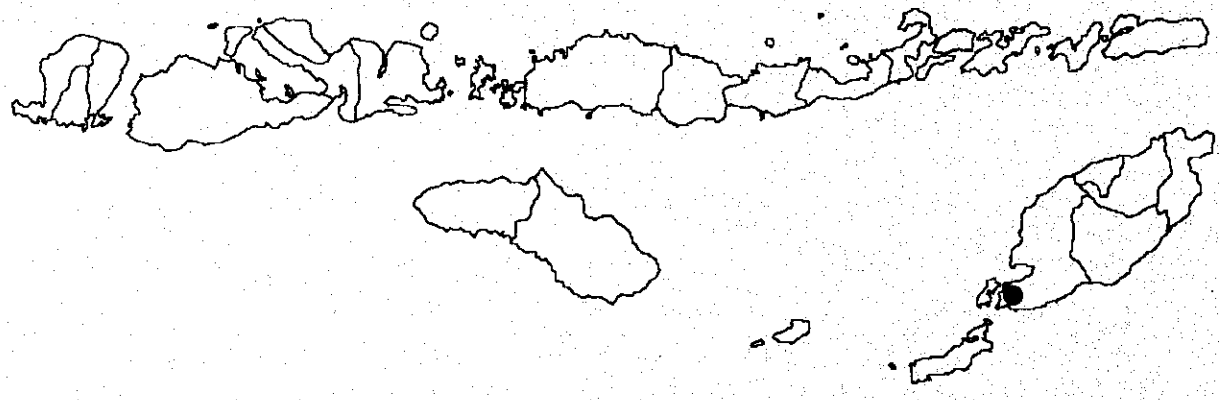


Table 1.1 Monthly Rainfall Record

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
Oeltua	Oelusapi	382	430	482	76	86	96
	Oeltua Pusat I	593	668	749	119	134	150
	Oeltua Pusat II	357	402	451	72	81	91
	Oelekam	313	352	395	65	73	82
	Total	1,645	1,852	2,077	332	374	419

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							
Oeltua	Oelusapi	67	2	14	102	148	88
	Oeltua Pusat I	119	0	0	89	306	137
	Oeltua Pusat II	129	3	0	153	384	161
	Oelekam	169	1	0	125	422	195
	Total	484	6	14	469	1,260	581
1999							
Oeltua	Oelusapi	76	2	17	129	204	103
	Oeltua Pusat I	136	0	0	113	421	173
	Oeltua Pusat II	147	3	0	194	528	187
	Oelekam	192	1	0	158	581	225
	Total	551	6	17	594	1,734	688
2004							
Oeltua	Oelusapi	87	2	21	164	280	120
	Oeltua Pusat I	154	0	0	143	579	184
	Oeltua Pusat II	168	3	0	245	727	219
	Oelekam	219	1	0	200	798	262
	Total	628	6	21	752	2,384	785

Source : Provincial Livestock Office, NTT and JICA Study Team

Table 1. 5 Summary of Farm Economic Survey

Oeltua Embung Scheme

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 54	Male 37	Male 28	Male 34	Male 29	Male 56	Male 47	Male 65	Male 33	Male 57	44
2 No. of Family Member		M-3/F-3	M-2/F-3	F-2	F-3	M-1/F-1	M-1/F-5	M-1/F-4	M-1/F-3	F-1	M-2/F-2	M-1/F-3
3 Type of Side Job		Workman	None	Workman	None	Workman	None	None	None	None	Carpenter	
4 Own Farmland	ha	1.50	1.75	1.50	0.50	0.70	1.85	2.80	2.50	0.75	1.75	1.56
(Paddy field)	ha	1.00	0.50	1.00	0.00	0.00	1.00	2.00	1.00	0.50	0.50	0.75
5 Cropped Area	ha	1.50	1.25	1.25	0.20	0.27	1.55	2.80	1.27	1.25	1.75	1.31
(Paddy)	ha	1.00	0.50	1.00	0.00	0.00	1.00	2.00	1.00	0.50	0.50	0.75
(Palawija)	ha	0.50	0.50	0.25	0.15	0.27	0.55	0.80	0.27	0.75	1.25	0.53
(Others)	ha	0.00	0.25	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.03
6 Cow/Buffalo	head	3	8	8	0	2	4	3	5	0	0	3.3
Horse	head	0	0	0	0	0	0	0	0	0	0	0.0
Goat/Sheep	head	0	2	2	2	0	0	0	2	0	0	0.8
Pig	head	4	1	0	2	4	10	6	2	0	0	2.9
Chicken/Dug	head	13	10	6	17	7	18	22	7	5	20	12.5
7 Gross Income	Rp/yr	1,868,250	825,000	1,768,000	184,000	1,242,500	500,000	1,137,750	808,000	161,600	270,000	876,510
(Crop)	Rp/yr	630,750	0	168,000	4,000	112,500	0	687,750	438,000	161,600	0	220,260
(Livestock)	Rp/yr	157,500	825,000	960,000	180,000	750,000	500,000	450,000	370,000	0	0	419,250
(Side job)	Rp/yr	1,080,000	0	640,000	0	380,000	0	0	0	0	270,000	237,000
8 Expenditure	Rp/yr	1,675,400	2,034,100	1,322,950	1,035,850	870,350	1,715,100	1,044,000	1,583,780	665,800	233,250	1,219,778
(Food/Drink)	Rp/yr	846,000	1,587,600	744,000	576,000	594,000	1,122,000	570,000	873,600	438,000	90,000	744,120
(Living)	Rp/yr	470,650	232,500	227,950	458,000	255,600	388,800	249,300	421,350	171,400	118,000	299,355
(Education)	Rp/yr	100,000	75,000	0	0	0	25,000	15,000	120,000	0	0	33,500
(Production)	Rp/yr	258,750	139,000	351,000	1,850	20,750	179,300	226,900	168,830	56,400	25,250	142,803
9 Surplus/Deficit	Rp/yr	192,850	-1,209,100	445,050	-851,850	372,150	-1,215,100	93,750	-775,780	-504,200	36,750	-343,268

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
Oeltua	Oelusapi	9,417	1,497	10,914	10,556	1,758	12,314
	Oeltua Pusat I	14,629	2,326	16,955	16,403	2,688	19,091
	Oeltua Pusat II	8,804	2,730	11,534	9,877	3,192	13,069
	Oelekam	7,709	3,291	11,000	8,651	3,825	12,476
	Total	40,559	9,844	50,403	45,487	11,463	56,950

Source : JICA Study Team

Table 3.1 Estimated Half Monthly Discharge at Proposed Embung Site

Embung Oeltua

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	19.00	39.00	32.00	51.00	10.00	7.00	0.00	0.00	0.00	0.00	13.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.00	0.00	0.00	35.00	31.00	243.00
1967	27.00	75.00	62.00	57.00	70.00	9.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	25.00	13.00	344.00
1968	11.00	58.00	77.00	40.00	15.00	5.00	8.00	6.00	22.00	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	13.00	12.00	267.00
1969	26.00	36.00	60.00	33.00	0.00	15.00	0.00	0.00	0.00	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	28.00	10.00	214.00
1970	10.00	22.00	7.00	23.00	10.00	0.00	0.00	12.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00	18.00	36.00	9.00	172.00
1971	8.00	69.00	61.00	53.00	72.00	22.00	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	14.00	19.00	24.00	10.00	359.00
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	6.00	23.00	5.00	34.00
1973	14.00	70.00	20.00	0.00	14.00	19.00	0.00	0.00	11.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	21.00	23.00	35.00	235.00
1974	173.00	12.00	78.00	79.00	56.00	51.00	22.00	0.00	6.00	0.00	13.00	0.00	9.00	0.00	0.00	0.00	8.00	0.00	0.00	0.00	23.00	23.00	0.00	5.00	558.00
1975	30.00	31.00	36.00	40.00	35.00	5.00	21.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	41.00	14.00	29.00	77.00	36.00	401.00
1976	89.00	34.00	23.00	50.00	102.00	35.00	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	0.00	19.00	0.00	45.00	11.00	415.00
1977	102.00	9.00	75.00	63.00	46.00	15.00	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	0.00	0.00	35.00	23.00	374.00
1978	31.00	27.00	51.00	137.00	12.00	13.00	21.00	0.00	9.00	30.00	13.00	0.00	9.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	57.00	6.00	58.00	474.00
1979	61.00	43.00	8.00	34.00	93.00	11.00	0.00	14.00	0.00	12.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.00	36.00	27.00	383.00
1980	35.00	115.00	143.00	10.00	8.00	9.00	0.00	23.00	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	18.00	33.00	55.00	449.00
1981	61.00	78.00	52.00	55.00	43.00	0.00	0.00	0.00	0.00	10.00	0.00	6.00	25.00	0.00	0.00	0.00	0.00	7.00	0.00	0.00	31.00	37.00	108.00	58.00	571.00
1982	17.00	94.00	56.00	55.00	77.00	20.00	0.00	9.00	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	19.00	9.00	30.00	386.00
1983	87.00	23.00	39.00	48.00	53.00	5.00	34.00	14.00	0.00	7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.00	0.00	20.00	0.00	22.00	364.00
1984	75.00	73.00	51.00	67.00	7.00	57.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	0.00	0.00	8.00	0.00	7.00	42.00	60.00	454.00
1985	0.00	43.00	18.00	28.00	30.00	0.00	6.00	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	0.00	30.00	23.00	28.00	213.00
1986	65.00	99.00	32.00	42.00	15.00	17.00	10.00	0.00	0.00	0.00	0.00	10.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.00	22.00	40.00	391.00
1987	38.00	131.00	51.00	44.00	0.00	13.00	6.00	0.00	0.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.00	49.00	24.00	393.00
1988	41.00	60.00	75.00	6.00	36.00	35.00	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	31.00	51.00	38.00	31.00	410.00
1989	22.00	50.00	24.00	20.00	87.00	25.00	0.00	21.00	10.00	0.00	0.00	9.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	28.00	30.00	331.00
1990	69.00	30.00	30.00	54.00	69.00	0.00	0.00	28.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.00	0.00	51.00	19.00	364.00
1991	47.00	75.00	60.00	63.00	11.00	8.00	104.00	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	15.00	32.00	12.00	7.00	434.00
1992	5.00	26.00	57.00	16.00	19.00	38.00	18.00	7.00	0.00	7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	14.00	31.00	0.00	245.00
1993	33.00	154.00	40.00	27.00	25.00	21.00	0.00	0.00	0.00	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	22.00	67.00	396.00
Average	42.71	56.29	47.07	42.68	36.25	16.25	9.61	5.50	2.25	2.64	1.79	1.14	1.54	0.71	0.00	0.00	0.54	0.25	0.21	2.18	7.18	17.64	31.21	27.00	352.64

Table 3.2 Estimated Flood Discherge

Oeltua Scheme

Characteristics of the catchment area								
Catchment Area	(km2)	0.82						
Eelevation at Dam Site (1)	(m)	354						
Maximum elevation in the catchment area (2)	(m)	482						
Height (3)=(2)-(1)	(h)	128						
Length of Catchment Area (l)	(m)	1,500						
Flow velocity	W2 (km/hr)	16.44						
Time of concentration	T2 (hrs)	0.09						
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)	69	108	138	171	221	263	310
Designed Flood	(m3/s)	13	20	25	31	40	48	57
Specific Discharge	(m3/s/km2)	15	24	31	38	49	59	69

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

Oektua Scheme

DESCRIPTION	UNIT	1 Private Well	2 Public Well	3 downstream of proposed embung	Max. Limit of B Class by GR. NO. 20/1990
I. PHYSICS					
1 Temperature	C	27.00	25.00	27.50	Normal water temperature
2 Dissolved solid matter	mg/liter	517.00	383.00	392.00	1000
3 Electric Conductivety	umhos/cm	703.00	520.00	538.00	-
II. CHEMISTRY					
a. Unorganic chemistry					
1 Mercury	mg/liter	0.00	0.00	0.00	0.001
2 Ammonia	mg/liter	0.00	0.00	0.00	0.5
3 Aroenic	mg/liter	-	-	-	0.05
4 Barium	mg/liter	-	-	-	5
5 Ferro	mg/liter	0.02	0.03	0.03	1
6 Fluoride	mg/liter	0.90	0.90	0.90	1.5
7 Cadmium	mg/liter	0.00	0.00	0.00	0.005
8 Chloride	mg/liter	62.00	39.00	17.70	600
9 Chronium, valense-6	mg/liter	0.00	0.00	0.00	0.05
10 Manganese	mg/liter	0.00	0.00	0.00	0.5
11 Nitrate, N	mg/liter	2.60	0.90	0.90	10
12 Nitric, N	mg/liter	0.03	0.02	0.01	1
13 Dissolved Oxygen	mg/liter	4.99	6.55	7.87	*
14 pH	-	6.80	7.30	7.40	5-9
15 Selenium	mg/liter	-	-	-	0.01
16 Zinc	mg/liter	0.00	0.00	0.00	5
17 Cyanide	mg/liter	0.00	0.00	0.00	0.1
18 Sulphate	mg/liter	33.30	7.20	6.60	400
19 Sulfide, H2S	mg/liter	0.00	0.00	0.00	0.1
20 Copper	mg/liter	0.00	0.00	0.00	1
21 Lead	mg/liter	0.00	0.00	0.00	0.1
b. Organic Chemistry					
1 Aldrin and Dieldrin	mg/liter	0.00	0.00	0.00	0.017
2 Chlordane	mg/liter	0.00	0.00	0.00	0.003
3 DDT	mg/liter	0.00	0.00	0.00	0.042
4 Endrine	mg/liter	0.00	0.00	0.00	0.001
5 Fenol	mg/liter	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	0.056
9 Methoxychlor	mg/liter	-	-	-	0.035
10 Oil and Fat	mg/liter	0.00	0.00	0.00	Nil
11 Organofosphate and Carbomate	mg/liter	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	0.5
14 Toxaphene	mg/liter	0.00	0.00	0.00	0.005
III MICRO BIOLOGY					
1 Coliform tinja	per 100 ml	13,000	13,000	14,000	2,000
2 Total Coliform	per 100 ml	28,000	24,000	24,000	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

Oeltua Scheme

Item		Unit	Design Value
Natural Water Content	(NWC)	%	26.9
Bulk Density	(γ d max)	g/cm3	1.796
Maximum Dry Density	(γ t)	g/cm3	1.48
Saturated Density	(σ sat)	g/cm3	1.944
Optimum Moisture Content	(Wopt)	%	29
Specific Gravity	(Gs)	-	2.60
Liquid Limit	(LL)	%	54.0
Plastic Limit	(PL)	%	33.3
Plastic Index	(PI)	%	29.0
Shrinkage Limit	-	%	21.8
Angle of Internal Friction	(ϕ)	°	24.0
Cohesion (UU/CU)	(C)	kg/cm2	1.1
Permeability	(K)	cm/sec	2.00E-06
Classification of Soil	-	-	CH

Table 6.1 Summary of Construction Equipment

Oeltua 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 : OELTUA

Item	Amount (Rp. million)
I. Direct Construction Cost	
1.1 Preparatory Works	221
1.2 Embung Construction	
1) Main dam	1,991
2) Spillway	1,149
3) Intake, outlet & diversion channel	123
4) Leakage protection works	558
5) Miscellaneous	382
Sub-total of 1.2	4,203
1.3 Domestic Water Supply	
1) Pipe line	21
2) Division boxes	180
3) Miscellaneous	20
Sub-total of 1.3	221
1.4 Embung Operation and Maitenace Road	0
1.5 Irrigation Facilities	0
Sub-toal of I.	4,645
II. Administration Cost	232
III. Engineering Services	697
Sub-total of I, II & III	5,574
IV. Physical Contingency	836
Sub-total of I, II, II, & IV	6,410
V. Contract Tax	618
VI. Land Aquisition Cost	23
Sub-total I, II, III, IV, V & VI	7,051
VII. Price Contingency	705
GRAND TOTAL	7,757

Table 7.2 Direct Construction Cost (1/3)

Scheme : OELTUA

Item	Unit	Unit Price Rp.	Quantity	Total 1000 Rp.
I. Embung				
1. Main Dam				
1.1 Earth/stone works				
1) Clearing	m2	400	16,500	6,600
2) Excavation	m3	5,500	16,500	90,750
3) Embankment	m3	8,000	200,000	1,600,000
4) Rip-rap protection	m3	15,000	7,500	112,500
1.2 Other miscellaneous works				180,985
Sub-total of 1.				1,990,835
2. Spillway				
2.1 Earth works				
1) Clearing	m2	400	3,000	1,200
2) Excavation	m3	5,500	24,000	132,000
3) Backfill	m3	5,200	1,200	6,240
2.2 Concrete works				
1) Concrete - A	m3	250,000	300	75,000
2) Concrete - B	m3	170,000	2,900	493,000
3) Reinforcement bar	ton	1,500,000	65	97,500
4) Form	m2	15,000	16,000	240,000
2.3 Other miscellaneous works	L.S			104,494
Sub-total of 2.				1,149,434
3. Intake, Outlet & Diversion Channel				
3.1 Earth works				
1) Clearing	m2	400		0
2) Excavation	m3	5,500	1,500	8,250
3) Backfill	m3	15,000		0
3.2 Concrete works				
1) Concrete - A	m3	250,000		0
2) Concrete - B	m3	170,000	610	103,700
3) Reinforcement bar	ton	1,500,000		0
4) Form	m2	15,000		0
3.3 Other miscellaneous works	L.S			11,195
Sub-total of 3.				123,145
4. Leakage Protection Works				
4.1 Earth works				
1) Clearing	m2	400	34,000	13,600
2) Earth blanket works	m3	8,000	68,000	544,000
4.2 Concrete lining works	m2	170,000		0
Sub-total of 4.				557,600
5. Miscellaneous & Others				382,101
Total of I.				4,203,115

Table 7.2 Direct Construction Cost (2/3)

Scheme : OELTUA

Item	Unit	Unit Price Rp.	Quantity	Total 1000 Rp.
II. Domestic Water Supply				
1. Pipe line				
1.1 Earth works				
1) Clearing	m2	400	3,100	1,240
2) Excavation	m3	5,000	500	2,500
3) Backfill	m3	5,200	500	2,600
1.2 Pipe line setting works				
1) Dia 40 mm	m	5,300	630	3,339
2) Dia 50 mm	m	7,400	890	6,586
3) Dia 65 mm	m	9,200		0
5) Dia 75 mm	m	13,300		0
6) Dia. 400 mm	m	218,000		0
1.3 Pipe line related structures				
1) Check valve	nos.	624,000	6	3,744
2) Air valve	nos.	506,000	2	1,012
3) Drainage valve	nos.	1,036,000		0
Sub-total of 1.				21,021
2. Division Boxes				
1) Division box for inhabitants	nos.	6,990,000	21	146,790
2) Division box for livestock	nos.	1,130,000	29	32,770
Sub-total of 2.				179,560
3. Miscellaneous & Others	L.S			20,058
Total of II.				220,639
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)

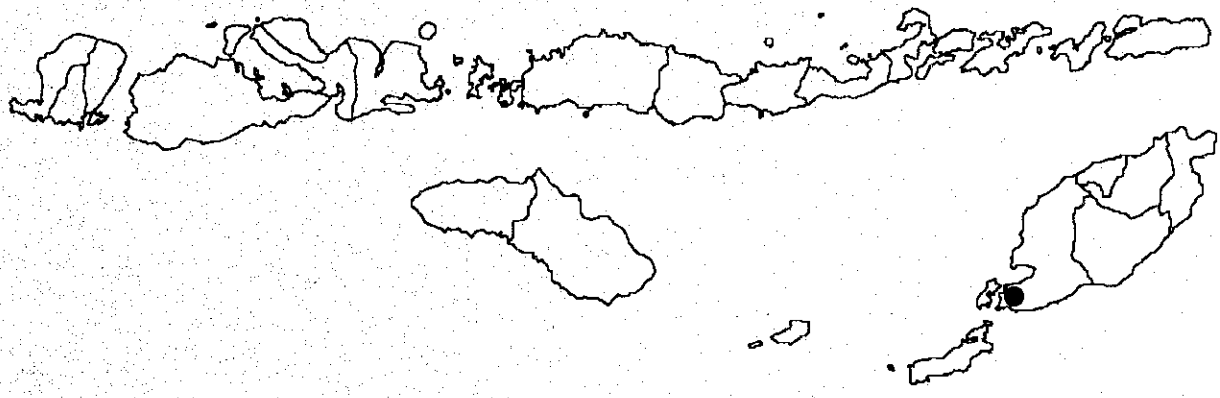
Scheme : OELTUA

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				4,423,755

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

Feasibility Study on
Oeltua Embung Development Project

Figures



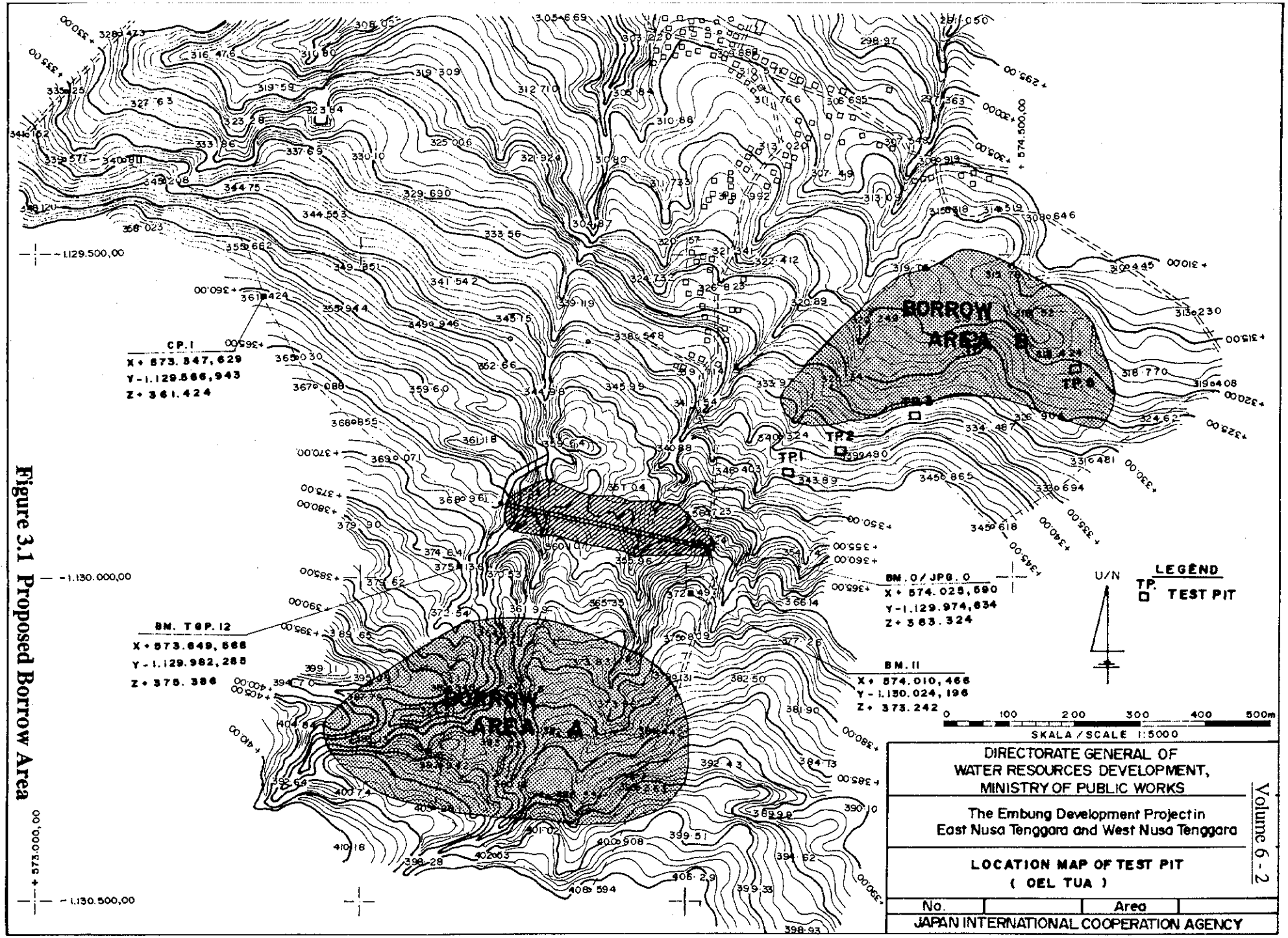
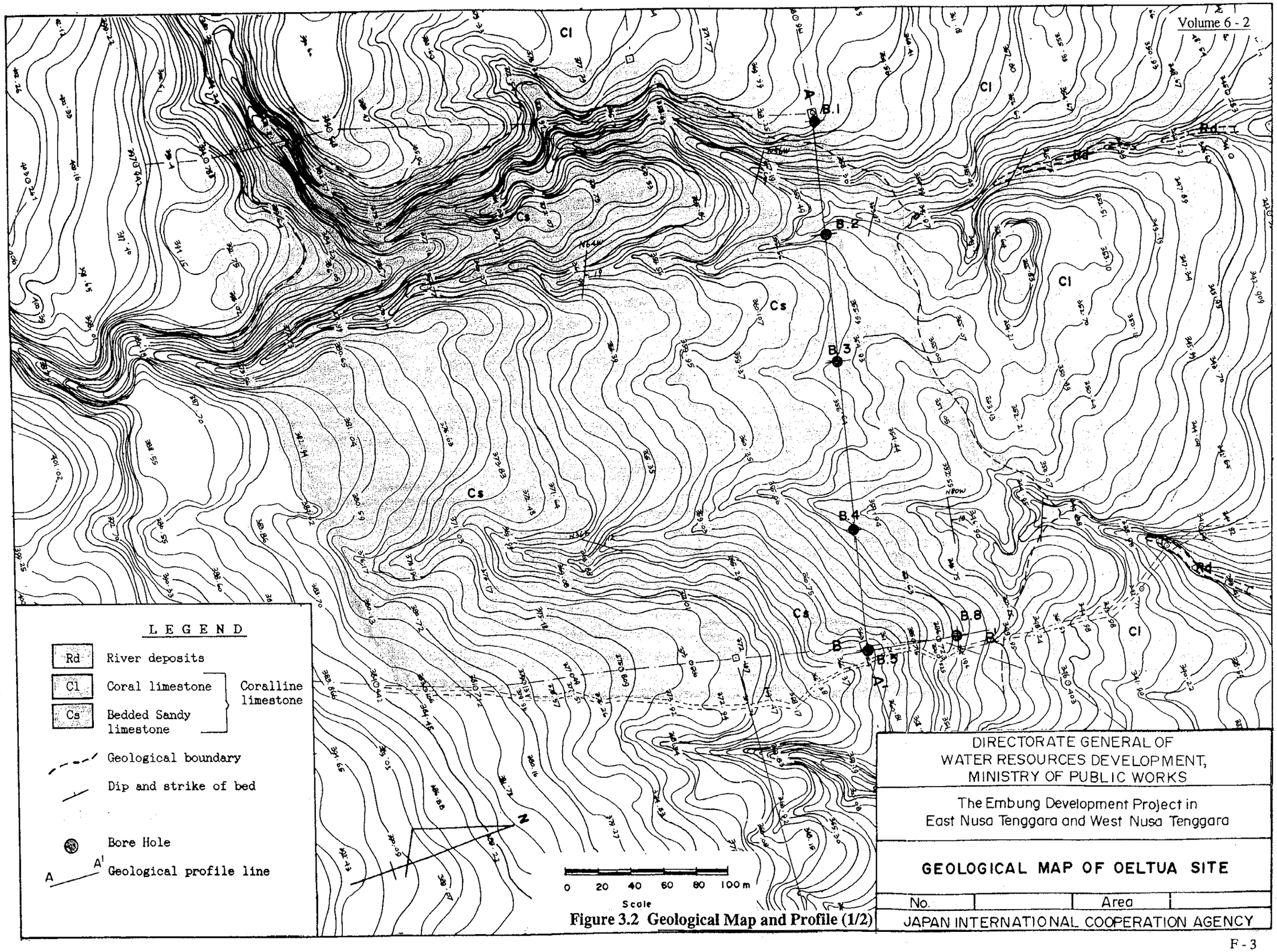


Figure 3.1 Proposed Borrow Area



DIRECTORATE GENERAL OF
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The Embung Development Project in
East Nusa Tenggara and West Nusa Tenggara

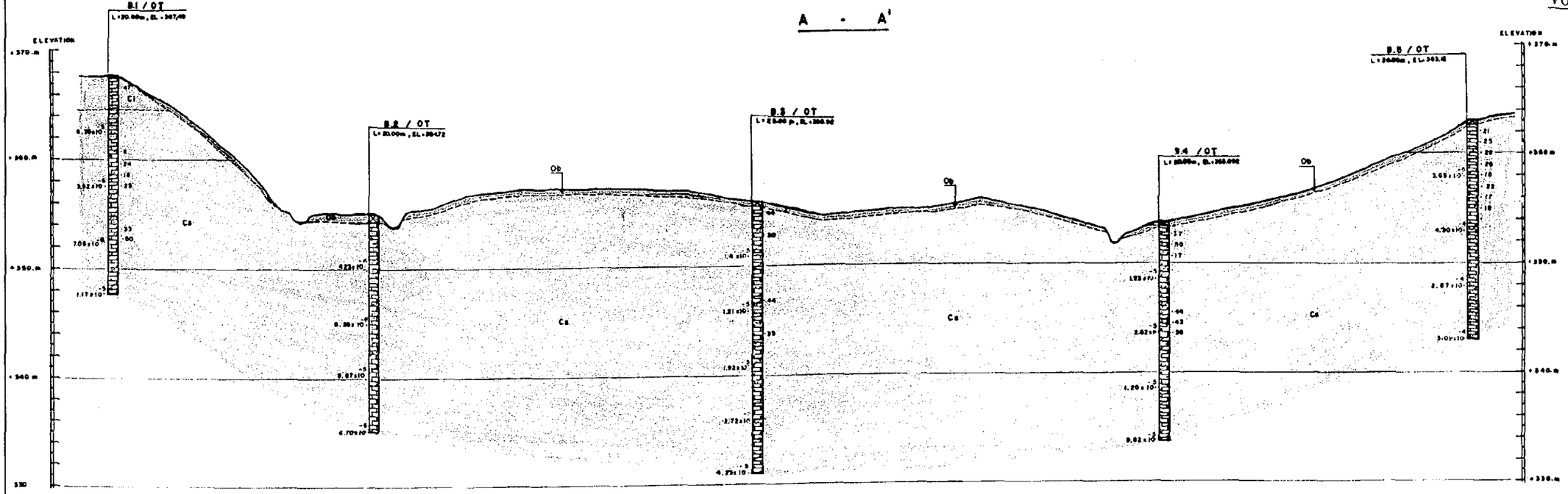
GEOLOGICAL MAP OF OELTUA SITE

No.		Area	

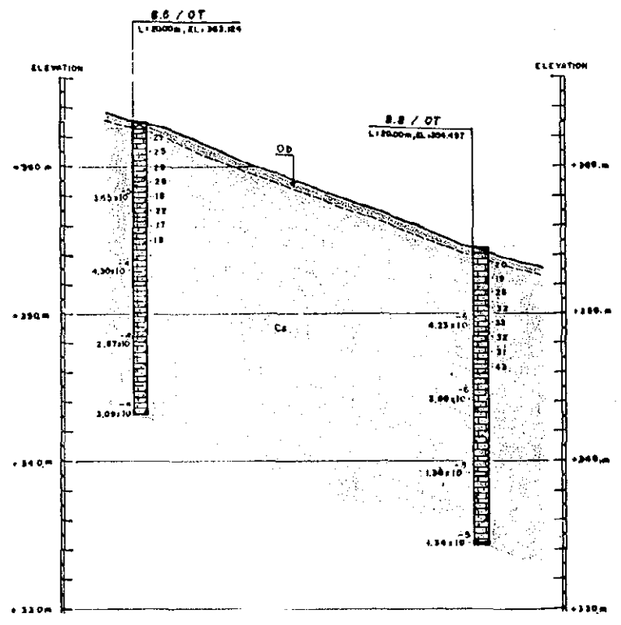
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 3.2 Geological Map and Profile (1/2)

A - A'

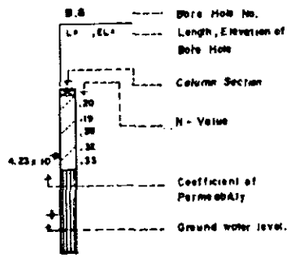


B - B'



LEGEND.

- Ob : Overburden
- Cl : Coral limestone
- Cs : Bedded Sandy limestone
- Coralline limestone.
- : Geologic boundary



Vertical. 0 2 4 6 8 10 m

Horizontal. 0 5 10 15 20 25 m

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The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara
GEOLOGICAL PROFILE OF OELTUA SITE
No. | Appp.
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 3.3 Geological Map and Profile (2/2)

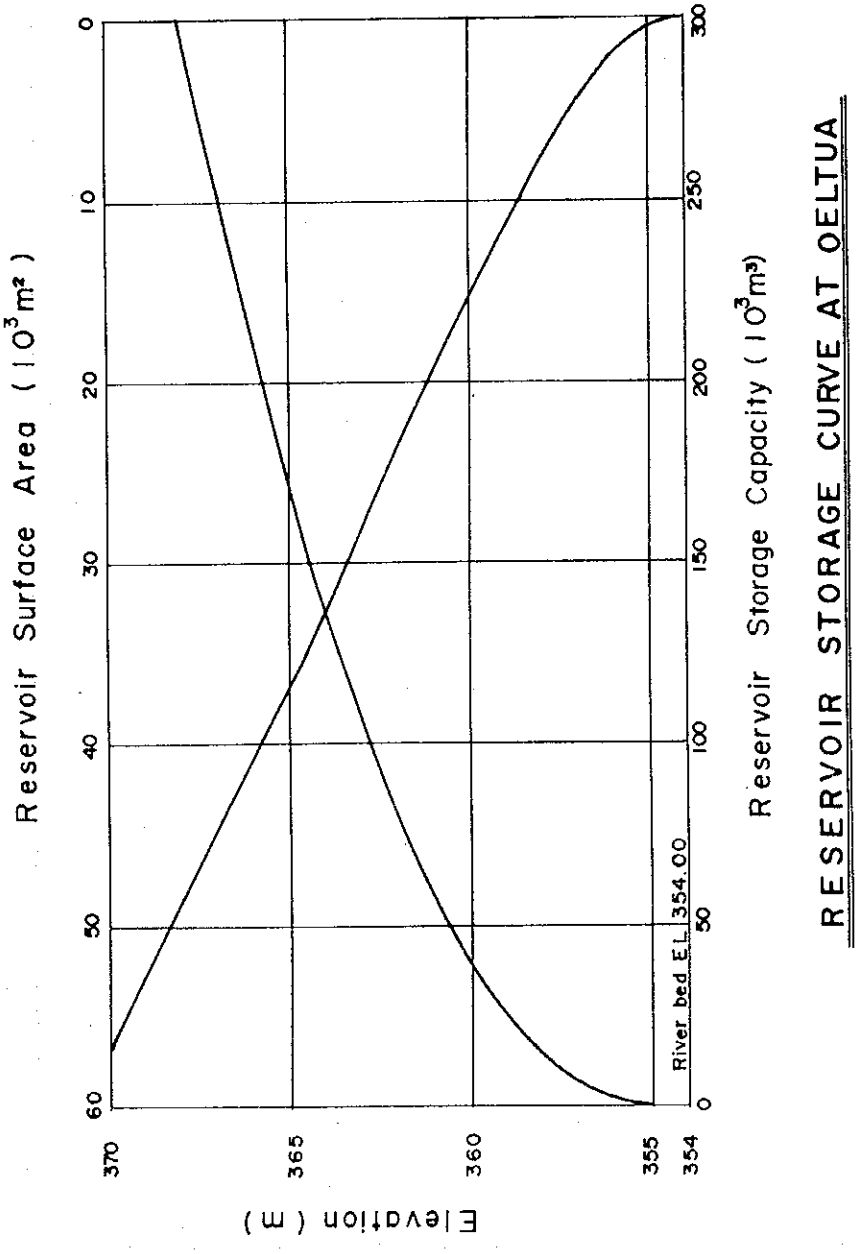


Figure 4.1 Reservoir Storage Curve

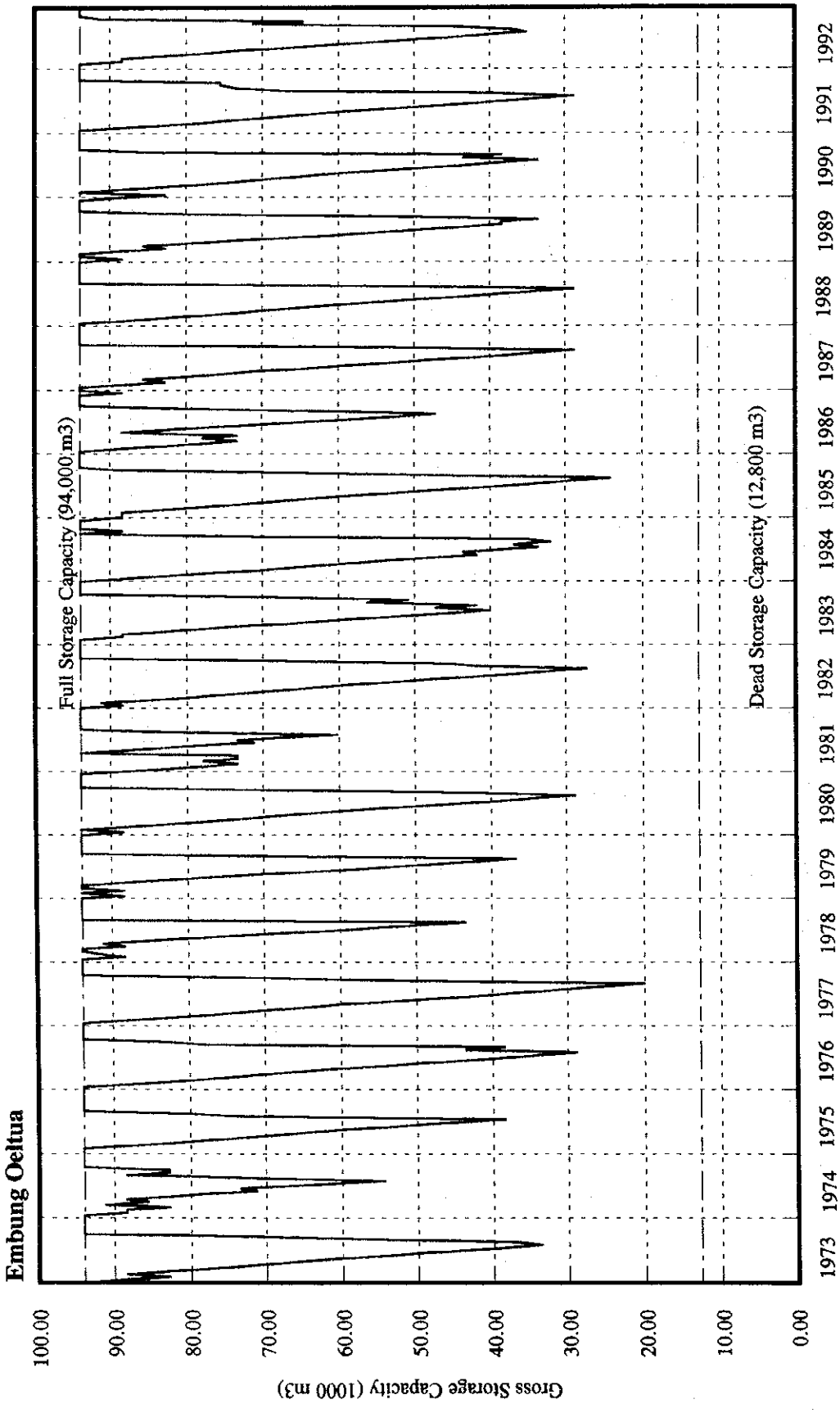
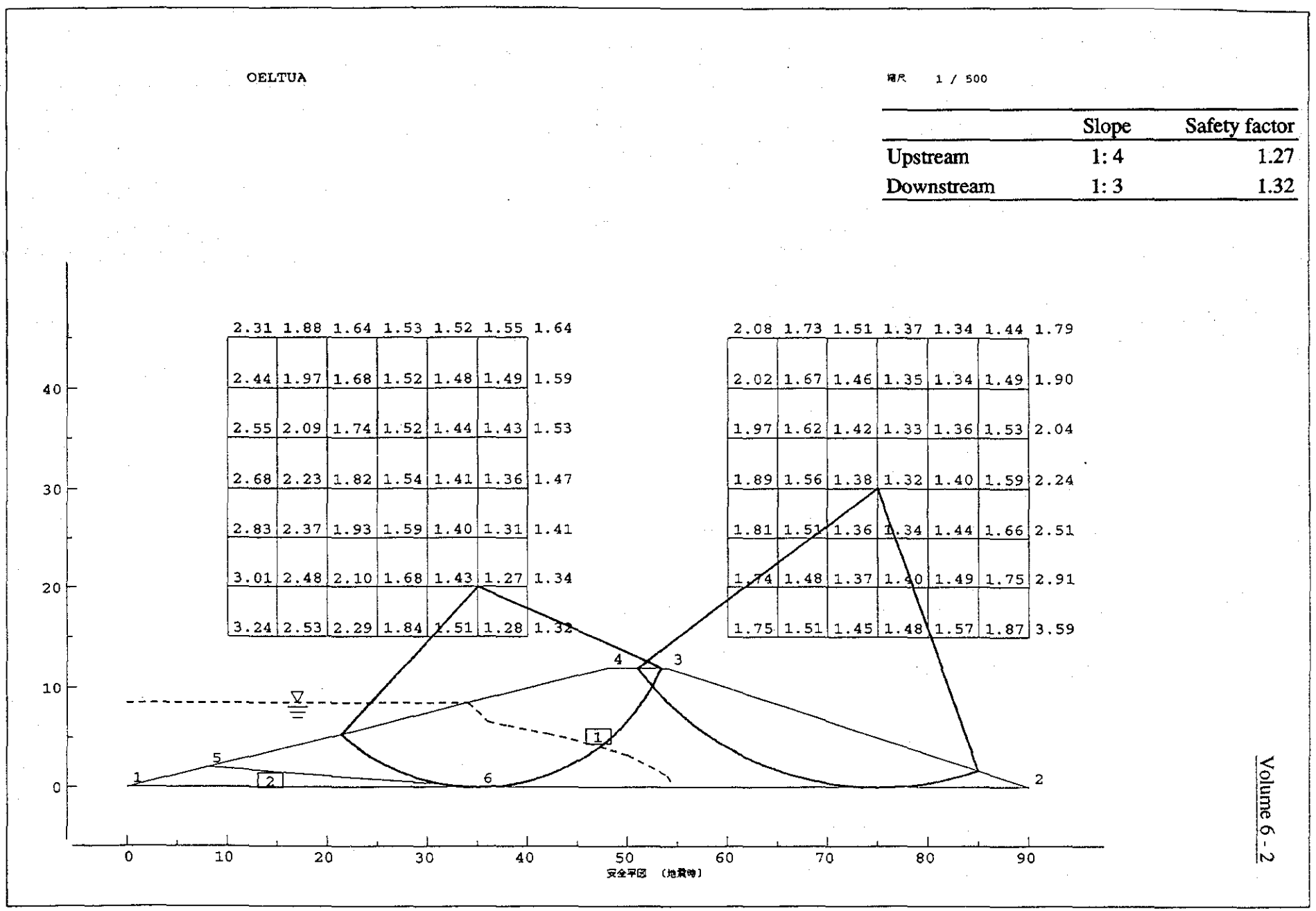


Figure 4.2 Result of Reservoir Operation



	Slope	Safety factor
Upstream	1: 4	1.27
Downstream	1: 3	1.32

Figure 5.1 Stability Analysis

Oeltua Scheme

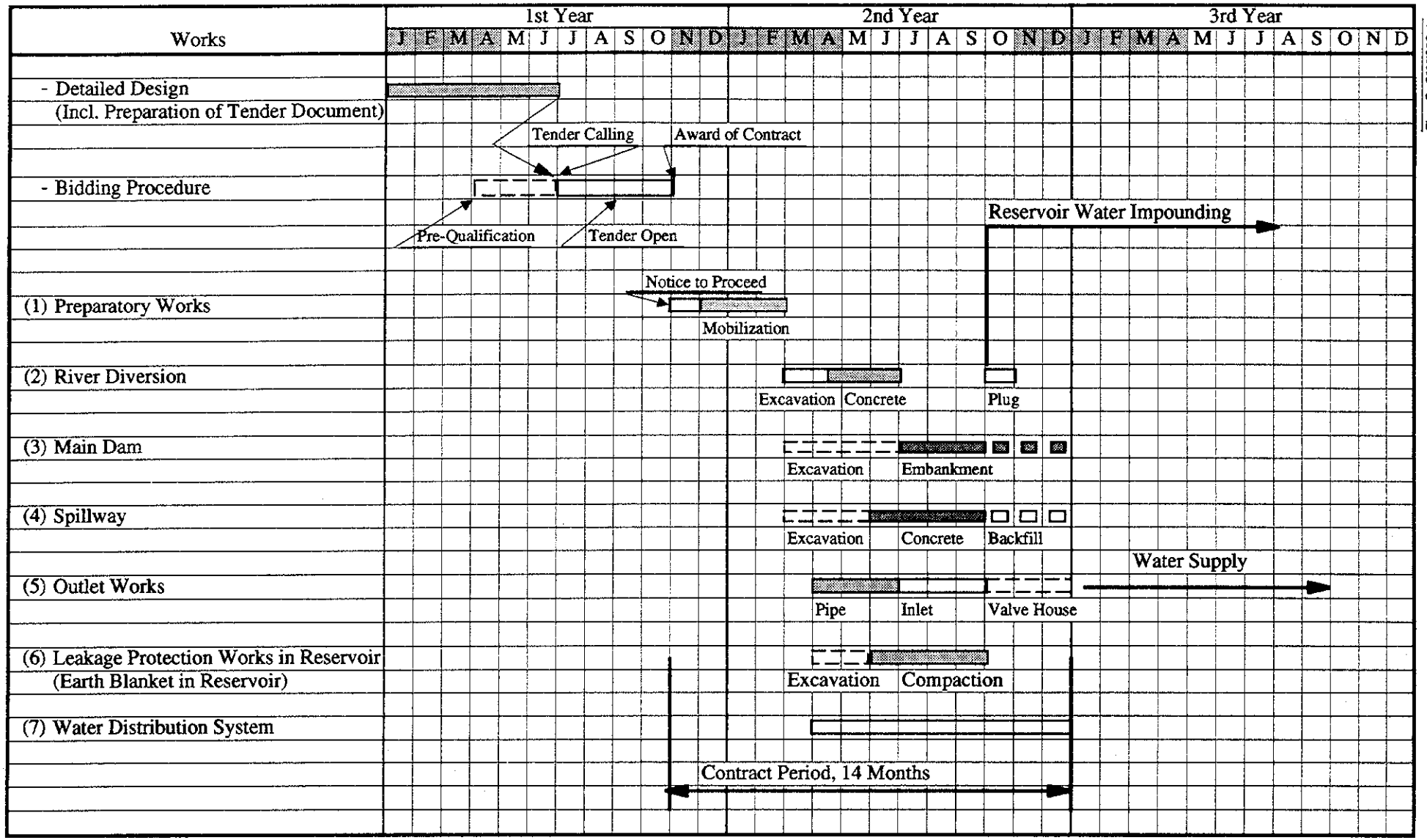
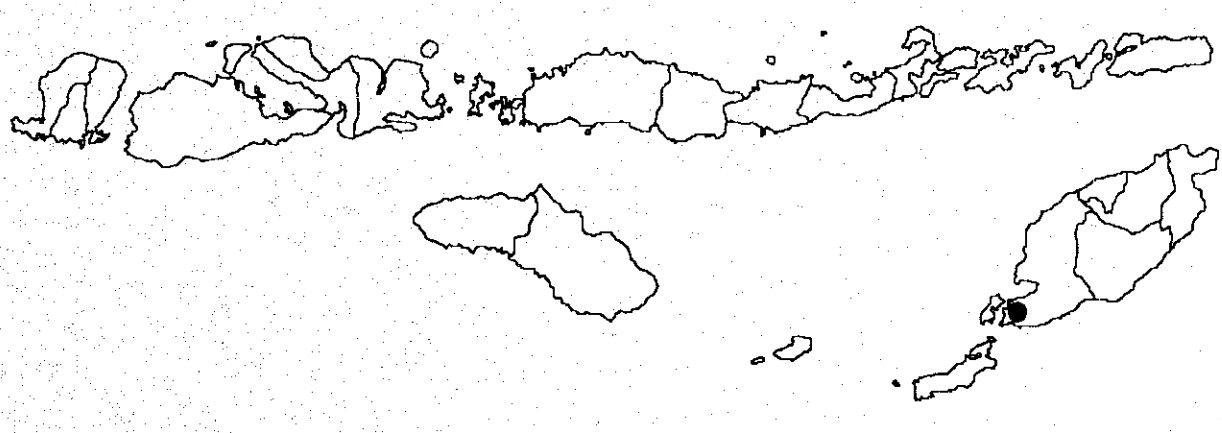


Figure 6.1 Construction Time Schedule

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

Feasibility Study on Oeltua Embung Development Project

Attachments



Attachment - 1

Result of Soil Laboratory Test in Oeltua

Bor.No. (Depth)	Formation Classification	Unified Soil Content(%)	Water (g/cm3)	Unit Weight	Specific Gravity
B1(8.0m)	Sandy limestone	SM-SC	31.2	1.57	2.73
B2(8.0m)	Sandy limestone	SM-SC	19.9	2.03	2.62
B3(8.0m)	Sandy limestone	MH	44.9	1.8	2.5
B4(3.0m)	Sandy limestone	CH	31.4	1.59	2.57
B4(12.0m)	Sandy limestone	CH	100.7	1.27	2.57
B5(8.0m)	Sandy limestone	MH	42.8	1.27	2.46
B8(6.0m)	Coral limestone	MH	55.4	1.55	2.48
B8(20.0m)	Sandy limestone	CH	30.9	1.58	2.69

Result of Rock Test in Oeltua

Sample	Formation	Unit Weight (g/cm3)	Specific Gravity	Unconfined Compression (kg/cm3)
B2(12.0m)	Sandy limestone	2.34	2.72	2.32
B3(12.0m)	Sandy limestone	2.42	2.71	11.03

Attachment-2

SUMMARY OF LABORATORY TEST

PROJECT : Embung Oeltua
LOCATION OF PROJECT : Ds. Oeltua, 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	3.00	3.00	3.00	3.00	3.00	
Water Content	(Wn)	%	34.05	19.72	30.03	21.35	29.26	26.88
Unit Weight	(γ w)	g/cm3						
Maximum Dry Density	(γ d max)	g/cm3	1.640	1.551	1.310	1.482	1.391	1.47
Optimum Moisture Content	(Wopt)	%	19.90	23.10	34.50	2.60	33.60	22.74
Specific Gravity	(Gs)	-	2.57	2.51	2.66	2.62	2.70	2.61
Liquid Limit	(LL)	%	52.00	41.05	68.90	54.70	52.00	53.73
Plastic Limit	(PL)	%	26.26	20.92	34.63	24.75	60.00	33.31
Plastic Index	(PI)	%	25.40	20.13	34.20	29.95	33.22	28.58
Shrinkage Limit	-	%	10.30	16.30	29.19	26.15	26.78	21.74
Angle of Internal Friction	(ϕ)	°	21	31	31	38	20	28.20
Cohesion (UU/CU)	(C)	kg/cm2	1.100	0.725	0.750	1.200	1.180	0.99
Permeability	(K)	cm/sec	1.36E-06	1.66E-06	1.32E-06	3.04E-06	2.68E-06	
Passing of # 200 Sieve	-	%	54.10	59.18	93.38	76.93	94.39	
Clasification of Soil			CL	CL	CH	CH	CH	

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	

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
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Positive Impact with Project

Negative Impact with Project

Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur	Embung Site	Mitigatory Measures
			I II III IV V VI				I II III IV V VI	1 2 3 4 5 6	
	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	

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
	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		I						
		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

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Positive Impact with Project

Negative Impact with Project

Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur	Embung Site	Mitigatory Measures
			I II III IV V VI				I II III IV V VI	1 2 3 4 5 6	
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

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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		available	· 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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Embung Site: 1: TI01 : Bimoku
2: TI02 : Oeltua
3: TI03 : Tasiepah
4: TI08 : Benkoko
5: TI09 : 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
	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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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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	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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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)

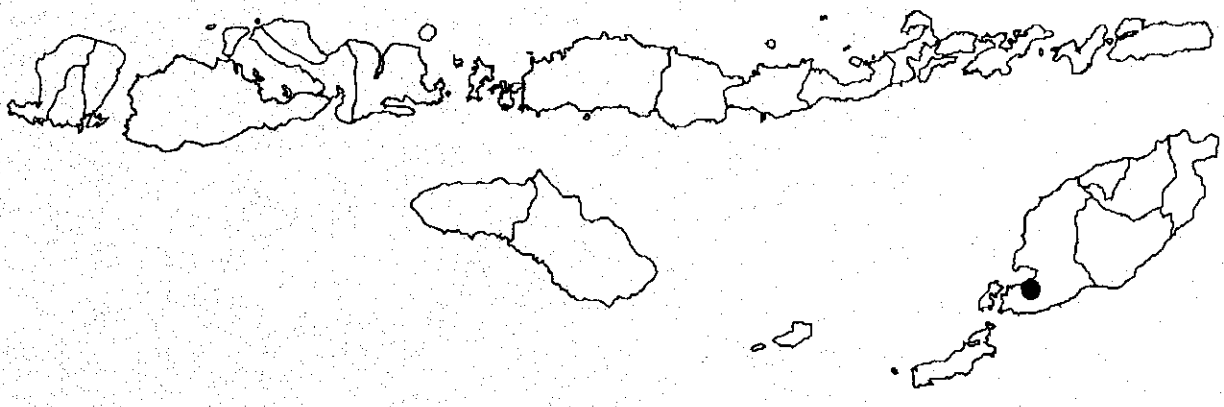
Directorate General of
Water Resources Development,
Ministry of Public Works

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

Volume 6-3

Feasibility Study
on
Tasiepah Embung Development Project



May 1995

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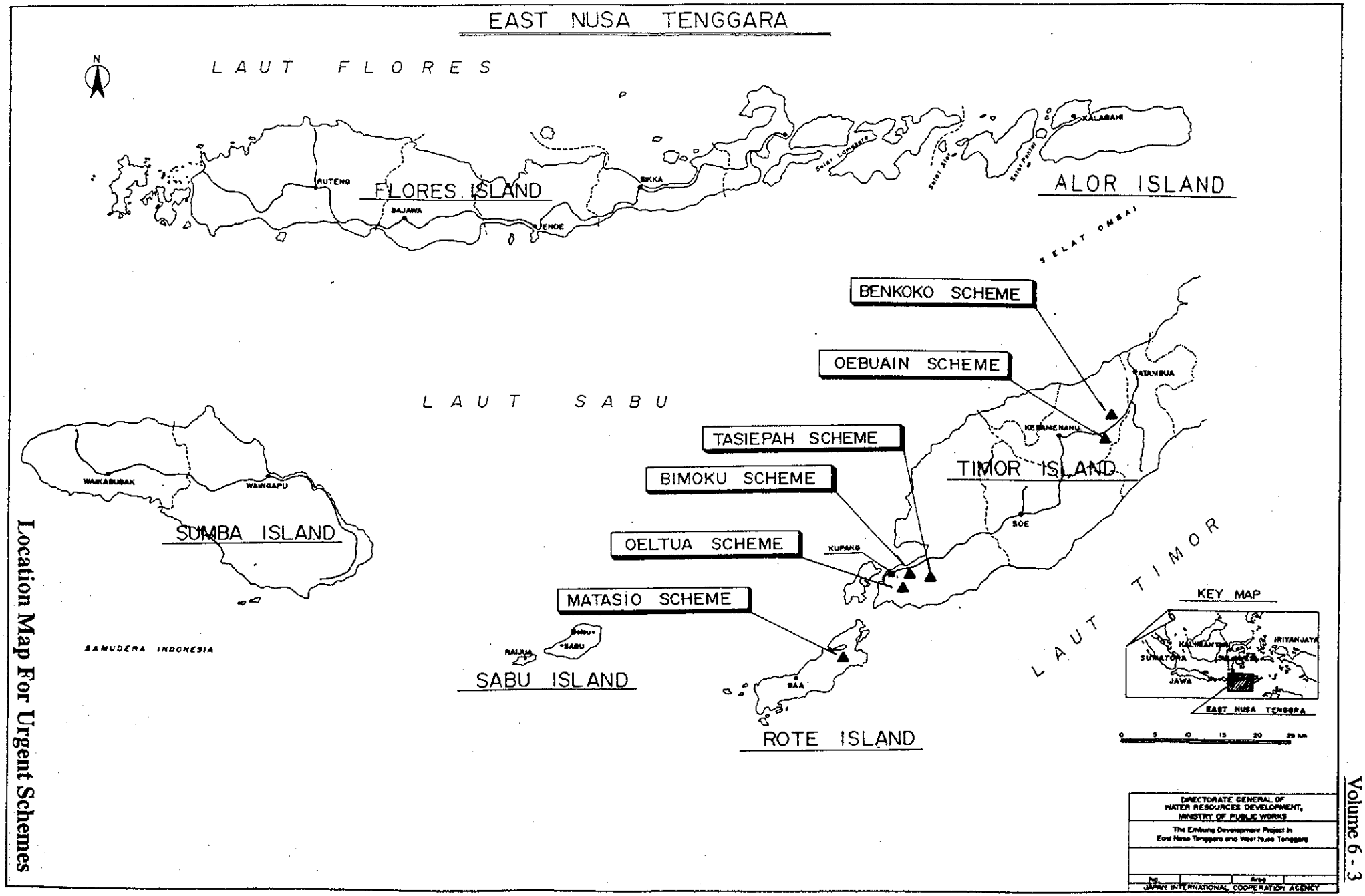
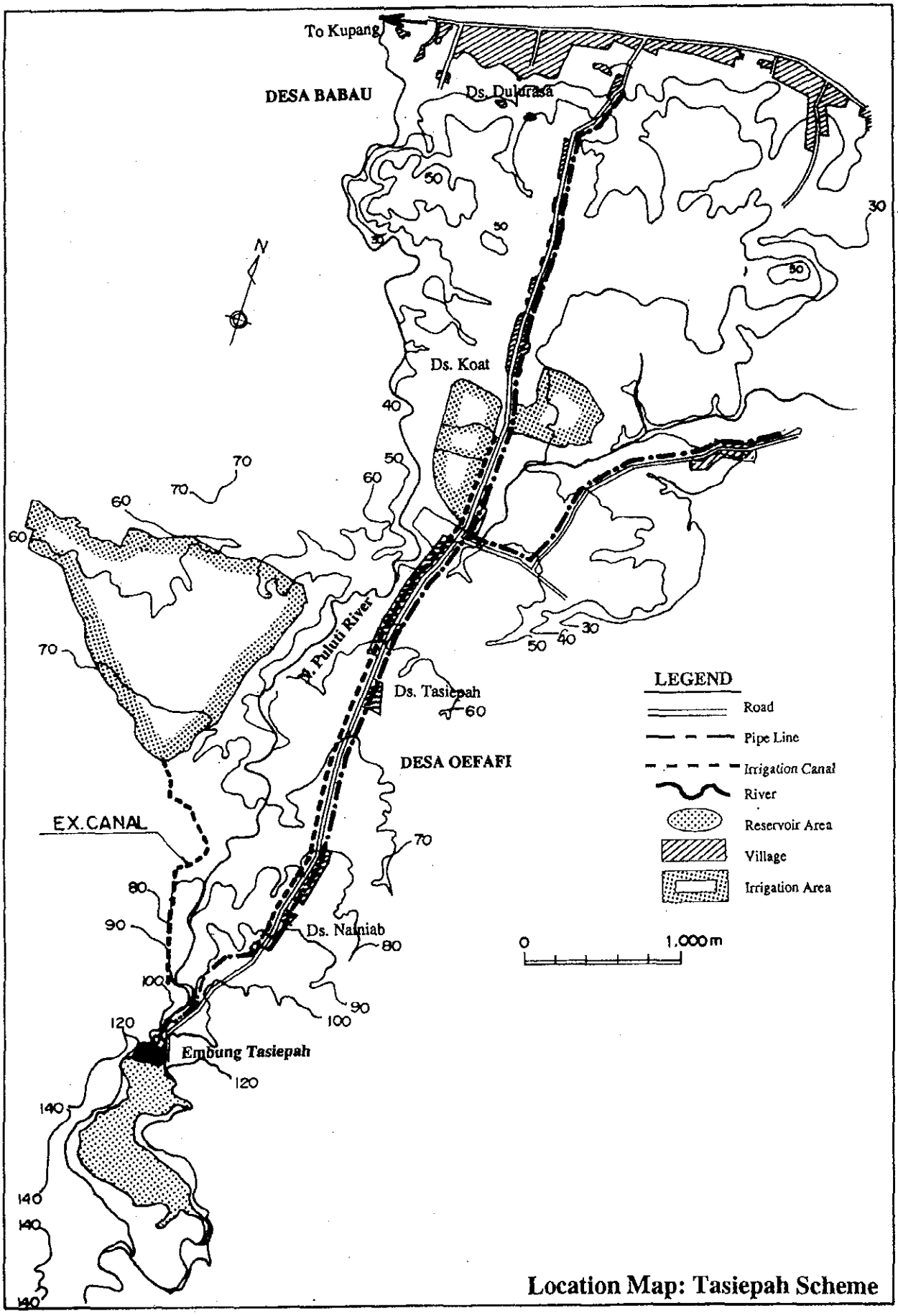


Location Map For Urgent Schemes



Location Map: Tasiepah 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 6-3

FEASIBILITY STUDY
ON
TASIEPAH 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 30 km of east of Kupang, the capital of East Nusa Tenggara (NTT) Province, in the western part of Timor island. The proposed site of Tasiepah Embung has coordinates of 123°46'48" east longitude and 10° 10' 00" south latitude.

The Project area extends along the both sides of the N. Puluti river. It is bounded on the south by hills and the north by the Kupang bay. A broad terrace is distributed along the N. Puluti river and, at the proposed Embung site, comprises three tiers such as alluvial, lower and higher terraces. The Project area ranges from 12 to 110 m in elevation. The potential area for irrigated agriculture including the existing irrigation area is flat to gently rolling.

Main residential zones in the Project area are Oefafi Village (Desa) and a part of Babau Village in the Sub-district (Kecamatan) of Kupang Timur of the District (Kabupaten) of Kupang. These two villages within the Project area consist of four sub-villages (Dusun); Nainiab, Tasiepah and Koat in Oefafi Village and Dulurasa in Babau 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 at the Penfui station, respectively.

The N. Puluti river as a potential water resource is a perennial stream with a catchment area of 32.10 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 and claystone called the Bobonaro Complex. The Quaternary is formed by coral limestone, alluvial terrace deposits 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 with highly porous upper layer. Alluvial deposits comprise gravel, sand and some clay, being unconsolidated and highly permeable. Recent river deposits 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 clay loam, being sticky when wet and very firm when dried. 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 297 ha is used for agriculture activities comprising wet paddy field of 177 ha and dry upland of 120 ha. Out of the wet paddy field, 136 ha are

provided with irrigation facilities diverting seasoned flow from the N. Puluti river and the rest are idle. 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 1,305 and the number of households was 278 in total. The breakdown of population and household by sub-village is shown in Table 1.3. The average family size is 4.7 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 13 wells in the Project area. Another two irrigation headworks on the N. Puluti river are used by inhabitants as water sources for domestic use. Users of these water supply sources are suffering from water shortage problem for four to five months every year because these go almost completely dry from May to September. The present water use in each sub-village clarified under the Study is summarized as follows:

- In Nainiab Sub-village with 90 families and 435 persons, there are five grant wells at a distance of 150 m on an average from 24 family users and two private-owned wells at an average distance of 150 m from eight family users. These wells dry up from either May or June to the beginning of the wet season. Together with the remaining 58 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 284 heads of cow and water for these livestock use is taken from the five grant wells;

- In Tasiepah Sub-village with 79 families and 384 persons, there is only one grant well at a distance of 100 m on an average from 10 family users. Another water source is river flow taken by 15 family users at Naben headwork on the N. Puluti river. The average distance between this intake site and users' houses is 1,300 m. The well goes dry in either May or June and the river flow dries up in September. Together with the remaining 54 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 231 heads of cow and water for these livestock use is taken from the Naben headwork;

- In Koat Sub-village with 47 families and 202 persons, there are one grant well at distance of 150 m on an average from two family users and one artesian well at an average distance of 500 m from nine family users. The grant well dries up for five months during the dry season, while the artesian well supplies water throughout the year. To the remaining 36 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 74 heads of cow and water for these livestock use is taken from the Oefafi headwork as well as the N. Puluti river directly; and,

- In Dulurasa Sub-village with 62 families and 284 persons, there are one public well belonging to P2AT at a distance of 200 m on an average from six family users, one grant well at an average distance of 100 m from six family users and one private-owned well at a distance of 50 m from one family user. Another water source is river flow taken by eight family users at Batu Oek headwork on the N. Puluti river. The average distance between this intake site and users'

houses is 200 m. Except for the P2AT's well, all the water sources go dry from June to December. Together with the remaining 41 families without any specific water source, all users of 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 177 heads of cow and water for these livestock use is taken from the P2AT's and private-owned wells.

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 inside their houses. Instead, they are using river bed and water of the N. Puluti 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 exist farm land of 297 ha all of which are currently cultivable. The present cropped area amounts to 295 ha comprising 73 ha for paddy and 222 ha for maize. Irrigated rice cultivation is practiced on the wet paddy field during the wet season when river flow can be diverted through the existing intake facilities from the N. Puluti river. Maize is the main crop grown on not only the are upland field but also on the wet paddy field under the rainfed condition. The present cropping pattern is single cropping of paddy on the irrigated wet paddy field as well as maize on the dry upland and the non-irrigated paddy field for the wet season . The overall cropping intensity is thus 99% for farm 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 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 1.75 ton/ha for paddy and 1.8 ton/ha for maize. Annual crop production is 128 tons for paddy and 400 tons for maize.

As of 1993, a total of 580 cows/buffaloes, 75 horses, 208 goats/sheep, 300 pigs and 150 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 Irrigation Facilities

In the Project area, there exists the wet paddy field of 110 ha in net on the left bank and 26 ha on the right bank of the N. Puluti river. The left bank area has been irrigated by the existing Oefafi (Tasiepah) weir situated at around 800 m downstream of the proposed Embung site. This weir is deteriorated severely, especially intake and scouring gates, downstream apron and retaining wall. Irrigation water taken by the weir is leaded by the existing canal to the existing paddy field with a distance of about 1.6 km. This canal is also deteriorated severely. Due to shortage of surface water of the river and poor conditions of

the existing facilities, only a part of the wet paddy field has been irrigated during the dry season.

Irrigation water for the right bank area is taken by the existing temporary weirs called Batu Oe and Rakyat constructed by farmers themselves and situated at about 3.9 km downstream of the proposed Embung site. The existing irrigation canal also constructed by farmers themselves is passing from the weir to the wet paddy field with a distance of about 1.7 km. These facilities have no effective functions for proper irrigation. Since these facilities are unable to control flood water of the N. Puluti, flood water attacks directly to the villages and farm roads at flood time in the wet season. As same as the left bank area, only wet season paddy has been irrigated by insufficient surface flow. As a result, there is idle farm land with the net area of 24 ha adjacent to the existing paddy field.

1.10 Agro-economy

In terms of agricultural extension services, two rural extension centers (BPP) are established in Oefafi and Babau 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. 745,000 and expenditure of Rp. 1,127,000 as shown in Table 1.5.

2. DEVELOPMENT NEEDS AND CONCEPTS

2.1 Development Needs

In the Project area, it is common for 1,305 inhabitants to carry water from available water sources to their homes at the average distance of 360 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 upgrade their primitive 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 297 ha in the Project area. The wet paddy field occupies 177 ha comprising irrigated paddy field of 136 ha and rainfed paddy field of 41 ha. From the topographic viewpoints, rainfed paddy field of 24 ha is irrigable if irrigation water source is created. With the condition that irrigation water can be secured, the existing land resources already developed as paddy field, 110 ha on the left bank and 50 ha on the right bank of the N. Puluti river, can be expected to be fully utilized by practicing the following cropping pattern.

Proposed Cropping Pattern

Crops	Area (ha)	Nursery	Transplanting/Planting	Harvesting
Wet Season				
- Paddy in left bank area	110	Nov. 21 - Dec. 21	Dec. 16 - Jan. 16	Mar. 31 - Apr. 30
- Paddy in right bank area	50	Dec. 21 - Jan. 21	Jan. 16 - Feb. 16	Apr. 30 - May 30
Dry Season				
- Beans in left bank area	110		Apr. 16 - May 16	Jul. 5 - Aug. 5
- Beans in right bank area	50		May 16 - Jun. 16	Aug. 5 - Sep. 5

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 inhabitants 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 1,645 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 36,026 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 750 cows/water buffaloes, 87 horses, 598 sheep/goats, 451 pigs and 2,260 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 14,794 m^3 and the breakdown by each sub-village is shown in Table 2.1.

(3) Irrigation water demand

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

Tables 2.2 and 2.3 show the calculation results of evapotranspiration and effective rainfall, respectively, and Table 2.4 presents irrigation water requirement. Annual unit diversion requirement of irrigation water for irrigated paddy field of 1 ha amounts to 14,470 m^3 on the left bank and Palawija crop on the left bank area and 16,560 m^3 on the right bank area of the N. Puluti river, respectively.

2.3 Development Constraints

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

In developing water resource potential of the N. Puluti 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 Province 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 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 N. Puluti river nearby Oefafi Village. In the course of the Study, therefore, it is firstly to examine water resources development potential at this site called Tasiepah Embung from the viewpoints of topography, geology, soil engineering and hydrology. If the examination results reveal that there is possibility of creating new permanent water source facility, development strategies of the proposed Tasiepah 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 Tasiepah Embung was identified PRIS through its identification study done in 1986. Under the present Study, the original site and two alternative sites as shown in Figure 3.1 are reviewed from topographical and geological points of view including mapping and geological investigations. As a result, a new site is identified at 200 m downstream from the PRIS's original site and taken up as the proposed Embung site due mainly to better geological condition. The N. Puluti river flows with a width of around 200 m and riverbed of El. 87.8 m at the proposed Embung site. The left bank shapes gentle slope of about 15° up to around El. 114 m and then becomes very steep slope of about 40° up to about El. 135 m. The right bank is of steep slope of about 40° up to around El. 106 m and then becomes gentle slope of about 20° up to about El. 122 m. Elevation of hills surrounding the proposed reservoir ranges about 115 to 165 m above sea level.

3.2 Geological Condition

In the course of drilling works conducted under the Study, it is confirmed that the both sides of the abutments of the original Embung site (A-A axis) are composed of coral limestone layer with very high permeability. Thus, geological investigation sites are relocated to the newly proposed site (C-C axis). The results of core drilling, standard penetration test and field permeability test are presented as Attachment 2. Figures 3.2 and 3.3 depicts geological map and profile of the proposed Tasiepah Embung, respectively.

The proposed site of Tasiepah Embung is underlain by mainly siltstone, coral limestone and terrace deposits. The foundation rock of the proposed site is composed of siltstone of Noele Formation in the bottom portion of the proposed site and coral limestone on the both abutments of the proposed site. The surface of siltstone slopes gently from the left bank to the right bank along the proposed dam axis. 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 results of field permeability test reveal that the coefficient of permeability is 5×10^{-6} cm/sec for the siltstone and ranges from 5×10^{-4} to 5×10^{-5} cm/sec for the coral limestone zone. Regarding such high permeability of the coral limestone, special attention needs to be paid to leakage protection wall to cover the surface of the limestone zone in the reservoir area up to El. 109.0 m. For treatment of high permeability of the terrace deposits and the alluvial deposits on and around the river bed portion, it is required to consider provision of a cut-off trench in the middle of the main dam so as to cut the these deposits and to keep the water tight in this portion. Groundwater level is expected to be around El. 85 m, nearby the river bed.

The reservoir area is underlain by mainly the coral limestone and the siltstone of Noele Formation. The Bobonaro claystone covers only riverbed on the upstream part of reservoir. No major fault and landslide are recognized in the field. The coral limestone extends over the right bank of the middle part of the reservoir between El. 95 to 100 m. It is prospected that water leakage through the coral limestone occurs on the right bank along the surface of Noele Formation slopes. 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 Tasiepah 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 3.

(1) Embankment material

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	95	86	CL
TP. 2	93	86	CH
TP. 3	98	84	MH
TP. 4	84	55	CL
TP. 5	100	69	CH

As physical property to oppose piping, mean value of Plastic Index (PI) is 36, 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 1.35 to 1.47 ton/m^3 and 1.43 ton/m^3 on an average, which are slightly low in comparison with 1.73 as an average of CL;
- Optimum moisture content (OMC) ranges from 26 to 31% and 29% on an average;
- The discrepancy between OMC and the natural moisture content (NMC) is approximately 10%, wetter side from OMC. Considering the time of sampling in the beginning of May, 1994, in which some rain came despite the beginning of the dry season, 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 22° and 1.62 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 for the filter of the dam embankment and concrete aggregates, are investigated in the N. Puluti river in and around the Tasiepah Embung site. Quantity and quality of the gravel materials from the N. Puluti river are sufficient for the filter drain and the concrete aggregates. However, quantity of the sand is very limited, which is estimated to be not more than 5,000m^3.

3.4 Availability of Water Resources

(1) Catchment yield

As for the N. Puluti 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 Tasiepah 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 N. Puluti 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 32.10 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
3,876	3,512	2,055	593	193	115	89	0	31	95	97	2,286	13,814

(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 formula 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	113
1 in 5 year	175
1 in 10 year	225
1 in 20 year	278
1 in 50 year	359
1 in 100 year	428
1 in 200 year	504

(3) Sediment load

There is no available data on sediment load on the N. Puluti 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 3, 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

In order to determine the optimum development scale of Tasiepah Embung, the following three cases are compared:

- Case-1 : To develop Embung with the minimum height of 21.0 m to store water necessary for meeting domestic and livestock water demand. In this case, irrigation water can be supplied to the existing wet paddy field of 160 ha during the wet season;
- Case-2 : To develop Embung with the height of 26.0 m to store water necessary for meeting domestic and livestock demand as well as for irrigating presently available farm land resources of 160 ha to the maximum extent; and
- Case-3 : To develop Embung with the maximum height of 36.0 m from the viewpoints of topography and hydrology.

(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 N. Puluti river, discharge is generated from rainfall of the Penfui station.

2) Reservoir storage curve

Reservoir storage curve with surface area is shown in Fugue 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.	1,645	36,026
Livestock (equivalent to cow)	Nos.	1,013	14,794

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

As for the irrigation water demand, maximum irrigable areas for the both wet and dry seasons are outlined below.

Annual Irrigation Water Demand

Description	Area (ha)	Demand (1,000 m^3/season)
Maximum area in the wet season	160	2,315
Maximum area in the dry season	160	2,650

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

The priority of water use is to be given to domestic water, livestock water, irrigation water for the wet season and irrigation water for the dry season in order.

6) Water level of reservoir

Minimum water level is estimated at El. 100.20 m considering sedimentation volume for 25 years and 1.00 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. 125.0 m.

(3) Optimum development scale

From the topographic and hydrological points of view, it is possible to develop the proposed Tasiepah Embung up to the maximum height of 36.0 m and create effective storage capacity of 7.096 million cubic meters (MCM). In case of the full scale development of Tasiepah Embung, however, there still remain important issues such as confirmation of geological condition and identification of water demand centers outside of the N. Puluti river basin. Under the Study, thus, the Case-2 is selected as the development scale of Tasiepah Embung. The result of reservoir operation of the Case - 2 is shown in Figure 4.2.

4.2 Delineation of Beneficiary Area

By developing the proposed Tasiepah Embung at the scale of Case-2, water demand for domestic, livestock and irrigation use can be met to the fullest extent. The beneficiary area of water supply from the Tasiepah Embung covers Nainiab, Tasiepah and Koat Sub-village of Oefafi Village and Dulurasa Sub-village of Babau Village with 1,645 inhabitants, 1,013 heads of cows and 160 ha of paddy field in total. The beneficiary area of Tasiepah Embung is shown in Dwgs. - 301 to - 303.

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 Tasiepah 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 leakage protection wall to cover the reservoir area up to El.105 m so as to keep the water tightness of the sandy limestone layer in the reservoir.

The main components of Tasiepah Embung are the main dam, spillway, river diversion conduit and water supply facility as shown Dwg. - 304. In order to provide the reservoir with the optimum storage capacity of 1,996 MCM, F.S.L. is set at El. 109.0 m. Taking overflow depth of spillway and freeboard into account, the dam hight of Tasiepah Embung becomes 26 m above the river bed. In order to release the flood discharge during the construction period, a river diversion conduit of two lanes with 1.7-m square sections is provided below the dam body. The spillway is designed on the right bank of the main dam to release the flood discharge of 430 m^3/sec from the catchment area of 32.1 km^2. For the purpose of supplying domestic and livestock water to the beneficiary area, such related facilities are provided as an intake structure in the reservoir, water supply pipe with a diameter of 400 mm below the dam body and valve house at the downstream of the main dam.

The principal features of Tasiepah Embung are summarized Below.

(1)	Reservoir	
	- Catchment area	32.1 km^2
	- F.S.L.	El. 109.0 m
	- Minimum operating level	El. 100.2 m
	- Effective storage capacity	1,996,000 m^3
	- Dead storage capacity	504,000 m^3
	- Gross storage capacity	2,500,000 m^3
	- Sediment deposition level	El. 99.2 m
(2)	Main dam	
	- Type	Homogeneous earthfill
	- Height	26 m above river bed
	- Crest elevation	El. 113.8 m
	- Crest length	200 m
	- Crest width	8.0 m
	- Upstream slope	1:3.5
	- Downstream slope	1:3.0
	- Total embankment volume	267,000 m^3
(3)	Spillway	
	- Design flood (1/100 year)	430 m^3/sec
	- Type	Non gated overflow
	- Crest elevation of overflow weir	El. 109.0 m

- Width of overflow weir	50 m
- Discharge capacity	430 m^3/sec.
- Length	210 m
(4) River diversion	
- Design flood (1/5 year)	49.4 m^3/sec
- Type	Box culvert
- Flow section	1.70 m x 1.70 m x 2 nos
- Length	170 m
(5) Water supply system	
- Inlet structure	1.0 x 1.0 m with trashracks
- pipe diameter	400 mm
(6) Leakage protection wall	
- Type	Concrete lining
- Covering area	12,000 m^2
- Thickness	0.5 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 Tasiepah 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 109.0 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. - 304.

(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 culvert of two lanes with 1.7-m square section as a diversion facility as shown in Dwg. - 306. Since the volume of flood inflows from 32.1-km^2 catchment will be quite small as compared to the storage created by constructing low cofferdams, a 2.5 m high cofferdam with a crest level of El. 90.3 m would suffice to contain the dry season flood inflow of 49.4 m^3/sec having a return period of five years.

(5) Spillway

The spillway is located on the right 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 430 m^3/sec.

Based on the result of comparative study on combination of overflow depth and width of the spillway, overflow depth at 2.5 m and width of 50.0 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. 109.0 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. - 305.

(6) Water supply system

In order to meet BHN and irrigation to the downstream water users, the water supply system is provided to release the water of 201.6 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 99.2 m. Fixed trashracks are provided on the intake structure. Cast iron pipe with diameter of 400 mm is connected from the intake structure to the downstream through the main dam. The detail of water supply inlet is given in Dwg. - 306

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. - 307.

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 the 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; 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

Beneficiary area of the domestic water and livestock water supply from the Oeltua Embung covers six villages located at along the village road at 4 km downstream of the proposed Embung site. The total beneficiary inhabitants to be supplied with domestic water is estimated at 1,645 persons based on the population projection. Further, the projected livestock population in the beneficiary area is estimated as shown below with unit water demand. Embung site is used for the multiple purposes since it is difficult to construct an open channel irrigation canal in this section due to the steep topographic condition.

Projected Livestock Population in the beneficiary area of Tasiepah Embung

Livestock	Numbers (heads)	Water demand (lit/head/day)
Cattle/Buffalo	837	40
Sheep/Goat	598	5
Pig	451	6
Poultry	2,260	0.6

Design discharge of pipelines is estimated at 1.60 lit/sec adding the design discharge of domestic water supply estimated at 1.14 lit/sec taking the above population and the domestic water demand of 60 lit/sec/day and livestock water supply estimated at 0.46 lit/sec taking the above numbers and water demands.

(3) Preliminary design

In due consideration of the above basic concept and the design discharge, the locations of pipelines and related facilities are planed to be set as shown in the Dwgs. - 301 to - 03. Design of pipelines is executed by using the Hazen Williams formula. Pipeline with a distance of around 1 km at just downstream from the proposed Embung is used in combination with the irrigation water supply (70 l/sec) since it is rather difficult for the irrigation canal of open flow to be constructed in this distance due to steep topographic conditions. In this distance, the pipe line is protected by the concrete.

Typical designs for related facilities such as check valves, air valves, blow offs and division boxes for domestic and livestock water supply and livestock water supply are shown in Dwg - 309. Required water distribution facilities for domestic and livestock water supply are summarized below :

Water Distribution Facilities Requirement

Facilities	Quantities
Pipe Line	
- Dia. 400 mm	1.1 km
- Dia. 65 mm	3.0 km
- Dia. 50 mm	5.6 km
Related Facilities	
- Check valve	6 Nos.
- Air valve	5 Nos.
- Blow off	2 Nos.
- Division box for domestic water	17 Nos.
- Division box for livestock	38 Nos.

5.3 Preliminary Design of Irrigation Facilities

(1) Basic concept

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

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

(2) Irrigation area

The wet paddy field of 110 ha in net on the left is irrigated by the existing Oefafi weir situated at 800 m downstream from the Embung site. In the right bank area there exist irrigated paddy of 26 ha commanded by temporary weirs and rainfed paddy field of 24 ha. A total wet paddy field of 160 ha is the beneficiary irrigation area of Tasiepah Embung.

In due consideration of the development scale of Tasiepah Embung and water resources allocation plan, the future irrigation plan for the proposed Project area is to be two cropping of paddy for the wet season and mungbean for the dry season both under the irrigation condition.

(3) Irrigation plan

The outlet works of the Embung are planned to be used for dual purposes of supplying irrigation and domestic water. The water taken by the intake tower provided in the reservoir is leaded to the valve house through the cast iron pipe provided under the dam foundation. Domestic water plus irrigation water for the right bank area and the irrigation water for the left bank area are diverted at the valve house with check valve and flow meter. The water at the valve house with check valve and flow meter is diverted to irrigation water for the left bank area and domestic and irrigation water for the right bank area.

Irrigation water for the left bank area diverted at the valve house is again discharged to the N. Puluti river and is taken by the existing Oefafi weir for which the rehabilitation works are required. The water is then led to the left bank irrigation area through the existing canal with some rehabilitation works.

The domestic and irrigation water for the right bank area diverted at the valve house is delivered by a pipe lines as pressure flow with a distance of 1.0 km to the diversion point from which the irrigation water is conveyed to the beneficiary area through an open channel of concrete flume with a base with of 50 cm. This plan aims to save construction of an open channel on the steep slope between the Embung site and the diversion point or that for construction of a new intake weir and head reach canal to replace the existing temporary intake weir.

General layout is shown in Dwgs. - 301 to - 303 including the layout of irrigation canals and pipe lines for domestic water supply.

(4) Design discharge and initial water level

Design discharge for canal and related structures is decided based on the irrigation water requirement and proposed cropping pattern. Peak diversion requirement for the left bank area occurs in the second half month of December and design discharge is estimated at 130 lit/sec for the net irrigation area of 110 ha. On the other hand, peak diversion requirement for the right bank area occurs in the first half month of April and design discharge is estimated at 70 lit/sec for the net irrigation area of 50 ha.

Initial water level of the irrigation canal are decided to be El. 83.5 m for the left bank taking into consideration the crest elevation of Oefafi weir. That of the open channel is El. 93.0 m considering the elevation at the diversion point of domestic water and irrigation water for the right bank area.

(5) Irrigation facilities

The proposed layout of canal and design of irrigation facilities are made based on the 1/2,000 and 1/5,000 topographic maps prepared under this Study and in accordance with the following condition:

- Canal alignment is to be straight and short as much as possible;
- The alignment is to be planned to pass outside of villages and give no damages to public facilities;
- The types of canal related structures are to be minimized as much as possible; and,
- The structures are to be simplified as much as possible.

The existing weir and canal of the left bank area are rehabilitated. The new irrigation canal for the right bank area is constructed using the concrete flume taking into account the rather small design discharge of the canal, steep topographic condition, construction method and available construction materials in the Project. area. Canal related structures required are irrigation inlet boxes, cross drain and irrigation division boxes as summarized below. Preliminary design of each facility is shown in Dwgs. - 310 and - 311.

Irrigation Facilities Requirement

Facilities	Quantities
Left bank area	
- Valve house with irrigation inlet box (including in the facilities of Embung)	1 No.
- Rehabilitation of the existing weir	L.S.
- Rehabilitation of the existing canal with related structures (around 1.6 km)	L.S.
Right bank area	
- Pipe line used together with domestic water supply (including in the facilities of domestic water supply)	Approx.1.0 km
- Irrigation inlet box	1 No.
- Concrete flume type canal with a base width of 0.5 m	Approx. 3.1 km
- Cross drain	2 Nos.
- Irrigation division box	3 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 well as taking into consideration the construction conditions such as availability of construction labor, material and equipment as well as weather and topographic condition 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 the receipt of the "Notice to Proceed", the contractor would commence the mobilization of construction equipment and key staff to the site from the beginning of November in the first year. Following this, preparatory works would be commenced at the Project site.

2) Setting out and excavation works

During the mobilization, setting out of 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 and 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 third year.

4) Commencement of reservoir water impounding

Commencement of the reservoir water impounding will be done at the beginning of October, in the third year after completion of the main dam embankment and spillway construction. Considering the rainfall in November and December in the third year, the Tasiepah reservoir would be quite full and the water could be supplied from the reservoir to the water users from January in the fourth 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 third 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 required a total floor area of 1,200 m^2 for an anticipated staff strength of 15 persons and labor force of 100 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 in the construction camp is planned to be taken from the rivers or springs near the Embung site or the wells drilled in the contractor's yard.

The electric power for the construction camp is planned to be supplied by the constructor's diesel generators with an installed capacity of 200 kW to meet the following requirements.

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 third year. The river diversion conduit would be provided along the right bank of the N. Puluti 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. -. 306.

After completion of the main dam embankment around the end of September in the third 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 third year. Considering a total embankment volume of 267,000 m^3 and the remaining dry season period of 5 months until the end of September in the third year, the daily embankment volume is to be 2,200 m^3 which is quarried from the borrow area in the reservoir.

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 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 May, in the third 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 type roller. This filter material will be hauled with 11-ton dump trucks from the river bed of N. Puluti river.

Riprap placement is scheduled to be made simultaneously as the homogeneous earth embankment of the main dam. The riprap volume is estimated to be 6,500 m^3 and the rock material will be quarried from the river bed of N. Puluti river. 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 for about 5 months from May to September in the second year. As the total excavation volume of common and weathered rock estimated to be 63,000 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 material will be stocked in the designated area. For loading the excavated materials to 11-ton dump trucks, 1.2-m^3 wheel loader 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 third 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 inlet portion of the river diversion culvert. From the plug portion of the river diversion culvert, a cast iron pipe

with a diameter of 400 mm is installed up to the downstream end of the main dam. Immediately after commencement of the river water impounding at the beginning of October in the third year, the river diversion conduit should be plugged with installation of the cast iron pipe. This pipe should be connected to the guard valve and control devices in the valve house.

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 third year.

(6) Leakage Protection Wall

Upon arrival of the construction equipment at the site, stripping and excavation for the surface of the coral limestone zones will be commenced by 21 ton bulldozer, 3.7 m motor grader for flat area and 1.2 m^3 backhoe for steep slope portion. After smooth grading and trimming for the surface of the coral limestone zone, installation of the anchor bars will be done using leg drill and D 25 reinforcement bars with mortal injection.

Concrete placing into the protection wall will be done using the 20 ton truck crane with concrete bucket (1.0 m^3) or concrete pump with capacity of 20 m^3/hr. A 3.0 m^3 agitator truck (Track mixer) should be used from the batching plant to the site. Time limit for completion of the protection wall construction will be the end of September, 3 rd year, however considering the large amount of the concrete volume of spillway and the river diversion culvert, concrete works of the protection wall will be completed before starting the concrete works of the spillway so as to not to overlap each others.

(7) Construction materials

Quantities of the major construction materials required for constructing the Tasiepah Embung are summarized below.

Item	Quantity	
Earthfill materials		
Main dam	267,000	m^3
Filter materials		
Horizontal drain	8,000	m^3
Riprap portion	2,000	m^3
Rock materials		
Riprap protection	5,200	m^3
Toe rockfill	2,000	m^3
Concrete		
Cement	3,340	tons
Reinforcement bars	265	tons
Aggregates	8,400	m^3

(8) Construction equipment

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

6.3 Construction Plan of Water Distribution and Irrigation Facilities

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