CHAPTER 5. FEASIBILITY STUDY FOR PRIORITY PROJECTS

5.1 Introduction

(1) Flood Mitigation Master Plan

Suffering Areas: Major areas suffering from flood and sediment disasters in the Study Area are southern part of Gorontalo City, middle reaches of the Bolango River, Limboto area, Isim-Pohu area, and western area of Lake Limboto. Among these, problems are more serious in the southern part of Gorontalo City near the confluence of the Bolango and Bone rivers.

Roles of Flood Mitigation: Per capita GRDP of the Study Area is far low comparing with the national average. Flood mitigation is one of the important infrastructures to support sound economic development of the basin and to stabilize people's livelihood, accordingly to alleviate poverty of the region.

Objective of Master Plan: The Flood Mitigation Master Plan (FM-MP) aims to direct or guide the flood mitigation activities that will be conducted by various agencies and organizations concerned.

Scope: The FM-MP shall cover structural and non-structural measures. The structural measures discussed in the master plan are limited to primary facilities to mitigate flood and sediment damages of the area, and the secondary facilities to be connected to the primary facilities are not included in principle.

Target Year: In line with the phasing of National Five-Year Plan, target year of the FM-MP was set at the end of Tenth Five-Year Plan in 2019. The proposed works will be implemented to support basin's socio-economic conditions at the target year.

Design Scale: Facilities for the FM-MP are planned and designed based on 20-year flood.

Component Works of FM-MP: The FM-MP is composed of following four (4) major component works:

1) Bone-Bolango River System: River improvement and construction of Tamalate

floodway

2) Lake Limboto System: River improvement and Lake Limboto management: including Tapodu River improvement with Tapodu Gate
3) Watershed Management and Flood Plain Management

Implementation of Master Plan: The Flood Mitigation Master Plan (FM-MP) is proposed for implementation by the target year of 2019. The FM-MP is proposed to be implemented stage-wise as follows:

1) Preparatory stage : Until end of 2004
2) Intensive implementation stage : From beginning of 2005 to end of 2009
3) Sustainable implementation stage : From beginning of 2010 to end of 2019

(2) Priority Project

Intensive Implementation: During the period of the Eighth National Five-Year Plan from 2005 to2009, actual construction works at site and activities for watershed management and flood plain management will be implemented intensively. Through the intensive implementation, it is expected the flood mitigation activities in the basin will be stimulated and related personnel and administration will be trained and adjusted toward effective implementation of the project.

Priority Projects Selected: The Priority Projects selected include structural measures and non-structural measures. The structural measures selected for the intensive implementation are:

1) Lower Bone River Improvement
2) Lower Bolango River Improvement
3) Tapodu River Improvement with Tapodu Gate
4) Tamalate Floodway
5) Sediment Trap Works in Lake Limboto

The following non-structural measures will be implemented within a framework of the intensive implementation as follows:

1) Watershed management by encouraging activities to conserve flood-water and sediment retention function the watershed areas, and

2) Flood plain management by guiding and promoting activities to improve vulnerability of the local community and individuals in the flood plain areas.

(3) Sub-projects for Feasibility Study

The Feasibility Study is to be conducted for the structural measure components of the Priority Projects. The structural measures are further rearranged as following three projects each of which has common functions and inseparable benefits mutually related:

1) Bone-Bolango-Tapodu (BBT) River Improvement Project, which consists of improvement of the lower Bone, lower Bolango and Tapodu rivers with Tapodu Gate.
2) Tamalate Floodway Project
3) Sediment Trap Works in Lake Limboto

5.2 Supplementary Surveys and Review of Master Plan

5.2.1 Supplementary Surveys and Investigations

Supplementary data for the Feasibility Study of the priority project(s) were collected and analyzed at the inceptive period of the Feasibility Study. Detailed field reconnaissance was also made in the priority project areas. In parallel to the data collection and field reconnaissance, the following supplementary field surveys were carried out:

1) River Survey and Topographic Mapping
2) Geological Investigation
3) Investigation for Environmental Impact Assessment (EIA)

The Indonesian contractor implemented the above surveys and investigation under sublet contract with the Study Team.

(1) River Survey and Topographic Mapping

For the purpose of preliminary facility design on the Feasibility Study level, detailed river survey of the proposed rivers and facility sites were carried out. Topographic survey and topographic mapping based on the existing aerial photos were also conducted for the proposed rivers and facility sites as follows:

1) River Survey:
   - Lower Bone River: 1.5 km
   - Lower Bolango River: 6.5 km
   - Tapodu River: 2.5 km
   - Alo-Pohu and Biyonga rivers in relation with sediment trap works: 3.0 km
   - Tamalate and middle Bone rivers in relation with Tamalate Floodway: 2.0 km
2) Topographic survey of proposed site for Tamalate Floodway: 2.0 km^2 with scale of 1/5,000
3) Topographic mapping of proposed river improvement sites: 9.5 km^2 with scale of 1/5,000

Location map for the river and topographic mapping is shown in Figure 5.2.1.

(2) Geological Investigation

For the foundation treatment of major structures for the selected Priority Projects and to obtain physical properties as construction materials, geological investigation of subsurface layers by core boring and laboratory soil tests were conducted as follows:

1) Core drilling with standard penetration test at the following proposed sites:
   - Tapodu Gate site: 8 boreholes, total 165m
   - River work sites : 2 boreholes, total 30m
   - Diversion facilities for Tamalate Floodway: 1 borehole, total 15m
   - Estuary of Bone River: 5 boreholes, total 25m
2) Laboratory tests of earth core materials:
   - Grain size analysis
   - Physical property tests for dike embankment and concrete aggregates.

Location of the Geological investigation is shown in Figure 5.2.2.

(3) Investigation for Environmental Impact Assessment (EIA)

The main objective of the EIA Study is to examine and evaluate the conceivable impacts on both natural and social environment to be affected by the Priority Projects subject to the Feasibility Study. The objective also includes the recommendation on necessary countermeasures to make the Projects environmentally sound and sustainable. The main components of the EIA Study are:

1) To prepare KA-ANDAL (TOR of the EIA Study) for the Projects;
2) To grasp the existing environmental conditions in and around the Project sites by data collection and its analysis focusing on natural and social environments;
3) To identity, predict and evaluate the conceivable environmental impacts brought about by the Project implementation;
4) To develop and recommend the mitigation measures, and environmental management plan (RKL) and monitoring plan (RPL):
5) To prepare ANDAL (EIA report) for the Projects; and
6) To support the dissemination and the approval of KA-ANDAL and ANDAL to and/or from the AMDAL Commission (EIA Appraisal committee) and other relevant organizations and local community.

5.2.2 Toheti-Dahua Multi-purpose Dam

Toheti-Dahua flood control dam scheme was studied as an alternative measure in comparison with channel improvement works of the Bolango River. The dam scheme was not adopted as a component of the Flood Mitigation Master Plan of the LBB basin mainly due to economic viability. However, this does not mean to deny the dam scheme with multi-purpose function.

Considering the water demands in the middle Bolango river basin and the water supply further to western Limboto areas where suffer from shortage of water resources, Toheti-Dahua multi-purpose dam would be required by the water user in the basin. And once the dam was constructed, the dam reservoir functions much for flood mitigation in the middle and lower basins of the Bolango River including the city of Gorontalo. According to results of site reconnaissance and geological investigation by the Study Team, the site of Toheti-Dahua dam is recognized to be suitable geologically and topographically to dam site.

Construction of the dam, however, required big cost and give favorable and unfavorable impacts to the surrounding nature and society. Careful studies are therefore required for the plan and design of the dam. In view of these, investigation and study items required for the planning and design of Toheti-Dahua multi-purpose dam were discussed.

Existing data were reviewed and study and survey items were recommended for future study. Data available for the study and planning Toheti-Dahua multipurpose dam are very few for all the items; among others shortage of hydrological data is serious.

Unlike other data, hydrological records can be made available only by persevering long period observation activities. For a reliable planning of water resources development, it is generally said that 20 years of records are at least necessary. Intensive studies on the rainfall and runoff characteristics would be necessary covering broader area of similar hydro-meteorological conditions, using all the observation records available in the area.

5.2.3 Study on Lower Bone-Bolango River

(1) Existing River Facilities

Existing river facilities includes dikes, bank protection works, drainage culverts, and other river-crossing facilities as bridges.

Since these facilities were constructed by various agencies of Gorontalo and North Sulawesi provinces, Kabupaten Gorontalo, and Kota Gorontalo, even the provincial government does not always has clear grasp of the conditions of the existing river facilities. Inventory of these facilities were not available yet. Therefore, the Study Team carried out field investigation on the existing facilities and prepared a temporary inventory on the field data basis.

Figure 5.2.3 show the approximate locations of the existing river facilities. According to the Figure, distribution of the existing river facilities is outlined as follows:

1) In the stretch of the Bolango River from the confluence of the Bone River to the confluence of the left and right Bolango rivers (Stretch-I), gabion works are found on the left bank near the upper end of the stretch, and concrete flood-walls on the left bank near the lower end.
2) In the left Bolango River (Stretch-II_L), existing river facilities are sporadic sandwiched by built-up areas as a whole. Dikes (concrete flood-walls and some earth dikes) are provided on both banks in the upper half of this stretch and bank protection works by gabion (Bronjong) at the lower end.
3) The right Bolango River (Siendeng River: Stretch-II_R) is provided with bank protection works made of gabion (Bronjong). Earth dikes and flood walls are located sporadically in the upper half of the stretch.
4) In the upstream reaches of divergence of the left and right Bolango rivers (Stretch-III), the Bolango River is provided with earth dikes on both banks for almost entire stretch including partially flood-wall made of cobble concrete. Bank protection works are sporadic.
5) There are eight (8) road bridges and two (2) footpath bridges

Through the investigation works of the existing river facilities, the following river related issues were recognized:

1) **Coordination among Implementing Agencies:** The river facilities have been constructed by local governments of Gorontalo Province and Kabupaten/Kota Gorontalo, seemingly, with less mutual communication and coordination. The river is a continuous system and its improvement should be carried out according to a plan authorized by the relevant agencies.

2) **Sequence of Works:** Looking at the distribution of the existing river facilities, diking system has been constructed in the upper reaches (Stretch-III) before the improvement in the lower reaches. The diking system might concentrate floodwater to the lower reaches (urban areas of Gorontalo City). This sequence of works is probably resulted from the difficulty in land acquisition. River improvement in the lower urban area (Stretches I and II) is urgently needed.

3) **Incomplete Works:** In some sections of dike, especially for concrete flood-walls, incomplete works are found; for instance, discontinuous dike at a house thrust into the river, opening dike at the confluence of tributary, lowered dike at bridge crossing, etc. These incomplete sections make other part of continuous dike useless, since flood water would easily be spilt over lands through these sections. These incomplete works would be brought from the shortage of time for land acquisition and less considerations for project functions giving more attention to the progress of works.

These issues show up the difficulties in land acquisition and implementation of river improvement works under yearly budgeting system.

(2) Existing Channel Capacity

Contour map of the flood prone area in Gorontalo City is shown in Figure 5.2.4. Using the latest survey sections conducted at smaller intervals, existing channel capacity was examined by non-uniform flow calculations. Results of the flow calculation are shown in Figure 5.2.5.

According to the result of calculation, channel capacity of the Bolango River was evaluated as follows:

1) Stretch-I: 100 m^3/s except for some sections.

2) Stretch-II_L: 75 m^3/s.
3) Stretch-II_R: 75 m^3/s except for some sections.
4) Stretch-III: 200 m^3/s except for some sections.

Judging from the existing capacity of the Stretch-III, the Stretch-II ($=II_L+II_R$) and Stretch-I should be improved so as to have 200 m^3/s at least.

(3) Riverbed of Lower Bone River

Abrupt drop of riverbed at the mouth of the Bone River was recognized by the aerial photo and site reconnaissance. The drop was also confirmed by the river survey as shown in Figure 5.2.6. The depth of the Bone River of around one meter increases abruptly to more than 70 meters, in front of the oil tank yard of Pertamina.

Cause of the abrupt riverbed drop was initially supposed to be the existence of rock exposed on the riverbed, because the river is sandwiched by hills formed with granite. If so, removal of the rock may contribute to lower the flood water level in the Lower Bone River and accordingly to promote drainage of the southern part of Gorontalo City.

In order to confirm the geological conditions of the Bone estuary, borings were carried out at five holes and the results are summarized in Figure 5.2.7. From the investigation, it was disclosed that the riverbed of the Bone estuary was filled with thick sediment of sand and gravel. No rock was found at any bore holes.

Based on the results of geological investigation, the abrupt drop of riverbed was judged to be the front limb of sediment deposit in deep water. Riverbed excavation under such geological condition may be, in general, difficult to be maintained, being filled up again soon.

5.2.4 Control of Bolango Flood by Lake Limboto

(1) Necessity of Review

In the Master Plan prepared in the previous study stage, the Bolango River was planned as an independent system from Lake Limboto without considering its flood control function, so as not to adversely affect the environmental and other physical conditions of the lake. However, according to the field survey data and information obtained

during the Feasibility Study period, the following facts were disclosed:

1) **Difficulty in Land Acquisition:** The Bolango River is sandwiched by densely built urban buildings, especially in the downstream reaches from the divergence of left and right Bolango rivers. Implementation of the river works has been constrained by the land acquisition problems. The dike works in the downstream reaches are not many and discontinuous because of land acquisition and house compensation problems. Local government agencies expressed anxiety on the difficulty of land acquisition and compensation along the Bolango River. In planning the future river improvement, this matter should also be taken into account for smooth implementation of flood mitigation without social conflict, minimizing the quantity of land acquisition and compensation for the work.

2) **Use of Existing River Facilities:** In the upper half of the Lower Bolango River, the river channel has been confined by narrow diking system. Besides the dike, there are 8 road bridges crossing the Lower Bolango River. These river facilities should be utilized as they are, as much as possible, for the effective use of the past public investment.

3) **Existing Flood Control Function:** According to the site information and flood flow analyses disclosed that a large amount of the floodwater of the Bolango River flows into the lake under the present condition and the lake have been playing a vital role in the flood peak reduction of the Lower Bolango River.

Necessity of Flood Control by Lake Limboto: In order to solve the issues mentioned above, it is necessary to reduce the design discharge of the lower Bolango River and to lower the design high water level. These could be realized only by flood control with Lake Limboto. Taking the above facts into consideration, flood control by Lake Limboto was finally adopted for the Bolango River Improvement as the second best solution.

(2) Revision of Design Discharge Distribution

In order to evaluate the flood control effects of Lake Limboto, flood storage calculations were conducted under the conditions and assumptions described below.

Discharge Distribution: After a comparative study on alternative design discharges of the Bolango River of 150, 200 and 250 m^3/s around the existing channel capacity, discharge distribution at the confluence of the Bolango and Tapodu River were set as follows based on 20-year flood:

- Discharge from upper Bolango basin: 750 m^3/s
- Discharge of lower Bolango River: 200 m^3/s
- Discharge controlled by lake: 550 m^3/s

The above discharge distribution requires the minimum total number of houses to be relocated of the Lower Bolango/Bone River and the Tapodu River. According to the flood storage calculation the lake water level is raised by 14 cm only due to the flood inflow of the Bolango River for the 20-year flood.

As a result, the design discharge distribution proposed for the Flood Mitigation Master Plan (FM-MP) was revised as shown in Figure 5.2.8.

(3) Flood Storage Calculation

Initial Lake Water Level: Lake water level at the beginning of flood storage was assumed as follows:

1) +4.90 m,MSL for the present lake with existing channel condition: Taking the average of annual maximum water level excluding those of 1992 and 1993 which were affected by artificial excavation of the outlet channel (Tapodu River). Under the existing condition the drawdown of the lake water level is very slow because of small outlet channel.
2) +4.40 m,MSL for the lake with improved Tapodu River and Gate: Considering the assumed overflow depth above the weir crest at +4.00 m,MSL due to base-flow runoff from the tributaries of the Lake Limboto.

Tapodu River: Lake Limboto and the Bolango River is connected with the Tapodu River of 1,516 m in length. The discharge of the Tapodu River was calculated depending on the water levels of the Bolango River and the lake. Therefore, the river water flows both directions, regularly (from the lake to the Bolango R.) and reversely (from the Bolango R. to the lake). Single section channel was assumed for the Tapodu River with riverbed elevation +2.00 m,MSL and side bank slope of one on two. River

width was determined to be 70 m at the riverbed in the process of trial and error by storage calculations so that the reverse flow would be 550 m^3/s at maximum based on 20-year flood.

Control of Tapodu Gate: Tapodu Gate installed at the outlet to the Bolango River was assumed to be kept open as far as the lake water level is higher than +4.40 m,MSL.

(3) Flood Control by Lake Limboto

Flood control by Lake Limboto was simulated using the flood storage model for the 2, 5, 10 and 20 year probable floods under the existing and improved channel conditions. Results of simulations are summarized in Figure 5.2.9 and the maximum lake water levels are shown below.

Condition of the Tapodu	Maximum lake water level (m,MSL)			
	2 yr	5 yr	10 yr	20 yr
Existing	5.081	5.213	5.322	5.434
Improved	4.675	4.900	5.077	5.247

Focusing on the 20-year flood with the improved Tapodu River, discharge and water level hydrographs are shown in Figure 5.2.10. The maximum lake water level still remains below the design high water level of the lake.

5.3 Facility Plan

5.3.1 Basis of Facility Plan

(1) Design of River Channels

Channel Flow Calculation: Surface profiles of the flood flows shall be calculated basically by uniform flow formula because of relatively steeper channel slope in the Study Area. Non-uniform flow calculations are applied to the reaches where back-water and drawdown water profiles are dominated and to the final checks of flow profiles. Manning's roughness coefficients for the flow calculations are assumed as follows;

n = 0.030 for ordinary low-water channel
n = 0.060 for high-water channel

Standard River Section: Standard river sections are designed for each river stretch which need improvement. The standard section shall be modified, if necessary, section by section depending on the situation. Course of the Bone-Bolango-Tapodu (BBT) River is stable as a whole and the channel forms single section surrounded by house buildings and the dike located close to the riverbank. Considering such conditions of the existing river, low-water channel shall be designed so as to carry the design discharge as single section channel.

Dike and High-water Channel: Dike shall be provided to prevent floodwater from spilling over the land. High-water channel between the low-water channel and dike is to be provided primarily not for the floodwater conveyance but for the safety of dike against bank erosions and slope failures. The dike alignment shall be smooth allowing free flood flows.

Width of High-water Channel: In case bank protection is not provided, width of high-water channel shall be taken enough to the bank during a flood season. Considering the data on bank erosion rate in Japan, the width was proposed as shown in Figure 5.3.1.

Length of Sure-Footing: Most of the failures of bank protection works are caused by scouring at the toe of the revetment work. Sure-footing works are important for the durability of the revetment. The length of the sure-footing shall be determined

referring to the Figure 5.3.1.

Dike: Earth dike and concrete floodwall would be the major types of dike to prevent floodwater from spilling over the land. Earth dike shall be adopted in principle because of its durability and easiness to repair and strengthening even during the flood. Concrete floodwall shall be applied where the earth dike cannot be constructed owing to land and other unavoidable reasons. Standard earth dike section and free board necessary for the safety of dike are shown in the Figure 5.3.1.

(2) Design of River Structures

Design Standards and References

Material Standard: Applied Standards are as follows:

- SNI (Standar Nasional Indonesia)
- SII (Standar Industri Indonesia)
- JIS (Japan Industrial Standard)
- ASTEM (American Society for Testing and Material)
- AASHOT (American Association of State Highway and Transportation)

Design Standard: Applied Standards are as follows:

- PBI (Peraturan Beton Bertulang Indonesia 1971 N.L-2)
- Peraturan Muatan untuk Jembatan Jalan Raya No.12/1970 (Indonesian Loading Specification for Highway Bridge)
- Technical Standards for River and Sabo issued by The Ministry of Construction, Japan
- Design and Planning Criteria for Land Improvement Works issued by The Ministry of Agriculture Forestry and Fishery, Japan
- Specifications for Road Bridge issued by The Association of Road Construction, Japan

Loading Conditions

Dead Load: The unit weights of materials for calculating the dead load are as follows:

- Reinforcement concrete (for bridge) 2.50 t/m^3
- Reinforcement concrete (for structure) 2.40 t/m^3
- Plain concrete 2.30 t/m^3

-	Water	1.00	t/m^3
-	Embankment material (dry)	1.80	t/m^3
-	Embankment material (submerged)	1.00	t/m^3
-	Asphalt pavement	2.30	t/m^3
-	Soil (clay)	1.70	t/m^3
-	Soil (sand)	1.80	t/m^3
-	Rubber dam (by 2.0m height)	0.40	t/m^1

Wind Load: The wind load is assumed at 100 kg/m^2 by the pressure.

Machine Load: The gate and machine load shall be decided depending on actual loads.

1) Tamalate Flood Way:
   - Inspection bridge: 225.0 t (normal), 140.0 t (seismic)
2) Tapodu River Improvement with Tapodu Gate :
   - Crossing Bridge (25.0m): 165.0 t (normal), 100.0 t (seismic)
   - Crossing Bridge (20.0m): 130.0 t (normal), 85.0 t (seismic)
   - Gate leaf: 9.0 t
   - Hoist Machine: 5.0 t
   - Lifting Load: 15.0 t

<u>Allowable Stress</u>

According to the Indonesian Concrete Code, the following allowable stress shall be applied in the structural analysis.

1)	Concrete:	Class-C (structural)	Class-E (massive)
	- Design strength	210 kg/cm^2	180 kg/cm^2
	- Bending comprehensive stress	70 kg/cm^2	60 kg/cm^2
	- Shearing stress	3.6 kg/cm^2	3.6 kg/cm^2
	- Tensile stress	0 kg/cm^2	0 kg/cm^2
	- Bond stress	14 kg/cm^2	14 kg/cm^2
2)	Reinforcement bar:		
	- Tensile stress	1,400 kg/cm^2 (normal), 2,100 kg/cm^2 (seismic)	
3)	Increase of allowable stress:		
	- In case of flood	0 %	
	- Incase of seismic/construction	50 %	

5.3.2 Design of Bone-Bolango River

(1) Particular Site Conditions and Principles for Design

Names of rivers and bridges across the rivers are specified as shown in Figure 5.3.2 for the conveniences of descriptions.

Lower Bone River: Length of stretch is about 1.1 km from river mouth to the confluence of the Bolango rivers. The river is affected by tides. The river is sandwiched by granite hills with narrow flat plain. Riverbed is filled up with deep sediment with abrupt drop at its lowest end. Bank protection works are provided to protect the road adjacent to the road.

No excavation/dredging nor dike works are proposed. Bank protection shall be provided at the eroded banks.

Bolango River Stretch-I: Stretch length is about 1.1 km from the confluence of the Bone River to the confluence of the left and right Bolango Rivers. Tidal movement affects the river flows. Densely built-up areas are located on the left bank in the upper portion of this stretch. River bank elevation is absolutely low, and the riverine areas are flooded by the floods from the Bolango and Bone rivers and storm water gathered from relatively high surrounding areas. Concrete floodwall and bank protection works made of gabion (Bronjong) are provided partly.

No channel excavation is proposed. Dike shall be provided on both banks, and the bank protection at the eroded banks.

Bolango River Stretch-II_L: Stretch length is about 2.1 km from the confluence of the right Bolango (Siendeng) River to the divergence of the said river. River channel in this stretch is surrounded by densely built-up areas of the Gorontalo City. In the reaches downstream from Siendeng Bridge, flooding conditions are similar to those of the Stretch-I with the low elevation riverbank and the channel affected by the Bone floods and tidal movements. Bank protection works (Bronjong) are the main facilities in the lower reaches of this stretch, and in the upper reaches concrete floodwall and earth dike are provided.

Channel improvement shall be limited to minor one using fully the existing capacity.

Concrete floodwall shall be provided for the whole stretch, and partly existing dikes shall be strengthened.

Bolango River Stretch-II_R: Stretch length is about 1.7 km from the confluence of the left Bolango River to the divergence of the said river. The river called as the Siendeng River or the Right Bolango River takes route at the skirt of the hilly land on the right bank. In the reaches downstream from Siendeng-2 Bridge, flooding conditions are similar to those of the Stretch-I with the low elevation riverbank and the channel affected by the Bone floods and tidal movements. In the upper portion of this stretch, large channel meander exists. Bank protection works (Bronjong) are provided at the major eroded sections on both banks for the whole stretch. Dikes, earth dikes and concrete flood walls, were also installed intermittently in the upper portion of this stretch.

The Stretch-II_R shall be improved as main flood channel of the Lower Bolango River. Whole stretch of channel shall be excavated by widening and deepening. Dikes shall also be installed where the ground elevation is not high enough. In order to minimize the land to be acquired, bank protection is provided for the whole stretch on both banks.

Bolango River Stretch-III: Stretch length is about 2.8 km from the divergence of the left and right Bolango rivers to the confluence of the Tapodu River. Existing river course seems to be stable as a whole surrounded by natural levees on both banks. Continuous earth dikes are installed along almost all stretch. Concrete floodwalls and bank protection are also installed locally. The existing dike shall be strengthened and the incomplete dike works due to existing buildings and structures shall be completed.

Channel shall be excavated and existing dike shall be strengthened. Bank protection is provided for the reaches subject to the channel excavation.

(2) Hydraulic Design Values and Site of Works

Design Discharge: Figure 5.3.3 shows the design discharge distribution based on 20-year flood. Discharge distributions for other return periods are also shown in the Figure. The design discharge is compared with the existing bank-full channel capacity in Figure 5.3.4. If the freeboard is taken into account, the effective channel capacities are less than those shown in the Figure.

Design High Water Level (DHWL): DHWL was set to be +6.10 m,MSL at the confluence of the Tapodu River and the slope of the DHWL was set to be 1/1200 as shown in Figure 5.3.5, considering the elevations of riverbanks and existing dike crown along the river. The DHWL at each river stretch is summarized below.

River	DHWL (m,MSL)	Slope
Lower Bone R.	+1.17 to +2.62	1/780
Lower Bolango R.		
Stretch-I	+2.62	Level
Stretch-II_R	+2.62 to +3.80	Level, 1/1200
Stretch-II_L	+2.62 to +3.80	Level, 1/1760
Stretch-III	+3.80 to +6.10	1/1200

Site of Channel Improvement Works: In order to convey the design discharge smoothly and safely below the DHWL, channel works shown in Figure 5.3.6 are required. Except for the dike and bank protection works, the following major channel works were proposed, of which design features are described in the following sub-sections:

1) Cut-off channel at Tenda
2) Channel excavation of the Right Bolango River including normalization of meandering sections and channel realignments at the divergence of the Left Bolango River.
3) Channel excavation in Stretch-III of the Lower Bolango River downstream reaches from Tenilo Bridge.

(3) Cut-off Channel at Tenda

At about 150 m downstream of the confluence of the Left and Right Bolango rivers, the Lower Bolango River is forced to bend almost at right angle (Figure 5.3.7). Due to the bend, floodwater level is raised by about 40 cm according to the preliminary estimate for the 20-year flood. This raises the water levels of the both rivers around the confluence. At about 250 m upstream of the confluence, the Left Bolango River also bends its course almost at right angle. At the bend, floodwater often overtops the left bank and runs toward the Bolango River causing damages in the area. Coping with the above problems, a cut-off channel (COC) was proposed as shown in the Figure 5.3.7. Judging from the change in riverbed profile, drop structure or riverbed consolidation

work was not planned at the lower end of the COC. The COC is expected to have following functions:

1) To promote drainage of the Left Bolango River, shifting the confluence toward downstream. According to the flow calculations water level is lowered, due to the COC, by 21 cm at maximum in the Left Bolango River and by 17 cm in the Right Bolango River under the design flood condition.
2) To make Tenda area free from flooding, changing the river course of lower portion of the Left Bolango River.
3) To alleviate water-level rising at the sharp bend downstream of the existing confluence, reducing the river discharge.

(4) Channel Excavation of Right Bolango River

Right Bolango River as Main Flood Channel: The Right Bolango River shall be improved as a main flood channel of the Lower Bolango River, since the floodwater should be led apart from the city center and the acquisition of lands for the river improvement is relatively easier. The design discharge of the Right Bolango River is 125 m^3/s, while the Left Bolango River shall be subjected to minor improvement with existing channel capacity of 75 m^3/s.

Normalization of Right Bolango River: The channel works of the Right Bolango River include (1) normalization of meandering sections and (2) re-alignment of channels at the divergence of the Left Bolango River as well. The Right Bolango River meanders severely in its upper reaches. The meandering shall be normalized for smooth and safe passage of floodwater flows. Outline of the channel normalization is shown in Figure 5.3.8. According to the flow calculation, water level is lowered by 19 cm at maximum due to the normalization of meandering sections under the design flood condition.

Realignment of Channels at Divergence: The channel of the Lower Bolango River in Stretch-III is connected straightly to the Left Bolango River at the divergence of the Right Bolango River. River channel should be realigned so as to guide the floodwater into the Right Bolango River as shown in the Figure 5.3.8. At the divergence of the Left Bolango River, a consolidation work of river section was planned to control the diverging flow within design discharge (75 m^3/s) for 20-year flood.

(5) Channel Excavation in Stretch -III

In order to increase the channel capacity in the Stretch-III of the Lower Bolango River, channel excavation was proposed for the reaches from the divergence of the Left Bolango to Tenilo Bridge.

At the upper end of Stretch-III (upstream of Potanga Bridge), a consolidation work of river section was planned to control the discharge downstream of the Lower Bolango River being kept below the design discharge (200 m^3/s) for 20-year flood.

(6) Design of Appurtenant Facilities

Bridges are the major appurtenant facilities. There are eight (8) road bridges and two (2) footpath bridges crossing the Lower Bolango River. Out of these, two (2) road bridges and one (1) footpath bridge need re-construction, two (2) bridges need heightening in relation with the channel improvement works. One new bridge across the Tenda COC also needs to be constructed. Name of the bridges requiring works are summarized below:

River/Bridge	Required works
Stretch-I / Tenda Br.	Heightening
Stretch-II_L / New Br.	New bridge for Tenda COC (4 m x 24m)
Stretch-II_L / Footpath Br.	Re-construction (4m x 25m)
Stretch-II_R / Siendeng-2 Br.	Re-construction (4m x 32 m)
Stretch-II_R / Donggala Br.	Re-construction (4m x 32 m)
Stretch-III / Tenilo Br.	Heightening

5.3.3 Design of Tapodu River with Tapodu Gate

(1) Particular Site Conditions and Principles for Design

Component Works: Tapodu River Improvement Project includes construction of (1) Tapodu River, (2) Tapodu Gate, and (3) lake/river dikes as component works. The main functions of the Tapodu River are to lead floodwater of the Bolango River to the lake and to drain stored water to the Bolango River as fast as possible preparing for the forthcoming floods. Tapodu Gate installed across the Tapodu River primarily serves for maintaining lake water level above + 4.00 m,MSL for fishery. The lake/river dikes

aims to protect the surrounding villages from the lake water. General layout of the Tapodu River Improvement with Tapodu Gate is shown in Figure 5.3.9.

Topography: The proposed site is a part of the low-lying area located at the outlet of the lake. Ground elevation is around +4 to +5 m,MSL. The area is presently suffering from long lasting inundation due to floodwater from tributaries of the Lake Limboto and that from the Bolango River as well.

Geology: Tapodu gate is proposed to be installed across the Tapodu River at the outlet of Lake Limboto. No base rock was confirmed according to the drilling works. However, recent deposits of sandy gravel are distributed in the river section. Sandy gravel layers of more than 30 in N-value appear to have sufficient strength for foundation of the structures. The area seems to be once a part of the course of the Bolango River judging from the existence of gravel layers.

Long Lasting High Water: The lake area is huge ranging from 28 km^2 at +4.00 m,MSL to 50 km^2 at +5.00 m,MSL. Because of the wide lake area, if the lake water is once raised high, it takes long period to draw down for a few months. This matter should be kept in mind for the facility design.

(2) Design of River Channel

Design Discharge: The design discharge was decided to be 550 m^3/s in reverse flow (from the Bolango River to Lake Limboto).

River Route: Route of the proposed Tapodu River was selected as shown in the Figure 5.3.9. The route were decided considering the existing channel route and the open space so as to minimize the land acquisition and house compensation.

Longitudinal Profile: Riverbed was designed to be level at +2.00 m,MSL considering the bed elevations of the lake and the Bolango River, and flow directions of both regular and reverse flows. Total improvement length is about 2,830 m, out of which river stretch confined by the dikes is 1,850 m long. Design high water level (DHWL) of the lake is +5.50 m,MSL and elevation of the lake dike crown is +6.50 m,MSL taking 1-m freeboard, while DHWL of the Bolango River is +6.10 m,MSL with dike elevation of +6.90 taking freeboard corresponding to the design discharge. The longitudinal profile of the Tapodu River is shown in Figure 5.3.10.

Standard Design Section: Required width of the Tapodu River was determined according to the flood storage calculations. The design riverbed was decided to be 70 m with bank slope of one (vertical) on two (horizontal). Bank protection works are not provided for the river channel except for the river bends. In stead, 15 m wide high-water channels of were provided on both banks between the earth dike and the low-water channel considering the safety of dike against erosion. It is also proposed that the high-water channels should be covered with vegetation to resist the erosion. In the downstream of Tapodu Gate, high water channels were not provided since the riverbanks were protected.

Hydraulic Model Test: In order to design the appropriate channel shape to ensure the discharge diversion and to investigate the sediment movement at the confluence of the Bolango and Tapodu rivers, hydraulic model test should be carried out at the detailed design stage.

Further Study on Sedimentation: Sedimentation is anticipated on the riverbed of the Tapodu and its confluence with the Bolango River. Further studies on the method of maintenance and the use of the sediment materials should be made at the detailed design stage. The improvement of the Tapodu River may increase the turbid water inflow to Lake Limboto from the Bolango River. Influence of the turbid water should also be studied at the following stage.

(3) Design of Tapodu Gate

<u>Design Conditions of Gate:</u>

The hydraulic conditions around the proposed Tapodu Gate are summarized below.

1) Lake water level
   - Design high water level: +5.50 m,MSL
   - Minimum water level to be maintained: +4.00 m,MSL
2) Tapodu River
   - Design discharge: 550 m3/s
   - Design high water level: +5.50 to +6.10m,MSL
   - Riverbed elevation: +2.00 m,MSL
   - Design dike crown: +6.50 to +6.90m,MSL
   - Low-water channel width (bottom): 80 m

River width (dike to dike): 110 m

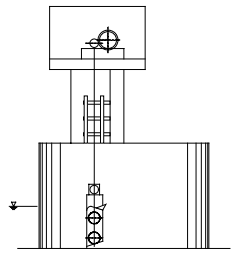
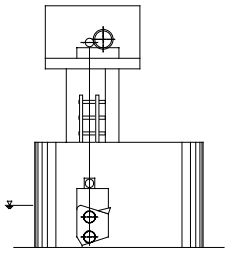
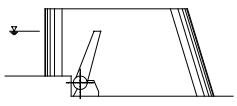
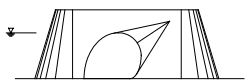
3) Bolango River
   Design high water level: + 6.1 m,MSL
   Design dike crown: + 6.9 m,MSL
4) Tapodu Gate
   Design discharge: 550 m3/s
   Design high water level (lake-side): +5.50 m,MSL
   Design high water level (Bolango-side): +6.10 m,MSL
   Bed elevation: +2.00 m,MSL

Gate Operation: Tapodu Gate shall be operated under the following conditions:

1) Gate shall be closed to keep the lake water above +4.00 m,MSL.
2) The gate shall be fully opened to lead floodwater of the Bolango River to the lake or to drain the stored water as fast as possible so as to keep the lake water level below +5.50 m,MSL.

Selection of Gate Type:

Type of Control Gates: As a type of control gate like Tapodu Gate, fixed wheel gate, flap gate and rubber gate is generally considered to be applicable. In case of fixed wheel gate, the gate is further categorized into two types, namely girder and shell types, according to the ratio of height and span. Where the ratio of height and span is less than 1/10, the shell type is generally adopted. Since the Tapodu Gate has a height of 2 meters, the shell type should be selected for the span of 10 meters or more. In case of the span less than 10 meters, the girder type can be adopted. The principal profile of each type is shown below.

			
Girder type fixed wheel gate	Shell type fixed wheel gate	Flap gate	Rubber gate

Selection of Gate Type: Where sedimentation heavily occurs like the Tapodu River, the flap gate is not suitable, because the gate will not lie down flatly due to sedimentation. Thus, the fixed wheel gate and rubber gate were considered as the applicable type of gate. Taking account of the requirements for the Tapodu Gate, the functional characteristics are compared between the fixed wheel gate and rubber gate in Table 5.3.1.

Through the comparative study on functional characteristics and economical efficiency, the rubber gate was judged suitable for Tapodu Gate, having advantages over the fixed wheel gate mainly on the following aspects:

1) **Light Weight:** Bearing capacity of gate site is low with thick and soft sediment layers. The rubber gate is light in weight and requires lighter civil structure. The construction work is also easier and shorter in period.

2) **Simple Operation and Maintenance:** The rubber gate is capable to open (deflate) without power. Accordingly, the operation at flooding is reliable. Operation system consisting of engine blower and piping is simple in structure for maintenance. No electric power supply is required for operation and protection system. Running cost of diesel engine, as the prime mover, is economical compared with the diesel engine generator.

3) **Enough Durability:** Lifetime is long enough provided that the maintenance is suitably made for the rubber body.

From the design requirements for both regular and reverse flows, double clumping type of rubber gate is selected.

Design of Gate:

Weir: The weir functions as a settling layer for rubber gate anchoragement. Considering the required space for movement of rubber gate deflated during regular and reverse flow directions, a 19.0 m wide concrete slab was designed as main slab.

Apron: Aprons were designed for both sides (upstream and downstream) of the weir (main slab). The apron shall have functions (1) to prevent piping and (2) to dissipate flow energy by forming hydraulic jump as stilling basin.

General layout of the Tapodu Gate is shown in Figure 5.3.11.

(4) Lake Dikes and Sluices

Tapodu River and Lake Dikes: Dikes along the Tapodu River is required to protect the settlement and farmlands from the Bolango floodwater led by the improved Tapodu River. The lake dikes connected with the Tapodu dikes were also proposed for the effective use of the excess excavated material of the Tapodu River. North and south dikes were proposed. Length of the north dike is 3,150 m and the south dike is 2,130 m. The dikes were designed with crown elevation at +6.50 m,MSL taking 1-m freeboard. The dike crown is paved with gravel bedding (2.0 m width and 0.20 m thickness) as inspection and rural road. The standard dike section is shown below.

Intake Sluice: Considering existing water use, local drainage, and conservation of existing river environment (for such as eel), the existing right and left Tapodu channels will be kept run. For this purpose, an intake shall be installed at the head of each channel across the dike. Two (2) slide gates with 2.00 m width x 1.50 m height were proposed to control the water discharge during normal conditions.

Drainage Sluice: The existing Tapodu channels are drained into the new Tapodu River at the downstream of Tapodu Gate. At the outlet of each channel, drainage sluice was proposed to drain excess interior water and to check floodwater of the Bolango River. The sluice with opening size of 2.00 m width and 1.50 m height has steel gate. Bed elevation was proposed at +3.00 m,MSL, 1.0 m higher than bed elevation of the drainage channel.

(5) Design of Appurtenant Facilities

Two (2) bridges (4.0 m width x 88.0 m length) need to be constructed across the Tapodu River around Kuba and Tapodu villages. Another bridge (7.0 m width x 80.0 m length) was also proposed for the existing main road in the stretch between Tapodu Gate and the Bolango River.

5.3.4 Design of Tamalate Floodway

(1) Particular Site Conditions and Principles for Design

Component Works: Tamalate Floodway Project includes construction of (1) floodway, (2) diversion weir and (3) sluice gate as component works. The floodway is the main facility to convey floodwater of the Tamalate River to the Bone River. At the head of the floodway a diversion weir is installed to consolidate the bed or crest elevation at the divergence. The existing Tamalate River is closed for floodwater at the diverging point, but a sluice gate is installed to supply water during ordinary time for the water use in the downstream reaches and maintenance of the river environment. General location map of Tamalate Floodway is shown in Figure 5.3.12.

Topography and Geology: The proposed floodway traverses fertile paddy fields and natural levee of the Bone River, of which ground elevation ranges from +8.1 to +9.7 m,MSL. The materials to be excavated would be alluvial deposit composed of silt, sand and gravel. Recent deposits of sand and gravel are distributed around the inlet of Tamalate Floodway. No bedrock was confirmed through drilling works. However, outcrops of tuff breccia are observed around 200 m west of the proposed weir site.

(2) Design of Floodway

Basic Design Value: Design discharge of the floodway is 120 m^3/s based on 20-year flood, taking whole runoff of the Tamalate River at the diverging point (Figure 5.3.13). Floodway route was planned where the Tamalate River get closer to the Bone River and open lands for the floodway are available using the topographic maps prepared based on the aerial photos, so that the floodway length and house compensation could be minimized.

Longitudinal Profile: The Total floodway length subject to the works is about 2.7 km. Design riverbed was designed to be at +6.50 m, MSL at the head of the floodway and connected to the riverbed of the Bone River with design bed slope of 1/1,000 which is almost the same slope as the upper Tamalate River connected to the floodway (Figure 5.3.14). DHWL is +9.70 m,MSL at the head of the floodway (the Tamalate River) and +6.98 m,MSL at the lower end of the floodway (the Bone River)

Standard Floodway Section: Riverbed width was designed to be 14 m with bank slope

of one (vertical) on two (horizontal). The water level below DHWL is 3.20 m. Bank protection works are designed for the whole floodway. The standard floodway section is shown in the Figure 5.3.12.

Influence to Bone River: The Tamalate Floodway does not increase design discharge of the Bone River, since the runoff of the Tamalate River fast and the discharge is by far small comparing to that of the Bone River. However, the inflow of the Tamalate Flood may influence the Bone River before its improvement. According to the flow calculation of the existing Bone River, it was confirmed that the floodwater level was still below the surrounding settlement areas even in the case floodway inflow (120 m^3/s) happened to meet with 2-year flood discharge of the Bone River (290 m^3/s). The inflow of the Tamalate Floodway will not cause substantial damages and no structural countermeasures are considered for the Bone River.

Further Studies: In relation with the construction of the Tamalate Floodway, following studies would be required further in the following stages:

1) Facility plan and compensation of the existing bridges and irrigation facilities affected by new floodway.
2) Study and investigation on ground water draw down, due to floodway excavation
3) Study on frequency of floodway flows and preparation of warning system to secure the safety of the resident people.
4) Hydraulic model test to examine the shape of diversion facility and sediment movement at the diverging point.

(3) Design of Diversion Facilities

Tamalate Diversion Weir: Layout plan and profiles of the diversion facilities for the Tamalate Floodway are shown in Figures 5.3.15. The diversion weir was designed with the crest elevation at +6.50 m,MSL, width of 14.0 m and side slope of one on two, so that the weir could pass the design discharge of 120 m^3/sec. The freeboard of 0.60 m was taken above the DHWL.

Sluice Gate: In order to supply water to the lower Tamalate River during ordinary time, a 2-m wide sluice gate is proposed to across the existing river. The sluice gate is combined with concrete culvert that serves as a bridge to connect to the existing

footpath.

(4) Design of Appurtenant Facilities

Bridges: Four (4) bridges (4.0 m width x 28 m length) were planned across the Tamalate Floodway and one (1) bridge (7.0 m width x 28 m length) for the provincial road.

Waterway: Four (4) aqueducts were planned to keep the services for irrigation water supply to the areas separated by the Tamalate floodway. The width of the aqueduct varies from 0.80 m (mainly for tertiary canals) to 2.0 m (Alale secondary canal). Detail investigation for the irrigation system and studies on alternative measures to cope with farmlands to be separated by the floodway should be made at the detail design stage.

5.3.5 Design of Sediment Trap Works

(1) Sedimentation Problems of Lake Limboto

Sedimentation volume of Lake Limboto was estimated within the range of 1 to 2 MCM annually, based on sounding survey results of the lake conducted in 1996 by CIDA Team and 2001 by the JICA Study Team. This amount is quite large. Supposing the land reclamation using the sediment materials, an area of 1 to 2 km^2 of land could be reclaimed annually with one-meter thickness.

It is quite sure that the sediment comes from its own basin transported by river flows. However, the sources of sediment scatter over basin, namely in the watershed areas as original sources and in the plain areas as secondary sources. According to the analysis using satellite images taken in around 1990 and 2000, any specific sites of severe sediment yield were not identified. In order to cope with the sedimentation problems of the lake, it would be necessary to take actions from various aspects in combination with the measures to remove/reduce sediment in the lake, to reduce sediment flowing into river preventing sheet erosion and riverbank erosion in the plain area, and to reduce sediment yield in the watershed area.

(2) Sediment Trap Works in Lake Limboto

Various measures to cope with the sediment issues are conceivable as was discussed in the above paragraphs, but no definitive solution is found. In order to initiate the measures to the lake problem, sediment trap works were proposed as follows:

1) **Objective:** Sediment trap works in Lake Limboto aims to trap the sediment transported by the Biyonga, Alo-Pohu and other rivers leading into the specified sedimentation area, for the purpose of sediment research in the lake and project development for the use of trapped sediment.

2) **Sediment Trap Works:** Sediment trap works consist of mainly two works, sediment trap works and realignment of the Biyonga River and the Alo-Pohu River at their lowest ends. General layout of the sediment trap works is shown in Figure 5.3.16. The sediment trap is a bamboo-net fence installed in the Lake with crest elevation at +4.00 m,MSL. The sediment trap is placed from the Biyonga river mouth to the Alo-Pohu river mouth confining northwestern part of the lake. The confined area is used as the specified area for sedimentation. The Biyonga and the Alo-Pohu rivers are realigned so as to lead the sediment inside the confined area. Other two rivers, the Meluopo and Marisa rivers also empty into the area.

3) **Research Works:** By measuring the sedimentation conditions and testing the sediment materials, (1) sedimentation volume and (2) the physical characteristics and geo-technical features of the sediment will be clarified, seeking for the possible usage of the sediment materials.

4) **Test Work:** Land reclamation project by use of lake sediment will be exercised as a test work in the near-by low-lying lands. Test-works by the third sector agency to be established by the private corporations and government agency can also be considered. The area to be reclaimed should be selected so as not to reduce the flood storage capacity of Lake Limboto.

5) **Further Study:** Compensation issues may arise for the agriculture and fishery in and around the sediment trap area. Further study is necessary on this matter in the following stage. It is also recommended, in carrying out the research work and test work, that the scale of the work should be gradually

increased observing the conditions of the sedimentation and the lake water movement.

5.3.6 Quantities of Works

Quantities of works estimated based on the results of facility design are shown in the Table 5.3.2.

5.3.7 Land Acquisition and Compensation

Houses to be removed (urban and rural) and lands to be acquired (resident and agriculture) for the project implementation were estimated, using the topographic maps prepared based on the aerial photos taken in the year 2001. The quantities of houses and lands are summarized below by component sub-projects.

Sub-project	Houses (nos)		Lands ('000 m^2)	
	Urban	Rural	Resident	Agriculture
1) BBT-R.I.	28	50	59	545
① Lower Bolango R.I.	-	-	-	-
② Bolango R.I.: Stretch-I	-	-	-	-
③ Tenda COC	11	-	5.5	-
④ Bolango R.I.: Stretch-II_R	12	-	13	10
⑤ Bolango R.I.: Stretch-II_L	-	-	-	-
⑥ Bolango R.I.: Stretch-III	5	-	5.5	5
⑦ Tapodu R.I./Gate	-	50	35	530
2) Tamalate Floodway	-	40	27	197
3) Sediment Trap Works	-	10	1	70
Total	28	100	87	812

R.I.: River improvement

Sub-projects which include important resettlement problems are Tenda COC, Bolango R.I./Stretch- II_L, Tapodu R.I./Gate and Tamalate Floodway. As to the Tenda COC and Bolango R.I./Stretch- II_L, resettlement sites could be found at the abandoned channel areas. Regarding the Tapodu R.I./Gate, the land reclaimed with the excess excavated soil in the area protected by dike would be available for resettlement. For the Tamalate Floodway, resettlement sites were not yet specified, it is preferable to look for the sites coupled with excess soil disposal sites.

The land acquisition and compensation issues often become the cause of social problems and delay or suspension of the project implementation. Careful consideration should be given on these mattes and proper procedures should be taken with enough time to communicate with relevant organizations and individuals.

5.4 Construction Plan

5.4.1 General

(1) Types and Kinds of Works

The following kinds of works are included in the Priority Projects:

1) Lower Bone River Improvement: Bank protection work
2) Lower Bolango River Improvement: Channel excavation work, cut-off channel works, bank protection work, dike work, drainage sluice work, and bridge works
3) Tapodu River Improvement with Tapodu Gate: Channel excavation work, bank protection work, dike work, sluice work, Tapodu Gate work, and bridge work
4) Tamalate Floodway: Floodway excavation work, bank protection work, dike work, sluice work, diversion weir work, and bridge works
5) Sediment Trap Works in Lake Limboto: Sediment trap work and channel realignment work

(2) Basis of Planning

For discussions of the construction plan, the following assumptions and principles were introduced:

1) Execution method: Full contract system
2) Construction Period: 5 (five) years from 2005 to 2009 for actual work implementation at site
3) Principles: Use of local materials as much as possible

(3) Procurement of Construction Materials

Sand: Natural sand is easily available from the Tamalate and Bone rivers. The natural sources are judged available to fulfill the required quantity.

Gravel: Gravel is available from the river deposit and the quality is judged good for middle class concrete. For high quality concrete which is required for such as bridge beam, concrete pile, slab concrete wall and other structural works, the crushed stone

should be provided

Stone / Boulder: Stone material will be used for construction of wet rubble masonry and gabion. Boulder is proposed for rip-rap. Both materials are available near around Gorontalo from the river or from quarry in the hill.

Portland Cement: Cement for concrete works (in-situ and pre-cast) and wet rubble masonry works is available in the local market. Concrete piles are to be executed under fabrication license and need special handling.

Water: Water from Lake Limboto, Tamalate and Bolango rivers can be used during construction phase. Simple treatment may become necessary if the water contains much suspended solid and sediment during rainy season. Shallow dig-well is recommended as main sources of water for higher structural specification.

Embankment Material: Embankment materials are available from the excavated materials from river channel. In case special specification is required, the embankment material can be taken from a small hill near Buidu village around 12 km north-east of Gorontalo and from Buliide village, District Kota Barat about 3 km south of Gorontalo.

Bamboo: Bamboo rod and bamboo net necessary for the sediment trap works are available in local market in Gorontalo.

5.4.2 Specific Descriptions by Sub-Projects

(1) Lower Bone River Improvement

Site Conditions: The site is located in the narrow area between the hill and the Bone River.

Other Matters to be Considered during Construction: No specific matters needed to be considered during construction on this section.

(2) Lower Bolango River Improvement

Site Conditions: Along the upper reaches of the Lower Bolango River for about 3.0 km length not so many settlements nor community structures exist. Access road will be

not a problem for construction. Asphalt paved road already constructed in parallel with the river alignment. On the other hand, densely built-up settlement are found in the downstream reaches from the division point of the Bolango and Siendeng rivers up to junction with Bone river. Two (2) reference bench marks are available at site for the construction.

Treatment of Construction Disposal: The excavated materials that have proper quality should be used for embankment as much as possible. The remaining excess materials are proposed to be spread in the low-lying areas around Tapodu River.

Other Matters to be Considered during Construction:

1) Material Sources: Environmental impacts should be considered for taking materials from natural sources, mainly for sand, stone and embankment material and lands for disposal.
2) Land Acquisition: Land acquisition is predicted to be one of major social issues that could be a trigger of social problems and delay of the construction. Inventory, coordination and dissemination between Pemda / Kabupaten Gorontalo with land-owner should be prepared and handed carefully as early as possible.
3) Heavy Equipment: Operation of heavy equipments are required, mainly for earth excavation, hauling, and construction of pile protection.
4) Participation of Local Community: During construction stage, participation by local villagers or local contractor will be very important to build their sense of ownership. Cooperation and good relation should be kept compensating their sacrifice for land/ plant and disturbing during construction.

(3) Tapodu River Improvement with Tapodu Gate

Site Conditions: The proposed works cover about 24 hectare in total including river area, embankment, dikes, required structures, etc. According to the geological investigation data, the soil in the work site is dominated by sedimentation deposit such as clay sand, gravel sand and sandy clay that contain organic matters. According to the topographic survey data around the proposed site, ground elevation varies from + 4.20 to + 5.20 m,MSL. Reference bench mark is available at site for the construction. Access to the gate site is relatively easy with short construction road.

Treatment of Construction Disposal: The excavated material that have proper quality

should be used for embankment as much as possible. The excavated material should be used for lake dike embankment. The remaining disposal materials are to be spread over to reclaim the low-lying lakeside areas. The reclaimed area could be used for the re-settlement of the houses demolished under this project. The reclamation should planned only in the lakeside areas higher than +4.50 m,MSL. Otherwise the effective lake area may be reduced.

Other Matters to be Considered in Construction:

1) Material Sources: Natural sources should be exploited carefully considering the environmental impacts.
2) Material to be Taken from Overseas: A part of the structural materials should be import from overseas. These includes rubber weir with accessories, high quality steel beam for bridge.
3) Land Acquisition: Land acquisition could be one of the major social issues to cause delay of the construction.
4) Inventory and Coordination: Inventory and coordination between Pemda / Kabupaten Gorontalo with land-owner should be prepared and handed carefully as early as possible.
5) Heavy Equipment: Heavy construction equipment is required mainly for earth excavation and hauling, piling for gate and bridge foundation, etc.
6) Cofferdam: Even though the proposed gate is located on dry land, the site is subject to inundations due to the lake and the Bolango River.
7) Participation of Local Community: Participation of local villagers or local contractor for the construction and O & M activities is very important to grown-up their sense of ownership. Cooperation and good relation should be kept to compensate their sacrifice due to land acquisition and disturbance during the construction.

(4) Tamalate Floodway

Site Conditions: The proposed works cover about 14 hectare of residential and farming area (estimated square also include river area. Fiver (5) reference bench marks are available for the work. According to the result of topographic survey around the proposed site, the ground elevation varies from + 8.20 to + 9.50 m,MSL while the floodway bed lays on elevation ranging from + 6.50 to + 4.35 m,MSL. Access road for heavy equipment would not be problem because of enough existing road network.

Treatment of Construction Disposal: The excavated material should be used for embankment material as much as possible. The remaining excess materials are spread in the open areas downstream of the floodway and in the selected riverside areas of the Bone River.

Other Matters to be Considered during Construction:

1) Material: Natural sources should be exploited carefully considering the environmental impacts.
2) Location of Disposal Area: Location of disposed material should be confirmed and determined after consultation with landowner. Survey of land status, and socialization to community should be conducted by the Government agency in early stage.
3) Participation of Local Community: During construction stage, participation by local villagers or local contractor will be very important to build their sense of ownership.
4) Cooperation and good relation should be keep to compensate their sacrifice due to land/plant acquisition and disturbing during construction.
5) Cofferdam / Dewatering: Due to proposed location of Diversion Weir is on the Tamalate River alignment, consideration should be taken when the construction stage on rainy season.
6) Preliminary Warning: Since the floodway alignment crosses paddy field, arrangement and warning should be made to so as not to disturb their farming.

(5) Sediments Trap Works in Lake Limboto

Site Conditions: The work site distributes in Hunggalua Bawah village and Ilomangga village, Sub-District Limboto. For the execution of the sediment trap works and channel excavation of Alo-Pohu and Biyonga rivers, access road for the construction would be the main problem, because the work sites are located on the soft, swampy and submerged ground. All the excavated material should be hauled to the approved dispose area. The bamboo nets are installed on a part of lake bottom with elevation ranging from +2.40 to +3.50 MSL. Two (2) reference benchmarks are available for the work.

Treatment of Construction Disposal: All the excavated material from both rivers should be hauled to specified disposal areas outside of the lake.

Other Matters to be Considered during Construction: Since the sediment trap works is implemented as a test work for sediment research and project development for sediment use, the work shall be carried out carefully in line with the research program to be prepared.

5.5 Estimation of Project Cost

5.5.1 Principles for Cost Estimation

(1) Sub-Projects and Works for Cost Estimation

The priority project subject to cost estimation includes following sub-projects:

1) Bone-Bolango-Tapodu River Improvement
   ① Lower Bone River
   ② Bolango Stretch-I
   ③ Tenda COC
   ④ Bolango Stretch-II_R
   ⑤ Bolango Stretch-II_L
   ⑥ Bolango Stretch-III
   ⑦ Tapodu River with Tapodu Gate
2) Tamalate Floodway
3) Sediment Trap Works in Lake Limboto

(2) Basis of Cost Estimate

Costs for the proposed priority projects were estimated on the basis of the following conditions.

1) **Price Level:** The project cost and other related unit costs are expressed under the economic conditions prevailing in November 2001.

2) **Exchange Rate of Currencies:** Exchange rate of currencies are assumed as follows:
   US$1.00 = Rp.9,600 = ¥124 (¥1 = Rp.77.4)

3) **Foreign Currency and Domestic Currency Portions:** Project cost is estimated dividing the cost into foreign currency (F.C.) and domestic currency (D.C.) portions. The F.C. portion is expressed in US dollar (US$) and the D.C. portion in Indonesian Rupiah (Rp.).

4) **Constitution of Project Cost:** Project cost is composed of direct cost, land

acquisition and compensation cost, administration cost, engineering service cost, and physical contingency. The project cost is estimated based on the following procedures and assumptions:

(1) Direct cost: Unit cost basis
(2) Land acquisition and compensation cost: Unit cost basis
(3) Administration cost: 5 % of (1) + (2)
(4) Engineering service cost: 10 % of (1)
(5) Sub-total = (1) + (2) + (3) + (4)
(6) Physical contingency = 10 % of (5)
(7) Price contingency: Assumed at 0 % for F.C. and 10 % for D.C.

(3) Unit Work Costs

The work cost is estimated based on the quantity of works multiplied by standard unit work cost. The unit work costs were assumed based on the cost data of similar works executed in Sulawesi. The unit work costs were broken-down to F.C. and D.C. portions with composition rates assumed respectively for the works. The standard work costs applied are as listed below.

Work	Specifications	Unit	Cost (Rp.)	Composition of F.C. portion (%)
Excavation		m^3	20,000	55
Embankment		m^3	27,000	55
Sediment trap:	(h=1.0m)	m	170,000	0
	(h=2.0m)	m	290,000	0
Wet rubble masonry		m^2	300,000	8
Riprap		m^3	100,000	5
Gabion mattress		m^3	270,000	3
Concrete		m^3	480,000	35
Pile	PC concrete pipe pile (ϕ 450)	m	440,000	50
	Steel sheet pile	m^2	1,300,000	50
Bridge work	Type-1 (w = 4m)	m	19,000,000	60
	Type-2 (w = 7m)	m	37,000,000	60

As to the land acquisition and compensation cost (D.C.100%), following unit prices were assumed based on the information obtained in Gorontalo.

1) Compensation for houses in urban area : Rp. 18,000,000/nos
   Compensation for houses in rural area : Rp. 7,700,000/nos

2) Land acquisition for residential land : Rp. 2,000/m^2
Land acquisition for agriculture land : Rp. 3,000/m^2

5.5.2 Project Costs

Project cost required for implementation of the Priority Projects was estimated as shown in Table 5.5.1, and the costs by sub-projects were shown in Table 5.5.2. The project cost of Bone-Bolango-Tapodu River Improvement was further broken down and shown in Table 5.5.3. The results of the estimated project costs are summarized below.

(Sub-project)	F.C. (US$'000)	D.C. (Rp.mil.)	Total (Rp.mil)
1) Bone-Bolango-Tapodu R. Improvement	6,546.0	57,322	120,164
① Lower Bone River	38.0	2,138	2,503
② Bolango Stretch-I	55.7	595	1,130
③ Tenda COC	76.6	1,259	1,994
④ Bolango Stretch-II_R	480.1	11,424	16,033
⑤ Bolango Stretch-II_L	124.2	1,616	2,808
⑥ Bolango Stretch-III	84.1	728	1,535
⑦ Tapodu River with Topdu Gate	5,688.1	39,565	94,170
2) Tamalate Floodway	931.4	11,850	20,792
3) Sediment Trap Works in Lake Limboto	94.2	1,760	2,665
TOTAL	7,571.8	70,933	143,622

The total project cost for the Priority Project was estimated at Rp.143,622 million (US$ 14.96 million or ¥ 1,856 million equivalent) at November-2001 fixed price, of which breakdown is as follows:

(Cost items)	F.C. (US$'000)	D.C. (Rp.mil.)	Total (Rp.mil)
1) Direct cost	5,7387.7	54,907	109,988
2) Land acquisition and compensation cost	0	3,884	3,884
3) Administration cost	0	5,694	5,694
4) Engineering service cost	1,145.7	0	10,999
5) Physical contingency	688.4	6,448	13,057
TOTAL	7,571.8	70,933	143,622

5.5.3 Fund Required

Fund required for the project implementation was estimated taking account of the price contingency for fluctuation of construction costs until and during the construction period in consideration of the trend of price indices. The price contingency was assumed at the annual rate of 0% for foreign currency (F.C.) portion and 10% for domestic currency (D.C: Rupiah) portion.

Based on the assumed annual disbursement schedule of the project costs for both the F.C. and D.C. portions, the fund required for the implementation of the Priority Project was estimated as shown in Table 5.5.4. The total fund required were estimated at Rp.179,424 million (US$ 18.69 million or ¥ 2,318 million equivalent), of which breakdown is as follows:

(Sub-project)	F.C. (US$'000)	D.C. (Rp.mil.)	Total (Rp.mil)
1) Bone-Bolango-Tapodu R. Improvement	6,546.0	83,491	146,333
2) Tamalate Floodway	931.4	20,840	29,780
3) Sediment Trap Works in Lake Limboto	94.3	2,408	3,313
TOTAL	7,571.7	106,739	179,428

5.5.4 Operation, Maintenance and Running Cost

In order to maintain constructed facilities in functional conditions as planned and designed, incessant operation and maintenance activities are inevitable. For these activities, 0.5 % of the construction cost was assumed as annual cost required for operation and maintenance. In case of Tapodu Gate which has running device such as engines and/or motors, 1.0 % of the weir work cost was assumed as annual cost required for operation, maintenance and running. Since the sediment trap works are the test work for researches and project development, a assumed annual amount to be required for these activities were accounted.

According to the assumptions mentioned above, the annual operation, maintenance and running costs for respective sub-projects were estimated as follows:

(Sub-project)	Total (Rp.mil/yr)
1) Bone-Bolango-Tapodu R. Improvement	612.6
2) Tamalate Floodway	77.8
3) Sediment Trap Works in Lake Limboto	100.0
TOTAL	790.4

5.6 Operation and Maintenance

5.6.1 Operation and Maintenance Plan

(1) General

Public works development policy of the central government addresses the following:

1) To create infrastructure development which supports the national sectorial development.
2) To utilize the whole functions of infrastructure development product in optimum level, through activities of operation and maintenance and rehabilitation done by the central and regional governments or private corporations and direct beneficiaries.
3) To execute guidance and arrangement to the orderly development and the correct utilization of the development product.

Regarding the item-2), it is intended that the existing water resources infrastructure should be kept functional during the planned lifetime more efficiently by the operation and maintenance activity, so that:

- Safety against flood should be attained,
- Conditions of living environment should be enhanced, and
- Functions of water and water resources could be sustained.

(2) Operation Activity

Implementation of the river operation covers following tasks:

1) Water utilization including water allotment, water quality control, monitoring and supervising.
2) River channel utilization and safeguard regulation.
3) Sediment management in rivers
4) Management and safeguard of lake and reservoir

(3) Maintenance Activity.

River maintenance covers following objects:

1) **Maintenance of River Channel:** River channel may change by the natural forces, human acts and animal influences. The changes of river channel may reduce the structural stability, functions and quality of surroundings environment. The maintenance of river channel aims to keep functions of the river channel without damaging the surrounding environment.

2) **Maintenance of River Structures:** Maintenance of river structure aims to keep related structures in functional and appropriate conditions to the purpose and service standard or planned performance.

3) **Supporting Facilities / Equipment:** Implementation of river operation and maintenance needs various supporting facilities and equipment. Supporting facilities can be grouped into four (4) types i.e., (1) civil structures, (2) operational equipment, (3) data monitoring and data processing, and (4) communication instrument.

(4) Activities of River Maintenance

Activities of river maintenance can be grouped in three depending on the phases as follows:

1) **Preventive Maintenance:** Preventive maintenance aims to keep river channel and the structures therein in optimal function way in accordance with the planned performance and lifetime. The preventive maintenance can be performed through routine, periodical and light reparation.

2) **Corrective Maintenance:** Corrective maintenance aims to repair the damage of river and the structures therein or correct the lack of structure without changing their functions. The activity of corrective maintenance can be performed through special maintenance and rehabilitation rectification.

3) **Emergency Maintenance:** Emergency maintenance shall be carried out in urgent situation, like flood fighting activities to stop the dike breach

Standard activities to be considered for the maintenance of the river and river structure are shown in Table 5.6.1. Operation and maintenance program should be prepared referring to the Table for specific facilities and structures.

5.6.2 Capacity Building

(1) Background

Gorontalo province and Kabupaten and Kota Gorontalo have just established new Public Works Office. In order to ensure that the flood mitigation works in LBB Basin are executed, operated and maintained by competent, qualified personnel, the regional Dinas for public works should establish a satisfactory organization for it as soon as possible. For this purpose strengthening of the existing institution is needed for Sub-Dinas water resources management at province level, Kabupaten as well as Kota Gorontalo. On the other hand, to fulfill the staff in number and capability, training should be conducted.

(2) Strengthening Sub-Dinas of Province

In the year of 2001, Sub-Dinas Water Resources Development of Gorontalo Province had two sections, i.e., Section of Technical Design and Irrigation, and Section of River, Swamp and Coast and O&M. To conduct the decentralization job (Government Regulation No.25/2000) and deconcentration job (Gov. Regulation No.39/2001 article 3) of the provincial Dinas, the Sub-Dinas of Water Resources has been expanded in the year 2002, i,e., (1) Section of Planning, (2) Section of Irrigation and O&M, (3) Section of River, Swamp, Coast and Lake.

For more perfection in implementation, Technical Implementation Unit (TIU or Balai PSDA) need to be established. The organization of TIU is shown in Figure 5.6.1. The TIU is needed for implementation of water resources management in the river basin covering more than one Kabupaten/Kota like the LBB River Basin. By the Minister of Home Affair Decree No. 179 / 1996, TIU has been established in several provinces under the name Balai Pengelolaan Sumber Daya Air (Balai PSDA). There have already been established 4 Balai in West Java, 1 in Banten, 9 in Central Java, 2 in Lampung, 2 in South Sumatra, 6 in North Sumatra, 2 in NTT and 5 in North Sulawesi respectively. The obligation of TIU includes:

1) **Main Job:** Management of water resources by activities of water allocation, water quality control, flood management, maintenance of river course and the facilities therein, and operation and maintenance of irrigation network inter Kabupaten/Kota; and
2) **Supporting job:** Management data of hydrology, hydrometeorology and database, and supporting coordination inter institutions

For the implementation of the above job, the TIU has following functions:

1) Operational services for communities in water resources sector
2) Operational services in conservation of water and water resources
3) Technical and administrative services covering finance, personnel and equipment

(3) Strengthening Sub-Dinas of Kabupaten/Kota Gorontalo

Sub-Dinas related to water resources of Kabupaten/Kota Gorontalo is still in transition condition, and the operation and maintenance for the irrigation network located in Kabupaten/Kota Gorontalo and inter-kabupaten/kota are still implemented by the provincial level. In future when the job is transferred to Kabupaten from Province, the functions of Sub-Dinas Kabupaten Gorontalo must be enhanced more in human power, budget and equipment. In implementing the FM-MP, Sub-Dinas will share a part of the flood mitigation facilities. To conduct the job of Sub-Dinas in Water Resources Management, it should be strengthened in two ways in short term and long term measures. Sub-Dinas is needed to be expanded as Dinas of Water Resources.

(4) Training for Water Resources Development

Training activities for the staff of water related Sub-Dinas of Province, Kabupaten and Kota Gorontalo should be emphasized on organization, planning, implementation, and management functions. It should cover the technical and management staff, operating personnel and unskilled workers as well. The staff profiles of Dinas PU in Gorontalo are summarized below.

	PU Province		PU Kabupaten		PU City	
	Organic	**Non Org.**	**Organic**	**Non Org.**	**Organic**	**Non Org.**
Total Staff	99	237	73	29	53	3
Technical Professional	18%	2%	12.3%	-	22.7%	-
Non-Tech..Professional	6%	2%	-	-	3.8%	-
High School	76%	96%	87.7%	100%	75.5%	100%

The training should also give special attention to recent administrative changes in the direction and responsibility between the central and regional governments. The development and implementation of training program should be recognized as particular needs in developing human resources for operation and maintenance (O&M).

5.6.3 Proposed Institutional Arrangements for Operation and Maintenance

(1) Institution for Project Implementation

An institution for project implementation is proposed to be established as a special project (the Project) which is responsible to Directorate General of Water Resources and PU / Kimpraswil Gorontalo Province.

(2) Institution for Operation and Maintenance

As to the institution for Operation and Maintenance, following alternatives can be conceivable, though the Operation and Maintenance of the LBB basin would be started with the institution of Alternative-I which used to be adopted so far in Indonesia.

Alternative I: Operation and Maintenance by Government Institution

As soon as the structures are completed by the Project, the activities of O&M must be started. For the first two years, it is suggested that the operation and maintenance works are implemented by the Project, and then the responsibilities for O&M of the structures to be handed over to the related institution. The related institution could be Dinas PU Kota Gorontalo or Dinas PU / Praswil Kabupaten Gorontalo according to the location of the structure; or since the flood mitigation facilities of LBB River Basin is located across Kabupaten and Kota Gorontalo, the responsibilities should be to Dinas PU / Kimpraswil Gorontalo Province.

To implement this job Dinas PU / Kimpraswil Gorontalo Province should establish the Technical Implementation Unit. The implementation of O & M of flood mitigation facilities in LBB river basin is shown in Table 5.6.2

Alternative II: Operation and Maintenance by Management Corporation

River Territory (Wilayah Sungai): According to the Government Regulation No.22/1982 concerning water management, the unit of water resources management is desirable to be base on the river territory (Wilayah Sungai). River territory may consist of some river basins, and river basin sometimes located in more than one Kabupaten or province. Ministry of Public Works' Regulation No.39/PRT/189 divided the whole Indonesia into 90 river territories. In Gorontalo Province there are two river territories, Wilayah Sungai Limboto-Bone (05.02) and Wilayah Sungai Paguyaman-Randangan (05.03).

Recently water resources in LBB Basin is in aggravated condition, and the problems are how to begin the operation and maintenance of the water resources facilities involving water resources stakeholders.

In arranging the institution, the water resources management (O&M) has to involve local communities or stakeholders, and the regulation should to meet their aspiration. Coping with these matters it may become necessary to establish a River Basin Management Board which has task to manage water resources in the river territory as Perum Jasa Tirta (PJT).

5.6.4 Budget for Operation, Maintenance and Running (OMR)

Components of OMR Budget: The budget for operation and maintenance will be prepared by the related agency. There are two items for preparing the budget, namely, work schedule and unit rates of activities involved. The budget for operation, maintenance and running (OMR) consists of the following components:

- General and administrative budget
- Operation Budget, and
- Maintenance budget

Cost Items for Operation and Maintenance: The annual budget required for the OMR consists of following cost items:

1) General and Administrative Cost:
   - Cost for staff
   - Running cost of office
   - Maintenance cost of office
   - Running cost of equipment

2) Operation Cost:
   - Monitoring and observation cost
   - Cost for operation of river structure
   - Flood fighting cost

3) Maintenance Cost:
   - River survey cost
   - Patrol and inspection cost
   - Maintenance cost for river structure, water level and rainfall gauging station
   - Maintenance of warning system equipment.

5.7 Non-Structural Approaches

5.7.1 Watershed Management

(1) Current Issues

Sedimentation of Lake Limboto is a serious problem. The lake, which has storage capacity of 47.4 MCM below elevation +4.0 m,MSL, is estimated to receive annually 2 million to 5 million m^3 of sediment from the basin. Major source of the sediment is the Biyonga River followed by the Meluopo and Alo-Pohu rivers.

In the Bolango-Bone river system, the Bolango River transports more sediment than the Bone River although basin size of the Bolango River is only 37% of the Bone River. Vegetation of the Bone River is good. During past ten years, a total of 54 km^2 bush land and 21 km^2 forest lands were converted to farmland. Most of these took places in Lake Limboto basin and the Bolango River basin. Watershed management is duly required for these basins.

There are two sources of sediment, primary and secondary sources. The primary source is in the mountainous area. The sediments yielded in the mountainous area are transported by the river to the lower reaches, and first deposit on the plain area along the river. The secondary source is in the plain area. The deposits in the plain area are transported again toward downstream due to secondary side erosion. The Biyonga and the Bolango rivers are the typical rivers of the former type and the Alo-Pohu River of the latter type. In order to cope with the sedimentation problems of the lake, measures must be taken for the both sources.

(2) Possible Measures for Watershed Management

In order to promote watershed management activities in the Study Area, the agencies in responsible to flood mitigation should take all the possible actions to encourage:

1) Construction of erosion control facilities,
2) Afforestation and land use control, and
3) Dissemination/extension activities.

For respective actions to be encouraged, possible measures and activities are presented

in the following paragraphs.

Erosion Control Facilities:

1) Construction of check dam
2) Bank protection works along rivers
3) Protection of hillside slope by terracing works and nursing vegetation
4) Protection of small-scale channel with gully plugging and surrounding slopes by planting shrubs and grasses.

Afforestation and Land Use Control:

1) Afforestation and reforestation artificially and fostering natural regeneration of trees.
2) Promoting farm tree and shrub planting by growing commercial crops such as fruit trees, medicinal herbs, aromatic plants and natural dyes. Well-managed commercial crops prevent land erosion in watersheds and promote sustainable watershed management activities through generation income.
3) Planting of fodder grasses on slopes, fodder trees on terraces, and restricting the number of livestock within permissible limits for sustaining the pasture and forest.
4) Conservation of wild medical herbs, by protecting from over-collect, thus allowing a sustained yield.
5) Reducing energy use.
6) Training the local leaders in land use and woodland management, and exchanging know-how among other communities.

Dissemination/Extension Activities:

In order to promote watershed management, the understanding and cooperation of local communities and individual are essential. Dissemination activities should be extended employing all the possible means as follows:

1) Establishing a specific date or dates for tree planting activities as a national and/or local level events and conducting tree planting campaign for afforestation, reforestation, for tree planting and forest conservation.
2) Commemorative tree planting for any ceremonies and memorial events by residents, and local and national leaders.

3) Environmental education, tree misery and small arboretums in school.
4) Enactment of a system of commendation for excellent tree planting projects, including agro-forestry, riverside plantings and other community activities.
5) Combination of natural regeneration and/or afforestation project with tourism and local development project.
6) Campaign by mass media for planting trees.
7) Establishment of foundations and solicitation of funds to encourage tree planting.
8) Organizing tree-planting volunteer groups and facilitating volunteers from the overseas countries to participate as well.
9) Conducting of study tours to on-going projects to learn from past initiatives.

(3) Land Rehabilitation and Soil Conservation Project

Land Rehabilitation and Soil Conservation Center (Balai Rehabilitasi Lakan dan Konservasi Tanah: BRLKT) of Department of Forest and Plantation, North Sulawesi Province formulated a Project Plan for Land Rehabilitation and Soil Conservation (LRSC) in Limboto Sub-Basin in March 1999. The project plan stands on the same intention with watershed management proposed in the FM-MP. Implementation of the LRSC for Limboto is strongly recommended to alleviate sediment yield from the watershed and flood runoff as well. The outline of the LRSC in Limboto sub-basin are presented below.

Objectives: The objectives of the LRSC in Limboto sub-basin are:

1) To rehabilitate critical lands, and maintain and enhance soil fertility;
2) To control erosion and flood, and conserve natural resources;
3) To reduce sediment transport;
4) To build community awareness and attitude towards the conservation of natural resources; and
5) To enhance community income and welfare.

Necessary Actions: To accomplish the objectives, actions need to be implemented include:

1) Implementing the LRSC through re-greening and reforestation with tree crops such as Sengon, Mahoni, Jati and Acasia; and MPTS species such as Kemiri, Jackfruit and jambu mete. In agricultural lands, such trees should combined

with crop plants according to a recommended planting pattern;
2) Creating a good relationship between those who utilize the land and water resources (local people) and re-greening and reforestation program officers;
3) Building community awareness and developing self-supporting community to adopt information and technology about plant cultivation through some assistance from related institutions;
4) Developing agricultural production market system between community (farmer groups) and Village Cooperative (Koperasi Unit Desa); and
5) Enhancing community's income and welfare through forest and other lands productivity improvement in a sustainable manner.

Physical Targets: Total critical land areas in the forests is 12,573 ha and that of outside the forests is 13,524 ha. Total target area for the project during the first five years is 7,820 ha in the Limboto sub-basin, composed of 2,100 ha in the forest for social forest reforestation and 5,720 ha outside the forest for re-greening. Locations of these target areas are Kecamatan Limboto, Tibawa, Batudaa and Telaga, which are identified to have high and medium erosion rate.

Community Development Target: The first phase (5-year period) of the project targets on community's participation and income improvements as well as community's attitude and awareness level changes.

5.7.2 Flood Plain Management

Flood damages sometimes occur or become serious because of the people's vulnerability, e.g., lack of awareness and motivation for preparedness, inadequate resources for risk reduction, lack of access to alternative sources of livelihoods. Flood plain management activities aim to reduce the vulnerability. The flood plain management scheme intends to promote following activities that will be done by relevant communities and individuals for flood damage mitigation:

1) Community Mobilization: By assisting to form community organizations, it intends to build up organizational bases for the implementation of the Flood Mitigation Program.
2) Flood Proofing: This will assist the communities and individuals in flood-prone areas in taking preparedness to reduce damages by own efforts.
3) Flood Forecasting, Warning and Evacuation: Community people can be ready

for reducing damages and evacuation, getting correct and timely information on coming flood.

4) Flood Fighting: In collaboration with the relevant agencies, the community organizations implement emergency flood mitigation activities fighting the attacking flood.
5) Community-based Flood Mitigation Measures: It will motivate the community organizations to contribute their shares in maintaining and sustaining the flood control structures, by deriving additional benefits for improving their livelihoods.

(1) Mobilization of Community

The flood plain management will start with the community mobilization to strengthen the organizational bases for local flood mitigation initiatives.

Workshops for Local Community Leaders:

Local community leaders will play crucial roles in the flood plain management. The leaders' main responsibilities will be to encourage and mobilize local resident to the activities. In order to enable the leaders to perform the tasks, a series of training/workshop will be undertaken for the local community leaders at the inception and during the implementation of the flood plain management.

Creation of Organizational Bases at Community:

The flood plain management will then mobilize the local community leaders to create organizational bases at the community level. This will be achieved with three sets of activities, i.e., (1) formation of community organizations, (2) promotion of public awareness, knowledge, and skills, and (3) generation of financial resources by the community organizations.

(2) Possible Measures for Flood Plain Management

Necessity of Local Coping Measures: It is important for people to be aware of the importance of taking community-based coping measures on their own, to complement the physical facilities. Moreover, they are instrumental in heightening the people's awareness of their vulnerabilities to floods.

Each local area has a particular set of needs for local coping measures. The program component for local coping measures will therefore be undertaken on a community-by-community basis. The following are a menu of support, which the Program will draw upon in assisting local communities to enhance their local coping measures.

Promotion of Flood Proofing

One common method is to reduce the risks of damage by adjusting agriculture, and by strengthening building. There are also other ways of promoting flood proofing.

1) Agricultural Adjustments:
   - Immediately after the summer crops are damaged, cultivate fast-growing crops (e.g., certain types of vegetables, Arun maize) which can even harvested in a few months' time - even in time for farmers to start winter crops;
   - Grow sweet potatoes if as a result of floods their farming lands are covered by thick sand, thus preventing them from cultivating other crops;
   - Where feasible, change from maize growing to rice cultivation which is less vulnerable to inundation, and in other words, more flood-resistant;
   - Double transplanting of paddy seedlings; and
   - Set aside rice seedlings, in order that they can re-plant paddies, even in case rice fields are destroyed due to flooding.

2) Housing Structures:
   - Construct houses on plinths, so that flood water flows underneath;
   - Build walls of mud which will let water pass through in times of flooding, to prevent houses from collapsing;
   - Raise grain stores on stilts, while building escape areas under roofs for family members and other valuables; and
   - Concentrate houses on higher grounds of the communities, to prevent residential shelters from being inundated during floods.

3) Other Possible Flood Proofing Measures:
   - Aforestation/reforestation on the riverbanks will serve to curtail the speed of overflow water in case of emergencies;
   - In low-lying areas, drainage construction to reduce the level of inundation

as well as to improve hygienic conditions during the monsoon; and,

- Small-scale reservoirs development (e.g., creation/expansion of new/existing ponds) on community-owned barren land.

Flood Forecasting, Warning and Evacuation

Many farmers in the flood plains have their own ways of forecasting and warning, in an attempt to give themselves enough lead time for evacuation. Usually, those who have experienced floods periodically have their own ways of evacuation in times of disasters.

Similarly, it is possible to incorporate more systematic approaches in local forecasting and warning simply by utilizing existing facilities and resources, which can be used to pass flood notices from the upstream areas. Where there is an irrigation barrage along the river, the irrigation office can possibly inform of the rising of the water level to other areas, in addition to the task of closing the water intake.

For evacuation purposes, people should find refuges in their own localities in advances, and if that is not possible, seek to safer areas in neighboring areas.

Flood Fighting

Some local communities, when they notice the comings of flooding, install temporary flood fighting structures using local resources and materials. The structures serve either to contain the extent of bank erosion, or to deter the velocity of overflow.

However, those village-level measures, albeit commendable for their self-help approaches, often lack technical soundness. Such technical advise will be easily absorbed and to be put to practice, given the fact that those communities are already motivated and at least are aware of potentiality of collective efforts.

Support to Community-based Flood Mitigation Measures

The program component for community-based sustainable measures is intended to derive additional benefits from the physical facilities, and to motivate the beneficiaries to help sustain the structures. Some examples of community-based flood mitigation measures are listed below.

1) **Community forest as dike works:** Community forests managed along the river and lakeshore and around the village will serve not only as flood mitigation, but also to serve various necessities of the local residents. Having met the local needs for forest products, the community organization can sell surpluses in the market. Moreover, in case the local communities choose those species that require nurseries, the organizations can sell extra seeds and seedlings that are produced in their community nurseries.

2) **Access improvements using flood control structures:** When dikes are constructed for flood mitigation projects, they provide opportunities to simultaneously develop rural road networks. In some places, the dikes alone can be designed as access roads. In access improvement purposes, emphasis will be placed on labor-intensive methods which are locally suitable and affordable.

3) **Exploitation of bed material as channel excavation works:** Many rivers in the LBB basin are being mined for sand, gravel and boulder as construction materials. More importantly, exploitation of sand/gravel/boulder from a riverbed can be part of a river training scheme, which serves to increase the flood carrying capacity of a river if it is done orderly under control. It can also provide employment opportunities for rural people in the local community.

4) **Operation and maintenance of flood control structures:** Even for sophisticated engineering structures, a system of regular monitoring is necessary to ensure their continued stability. For this purpose, local communities will be given the responsibilities to constantly monitor the sites, and when necessary, seek external support for rehabilitation. These activities are for the direct benefit of the communities concerned.

5) **Land use management:** The purpose of land use management is to ensure flood risks are not worsened by ill-conceived land uses. It is crucial for the local communities to agree on local rules and practices that will stop these poor land use management for the profit of own communities.

5.7.3 Arrangement for Implementation

(1) General

In order to promote the non-structural flood mitigation measures (watershed management and flood plain management) in the LBB basin, some arrangements to be considered for initiation of the activities are discussed here.

Participation of Local Community: The watershed management and the flood-plain management will be accomplished by mobilizing the relevant agencies, local communities and individuals in the flood plain areas. It is, therefore, essential to implement the program with participation of the local community organizations, even from the preparation stage of the program.

Collaboration with Community Based NGO: The program shall be implemented with close contact with the community people. It will be effective to promote the program in collaboration with community based NGO who know the peoples and real situation of the community.

Pilot Communities: It will be a practical approach to select a few communities as pilot communities for the implementation of watershed management or flood-plain management program. Accumulating the experience (both succeeded and failed) and know-how in the pilot communities, the program will be extended to other communities stage wise.

(2) Implementation of Watershed Management

Support for Promoting of LRSC Project: It is proposed these activities should be implemented by the office of Land Rehabilitation and Soil Conservation (Balai Rehabilitasi Lakan dan Konservasi Tanah: BRLKT) of Gorontalo Province within the frame of project plan for Land Rehabilitation and Soil Conservation (LRSC) formulated in 1999. Dinas PU/Kimpraswil of Gorontalo Province, Dinas PU-Praswil of Kabupaten Gorontalo, and Dinas PU of Kota Gorontalo should extend all the possible support to promote the LRSC project.

(3) Implementation of Flood-Plain Management

Community Mobilization: In order to mobilize community people for flood plain management activities, it is first necessary to organize the people for the activities. To establish community organization, it is practical to utilize existing governmental and community organizations adding new functions for flood-plain management to them. In the Study Area various community organizations exist or to be established as listed below.

Name of Organization		Level
1	PTPA/PPTPA (Province)	Province/River Basin *
2	PTPA/PPTPA (Kabupaten)	Kabupaten **
3	Irrigation Committee Province	Province
4	Irrigation Committee Kabupaten	Kabupaten
5	Water User Association (Irrigation)(P3A)	Farmer
6	Water User Association (Non Irrigation)	Industry, etc. ***
7	Land User Association (Arable)	Farmer ***

* Not yet established in Gorontalo Province

** Has been established in Kabupaten Gorontalo

*** Suggested to be established

Workshops/Trainings: In order to add new functions to the existing community organization, workshops and training are necessary for the community leaders and local government officers in charge as well. The workshops and training should be held by the relevant Dinas periodically every year before the flood seasons.

National Organization for Disaster Prevention: It is also important to link the flood-plain management activities with national organization for disaster prevention. The organization covers the whole country and respective administrative levels. It has subordinate organizations as follows:

Name of Organization		Level	Chairman
i	BAKORNAS PBP (National Board for Coordination of Disaster Prevention)	National	Vice President

Name of Organization		Level	Chairman
ii	SATKORLAK PBP (Implementation Coordination Unit for Disaster Mitigation and Evacuation)	Province	Governor
iii	SATLAK PBP (Implementation Unit for Disaster Mitigation)	Kabupaten/Kota	Bupati/Walikota
iv	Unit Operasi PBP (Operation Unit for Disaster Mitigation and Evacuation)	Kecamatan	Camat
v	SATGAS PBP (Task Force Unit for Disaster Mitigation and Evacuation)	Village	Head of Village

Flood Proofing: Various types of flood proofing measures are conceivable and each of them may have different agency in charge. Development, promotion and evaluation of the flood proofing activities should be done in coordination/collaboration with these agencies in charge.

Flood Forecasting, Warning and Evacuation: There exist water intake weirs at the head of plain areas of the most major rivers. At these weirs, flow conditions are observed continuously. The information from these weirs is invaluable for flood forecasting, warning, and evacuation purposes. Even the information is not in time for evacuation, it will surely contribute to reduce damages in the flood plain areas in the downstream reaches. A conceptual flood forecasting system for the basin and a flow chart for flood warning procedure are shown in Figures 5.7.1 and 5.7.2.

Flood Fighting: Flood fighting activities can be implemented in combination with activities of SATLAK PBP Kabupaten Gorontalo. The organization of the SATLAK PBP is shown in Figure 5.7.3.

Community Based Flood Mitigation Measures: Local community should take the initiative in proposing and implementing the projects of this type getting technical and financial subsidy. Workshops and training are effective tool to disseminate the activities. They are also necessary to enhance the capability of community leader and local government officers in charge and to develop and promote practical community-based sustainable flood mitigation measures by themselves. The incorporation of community-development NGOs and volunteers is also advisable to make the activities sustainable.

5.8 Project Evaluation

5.8.1 Procedures for Evaluation

In the previous chapters, priority projects selected for the intensive implementation of flood mitigation in the LBB basin were discussed and formulated mainly from technical point of view, seeking for the optimum technical solution of basin's flood and sediment issues. The priority projects is then subject to the examinations from the following aspects:

1) Economic viability
2) Financial aspects
3) Environmental impact assessment (EIA)

5.8.2 Economic Evaluation

The priority projects were reorganized into two compound projects, i.e., Bone-Bolango-Tapodu (BBT) river improvement project and Tamalate Floodway project. These projects are subject to economic evaluation. Sediment Trap Works in Lake Limboto will not be subject to the economic evaluation, since these were proposed for research and test works.

(1) Basic Conditions for Economic Evaluation

Conversion to Real Economic Values

Composite Conversion Factors: Economic work costs were estimated from the market values adjusting for transfer payments and shadow wage rate applying composite conversion factors.

Land Value: Crop land value is evaluated on the basis of productivity. The net income from irrigated field was estimated at Rp.12.1 million/ha/year in economic terms under present conditions. Meanwhile, the market value of residential land is converted to opportunity cost in the market. Unit cost of residential land was estimated at Rp.18.000/m^2 in economic terms in Kota Gorontalo. In Kabupaten Gorontalo, however, a unit cost of residential land was estimated at Rp.1.800/m^2 in economic terms. Other areas are considered as no values from the economic point of view.

Construction Schedule and Evaluation Period

1) Base Year: Beginning of 2003 (BBT case) or 2005 (Tamalate case) for detailed design and land acquisition
2) Construction Period: The year from 2003 to 2007 for BBT River Improvement Project and from 2005 to 2009 for Tamalate Floodway Project
3) Disbursement Schedule: Disbursed in accordance with construction schedule during the construction period above
4) Economic Life: 50 years after the completion of the project
5) Evaluation Period: 55 years including preparatory works such as detailed design and construction period, and economic life of the project scheme
6) Timing of Benefits Accruing: In proportion to the progress of the construction works for river improvement scheme
7) Social Discount Rate: 12% per annum

Future Damageable Assets

Socio-economic conditions in the LBB Basin will be improved in accordance with the growth of regional economy, and the damageable assets could increase along with the growth of socio-economic conditions.

The number of residential units in the respective desa or kelurahan was assumed to increase in proportion to population growth (household growth). Their damageable value was assumed to increase in proportion to GRDP per capita in LBB Basin. Incidentally, GRDP in 2020 in the basin was estimated as 3.17 times of that in 2001. Accordingly, their total assets will increase in proportion to GRDP growth (3.17 times of the present values), as a result.

Regarding industrial establishments such as manufacturing, trading and others, the increment of their assets holdings was assumed to increase in proportion to the GRDP growth. The increment is also revealed by means of an increase of the number of establishments and the growth of their production. In the basin, the increment of these phenomena was assumed to be absorbed in the same desa or kelurahan.

Paddy production in irrigated fields was assumed to increase its yield from 5.0 ton/ha to 6.0 ton/ha by the year 2020. Rainfed crop production, however, was assumed to keep

the same yield even in the future. Fishpond production was also assumed to maintain the same production yield.

(2) Economic Benefit

Benefit Components of Priority Projects

The project benefits accrue from the following three damage items, as mentioned in the master plan study: (1) direct damages, (2) infrastructure damages and (3) indirect damages. The components of the direct damages consist of residential building, manufacturing establishment, wholesale and retail establishment, educational facility, medical facility, crop production, and fishpond production. The damage rate of infrastructures was set as 30% of the direct damages, which was the same rate used in the master plan study. In terms of indirect damages, the following three components were selected: (1) residence, cleaning away materials damaged after inundation; (2) business losses of private business establishments; and (3) other indirect damages.

Distribution of Damageable Assets

According to the hydraulic analysis, the potential flood areas were estimated at approximately 31.5 km^2 in BBT River Improvement area and 3.9 km^2 in Tamalate Floodway area. In these inundated areas, damageable assets are distributed as shown in Tables 5.8.1 through 5.8.4. This distribution was worked out through the same procedure done in the master plan study.

Economic Benefit:

The project was proposed as flood control scheme for 20-year probable rainfall. Even after the implementation of the BBT Project, however, some flood damages remains in outer areas of the proposed dikes. For more than 20-year return period flood, on the other hand, some flood mitigation effects in the protected areas could be expected owing to the dike effects. Then, these effects were considered for the damage estimation of with-project conditions. The annual benefits thus estimated are summarized below.

(Unit: Rp.billion)

Socio-economic condition	BBT River Improvement	Tamalate Floodway
1. Under present condition	10.6	1.6
2. Under future condition	31.3	5.1

(3) Economic Cost

The economic cost of the priority project was calculated from the corresponding financial cost applying the composite conversion factors. The respective financial and economic costs were tabulated in Table 5.8.5. They are summarized as follows.

(Unit: Rp. billion)

Cost Item	BBT River Improvement		Tamalate Floodway	
	Financial cost	Economic cost	Financial cost	Economic cost
1. Direct construction cost	92.4	85.1	16.2	15.0
2. Land Acquisition & Compensation	2.6	0.8	0.9	0.3
3. Administration	4.8	4.3	0.9	0.8
4. Engineering services	9.2	9.2	1.6	1.6
5. Physical contingency	10.9	10.0	2.0	1.8
Total	119.9	109.4	21.6	19.5

Regarding the land acquisition, agricultural lands were evaluated as negative benefit for the evaluation period, so their cost values were not included in the economic cost items.

In addition, the operation and maintenance (O&M) cost is annually required during the economic life of the proposed project. The O&M cost is assumed to be approximately 0.5% of the total direct construction cost of river improvement schemes. In addition, the rubber gate in the BBT Project is installed in Tapodu River, so its maintenance costs of Rp.0.14 billion for every five years must be appropriated in the O&M cost.

(4) Economic Evaluation

The economic evaluation indices are calculated applying the economic benefits and costs estimated in the respective sections. The annual streams of benefit and cost were tabulated in Table 5.8.6 and 5.8.7 for the BBT River Improvement Project and Table 5.8.8 and 5.8.9 for the Tamalate Floodway Project.

Results of economic evaluation are shown in the table below. Under the present

socio-economic conditions, the project is not viable from the economic viewpoint. Under the future socio-economic conditions, however, the project could be viable.

Index	BTT River Improvement		Tamalate Floodway	
	Under present socio-economic condition	Under future socio-economic condition	Under present socio-economic condition	Under future socio-economic condition
EIRR (%)	8.3	17.0	6.3	16.2
B/C*1	0.71	1.54	0.55	1.44
NPV*1 (Rp. Billion)	-21.5	39.4	-5.8	5.7

Note: *1 Discounted at 12%

The entire priority project including both the BBT River Improvement Project and the Tamalate Floodway Project was also evaluated as a whole. The annual streams of benefit and cost under without-project conditions were tabulated in Table 5.8.10 and 5.8.11. The evaluation indices are enumerated in the table below.

Item	EIRR (%)	B/C*1	NPV*1 (Rp. Billion)
Under present socio-economic conditions	8.1	0.69	-26
Under future socio-economic conditions	16.9	1.53	44

(5) Sensitivity Analysis

The cost and benefits are estimated with discretion by respective experts in this study. In spite of that, some uncertainty still exists in the estimation. In particular, the cases with long implementation period and/or expectation of future growth have high risks in terms of judgment on project viability. In this context, thus, the sensitivity analysis was introduced for (1) 5% or 10% higher than the cost estimated, (2) 5% or 10% lower than the benefit expected, and (3) Combined the both aspects at the same time.

The influence of these changes was examined. The results were presented under future socio-economic conditions in the Table 5.8.12 for the BBT River Improvement project, Table 5.8.13 for the Tamalate Floodway project, and Table 5.8.14 for the entire priority project. The EIRRs under the future socio-economic conditions exceed 12% for the all cases.

5.8.3 Financial Aspect

(1) Constraints on Financial Procurement

The financial requirement of the master plan schemes was estimated at Rp.555 billion at 2001 market prices. This amount has to be invested between 2004 and 2019, as explained in the master plan study. On the other hand, the development investment expected for the same period was estimated at Rp.96 billion for the Propinsi Gorontalo. This was around 17% of the financial requirement for the projects proposed. Thus, it is obvious that the governments are short in their capital investment for the projects.

Furthermore, the national debt stocks from external financial sources aggregated to US$150 billion as of the end of 1999. Due to these external debts, the total debt service aggregated to US$17.8 billion in 1999. Then, the DSR was 30.3% in the sane year. Thus, Indonesia already runs into the critical position to procure more external loans.

(2) Motivation for Sustainable Development

The priority project was proposed as an essential scheme for the flood mitigation in the LBB Basin. The project will function as a core scheme for the river facilities for the basin. Thus, the priority project is important for the local society.

The total amount of Rp.140 billion for the priority project is not small for the public finance of the national and local governments as compared with the past trend of development funds. The project is quite important as a core facility for the comprehensive flood control system. Then, the development stage would rather be divided into two periods, i.e., intensive development stage and sustainable development stage. In the intensive development stage, the priority project is implemented intensively as promoting the regional economic development. It takes seven years by the completion of the project. The governments concerned must appropriate their budgets to the priority project. For this promotion, the following financial sources should be considered.

1) To increase capital funds for the project in the national budget intensively
2) To procure loans having higher grant element
3) To procure grant sources

5.8.4 Environmental Impact Assessment (EIA)

(1) Legal Basis of EIA

Indonesian government is implementing the sustainable development as a part of national development by executing the policies that preserve: (a) water resource, (b) land resource, (c) forest resource, (d) water quality, (e) environment health and freshness, and (f) environmental carrying capacity. Such policies are executed to minimize any negative impacts of development activities on the environment and to promote and maximize the positive impacts. EIA is integrated to the feasibility of development plans and activities because the feasibility of a development project is not only examined on its economical and technological point of view but also on resource carrying capacity as well as environmental harmony.

Indonesian Law No. 23/1997 on Environmental Management, Section 15 states that each effort plan or activity, which might possibly cause big and important impacts on environment, is obligated to carry out EIA. Thus, the EIA study on the priority project in LBB basin is to accomplish necessary obligations required by the laws, regulations, and decrees issued by the government in order to attain the targeted sustainable development.

Other than the Indonesian Law No. 23/1997 on Environmental Management, the following Governmental Regulation and Ministry Decrees are available covering the technical and procedural aspects of the EIA study for the priority project.

(2) Project Description

Project Components: The EIA shall be conducted for the Priority Project for intensive implementation. As a result of Master Plan Study, the following projects were selected as the priority projects:

1) Lower Bone River Improvement,
2) Lower Bolango River Improvement,
3) Tapodu River Improvement with Tapodu Gate,
4) Tamalate Floodway, and
5) Sediment Trap Works in Lake Limboto (including Realignments of Alo-Pohu and Biyonga Rivers).

Identification of Impact Activities: All the priority projects are categorized as structural measures and the impacts activities involved were identified and enumerated in Table 5.8.15.

(3) Methodology of Analyses

Environmental Components to be Evaluated:

Each impact activity was examined and the environmental components that may be affected by each impact activity were identified. With regard to the identified components, environmental impact study is to be conducted in the next stage. The environmental components identified are the following:

1) **Natural Environmental Components:**
   - Geology (erosion and sedimentation),
   - Groundwater and land subsidence,
   - Water regime,
   - Terrestrial flora and fauna,
   - Aquatic flora and fauna,
   - Air quality including noise, and
   - Water quality.

2) **Social Environmental Components:**
   - Resettlement,
   - Livelihood,
   - Local population's opposition
   - People's mobility,
   - Access to water,
   - Public health and sanitation, and
   - Waste.

(4) Impact Assessment for Natural Environment

Impact Prediction

Enumeration of Conceivable Impacts: The impacts of the implementation of the

priority projects were examined and predicted in detail. First and foremost, the priority projects are not such a project that generates pollutant, toxic or hazardous substances. In this regards, the priority projects are not considered to be the origin of pollution. The priority projects are planned to locate in the lower reaches of the Bolango, Bone, Alo-Pohu and Biyonga rivers, and around Lake Limboto and on Tapodu river. The surrounding areas of them are densely populated and heavily modified already by human activity: hence, there is no protected area, such as game refuges, or national parks. Further, there considered not to be growing or inhabiting the protected species of terrestrial flora and fauna designated by the Indonesian Law No. 5 of 1990 regarding "Conservation of Biological Resources and Its Ecosystems."

Descriptions of Impacts: In spite of the nature of the priority projects mentioned above, they will bring about impacts on natural environmental components, including both negative and positive ones. The details of these conceivable impacts were described with its characteristics and possible secondary impacts in Table 5.8.16.

Impact Evaluation

Overview: The impact evaluation should be undertaken comprehensively taking into account not only the feature of negative or positive but also nature of the impact, i.e. reversibility, possibility of avoidance and duration, spatial extent, and so on. In addition, the impacts should be evaluated based on the identicalness of those who get benefit and those who suffer from the project, namely, whether or not people who get benefit from the project is identical with the people who suffer from it.

First of all, it should be noticed that the priority project is not such a project that generates pollutants, toxic or hazardous substances, as stated earlier. The project is aimed to control the flood risks and therefore it is evaluated to contribute to the improvement of natural condition, especially of living condition. And also, the priority projects will not disturb any precious species of terrestrial flora and fauna, either, nor will they occupy any protected area of the basin as described in the previous section. As for the details, however, the impacts on natural environmental components were evaluated as in Table 5.8.17 and as described below:

Evaluation of Negative Impacts: There are some negative impacts which can not be evaluated clearly. They include the impacts on groundwater and land subsidence, and on aquatic fauna, especially eels. Those who suffer from these negative impacts are not

necessarily identical with those who get benefit from the project, because, for example, people who suffer from groundwater lowering along the Tamalate floodway will not get direct benefit from the floodway – the people who currently live around the planned Tamalate floodway are not suffering from flood risks. As for the impacts on eels, it is not clear if fishermen who catch eels are identical with those who are currently suffering from flood risks.

Although the magnitude of some negative impacts cannot be evaluated clearly, these are not considered to be serious provided that these negative impacts are to be compensated with money or the same materials. For example, the fishing output decrease of eels should be compensated with money in reality, and the drawdown of well water revel should be compensated with the supply of drinking water.

Evaluation of Positive Impacts: As for positive impacts, on the other hand, all of them are considered to be significant, except for the impacts of sediment trap. The effects of sediment trap cannot be evaluated quantitatively. All of the positive impacts are considered to last for years or forever if proper operation and maintenance are given.

Conclusion: In conclusion, the negative impacts are evaluated as not significant or not serious in terms of applicability of compensatory mitigation. Positive impacts are evaluated significant taking into consideration the possible secondary effects. Thus, the negative impacts are canceled by the positive impacts with a surplus of substantial benefits, and the priority projects are considered to be valid from the viewpoint of natural environment.

(5) Impact Assessment for Social Environment

Impact Prediction

Predicted impacts on each social environmental component were judged in principle as “negative” or “positive” and summarized in the Table 5.8.18. In the table, additional information useful for impact assessment, such as quantitative magnitude and possible secondary impacts, are also presented. Hereunder is the summary of both negative and positive impacts foreseen for the project implementation.

Impact Evaluation

The nature of predicted impacts, both negative and positive, is examined and each impact is evaluated in a comprehensive manner, using the six criteria: number of affected people, dimension of affected area, intensity/duration of impacts, number of other environmental components affected, impact's cumulative nature and impact reversibility. Quantitative magnitude is also taken into account, but such a parameter was not considered as definitive. The result of evaluation is summarized in Table 5.8.19.

Regarding the negative impacts, all of them are considered as "Not significant". However, some of these "Not significant" impacts need certain considerations: Proper and fair land acquisition process and sufficient socialization (dissemination) activities should be secured. These two elements are very important, even crucial, since they affect more than one social environmental component and considering its practice at the earliest stage of project implementation.

As to the positive impacts, most of them are considered to be significant except for the impacts on a people's habit, precisely waste dumping practice. One of the positive impacts, job creation may improve immediately, during the construction phase, economic base for local population and even can alleviate directly the negative impact on livelihood of the affected households. In addition to this short-term income opportunity, stabilized water level of lake Limboto can offer sustainable income source for the people of surrounding areas in the long-term.

In conclusion, the negative impacts are evaluated as not significant provided that land acquisition and socialization are properly and fairly proceeded. Positive impacts are evaluated significant based on its large benefiting population and area and their long-lasting nature. Also most of the impacts are concentrated on the project sites, and so do the affected population and area. It is considered that the not significant negative impacts would be canceled by the significant positive impacts. The priority projects are considered as a whole, to be valid from the social environmental point of view.

(6) Environmental Management Plan

Purpose of Environmental Management

An environmental management plan (RKL) shall be formulated to ensure to maintain and/or enhance the current environmental condition when it is in good condition, and to mitigate the possible impacts to be affected by the implementation of the project. The environmental management plan shall provide the environmental components to be managed, management elements and goals, measures and/or actions for mitigation and/or enhancement and evaluation criteria for the management. The appropriate environmental management plan should contribute to maintain and enhance the current environment and develop an awareness building and a capacity building of all the concerned people, or stakeholders, through report and dissemination process to them.

Procedure of Environmental Management

JICA Study Team proposes the environmental management procedure listed on Figure 5.8.1. The project implementer, PU/Kimpraswill, Gorontalo province, is to disseminate the environmental aspect of the project, including the Environmental Management Plan and Monitoring Plan, prior to the commencement of the construction work. During construction phase, the project implementer is to execute the necessary environmental mitigation/enhancement measures as well as environmental monitoring activities. The results of the monitoring are to be reported to the supervisory governmental agency, BAPEDAL, Gorontalo province, for discussion, inspection and necessary revision of the implementation plan of the project, if necessary. The monitoring results are also to be disseminated to the stakeholders, including local residents, NGOs, relevant government agencies and so forth. Through the dissemination, the stakeholders are to give their questions, opinions and/or requests to the project implementer. These procedures should be held several times during the construction phase timely in line with its progress. After the completion of the construction work, namely, in operation and maintenance phase, the same procedure should be undertaken among stakeholders.

Environmental Management Plan on Natural Environment

The components of natural environment to be managed are the following (Table 5.8.20): Geology (erosion and sedimentation), Groundwater and land subsidence, Water regime,

Terrestrial flora and fauna, Aquatic flora and fauna, Air quality and Water quality. These are the same as those to receive negative or positive impacts, described in the previous section. The management objectives are the respective elements in each environmental component. Each environmental element is to be managed to keep its acceptable condition, and the condition of the elements is to be evaluated in comparison with a certain criteria, such as environmental standard for the physical elements, i.e. air quality and water quality. As for the elements whose environmental standards are not given or set up, the evaluation is to be done based on the qualitative criteria, or the management goal set up. The environmental condition of each element shall be monitored following the Environmental Monitoring Plan (RPL) which is described in detail in the next section.

Environmental Management Plan on Social Environment

The components of social environment, Resettlement, Livelihood, Local Population's opposition, People's mobility, Access to river and lake waters, Public Health and Sanitation and Waste are to be managed by the present management plan (Table 5.8.21).

The "management elements" are identified for each environmental component. In most of the cases, the environmental elements for social environmental components do not have any standard already set up for managerial purpose. Only an element "Land acquisition" has the regulations to be referred and its base for compensation (NJOP) is available. Therefore, it is proposed to utilize analogical method, in which evaluation is made by comparing the initial status (before-activity) with the status at the evaluation point (after-activity). For example, management element "Dissemination activity" can be evaluated by comparing the percentage of acceptance of local population after such activities, with the initial status (Agree: 68% as in June 2002). Official data can also be utilized to grasp initial status of the elements.

The environmental condition of each element shall be monitored by following RPL (Table 5.8.22), same as for natural environmental components.

(7) Environmental Monitoring Plan

Purpose of Environmental Monitoring

An environmental monitoring process is a part of the environmental management, on

which the existing environmental conditions are to be maintained or enhanced. The monitoring process shall provide information about the actual environmental impacts rendered. It is essential for the evaluation to determine whether the proposed projects have achieved their stated goals or not, from the environmental point of view. The real time evaluation as the results of environmental monitoring enables the project implementer to take immediate actions in case of contingency, unexpected and/or serious situation which might happen. In order to achieve this, RPL shall be the essential to be formulated.

Environmental Monitoring Plan on Natural Environment

The environmental monitoring plan is summarized in Table 5.8.23. Since the environmental monitoring process is a part of the environmental management, the environmental components and elements for the monitoring are the same as those of environmental management plan.

The monitoring sites where each monitoring activities are to be done are identical with those locations/areas where natural environmental elements are to be affected. The time when the monitoring activities are to be carried out is the same as the time when the actual impacts are to be brought about. Specifically, the monitoring should be undertaken at the peak period of each impact. The monitoring activities should be conducted in such frequency that the impact on or change of the environmental element is to be captured. In this regard, the time period of the monitoring also shall cover the duration in which the environmental change occurs. In most of the cases, the environmental impact or change will settle or become stable within five years after an intervention, except for some special cases or secondary impacts. The methodology of the monitoring process should be carried out by means of field observation, including sampling, identification, and/or laboratory tests.

Environmental Monitoring Plan on Social Environment

As regards social environmental components, impact can be monitored mainly by informal method: *i.e.* interview, questionnaire and field observation. The secondary data, such as statistics on economic performance of desa, population profile, are used as complementary information. Interviews and questionnaires can be made up of a series of points for various management elements so that monitoring activities can be done efficiently. To organize a public meeting inviting the affected residents, related

government offices and others, can be an alternative for listening directly to the people's voice. If there is a financial constraint for the above method, it is recommended that related officials contact frequently the local populations, when visiting the project sites as a routine work of structural facilities investigation.

The monitoring sites for each monitoring activity are usually coincident with project sites, *i.e.* sites of construction works, which is summarized in below table. In addition to these location, offices of relevant agency such as BPN (Badan Pertanahan Nasional: National Land Agency) and the contractor's office can provide useful information for the monitoring.

Project	Monitoring Sites
Tapodu River Improvement with Tapodu Gate	Desa Tualango, Tabumela, Tilote, Lauwonu, Hutadaa (Kec. Telaga), Kel. Lekobalo, Dembe I, Kel. Pilolodaa, especially fishery villages
Tamalate Floodway	Desa Oluhuta and Poowo (Kec. Kabila)
River Improvement (Bolango and Siendeng)	Kel. Siendeng and Tenda (Kota Selatan), Kel. Molosipat W (Kota Barat)
River Improvement (Lower Bone)	Kel. Tenda, Talumolo (Kota Selatan)
Realignment of Alo-Pohu and Biyonga, and sediment trap	Desa around the lake Limboto (Kec. Limboto, Batudaa, Telaga, etc.), especially at the fishery village level

As for monitoring timing, it should correspond to the occurrence of impact feature. For example, "Land acquisition" can be monitored at a regular pace during land acquisition process in addition to the point when the process is concluded. Apart from regular monitoring timing, adhoc monitoring should be programmed when necessary, for example when people complain about the situation and when local population's opposition becomes evident. Depending on a result of monitoring activities, mitigation measures may need to be enhanced or modified so that the management plan becomes appropriate and more accurate for the status of concerned environmental component at that point.

(8) Results of AMDAL Procedure

Establishment of AMDAL Commission

In Gorontalo province, AMDAL Commission, namely Environmental Impact

Assessment Evaluation Committee, have not been established yet because the province was newly established in 2001 and its administrative function has not been organized thoroughly. Accordingly, the temporal AMDAL commission was established specifically for this JICA priority projects.

The establishment of the AMDAL commission, including its Technical Evaluation Team, was provided by the provincial regulation (No. 231/2002), issued on June 4th, 2002. The AMDAL commission and the Technical Evaluation Team were composed of 28 and 6 members, respectively. The AMDAL commission were led by the chairman; the Vice Governor of Gorontalo province (*Wakil Gubernur Gorontalo*) and the deputy chairman; the head of Development Planning Board of Gorontalo province (*Kepala Bappeda Provinsi Gorontalo*). Other members include heads of relevant departments of Gorontalo province, university professors, NGOs and representative of community.

Dissemination

In addition to three times of public consultation meeting held by JICA Study team, the dissemination at two different venues, i.e. Kecamatan Telaga meeting hall and Kecamatatn Kota Barat meeting hall, was held specifically for the AMDAL procedure on June 7th, 2002. At the dissemination, the conceivable impacts of both negative and positive ones on environment as well as the components of priority projects were informed to the local communities and the relevant organizations. The numbers of participants were 50 and 65 at Kecamatan Telaga and at Kecamatatn Kota Barat, respectively. In the consultation meetings, some questions regarding the components of the priority projects were raised, specifically, the questions on the effectiveness of Tamalate floodway, Tapodu control gate and Sediment trap in Lake Limboto.

Approval of Environmental Impact Analysis

The necessary procedures were conducted following the relevant laws, regulations and decrees, and as a consequent, the Environmental Impact Analysis (ANDAL), Environmental Management Plan (RKL) and Environmental Monitoring Plan (RPL) have been approved by the AMDAL Commission effective on September 23rd, 2002. The letter of the approval is attached as Table 5.8.24, although the original letter of it is written in Indonesian language.

(9) Conclusion and Recommendations

Environmental Impact Evaluation

Natural Environment: The negative impacts on natural environmental components are evaluated as not significant or not serious in terms of the nature and magnitude of impacts or the applicability of compensatory mitigation. Positive impacts are evaluated significant judging from the secondary effects, or economic benefit. Thus, the negative impacts are canceled by the positive impacts with a surplus of substantial benefits, and the priority projects are considered to be valid from the viewpoint of natural environment.

Social Environment: In terms of social environmental components, no significant negative impacts are foreseen, provided that land acquisition and dissemination activity are fully taken into consideration. On the contrary, positive impacts are considered as significant, including the increase of the potential of fish culture production of the Lake Limboto which could be a sustainable impact for the regional economy.

Recommendations

The priority projects were evaluated as environmentally valid in the previous section. However, the validity is realized if the following are provided. JICA Study team strongly recommends the following be conducted surely.

Watershed management: Watershed management, specifically forest and land use managements are to be conducted. The structural measures are effective provided that the upstream watershed management be carried out. Since no Master Plan on watershed management has been developed, its formulation is first and foremost task to be got started.

Statistical Survey on Fishery in Lake Limboto: the fishing output, and aquaculture production, has not been investigated systematically so far. The daily survey of the fishery production from Lake Limboto is essential for the management of fishery resources in it, because almost all of the local people are owing to freshwater fish in the lake for protein intake. Survey of eel's migration is included for one the necessary survey.

Monitoring and Management of water environment in Lake Limboto: Since Lake Limboto is considered to be the resource origin of all the economic activities, such as fishery, agriculture, fluvial transportation, tourism, as well as daily water use in ordinary lives, the monitoring and management are by far important aiming to keep it in good condition.

Land Acquisition: It was realized, through the investigation by the EIA study, that the key persons of local communities affected by potential projects would play an important role in the process of socialization (dissemination), land acquisition and project implementation. The key persons would be a local religious leader, kepala desa, Tokoh masyarakat (public figures), a leader of local youth group, LSM (NGO) active at the site, etc. It is crucial to first of all convince them with the necessity and importance of the project at a very early stage of preparation. Local people tend to follow an instruction of such key persons at the local level. In this regard, a combination of informal and formal steps is recommended in practice, for smoothly proceeding land acquisition procedure. General flow of such actions is schematized in Figure 5.8.2. An informal approach to the targeted communities should be done by a third party: preferably not by the officials directly involved in the concerned project nor by the personnel of the project executor. The formal approach should fully respect the existing regulations. It is also considered as a part of socialization process.

5.9 Implementation Plan

5.9.1 Overall Implementation Plan

Implementation of Master Plan: The Flood Mitigation Master Plan (FM-MP) is proposed for implementation by the target year of 2019. Considering the effective and orderly implementation, early realization of project effects, and capacity building through the project implementation, the FM-MP was proposed for stage-wise implementation as follows (Figure 5.9.1):

1) Preparatory stage : Until end of 2004
2) Intensive implementation stage : From beginning of 2005 to end of 2009
3) Sustainable implementation stage : From beginning of 2010 to end of 2019

Intensive Implementation: During the period of the Eighth National Five-Year Plan from 2005 to2009, actual construction works at site and activities for watershed management and flood plain management will be implemented intensively. Through the intensive implementation, it is expected the flood mitigation activities in the basin will be stimulated and related personnel and administration will be trained and adjusted toward effective implementation of the project. The projects to be implemented in this stage must be the basic facilities and activities for flood mitigation and the priority ones expected to yield higher outcome.

Priority Projects Selected for Intensive Implementation: The Priority Projects include structural and non-structural measures. The structural measures selected for the intensive implementation are:

1) Lower Bone River Improvement
2) Lower Bolango River Improvement
3) Tapodu River Improvement with Tapodu Gate
4) Tamalate Floodway
5) Sediment Trap Works in Lake Limboto

In parallel with the structural measures, non-structural measures such as watershed management and flood plain management will also be implemented within a framework of the intensive implementation.

Structural Sub-Projects: The structural measures selected for the priority projects can be divided into following sub-projects which are expected to realize respectively the effects corresponding to the works implemented:

Work I: Bone-Bolango-Tapodu (BBT) River Improvement
- Work I-1: Lower Bone River
- Work I-2: Bolango Stretch-I
- Work I-3: Tenda COC
- Work I-4: Bolango Stretch-II_R
- Work I-5: Bolango Stretch-II_L
- Work I-6: Bolango Stretch-III
- Work I-7: Tapodu River with Tapodu Gate

Work II: Tamalate Floodway

Work III: Sediment Trap Works in Lake Limboto

Non-structural Measures: The non-structural flood mitigation measures are the activities to be carried out in collaboration with relevant government agencies, local communities and individuals. Rolls of the agency in charge of flood mitigation would not be project-type works but rather administrative works to be performed as routine works as described below.

1) Watershed management by encouraging activities to be undertaken by relevant agencies and local community organizations, so as to conserve flood-water and sediment retention function by means of construction of erosion control facilities, afforestation and land use control, and dissemination activities in the watershed areas; and
2) Flood plain management by guiding and promoting the activities to prevent occurrence of damages by such means of flood-proofing, flood forecasting-warning and evacuation, flood fighting, and community-based flood mitigation measures, by mobilizing local community organizations and individuals in the flood prone areas.

5.9.2 Preparatory Stage

During the preparatory stage until the end of the 7th National Five-Year Plan in 2004, various works and activities have to be performed for the forthcoming full-scale project. Main works and activities are presented below. Some activities below are to be continued after in the remaining stages.

(1) Institutional and Organizational Arrangements

The preparatory works for the implementation of the FM-MP should be initiated from the establishment or reinforcement of the implementation body of the project. This works would include institutional and organizational arrangements as follows:

1) Institutional Arrangements: The priority project will be implemented under the management of Gorontalo Province in cooperation with Kabupaten Gorontalo and Kota Gorontalo, since the LBB basin extends across the border of Kabupaten and Kota. Gorontalo Province should make administrative decision toward the project implementation in association with Kabupaten and Kota.
2) Organizational Arrangements: Organizational setup should be established for the full scale implementation of the project. In the organization, staffing, roles and budgeting shall be clarified based on the coordination with relevant agencies of Province, Kabupaten and Kota. Capacity building is an important aspect to materialize the organization. For the successful implementation of the project, recruit of capable staff and training for them should be started.

(2) Fund Arrangement

The project cost estimated in the feasibility study is allocated among the stakeholders such as central/local governments and communities, taking into consideration the nature of work and the capability of funding.

(3) Definite Plan/Detail Design

A definite plan of the flood mitigation works will be drawn up after getting consent of the central/local government agencies and communities concerned. A detailed design will be prepared of the project facilities.

(4) Preservation of Lands

One of the crucial issues of the works in urban area like Gorontalo is the land acquisition. Therefore, it is essential to preserve the lands for flood mitigation facilities. This should start immediately after the preparation of definite flood

mitigation plan.

(5) Research and Investigation:

Throughout the implementation period of the FM-MP, research and investigation activities should also be conducted in parallel for development of engineering tools to support the project. The following may be included among these activities, but not limited to:

1) **Sediment Runoff:** Study and analysis on sediment yield and transport are necessary especially in relation to the Lake Limboto.
2) **Development of Erosion Control Works:** For developing erosion control works effective and practical to the basin, various types of erosion control works should be introduced and tested. The work should include measures against sheet erosion and riverbank erosion. The works should be monitored for their sediment control effects and evaluated taking the materials available and cost-performance into consideration.
3) **Research on Application of Bioengineering Technology:** In order to introduce bioengineering technology as a component of flood mitigation, research works and accumulation of experience are necessary, in particular, on the selection of plant species, type and function of works applicable, raising techniques, and possibility of income generation for the community.

(6) Training and Workshops on Watershed and Flood Plain Management

1) For government officials and staff: Training and workshop of the government officials and staff in charge regarding watershed management, flood plain management and their application procedures to communities, so that they can coordinate, guide and support activities undertaken by relevant agencies, communities and individuals.
2) For community leaders: Training and workshop of the community leaders regarding flood plain management are also necessary to be undertaken by the government officer in charge.

(7) Coordination with Relevant Agencies and Communities

Implementation of flood mitigation requires coordination with various agencies and

organization, among others:

1) For structural measures: Coordination to allocate works and required cost among the relevant agencies and organizations;
2) For watershed management: Coordination mainly with the Department of Forest and Plantation to promote Land Rehabilitation and Soil Conservation (LRSC) project
3) For flood plain management: Coordination and promotion for Community Mobilization to establish organizational basis for the flood mitigation activities in the communities.

5.9.3 Intensive Implementation Stage

(1) Work I: Bone-Bolango-Tapodu (BBT) River Improvement

The implementation of Work I (BBT River Improvement), especially Works I-2 through I-5 and I-7 should be given the highest priority, because the suffering area is the center of the Gorontlo City, and that the areas related with these works are not protected by dikes in spite of inherently low ground elevations. The Work I was scheduled for its construction at site from 2005 to 2007.

(2) Work II: Tamalate Floodway

Although Work II (Construction of Tamalate Floodway) plays vital role on the flood mitigation for the city of Gorontalo, flood wall of the Tamalate River progresses almost entire stretches in the city. In view of this, priority was given lower than the Work I. The Work II was scheduled for its construction at site from 2007 to 2009.

(3) Work III: Sediment Trap Works in Lake Limboto

Considering the urgency for the establishment of countermeasures of Lake Limboto, it is advisable to start research and test work as early as possible. Therefore the Work III (Sediment Trap Works in Lake Limboto) was scheduled for its construction at site from 2005 to 2006.

(4) Non-structural Measures

Training/workshop and coordination activities initiated in the preparatory stage should be continued in this stage too. The dissemination activities of watershed management activities and flood plain management as well, community mobilization to establish the local community organizations, and other watershed and flood plain management activities should be put into practice in the selected pilot villages. All of these activities should be kept in record for future lessons and improvement including both succeeded and failed ones.

5.9.4 Sequence of Implementation

It is ideal the work should be implemented on the schedule mentioned above, getting enough funds for their implementation. Even if the enough funds are not in hand, it is advisable to implement the works using the fund as available and realize the flood mitigation effects. For the selection of works in such cases, priority or sequence of works are proposed as follows:

1) First Group: Implementation at anytime as soon as possible:
   - Work I-7: Tapodu River with Tapodu Gate
   - Work I-3: Tenda COC
   - Work I-2: Bolango Stretch-I
   - Work III: Sediment Trap Works in Lake Limboto
2) Second Group: Implementation at anytime after Work I-2:
   - Work I-4: Bolango Stretch-IIR
   - Work I-5: Bolango Stretch-IIL
3) Third Group: Implementation at anytime during intensive implementation:
   - Work II: Tamalate Floodway
   - Work I-1: Lower Bone River
   - Work I-6: Bolango Stretch-III

Works can be selected for implemented from any of the first group works, then the second and third group works, considering the fund and lands available.

The non-structural measures such as watershed management and flood plain management should be performed continuously as routine works starting from the preparatory stage

Table 5.3.1 COMPARISON OF TYPES FOR TAPODU GATE

	Fixed Wheel Gate	Rubber Gate
Hydraulic characteristic	The gate is adopted for both flow conditions of regular and reverse. The gate discharges in both way of overflow and underflow. Except the crack open discharge, the gate can control the flow in full range of gate opening.	The gate is adopted for both flow conditions of regular and reverse. The gate discharges in the way of overflow without discharge control. The gate cannot control discharge. In case of regular flow, inhibition of flow is less. In case of reverse flow, some inhibition may occur.
Operation	Generally electric motor hoist is used. Without powered drive, the gate cannot be opened. Electric power supply is essential. In case of long span gate, control system is complicated.	The gate can be opened, namely deflated without powered drive, by hand. The speed of deflation is depending on the condition of flow velocity. The gate closure, namely inflation, will take around 30 minutes to one hour.
Maintenance	The protection coating of gate leaf is repaired at an interval of several years. The electric parts and controls are required to inspect and maintain frequently.	The protection against corrosion is unnecessary. For the operation system is simple, inspection is required for a few points.
Safety	Since the gate is the steel structure, it is strong as a structure against impact shock of flowing trashes. In case of power failure or malfunction of hoist, the gate cannot be controlled.	The gate can be deflated (opened) without power. During flooding, operation of opening is reliable. As the gate body is made from the rubber, it is weak against the flowing material, such as woods, gravel, etc.
Durability	Although the structural parts are durable enough for thirty years and more, lifetime of mechanical and electrical parts is shorter.	The strength of rubber as the material will be kept for thirty years, but abrasion and damage of rubber body is inevitable.

Table 5.3.2 QUANTITIES OF WORKS FOR PRIORITY PROJECTS

No.	WORK ITEM	UNIT	BBT River Improvement	Tamalate Floodway	Sediment Trap in L. Limboto	Total
1	CHANNEL WORKS					
1.1	Earth Works					
	Excavation	cu.m	623,000	210,000	49,000	882,000
	Embankment	cu.m	161,000	29,000	0	190,000
	Sodding	sq.m	95,000	9,000	0	104,000
1.2	Stone Works					
	Bank Protection (Type-1)	m	1,900	0	0	1,900
	Wet Rubble Masonry	cu.m	14,000	7,600	0	21,600
	Riprap	cu.m				
	Gravel Bedding	cu.m	2,000	2,000	0	4,000
	Gabion Mattress	cu.m	0	2,500	0	2,500
1.3	Concrete Works					
	Bank Protection (Type-2)	m	2,000	0	0	2,000
	Concrete Dike (Type-3)	sq.m	1,800	0	0	1,800
	Concrete	cu.m	4,700	0	0	4,700
	Reinforcement Bar	ton	100	0	0	100
1.4	Sluice, Drainage Sluice Works					
	U/s. Sluice.	L.S	2	0	0	2
	Drainage sluice str. (2gates x 2m x 1.5m)	L.S	4	0	0	4
	Sluice Gate (2m x 1m)	Pc.	0	1	0	1
	Drainage sluice str. (1m x 1m)	L.S	0	4	0	4
2	WEIR WORKS					
2.1	Earth Works					
	Excavation	cu.m	51,000	4,000	0	55,000
	Embankment	cu.m	6,000	4,000	0	10,000
2.2	Stone Works					
	Wet Rubble Masonry	cu.m	0	1,700	0	1,700
	Riprap	cu.m	4,500	20	0	4,520
	Gabion Mattress	cu.m	0	100	0	100
2.3	Concrete Works					
	Concrete	cu.m	8,000	100	0	8,100
	Reinforcement Bar	ton	540	10	0	550
2.4	Pile Works					
	PC Concrete Pipe Pile (ϕ =450)	m	7,000	0	0	7,000
	Steel Sheet Pile	sq.m	1,100	0	0	1,100
2.5	Rubber Gate					
	Rubber Gate Sets	L.S	1	0	0	1
3	SEDIMENT TRAP WORKS					
3.1	Sediment Trap Works					
	Bamboo mess Type 1 (h=1.0 m)	m	0	0	1,300	1,300
	Bamboo mess Type 2 (h=2.0 m)	m	0	0	1,300	1,300
4	APPURTENANT WORKS					
4.1	Bridge Works					
	Br. Type-1(W=4.00m)	m	343	110	0	453
	Br. Type-1(W=7.00m)	m	100	30	0	130
	Heightening of Bridge	L.S	2	0	0	2
4.2	Waterway	L.S	0	1	0	1

Table 5.5.1 TOTAL COST OF PRIORITY PROJECTS

						Priority Project			
No.	ITEM	UNIT	UNIT COST	RATE			AMOUNT		TOTAL
			D.C.(Rp.)	F.C.(%)	D.C.(%)	Q'TY	F.C.(Rp.)	D.C.(Rp.)	D.C.(Rp.)
(1)	DIRECT COST						55,081,445,000	54,906,555,000	109,988,000,000
1.1	PREPARATORY WORKS			58%	42%		5,007,495,000	4,991,505,000	9,999,000,000
1.2	CHANNEL WORKS						16,769,200,000	32,358,800,000	49,128,000,000
1.2.1	Earth Works						12,523,500,000	11,702,500,000	24,226,000,000
	Excavation	cu.m	20,000	55%	45%	882,000	9,702,000,000	7,938,000,000	17,640,000,000
	Embankment	cu.m	27,000	55%	45%	190,000	2,821,500,000	2,308,500,000	5,130,000,000
	Sodding	sq.m	14,000	0%	100%	104,000	0	1,456,000,000	1,456,000,000
1.2.2	Stone Works						855,660,000	11,874,340,000	12,730,000,000
	Bank Protection (Type-1)	m	2,770,000	3%	97%	1,900	157,890,000	5,105,110,000	5,263,000,000
	Wet Rubble Masonry	cu.m	300,000	8%	92%	21,600	518,400,000	5,961,600,000	6,480,000,000
	Riprap	cu.m	100,000	5%	95%		0	0	0
	Gravel Bedding	cu.m	78,000	51%	49%	4,000	159,120,000	152,880,000	312,000,000
	Gabion Mattress	cu.m	270,000	3%	97%	2,500	20,250,000	654,750,000	675,000,000
1.2.3	Concrete Works						2,076,700,000	5,272,300,000	7,349,000,000
	Bank Protection (Type-2)	m	1,660,000	8%	92%	2,000	265,600,000	3,054,400,000	3,320,000,000
	Concrete Dike (Type-3)	sq.m	490,000	35%	65%	1,800	308,700,000	573,300,000	882,000,000
	Concrete	cu.m	480,000	35%	65%	4,700	789,600,000	1,466,400,000	2,256,000,000
	Reinforcement Bar	ton	8,910,000	80%	20%	100	712,800,000	178,200,000	891,000,000
1.2.4	Sluice, Drainage Sluice Works						712,320,000	2,679,680,000	3,392,000,000
	U/s. Sluice.	L.S	320,000,000	21%	79%	2	134,400,000	505,600,000	640,000,000
	Drainage sluice str. (2gates x 2m x 1.5m)	L.S	518,000,000	21%	79%	4	435,120,000	1,636,880,000	2,072,000,000
	Sluice Gate (2m x 1m)	Pc.	80,000,000	21%	79%	1	16,800,000	63,200,000	80,000,000
	Drainage sluice str. (1m x 1m)	L.S	150,000,000	21%	79%	4	126,000,000	474,000,000	600,000,000
1.2.5	Miscellaneous			42%	58%		601,020,000	829,980,000	1,431,000,000
1.3	WEIR WORKS						21,760,590,000	9,086,410,000	30,847,000,000
1.3.1	Earth Works						753,500,000	616,500,000	1,370,000,000
	Excavation	cu.m	20,000	55%	45%	55,000	605,000,000	495,000,000	1,100,000,000
	Embankment	cu.m	27,000	55%	45%	10,000	148,500,000	121,500,000	270,000,000
	Sodding	sq.m	14,000	0%	100%		0	0	0
1.3.2	Stone Works						64,210,000	924,790,000	989,000,000
	Wet Rubble Masonry	cu.m	300,000	8%	92%	1,700	40,800,000	469,200,000	510,000,000
	Riprap	cu.m	100,000	5%	95%	4,520	22,600,000	429,400,000	452,000,000
	Gravel Bedding	cu.m	78,000	51%	49%		0	0	0
	Gabion Mattress	cu.m	270,000	3%	97%	100	810,000	26,190,000	27,000,000
1.3.3	Concrete Works						5,276,800,000	3,506,200,000	8,783,000,000
	Concrete	cu.m	480,000	35%	65%	8,100	1,360,800,000	2,527,200,000	3,888,000,000
	Reinforcement Bar	ton	8,900,000	80%	20%	550	3,916,000,000	979,000,000	4,895,000,000
1.3.4	Pile Works						2,255,000,000	2,255,000,000	4,510,000,000
	PC Concrete Pipe Pile (ϕ =450)	m	440,000	50%	50%	7,000	1,540,000,000	1,540,000,000	3,080,000,000
	Steel Sheet Pile	sq.m	1,300,000	50%	50%	1,100	715,000,000	715,000,000	1,430,000,000
1.3.5	Rubber Gate						12,353,400,000	1,372,600,000	13,726,000,000
	Rubber Gate Sets	L.S	13,726,000,000	90%	10%	1	12,353,400,000	1,372,600,000	13,726,000,000
1.3.6	Miscellaneous			72%	28%		1,057,680,000	411,320,000	1,469,000,000
1.4	SEDIMENT TRAP WORKS						0	616,000,000	616,000,000
1.4.1	Sediment Trap Works						0	598,000,000	598,000,000
	Bamboo mess Type 1 (h=1.0 m)	m	170,000	0%	100%	1,300	0	221,000,000	221,000,000
	Bamboo mess Type 2 (h=2.0 m)	m	290,000	0%	100%	1,300	0	377,000,000	377,000,000
1.4.2	Miscellaneous			0%	100%		0	18,000,000	18,000,000
1.5	APPURTENANT WORKS						8,799,600,000	5,866,400,000	14,666,000,000
1.5.1	Bridge Works						8,356,200,000	5,570,800,000	13,927,000,000
	Br. Type-1(W=4.00m)	m	19,000,000	60%	40%	453	5,164,200,000	3,442,800,000	8,607,000,000
	Br. Type-1(W=7.00m)	m	37,000,000	60%	40%	130	2,886,000,000	1,924,000,000	4,810,000,000
	Heightening of Bridge	L.S	255,000,000	60%	40%	2	306,000,000	204,000,000	510,000,000
1.5.2	Waterway	L.S	850,000,000	20%	80%	1	170,000,000	680,000,000	850,000,000
1.5.3	Miscellaneous			60%	40%		443,400,000	295,600,000	739,000,000
1.6	MISCELLANEOUS WORKS			58%	42%		2,744,560,000	1,987,440,000	4,732,000,000
(2)	LAND ACQUISITION						0	3,884,000,000	3,884,000,000
2.1	Compensation for Houses(urban)	nos	18,000,000	0%	100%	28	0	504,000,000	504,000,000
2.2	Compensation for Houses(rural)	nos	7,700,000	0%	100%	100	0	770,000,000	770,000,000
2.3	Land Acquisition for Residential Land	sq.m	2,000	0%	100%	87,000	0	174,000,000	174,000,000
2.4	Land Acquisition for Agriculture Land	sq.m	3,000	0%	100%	812,000	0	2,436,000,000	2,436,000,000
(3)	ADMINISTRATION COST 5% of (1)+(2)			0%	100%		0	5,694,000,000	5,694,000,000
(4)	ENGINEERING SERVICE COST 10% of (1)			100%	0%		10,999,000,000	0	10,999,000,000
(5)	SUB TOTAL = (1)+(2)+(3)+(4)						66,080,445,000	64,484,555,000	130,565,000,000
(6)	PHYSICAL CONTINGENCY 10% of (5)						6,608,544,500	6,448,455,500	13,057,000,000
	GRAND TOTAL						72,688,989,500 (Rp.mil. 72,689) (US$'000 7,571.8)	70,933,010,500 (Rp.mil. 70,933)	143,622,000,000 (Rp.mil. 143,622)

Note :

1 JPYen1=Rp. 77.4

2 US$1=Rp. 9600

3 1. PREPARATORY WORKS 10%
2. CHANNEL WORKS 3%
3. WEIR WORKS (Topadu River) 5%
5. APPURTENANT WORKS 5%
6. MISCELLANEOUS WORKS 5%

Table 5.5.2 COST OF COMPONENT PROJECT (1/3)

No.	ITEM	UNIT	UNIT COST	RATE		Bone-Bolango-Tapodu R. Improvement			
							AMOUNT		TOTAL
			D.C.(Rp.)	F.C.(%)	D.C.(%)	Q'TY	F.C.(Rp.)	D.C.(Rp.)	D.C.(Rp.)
(1)	DIRECT COST						47,870,798,000	44,708,202,000	92,579,000,000
1.1	PREPARATORY WORKS			58%	42%		4,351,618,000	4,064,382,000	8,416,000,000
1.2	CHANNEL WORKS						12,940,220,000	26,011,780,000	38,952,000,000
1.2.1	Earth Works						9,243,850,000	8,893,150,000	18,137,000,000
	Excavation	cu.m	20,000	55%	45%	623,000	6,853,000,000	5,607,000,000	12,460,000,000
	Embankment	cu.m	27,000	55%	45%	161,000	2,390,850,000	1,956,150,000	4,347,000,000
	Sodding	sq.m	14,000	0%	100%	95,000	0	1,330,000,000	1,330,000,000
1.2.2	Stone Works						573,450,000	9,045,550,000	9,619,000,000
	Bank Protection (Type-1)	m	2,770,000	3%	97%	1,900	157,890,000	5,105,110,000	5,263,000,000
	Wet Rubble Masonry	cu.m	300,000	8%	92%	14,000	336,000,000	3,864,000,000	4,200,000,000
	Riprap	cu.m	100,000	5%	95%		0	0	0
	Gravel Bedding	cu.m	78,000	51%	49%	2,000	79,560,000	76,440,000	156,000,000
	Gabion Mattress	cu.m	270,000	3%	97%		0	0	0
1.2.3	Concrete Works						2,076,700,000	5,272,300,000	7,349,000,000
	Bank Protection (Type-2)	m	1,660,000	8%	92%	2,000	265,600,000	3,054,400,000	3,320,000,000
	Concrete Dike (Type-3)	sq.m	490,000	35%	65%	1,800	308,700,000	573,300,000	882,000,000
	Concrete	cu.m	480,000	35%	65%	4,700	789,600,000	1,466,400,000	2,256,000,000
	Reinforcement Bar	ton	8,910,000	80%	20%	100	712,800,000	178,200,000	891,000,000
1.2.4	Sluice, Drainage Sluice Works						569,520,000	2,142,480,000	2,712,000,000
	U/s. Sluice.	L.S	320,000,000	21%	79%	2	134,400,000	505,600,000	640,000,000
	Drainage sluice str. (2gates x 2m x 1.5m)	L.S	518,000,000	21%	79%	4	435,120,000	1,636,880,000	2,072,000,000
	Sluice Gate (2m x 1m)	Pc.	80,000,000	21%	79%		0	0	0
	Drainage sluice str. (1m x 1m)	L.S	150,000,000	21%	79%		0	0	0
1.2.5	Miscellaneous			42%	58%		476,700,000	658,300,000	1,135,000,000
1.3	WEIR WORKS						21,496,520,000	8,443,480,000	29,940,000,000
1.3.1	Earth Works						650,100,000	531,900,000	1,182,000,000
	Excavation	cu.m	20,000	55%	45%	51,000	561,000,000	459,000,000	1,020,000,000
	Embankment	cu.m	27,000	55%	45%	6,000	89,100,000	72,900,000	162,000,000
	Sodding	sq.m	14,000	0%	100%		0	0	0
1.3.2	Stone Works						22,500,000	427,500,000	450,000,000
	Wet Rubble Masonry	cu.m	300,000	8%	92%		0	0	0
	Riprap	cu.m	100,000	5%	95%	4,500	22,500,000	427,500,000	450,000,000
	Gravel Bedding	cu.m	78,000	51%	49%		0	0	0
	Gabion Mattress	cu.m	270,000	3%	97%		0	0	0
1.3.3	Concrete Works						5,188,800,000	3,457,200,000	8,646,000,000
	Concrete	cu.m	480,000	35%	65%	8,000	1,344,000,000	2,496,000,000	3,840,000,000
	Reinforcement Bar	ton	8,900,000	80%	20%	540	3,844,800,000	961,200,000	4,806,000,000
1.3.4	Pile Works						2,255,000,000	2,255,000,000	4,510,000,000
	PC Concrete Pipe Pile (ϕ =450)	m	440,000	50%	50%	7,000	1,540,000,000	1,540,000,000	3,080,000,000
	Steel Sheet Pile	sq.m	1,300,000	50%	50%	1,100	715,000,000	715,000,000	1,430,000,000
1.3.5	Rubber Gate						12,353,400,000	1,372,600,000	13,726,000,000
	Rubber Gate Sets	L.S	13,726,000,000	90%	10%	1	12,353,400,000	1,372,600,000	13,726,000,000
1.3.6	Miscellaneous			72%	28%		1,026,720,000	399,280,000	1,426,000,000
1.4	SEDIMENT TRAP WORKS						0	0	0
1.4.1	Sediment Trap Works						0	0	0
	Bamboo mess Type 1 (h=1.0 m)	m	170,000	0%	100%		0	0	0
	Bamboo mess Type 2 (h=2.0 m)	m	290,000	0%	100%		0	0	0
1.4.2	Miscellaneous			0%	100%		0	0	0
1.5	APPURTENANT WORKS						6,757,800,000	4,505,200,000	11,263,000,000
1.5.1	Bridge Works						6,436,200,000	4,290,800,000	10,727,000,000
	Br. Type-1(W=4.00m)	m	19,000,000	60%	40%	343	3,910,200,000	2,606,800,000	6,517,000,000
	Br. Type-1(W=7.00m)	m	37,000,000	60%	40%	100	2,220,000,000	1,480,000,000	3,700,000,000
	Heightening of Bridge	L.S	255,000,000	60%	40%	2	306,000,000	204,000,000	510,000,000
1.5.2	Waterway	L.S	850,000,000	20%	80%		0	0	0
1.5.3	Miscellaneous			60%	40%		321,600,000	214,400,000	536,000,000
1.6	MISCELLANEOUS WORKS			58%	42%		2,324,640,000	1,683,360,000	4,008,000,000
(2)	LAND ACQUISITION						0	2,642,000,000	2,642,000,000
2.1	Compensation for Houses(urban)	nos	18,000,000	0%	100%	28	0	504,000,000	504,000,000
2.2	Compensation for Houses(rural)	nos	7,700,000	0%	100%	50	0	385,000,000	385,000,000
2.3	Land Acquisition for Residential Land	sq.m	2,000	0%	100%	59,000	0	118,000,000	118,000,000
2.4	Land Acquisition for Agriculture Land	sq.m	3,000	0%	100%	545,000	0	1,635,000,000	1,635,000,000
(3)	ADMINISTRATION COST 5% of (1)+(2)			0%	100%		0	4,761,000,000	4,761,000,000
(4)	ENGINEERING SERVICE COST 10% of (1)			100%	0%		9,258,000,000	0	9,258,000,000
(5)	SUB TOTAL = (1)+(2)+(3)+(4)						57,128,798,000	52,111,202,000	109,240,000,000
(6)	PHYSICAL CONTINGENCY 10% of (5)						5,712,879,800	5,211,120,200	10,924,000,000
	GRAND TOTAL						62,841,677,800 (Rp.mil. 62,842) (US$'000 6,546.0)	57,322,322,200 (Rp.mil. 57,322)	120,164,000,000 (Rp.mil. 120,164)

Note :

1 JPYen1=Rp. 77.4

2 US$1=Rp. 9600

3 1. PREPARATORY WORKS 10%
2. CHANNEL WORKS 3%
3. WEIR WORKS (Topadu River) 5%
5. APPURTENANT WORKS 5%
6. MISCELLANEOUS WORKS 5%

Table 5.5.2 COST OF COMPONENT PROJECT (2/3)

No.	ITEM	UNIT	UNIT COST	RATE		Tamalate Floodway			
							AMOUNT		TOTAL
			D.C.(Rp.)	F.C.(%)	D.C.(%)	Q'TY	F.C.(Rp.)	D.C.(Rp.)	D.C.(Rp.)
(1)	DIRECT COST						6,571,949,000	8,994,051,000	15,566,000,000
1.1	PREPARATORY WORKS			58%	42%		597,359,000	817,641,000	1,415,000,000
1.2	CHANNEL WORKS						3,277,800,000	5,889,200,000	9,167,000,000
1.2.1	Earth Works						2,740,650,000	2,368,350,000	5,109,000,000
	Excavation	cu.m	20,000	55%	45%	210,000	2,310,000,000	1,890,000,000	4,200,000,000
	Embankment	cu.m	27,000	55%	45%	29,000	430,650,000	352,350,000	783,000,000
	Sodding	sq.m	14,000	0%	100%	9,000	0	126,000,000	126,000,000
1.2.2	Stone Works						282,210,000	2,828,790,000	3,111,000,000
	Bank Protection (Type-1)	m	2,770,000	3%	97%		0	0	0
	Wet Rubble Masonry	cu.m	300,000	8%	92%	7,600	182,400,000	2,097,600,000	2,280,000,000
	Riprap	cu.m	100,000	5%	95%		0	0	0
	Gravel Bedding	cu.m	78,000	51%	49%	2,000	79,560,000	76,440,000	156,000,000
	Gabion Mattress	cu.m	270,000	3%	97%	2,500	20,250,000	654,750,000	675,000,000
1.2.3	Concrete Works						0	0	0
	Bank Protection (Type-2)	m	1,660,000	8%	92%		0	0	0
	Concrete Dike (Type-3)	sq.m	490,000	35%	65%		0	0	0
	Concrete	cu.m	480,000	35%	65%		0	0	0
	Reinforcement Bar	ton	8,910,000	80%	20%		0	0	0
1.2.4	Sluice, Drainage Sluice Works						142,800,000	537,200,000	680,000,000
	U/s. Sluice.	L.S	320,000,000	21%	79%		0	0	0
	Drainage sluice str. (2gates x 2m x 1.5m)	L.S	518,000,000	21%	79%		0	0	0
	Sluice Gate (2m x 1m)	Pc.	80,000,000	21%	79%	1	16,800,000	63,200,000	80,000,000
	Drainage sluice str. (1m x 1m)	L.S	150,000,000	21%	79%	4	126,000,000	474,000,000	600,000,000
1.2.5	Miscellaneous			42%	58%		112,140,000	154,860,000	267,000,000
1.3	WEIR WORKS						264,070,000	642,930,000	907,000,000
1.3.1	Earth Works						103,400,000	84,600,000	188,000,000
	Excavation	cu.m	20,000	55%	45%	4,000	44,000,000	36,000,000	80,000,000
	Embankment	cu.m	27,000	55%	45%	4,000	59,400,000	48,600,000	108,000,000
	Sodding	sq.m	14,000	0%	100%		0	0	0
1.3.2	Stone Works						41,710,000	497,290,000	539,000,000
	Wet Rubble Masonry	cu.m	300,000	8%	92%	1,700	40,800,000	469,200,000	510,000,000
	Riprap	cu.m	100,000	5%	95%	20	100,000	1,900,000	2,000,000
	Gravel Bedding	cu.m	78,000	51%	49%		0	0	0
	Gabion Mattress	cu.m	270,000	3%	97%	100	810,000	26,190,000	27,000,000
1.3.3	Concrete Works						88,000,000	49,000,000	137,000,000
	Concrete	cu.m	480,000	35%	65%	100	16,800,000	31,200,000	48,000,000
	Reinforcement Bar	ton	8,900,000	80%	20%	10	71,200,000	17,800,000	89,000,000
1.3.4	Pile Works						0	0	0
	PC Concrete Pipe Pile (ϕ =450)	m	440,000	50%	50%		0	0	0
	Steel Sheet Pile	sq.m	1,300,000	50%	50%		0	0	0
1.3.5	Rubber Gate						0	0	0
	Rubber Gate Sets	L.S	13,726,000,000	90%	10%		0	0	0
1.3.6	Miscellaneous			72%	28%		30,960,000	12,040,000	43,000,000
1.4	SEDIMENT TRAP WORKS						0	0	0
1.4.1	Sediment Trap Works						0	0	0
	Bamboo mess Type 1 (h=1.0 m)	m	170,000	0%	100%		0	0	0
	Bamboo mess Type 2 (h=2.0 m)	m	290,000	0%	100%		0	0	0
1.4.2	Miscellaneous			0%	100%		0	0	0
1.5	APPURTENANT WORKS						2,041,800,000	1,361,200,000	3,403,000,000
1.5.1	Bridge Works						1,920,000,000	1,280,000,000	3,200,000,000
	Br. Type-1(W=4.00m)	m	19,000,000	60%	40%	110	1,254,000,000	836,000,000	2,090,000,000
	Br. Type-1(W=7.00m)	m	37,000,000	60%	40%	30	666,000,000	444,000,000	1,110,000,000
	Heightening of Bridge	L.S	255,000,000	60%	40%		0	0	0
1.5.2	Waterway	L.S	850,000,000	20%	80%	1	170,000,000	680,000,000	850,000,000
1.5.3	Miscellaneous			60%	40%		121,800,000	81,200,000	203,000,000
1.6	MISCELLANEOUS WORKS			58%	42%		390,920,000	283,080,000	674,000,000
(2)	LAND ACQUISITION						0	953,000,000	953,000,000
2.1	Compensation for Houses(urban)	nos	18,000,000	0%	100%		0	0	0
2.2	Compensation for Houses(rural)	nos	7,700,000	0%	100%	40	0	308,000,000	308,000,000
2.3	Land Acquisition for Residential Land	sq.m	2,000	0%	100%	27,000	0	54,000,000	54,000,000
2.4	Land Acquisition for Agriculture Land	sq.m	3,000	0%	100%	197,000	0	591,000,000	591,000,000
(3)	ADMINISTRATION COST 5% of (1)+(2)			0%	100%		0	826,000,000	826,000,000
(4)	ENGINEERING SERVICE COST 10% of (1)			100%	0%		1,557,000,000	0	1,557,000,000
(5)	SUB TOTAL = (1)+(2)+(3)+(4)						8,128,949,000	10,773,051,000	18,902,000,000
(6)	PHYSICAL CONTINGENCY 10% of (5)						812,694,900	1,077,305,100	1,890,000,000
	GRAND TOTAL						8,941,643,900 (Rp.mil. 8,942) (US$'000 931.4)	11,850,356,100 (Rp.mil. 11,850)	20,792,000,000 (Rp.mil. 20,792)

Note :

1 JPYen1=Rp. 77.4

2 US$1=Rp. 9600

3 1. PREPARATORY WORKS 10%
2. CHANNEL WORKS 3%
3. WEIR WORKS (Topadu River) 5%
5. APPURTENANT WORKS 5%
6. MISCELLANEOUS WORKS 5%

Table 5.5.2 COST OF COMPONENT PROJECT (3/3)

						Sediment Trap in Lake Limboto			
No.	ITEM	UNIT	UNIT COST D.C.(Rp.)	RATE F.C.(%)	RATE D.C.(%)	QTY	AMOUNT F.C.(Rp.)	AMOUNT D.C.(Rp.)	TOTAL D.C.(Rp.)
(1)	DIRECT COST						638,698,000	1,204,302,000	1,843,000,000
1.1	PREPARATORY WORKS			58%	42%		58,518,000	109,482,000	168,000,000
1.2	CHANNEL WORKS						551,180,000	457,820,000	1,009,000,000
1.2.1	Earth Works						539,000,000	441,000,000	980,000,000
	Excavation	cu.m	20,000	55%	45%	49,000	539,000,000	441,000,000	980,000,000
	Embankment	cu.m	27,000	55%	45%		0	0	0
	Sodding	sq.m	14,000	0%	100%		0	0	0
1.2.2	Stone Works						0	0	0
	Bank Protection (Type-1)	m	2,770,000	3%	97%		0	0	0
	Wet Rubble Masonry	cu.m	300,000	8%	92%		0	0	0
	Riprap	cu.m	100,000	5%	95%		0	0	0
	Gravel Bedding	cu.m	78,000	51%	49%		0	0	0
	Gabion Mattress	cu.m	270,000	3%	97%		0	0	0
1.2.3	Concrete Works						0	0	0
	Bank Protection (Type-2)	m	1,660,000	8%	92%		0	0	0
	Concrete Dike (Type-3)	sq.m	490,000	35%	65%		0	0	0
	Concrete	cu.m	480,000	35%	65%		0	0	0
	Reinforcement Bar	ton	8,910,000	80%	20%		0	0	0
1.2.4	Sluice, Drainage Sluice Works						0	0	0
	U/s. Sluice.	L.S	320,000,000	21%	79%		0	0	0
	Drainage sluice str. (2gates x 2m x 1.5m)	L.S	518,000,000	21%	79%		0	0	0
	Sluice Gate (2m x 1m)	Pc.	80,000,000	21%	79%		0	0	0
	Drainage sluice str. (1m x 1m)	L.S	150,000,000	21%	79%		0	0	0
1.2.5	Miscellaneous			42%	58%		12,180,000	16,820,000	29,000,000
1.3	WEIR WORKS						0	0	0
1.3.1	Earth Works						0	0	0
	Excavation	cu.m	20,000	55%	45%		0	0	0
	Embankment	cu.m	27,000	55%	45%		0	0	0
	Sodding	sq.m	14,000	0%	100%		0	0	0
1.3.2	Stone Works						0	0	0
	Wet Rubble Masonry	cu.m	300,000	8%	92%		0	0	0
	Riprap	cu.m	100,000	5%	95%		0	0	0
	Gravel Bedding	cu.m	78,000	51%	49%		0	0	0
	Gabion Mattress	cu.m	270,000	3%	97%		0	0	0
1.3.3	Concrete Works						0	0	0
	Concrete	cu.m	480,000	35%	65%		0	0	0
	Reinforcement Bar	ton	8,900,000	80%	20%		0	0	0
1.3.4	Pile Works						0	0	0
	PC Concrete Pipe Pile (ϕ =450)	m	440,000	50%	50%		0	0	0
	Steel Sheet Pile	sq.m	1,300,000	50%	50%		0	0	0
1.3.5	Rubber Gate						0	0	0
	Rubber Gate Sets	L.S	13,726,000,000	90%	10%		0	0	0
1.3.6	Miscellaneous			72%	28%		0	0	0
1.4	SEDIMENT TRAP WORKS						0	616,000,000	616,000,000
1.4.1	Sediment Trap Works						0	598,000,000	598,000,000
	Bamboo mess Type 1 (h=1.0 m)	m	170,000	0%	100%	1,300	0	221,000,000	221,000,000
	Bamboo mess Type 2 (h=2.0 m)	m	290,000	0%	100%	1,300	0	377,000,000	377,000,000
1.4.2	Miscellaneous			0%	100%		0	18,000,000	18,000,000
1.5	APPURTENANT WORKS						0	0	0
1.5.1	Bridge Works						0	0	0
	Br. Type-1(W=4.00m)	m	19,000,000	60%	40%		0	0	0
	Br. Type-1(W=7.00m)	m	37,000,000	60%	40%		0	0	0
	Heightening of Bridge	L.S	255,000,000	60%	40%		0	0	0
1.5.2	Waterway	L.S	850,000,000	20%	80%		0	0	0
1.5.3	Miscellaneous			60%	40%		0	0	0
1.6	MISCELLANEOUS WORKS			58%	42%		29,000,000	21,000,000	50,000,000
(2)	LAND ACQUISITION						0	289,000,000	289,000,000
2.1	Compensation for Houses(urban)	nos	18,000,000	0%	100%		0	0	0
2.2	Compensation for Houses(rural)	nos	7,700,000	0%	100%	10	0	77,000,000	77,000,000
2.3	Land Acquisition for Residential Land	sq.m	2,000	0%	100%	1,000	0	2,000,000	2,000,000
2.4	Land Acquisition for Agriculture Land	sq.m	3,000	0%	100%	70,000	0	210,000,000	210,000,000
(3)	ADMINISTRATION COST 5% of (1)+(2)			0%	100%		0	107,000,000	107,000,000
(4)	ENGINEERING SERVICE COST 10% of (1)			100%	0%		184,000,000	0	184,000,000
(5)	SUB TOTAL = (1)+(2)+(3)+(4)						822,698,000	1,600,302,000	2,423,000,000
(6)	PHYSICAL CONTINGENCY 10% of (5)						81,969,800	160,030,200	242,000,000
	GRAND TOTAL						904,667,800 (Rp.mil. 905) (US$'000 94.2)	1,760,332,200 (Rp.mil. 1,760)	2,665,000,000 (Rp.mil. 2,665)

Note :

1 JPYen1=Rp. 77.4

2 US$1=Rp. 9600

3 1. PREPARATORY WORKS 10%
2. CHANNEL WORKS 3%
3. WEIR WORKS (Topadu River) 5%
5. APPURTENANT WORKS 5%
6. MISCELLANEOUS WORKS 5%

Table 5.5.3 BROKEN-DOWN COST OF BBT RIVER IMPROVEMENT (1/7)

No.	ITEM	UNIT	UNIT COST D.C.(Rp.)	RATE F.C.(%)	RATE D.C.(%)	Lower Bone River QTY	AMOUNT F.C.(Rp.)	AMOUNT D.C.(Rp.)	TOTAL D.C.(Rp.)
(1)	DIRECT COST						133,014,000	1,844,986,000	1,978,000,000
1.1	PREPARATORY WORKS			58%	42%		12,274,000	167,726,000	180,000,000
1.2	CHANNEL WORKS						70,860,000	1,641,140,000	1,712,000,000
1.2.1	Earth Works						0	0	0
	Excavation	cu.m	20,000	55%	45%		0	0	0
	Embankment	cu.m	27,000	55%	45%		0	0	0
	Sodding	sq.m	14,000	0%	100%		0	0	0
1.2.2	Stone Works						49,860,000	1,612,140,000	1,662,000,000
	Bank Protection (Type-1)	m	2,770,000	3%	97%	600	49,860,000	1,612,140,000	1,662,000,000
	Wet Rubble Masonry	cu.m	300,000	8%	92%		0	0	0
	Riprap	cu.m	100,000	5%	95%		0	0	0
	Gravel Bedding	cu.m	78,000	51%	49%		0	0	0
	Gabion Mattress	cu.m	270,000	3%	97%		0	0	0
1.2.3	Concrete Works						0	0	0
	Bank Protection (Type-2)	m	1,660,000	8%	92%		0	0	0
	Concrete Dike (Type-3)	sq.m	490,000	35%	65%		0	0	0
	Concrete	cu.m	480,000	35%	65%		0	0	0
	Reinforcement Bar	ton	8,910,000	80%	20%		0	0	0
1.2.4	Sluice, Drainage Sluice Works						0	0	0
	U/s. Sluice.	L.S	320,000,000	21%	79%		0	0	0
	Drainage sluice str. (2gates x 2m x 1.5m)	L.S	518,000,000	21%	79%		0	0	0
	Sluice Gate (2m x 1m)	Pc.	80,000,000	21%	79%		0	0	0
	Drainage sluice str. (1m x 1m)	L.S	150,000,000	21%	79%		0	0	0
1.2.5	Miscellaneous			42%	58%		21,000,000	29,000,000	50,000,000
1.3	WEIR WORKS						0	0	0
1.3.1	Earth Works						0	0	0
	Excavation	cu.m	20,000	55%	45%		0	0	0
	Embankment	cu.m	27,000	55%	45%		0	0	0
	Sodding	sq.m	14,000	0%	100%		0	0	0
1.3.2	Stone Works						0	0	0
	Wet Rubble Masonry	cu.m	300,000	8%	92%		0	0	0
	Riprap	cu.m	100,000	5%	95%		0	0	0
	Gravel Bedding	cu.m	78,000	51%	49%		0	0	0
	Gabion Mattress	cu.m	270,000	3%	97%		0	0	0
1.3.3	Concrete Works						0	0	0
	Concrete	cu.m	480,000	35%	65%		0	0	0
	Reinforcement Bar	ton	8,900,000	80%	20%		0	0	0
1.3.4	Pile Works						0	0	0
	PC Concrete Pipe Pile (ϕ =450)	m	440,000	50%	50%		0	0	0
	Steel Sheet Pile	sq.m	1,300,000	50%	50%		0	0	0
1.3.5	Rubber Gate						0	0	0
	Rubber Gate Sets	L.S	13,726,000,000	90%	10%		0	0	0
1.3.6	Miscellaneous			72%	28%		0	0	0
1.4	SEDIMENT TRAP WORKS						0	0	0
1.4.1	Sediment Trap Works						0	0	0
	Bamboo mess Type 1 (h=1.0 m)	m	170,000	0%	100%		0	0	0
	Bamboo mess Type 2 (h=2.0 m)	m	290,000	0%	100%		0	0	0
1.4.2	Miscellaneous			0%	100%		0	0	0
1.5	APPURTENANT WORKS						0	0	0
1.5.1	Bridge Works						0	0	0
	Br. Type-1(W=4.00m)	m	19,000,000	60%	40%		0	0	0
	Br. Type-1(W=7.00m)	m	37,000,000	60%	40%		0	0	0
	Heightening of Bridge	L.S	255,000,000	60%	40%		0	0	0
1.5.2	Waterway	L.S	850,000,000	20%	80%		0	0	0
1.5.3	Miscellaneous			60%	40%		0	0	0
1.6	MISCELLANEOUS WORKS			58%	42%		49,880,000	36,120,000	86,000,000
(2)	LAND ACQUISITION						0	0	0
2.1	Compensation for Houses(urban)	nos	18,000,000	0%	100%		0	0	0
2.2	Compensation for Houses(rural)	nos	7,700,000	0%	100%		0	0	0
2.3	Land Acquisition for Residential Land	sq.m	2,000	0%	100%		0	0	0
2.4	Land Acquisition for Agriculture Land	sq.m	3,000	0%	100%		0	0	0
(3)	ADMINISTRATION COST 5% of (1)+(2)			0%	100%		0	99,000,000	99,000,000
(4)	ENGINEERING SERVICE COST 10% of (1)			100%	0%		198,000,000	0	198,000,000
(5)	SUB TOTAL = (1)+(2)+(3)+(4)						331,014,000	1,943,986,000	2,275,000,000
(6)	PHYSICAL CONTINGENCY 10% of (5)						33,601,400	194,398,600	228,000,000
	GRAND TOTAL						364,615,400 (Rp.mil. 365) (US$'000 38.0)	2,138,384,600 (Rp.mil. 2,138)	2,503,000,000 (Rp.mil. 2,503)

Note :

1 JPYen1=Rp. 77.4

2 US$1=Rp. 9600

3 1. PREPARATORY WORKS 10%
2. CHANNEL WORKS 3%
3. WEIR WORKS (Topadu River) 5%
5. APPURTENANT WORKS 5%
6. MISCELLANEOUS WORKS 5%

Table 5.5.3 BROKEN-DOWN COST OF BBT RIVER IMPROVEMENT (2/7)

No.	ITEM	UNIT	UNIT COST	RATE		Bolango Stretch-I			
							AMOUNT		TOTAL
			D.C.(Rp.)	F.C.(%)	D.C.(%)	Q'TY	F.C.(Rp.)	D.C.(Rp.)	D.C.(Rp.)
(1)	DIRECT COST						397,142,000	495,858,000	893,000,000
1.1	PREPARATORY WORKS			58%	42%		35,922,000	45,078,000	81,000,000
1.2	CHANNEL WORKS						177,800,000	327,200,000	505,000,000
1.2.1	Earth Works						0	0	0
	Excavation	cu.m	20,000	55%	45%		0	0	0
	Embankment	cu.m	27,000	55%	45%		0	0	0
	Sodding	sq.m	14,000	0%	100%		0	0	0
1.2.2	Stone Works						0	0	0
	Bank Protection (Type-1)	m	2,770,000	3%	97%		0	0	0
	Wet Rubble Masonry	cu.m	300,000	8%	92%		0	0	0
	Riprap	cu.m	100,000	5%	95%		0	0	0
	Gravel Bedding	cu.m	78,000	51%	49%		0	0	0
	Gabion Mattress	cu.m	270,000	3%	97%		0	0	0
1.2.3	Concrete Works						171,500,000	318,500,000	490,000,000
	Bank Protection (Type-2)	m	1,660,000	8%	92%		0	0	0
	Concrete Dike (Type-3)	sq.m	490,000	35%	65%	1,000	171,500,000	318,500,000	490,000,000
	Concrete	cu.m	480,000	35%	65%		0	0	0
	Reinforcement Bar	ton	8,910,000	80%	20%		0	0	0
1.2.4	Sluice, Drainage Sluice Works						0	0	0
	U/s. Sluice.	L.S	320,000,000	21%	79%		0	0	0
	Drainage sluice str. (2gates x 2m x 1.5m)	L.S	518,000,000	21%	79%		0	0	0
	Sluice Gate (2m x 1m)	Pc.	80,000,000	21%	79%		0	0	0
	Drainage sluice str. (1m x 1m)	L.S	150,000,000	21%	79%		0	0	0
1.2.5	Miscellaneous			42%	58%		6,300,000	8,700,000	15,000,000
1.3	WEIR WORKS						0	0	0
1.3.1	Earth Works						0	0	0
	Excavation	cu.m	20,000	55%	45%		0	0	0
	Embankment	cu.m	27,000	55%	45%		0	0	0
	Sodding	sq.m	14,000	0%	100%		0	0	0
1.3.2	Stone Works						0	0	0
	Wet Rubble Masonry	cu.m	300,000	8%	92%		0	0	0
	Riprap	cu.m	100,000	5%	95%		0	0	0
	Gravel Bedding	cu.m	78,000	51%	49%		0	0	0
	Gabion Mattress	cu.m	270,000	3%	97%		0	0	0
1.3.3	Concrete Works						0	0	0
	Concrete	cu.m	480,000	35%	65%		0	0	0
	Reinforcement Bar	ton	8,900,000	80%	20%		0	0	0
1.3.4	Pile Works						0	0	0
	PC Concrete Pipe Pile (ϕ =450)	m	440,000	50%	50%		0	0	0
	Steel Sheet Pile	sq.m	1,300,000	50%	50%		0	0	0
1.3.5	Rubber Gate						0	0	0
	Rubber Gate Sets	L.S	13,726,000,000	90%	10%		0	0	0
1.3.6	Miscellaneous			72%	28%		0	0	0
1.4	SEDIMENT TRAP WORKS						0	0	0
1.4.1	Sediment Trap Works						0	0	0
	Bamboo mess Type 1 (h=1.0 m)	m	170,000	0%	100%		0	0	0
	Bamboo mess Type 2 (h=2.0 m)	m	290,000	0%	100%		0	0	0
1.4.2	Miscellaneous			0%	100%		0	0	0
1.5	APPURTENANT WORKS						160,800,000	107,200,000	268,000,000
1.5.1	Bridge Works						153,000,000	102,000,000	255,000,000
	Br. Type-1(W=4.00m)	m	19,000,000	60%	40%		0	0	0
	Br. Type-1(W=7.00m)	m	37,000,000	60%	40%		0	0	0
	Heightening of Bridge	L.S	255,000,000	60%	40%	1	153,000,000	102,000,000	255,000,000
1.5.2	Waterway	L.S	850,000,000	20%	80%		0	0	0
1.5.3	Miscellaneous			60%	40%		7,800,000	5,200,000	13,000,000
1.6	MISCELLANEOUS WORKS			58%	42%		22,620,000	16,380,000	39,000,000
(2)	LAND ACQUISITION						0	0	0
2.1	Compensation for Houses(urban)	nos	18,000,000	0%	100%		0	0	0
2.2	Compensation for Houses(rural)	nos	7,700,000	0%	100%		0	0	0
2.3	Land Acquisition for Residential Land	sq.m	2,000	0%	100%		0	0	0
2.4	Land Acquisition for Agriculture Land	sq.m	3,000	0%	100%		0	0	0
(3)	ADMINISTRATION COST 5% of (1)+(2)			0%	100%		0	45,000,000	45,000,000
(4)	ENGINEERING SERVICE COST 10% of (1)			100%	0%		89,000,000	0	89,000,000
(5)	SUB TOTAL = (1)+(2)+(3)+(4)						486,142,000	540,858,000	1,027,000,000
(6)	PHYSICAL CONTINGENCY 10% of (5)						48,914,200	54,085,800	103,000,000
	GRAND TOTAL						535,056,200 (Rp.mil. 535) (US$'000 55.7)	594,943,800 (Rp.mil. 595)	1,130,000,000 (Rp.mil. 1,130)

Note :

1 JPYen1=Rp. 77.4

2 US$1=Rp. 9600

3 1. PREPARATORY WORKS 10%
2. CHANNEL WORKS 3%
3. WEIR WORKS (Topadu River) 5%
5. APPURTENANT WORKS 5%
6. MISCELLANEOUS WORKS 5%

Table 5.5.3 BROKEN-DOWN COST OF BBT RIVER IMPROVEMENT (3/7)

No.	ITEM	UNIT	UNIT COST	RATE		Tenda COC			
							AMOUNT		TOTAL
			D.C.(Rp.)	F.C.(%)	D.C.(%)	Q'TY	F.C.(Rp.)	D.C.(Rp.)	D.C.(Rp.)
(1)	DIRECT COST						529,651,000	855,349,000	1,385,000,000
1.1	PREPARATORY WORKS			58%	42%		48,241,000	77,759,000	126,000,000
1.2	CHANNEL WORKS						159,210,000	560,790,000	720,000,000
1.2.1	Earth Works						110,550,000	90,450,000	201,000,000
	Excavation	cu.m	20,000	55%	45%	6,000	66,000,000	54,000,000	120,000,000
	Embankment	cu.m	27,000	55%	45%	3,000	44,550,000	36,450,000	81,000,000
	Sodding	sq.m	14,000	0%	100%		0	0	0
1.2.2	Stone Works						0	0	0
	Bank Protection (Type-1)	m	2,770,000	3%	97%		0	0	0
	Wet Rubble Masonry	cu.m	300,000	8%	92%		0	0	0
	Riprap	cu.m	100,000	5%	95%		0	0	0
	Gravel Bedding	cu.m	78,000	51%	49%		0	0	0
	Gabion Mattress	cu.m	270,000	3%	97%		0	0	0
1.2.3	Concrete Works						39,840,000	458,160,000	498,000,000
	Bank Protection (Type-2)	m	1,660,000	8%	92%	300	39,840,000	458,160,000	498,000,000
	Concrete Dike (Type-3)	sq.m	490,000	35%	65%		0	0	0
	Concrete	cu.m	480,000	35%	65%		0	0	0
	Reinforcement Bar	ton	8,910,000	80%	20%		0	0	0
1.2.4	Sluice, Drainage Sluice Works						0	0	0
	U/s. Sluice.	L.S	320,000,000	21%	79%		0	0	0
	Drainage sluice str. (2gates x 2m x 1.5m)	L.S	518,000,000	21%	79%		0	0	0
	Sluice Gate (2m x 1m)	Pc.	80,000,000	21%	79%		0	0	0
	Drainage sluice str. (1m x 1m)	L.S	150,000,000	21%	79%		0	0	0
1.2.5	Miscellaneous			42%	58%		8,820,000	12,180,000	21,000,000
1.3	WEIR WORKS						0	0	0
1.3.1	Earth Works						0	0	0
	Excavation	cu.m	20,000	55%	45%		0	0	0
	Embankment	cu.m	27,000	55%	45%		0	0	0
	Sodding	sq.m	14,000	0%	100%		0	0	0
1.3.2	Stone Works						0	0	0
	Wet Rubble Masonry	cu.m	300,000	8%	92%		0	0	0
	Riprap	cu.m	100,000	5%	95%		0	0	0
	Gravel Bedding	cu.m	78,000	51%	49%		0	0	0
	Gabion Mattress	cu.m	270,000	3%	97%		0	0	0
1.3.3	Concrete Works						0	0	0
	Concrete	cu.m	480,000	35%	65%		0	0	0
	Reinforcement Bar	ton	8,900,000	80%	20%		0	0	0
1.3.4	Pile Works						0	0	0
	PC Concrete Pipe Pile (ϕ =450)	m	440,000	50%	50%		0	0	0
	Steel Sheet Pile	sq.m	1,300,000	50%	50%		0	0	0
1.3.5	Rubber Gate						0	0	0
	Rubber Gate Sets	L.S	13,726,000,000	90%	10%		0	0	0
1.3.6	Miscellaneous			72%	28%		0	0	0
1.4	SEDIMENT TRAP WORKS						0	0	0
1.4.1	Sediment Trap Works						0	0	0
	Bamboo mess Type 1 (h=1.0 m)	m	170,000	0%	100%		0	0	0
	Bamboo mess Type 2 (h=2.0 m)	m	290,000	0%	100%		0	0	0
1.4.2	Miscellaneous			0%	100%		0	0	0
1.5	APPURTENANT WORKS						287,400,000	191,600,000	479,000,000
1.5.1	Bridge Works						273,600,000	182,400,000	456,000,000
	Br. Type-1(W=4.00m)	m	19,000,000	60%	40%	24	273,600,000	182,400,000	456,000,000
	Br. Type-1(W=7.00m)	m	37,000,000	60%	40%		0	0	0
	Heightening of Bridge	L.S	255,000,000	60%	40%		0	0	0
1.5.2	Waterway	L.S	850,000,000	20%	80%		0	0	0
1.5.3	Miscellaneous			60%	40%		13,800,000	9,200,000	23,000,000
1.6	MISCELLANEOUS WORKS			58%	42%		34,800,000	25,200,000	60,000,000
(2)	LAND ACQUISITION						0	209,000,000	209,000,000
2.1	Compensation for Houses(urban)	nos	18,000,000	0%	100%	11	0	198,000,000	198,000,000
2.2	Compensation for Houses(rural)	nos	7,700,000	0%	100%		0	0	0
2.3	Land Acquisition for Residential Land	sq.m	2,000	0%	100%	5,500	0	11,000,000	11,000,000
2.4	Land Acquisition for Agriculture Land	sq.m	3,000	0%	100%		0	0	0
(3)	ADMINISTRATION COST 5% of (1)+(2)			0%	100%		0	80,000,000	80,000,000
(4)	ENGINEERING SERVICE COST 10% of (1)			100%	0%		139,000,000	0	139,000,000
(5)	SUB TOTAL = (1)+(2)+(3)+(4)						668,651,000	1,144,349,000	1,813,000,000
(6)	PHYSICAL CONTINGENCY 10% of (5)						66,565,100	114,434,900	181,000,000
	GRAND TOTAL						735,216,100 (Rp.mil. 735) (US$'000 76.6)	1,258,783,900 (Rp.mil. 1,259)	1,994,000,000 (Rp.mil. 1,994)

Note :

1 JPYen1=Rp. 77.4

2 US$1=Rp. 9600

3 1. PREPARATORY WORKS 10%
2. CHANNEL WORKS 3%
3. WEIR WORKS (Topadu River) 5%
5. APPURTENANT WORKS 5%
6. MISCELLANEOUS WORKS 5%

Table 5.5.3 BROKEN-DOWN COST OF BBT RIVER IMPROVEMENT (4/7)

						Bolango Stretch-II$_R$			
No.	ITEM	UNIT	UNIT COST	RATE			AMOUNT		TOTAL
			D.C.(Rp.)	F.C.(%)	D.C.(%)	Q'TY	F.C.(Rp.)	D.C.(Rp.)	D.C.(Rp.)
(1)	DIRECT COST						2,946,498,000	9,478,502,000	12,425,000,000
1.1	PREPARATORY WORKS			58%	42%		268,318,000	861,682,000	1,130,000,000
1.2	CHANNEL WORKS						1,599,940,000	7,880,060,000	9,480,000,000
1.2.1	Earth Works						685,850,000	561,150,000	1,247,000,000
	Excavation	cu.m	20,000	55%	45%	61,000	671,000,000	549,000,000	1,220,000,000
	Embankment	cu.m	27,000	55%	45%	1,000	14,850,000	12,150,000	27,000,000
	Sodding	sq.m	14,000	0%	100%		0	0	0
1.2.2	Stone Works						108,030,000	3,492,970,000	3,601,000,000
	Bank Protection (Type-1)	m	2,770,000	3%	97%	1,300	108,030,000	3,492,970,000	3,601,000,000
	Wet Rubble Masonry	cu.m	300,000	8%	92%		0	0	0
	Riprap	cu.m	100,000	5%	95%		0	0	0
	Gravel Bedding	cu.m	78,000	51%	49%		0	0	0
	Gabion Mattress	cu.m	270,000	3%	97%		0	0	0
1.2.3	Concrete Works						581,360,000	3,256,640,000	3,838,000,000
	Bank Protection (Type-2)	m	1,660,000	8%	92%	1,700	225,760,000	2,596,240,000	2,822,000,000
	Concrete Dike (Type-3)	sq.m	490,000	35%	65%	800	137,200,000	254,800,000	392,000,000
	Concrete	cu.m	480,000	35%	65%	1,300	218,400,000	405,600,000	624,000,000
	Reinforcement Bar	ton	8,910,000	80%	20%		0	0	0
1.2.4	Sluice, Drainage Sluice Works						108,780,000	409,220,000	518,000,000
	U/s. Sluice.	L.S	320,000,000	21%	79%		0	0	0
	Drainage sluice str. (2gates x 2m x 1.5m)	L.S	518,000,000	21%	79%	1	108,780,000	409,220,000	518,000,000
	Sluice Gate (2m x 1m)	Pc.	80,000,000	21%	79%		0	0	0
	Drainage sluice str. (1m x 1m)	L.S	150,000,000	21%	79%		0	0	0
1.2.5	Miscellaneous			42%	58%		115,920,000	160,080,000	276,000,000
1.3	WEIR WORKS						0	0	0
1.3.1	Earth Works						0	0	0
	Excavation	cu.m	20,000	55%	45%		0	0	0
	Embankment	cu.m	27,000	55%	45%		0	0	0
	Sodding	sq.m	14,000	0%	100%		0	0	0
1.3.2	Stone Works						0	0	0
	Wet Rubble Masonry	cu.m	300,000	8%	92%		0	0	0
	Riprap	cu.m	100,000	5%	95%		0	0	0
	Gravel Bedding	cu.m	78,000	51%	49%		0	0	0
	Gabion Mattress	cu.m	270,000	3%	97%		0	0	0
1.3.3	Concrete Works						0	0	0
	Concrete	cu.m	480,000	35%	65%		0	0	0
	Reinforcement Bar	ton	8,900,000	80%	20%		0	0	0
1.3.4	Pile Works						0	0	0
	PC Concrete Pipe Pile (ϕ =450)	m	440,000	50%	50%		0	0	0
	Steel Sheet Pile	sq.m	1,300,000	50%	50%		0	0	0
1.3.5	Rubber Gate						0	0	0
	Rubber Gate Sets	L.S	13,726,000,000	90%	10%		0	0	0
1.3.6	Miscellaneous			72%	28%		0	0	0
1.4	SEDIMENT TRAP WORKS						0	0	0
1.4.1	Sediment Trap Works						0	0	0
	Bamboo mess Type 1 (h=1.0 m)	m	170,000	0%	100%		0	0	0
	Bamboo mess Type 2 (h=2.0 m)	m	290,000	0%	100%		0	0	0
1.4.2	Miscellaneous			0%	100%		0	0	0
1.5	APPURTENANT WORKS						766,200,000	510,800,000	1,277,000,000
1.5.1	Bridge Works						729,600,000	486,400,000	1,216,000,000
	Br. Type-1(W=4.00m)	m	19,000,000	60%	40%	64	729,600,000	486,400,000	1,216,000,000
	Br. Type-1(W=7.00m)	m	37,000,000	60%	40%		0	0	0
	Heightening of Bridge	L.S	255,000,000	60%	40%		0	0	0
1.5.2	Waterway	L.S	850,000,000	20%	80%		0	0	0
1.5.3	Miscellaneous			60%	40%		36,600,000	24,400,000	61,000,000
1.6	MISCELLANEOUS WORKS			58%	42%		312,040,000	225,960,000	538,000,000
(2)	LAND ACQUISITION						0	272,000,000	272,000,000
2.1	Compensation for Houses(urban)	nos	18,000,000	0%	100%	12	0	216,000,000	216,000,000
2.2	Compensation for Houses(rural)	nos	7,700,000	0%	100%		0	0	0
2.3	Land Acquisition for Residential Land	sq.m	2,000	0%	100%	13,000	0	26,000,000	26,000,000
2.4	Land Acquisition for Agriculture Land	sq.m	3,000	0%	100%	10,000	0	30,000,000	30,000,000
(3)	ADMINISTRATION COST 5% of (1)+(2)			0%	100%		0	635,000,000	635,000,000
(4)	ENGINEERING SERVICE COST 10% of (1)			100%	0%		1,243,000,000	0	1,243,000,000
(5)	SUB TOTAL = (1)+(2)+(3)+(4)						4,189,498,000	10,385,502,000	14,575,000,000
(6)	PHYSICAL CONTINGENCY 10% of (5)						419,449,800	1,038,550,200	1,458,000,000
	GRAND TOTAL						4,608,947,800 (Rp.mil. 4,609) (US$'000 480.1)	11,424,052,200 (Rp.mil. 11,424)	16,033,000,000 (Rp.mil. 16,033)

Note :

1 JPYen1=Rp. 77.4

2 US$1=Rp. 9600

3 1. PREPARATORY WORKS 10%
2. CHANNEL WORKS 3%
3. WEIR WORKS (Topadu River) 5%
5. APPURTENANT WORKS 5%
6. MISCELLANEOUS WORKS 5%

Table 5.5.3 BROKEN-DOWN COST OF BBT RIVER IMPROVEMENT (5/7)

						Bolango Stretch-II$_L$			
No.	ITEM	UNIT	UNIT COST	RATE			AMOUNT		TOTAL
			D.C.(Rp.)	F.C.(%)	D.C.(%)	Q'TY	F.C.(Rp.)	D.C.(Rp.)	D.C.(Rp.)
(1)	DIRECT COST						862,028,000	1,357,972,000	2,220,000,000
1.1	PREPARATORY WORKS			58%	42%		78,548,000	123,452,000	202,000,000
1.2	CHANNEL WORKS						428,400,000	994,600,000	1,423,000,000
1.2.1	Earth Works						0	0	0
	Excavation	cu.m	20,000	55%	45%		0	0	0
	Embankment	cu.m	27,000	55%	45%		0	0	0
	Sodding	sq.m	14,000	0%	100%		0	0	0
1.2.2	Stone Works						0	0	0
	Bank Protection (Type-1)	m	2,770,000	3%	97%		0	0	0
	Wet Rubble Masonry	cu.m	300,000	8%	92%		0	0	0
	Riprap	cu.m	100,000	5%	95%		0	0	0
	Gravel Bedding	cu.m	78,000	51%	49%		0	0	0
	Gabion Mattress	cu.m	270,000	3%	97%		0	0	0
1.2.3	Concrete Works						302,400,000	561,600,000	864,000,000
	Bank Protection (Type-2)	m	1,660,000	8%	92%		0	0	0
	Concrete Dike (Type-3)	sq.m	490,000	35%	65%		0	0	0
	Concrete	cu.m	480,000	35%	65%	1,800	302,400,000	561,600,000	864,000,000
	Reinforcement Bar	ton	8,910,000	80%	20%		0	0	0
1.2.4	Sluice, Drainage Sluice Works						108,780,000	409,220,000	518,000,000
	U/s. Sluice.	L.S	320,000,000	21%	79%		0	0	0
	Drainage sluice str. (2gates x 2m x 1.5m)	L.S	518,000,000	21%	79%	1	108,780,000	409,220,000	518,000,000
	Sluice Gate (2m x 1m)	Pc.	80,000,000	21%	79%		0	0	0
	Drainage sluice str. (1m x 1m)	L.S	150,000,000	21%	79%		0	0	0
1.2.5	Miscellaneous			42%	58%		17,220,000	23,780,000	41,000,000
1.3	WEIR WORKS						0	0	0
1.3.1	Earth Works						0	0	0
	Excavation	cu.m	20,000	55%	45%		0	0	0
	Embankment	cu.m	27,000	55%	45%		0	0	0
	Sodding	sq.m	14,000	0%	100%		0	0	0
1.3.2	Stone Works						0	0	0
	Wet Rubble Masonry	cu.m	300,000	8%	92%		0	0	0
	Riprap	cu.m	100,000	5%	95%		0	0	0
	Gravel Bedding	cu.m	78,000	51%	49%		0	0	0
	Gabion Mattress	cu.m	270,000	3%	97%		0	0	0
1.3.3	Concrete Works						0	0	0
	Concrete	cu.m	480,000	35%	65%		0	0	0
	Reinforcement Bar	ton	8,900,000	80%	20%		0	0	0
1.3.4	Pile Works						0	0	0
	PC Concrete Pipe Pile (ϕ =450)	m	440,000	50%	50%		0	0	0
	Steel Sheet Pile	sq.m	1,300,000	50%	50%		0	0	0
1.3.5	Rubber Gate						0	0	0
	Rubber Gate Sets	L.S	13,726,000,000	90%	10%		0	0	0
1.3.6	Miscellaneous			72%	28%		0	0	0
1.4	SEDIMENT TRAP WORKS						0	0	0
1.4.1	Sediment Trap Works						0	0	0
	Bamboo mess Type 1 (h=1.0 m)	m	170,000	0%	100%		0	0	0
	Bamboo mess Type 2 (h=2.0 m)	m	290,000	0%	100%		0	0	0
1.4.2	Miscellaneous			0%	100%		0	0	0
1.5	APPURTENANT WORKS						299,400,000	199,600,000	499,000,000
1.5.1	Bridge Works						285,000,000	190,000,000	475,000,000
	Br. Type-1(W=4.00m)	m	19,000,000	60%	40%	25	285,000,000	190,000,000	475,000,000
	Br. Type-1(W=7.00m)	m	37,000,000	60%	40%		0	0	0
	Heightening of Bridge	L.S	255,000,000	60%	40%		0	0	0
1.5.2	Waterway	L.S	850,000,000	20%	80%		0	0	0
1.5.3	Miscellaneous			60%	40%		14,400,000	9,600,000	24,000,000
1.6	MISCELLANEOUS WORKS			58%	42%		55,680,000	40,320,000	96,000,000
(2)	LAND ACQUISITION						0	0	0
2.1	Compensation for Houses(urban)	nos	18,000,000	0%	100%		0	0	0
2.2	Compensation for Houses(rural)	nos	7,700,000	0%	100%		0	0	0
2.3	Land Acquisition for Residential Land	sq.m	2,000	0%	100%		0	0	0
2.4	Land Acquisition for Agriculture Land	sq.m	3,000	0%	100%		0	0	0
(3)	ADMINISTRATION COST 5% of (1)+(2)			0%	100%		0	111,000,000	111,000,000
(4)	ENGINEERING SERVICE COST 10% of (1)			100%	0%		222,000,000	0	222,000,000
(5)	SUB TOTAL = (1)+(2)+(3)+(4)						1,084,028,000	1,468,972,000	2,553,000,000
(6)	PHYSICAL CONTINGENCY 10% of (5)						108,102,800	146,897,200	255,000,000
	GRAND TOTAL						1,192,130,800 (Rp.mil. 1,192) (US$'000 124.2)	1,615,869,200 (Rp.mil. 1,616)	2,808,000,000 (Rp.mil. 2,808)

Note :

1 JPYen1=Rp. 77.4

2 US$1=Rp. 9600

3 1. PREPARATORY WORKS 10%
2. CHANNEL WORKS 3%
3. WEIR WORKS (Topadu River) 5%
5. APPURTENANT WORKS 5%
6. MISCELLANEOUS WORKS 5%

Table 5.5.3 BROKEN-DOWN COST OF BBT RIVER IMPROVEMENT (6/7)

No.	ITEM	UNIT	UNIT COST	RATE		Bolango Stretch-III			
							AMOUNT		TOTAL
			D.C.(Rp.)	F.C.(%)	D.C.(%)	Q'TY	F.C.(Rp.)	D.C.(Rp.)	D.C.(Rp.)
(1)	DIRECT COST						622,494,000	484,506,000	1,107,000,000
1.1	PREPARATORY WORKS			58%	42%		56,954,000	44,046,000	101,000,000
1.2	CHANNEL WORKS						376,900,000	313,100,000	690,000,000
1.2.1	Earth Works						368,500,000	301,500,000	670,000,000
	Excavation	cu.m	20,000	55%	45%	20,000	220,000,000	180,000,000	400,000,000
	Embankment	cu.m	27,000	55%	45%	10,000	148,500,000	121,500,000	270,000,000
	Sodding	sq.m	14,000	0%	100%		0	0	0
1.2.2	Stone Works						0	0	0
	Bank Protection (Type-1)	m	2,770,000	3%	97%		0	0	0
	Wet Rubble Masonry	cu.m	300,000	8%	92%		0	0	0
	Riprap	cu.m	100,000	5%	95%		0	0	0
	Gravel Bedding	cu.m	78,000	51%	49%		0	0	0
	Gabion Mattress	cu.m	270,000	3%	97%		0	0	0
1.2.3	Concrete Works						0	0	0
	Bank Protection (Type-2)	m	1,660,000	8%	92%		0	0	0
	Concrete Dike (Type-3)	sq.m	490,000	35%	65%		0	0	0
	Concrete	cu.m	480,000	35%	65%		0	0	0
	Reinforcement Bar	ton	8,910,000	80%	20%		0	0	0
1.2.4	Sluice, Drainage Sluice Works						0	0	0
	U/s. Sluice.	L.S	320,000,000	21%	79%		0	0	0
	Drainage sluice str. (2gates x 2m x 1.5m)	L.S	518,000,000	21%	79%		0	0	0
	Sluice Gate (2m x 1m)	Pc.	80,000,000	21%	79%		0	0	0
	Drainage sluice str. (1m x 1m)	L.S	150,000,000	21%	79%		0	0	0
1.2.5	Miscellaneous			42%	58%		8,400,000	11,600,000	20,000,000
1.3	WEIR WORKS						0	0	0
1.3.1	Earth Works						0	0	0
	Excavation	cu.m	20,000	55%	45%		0	0	0
	Embankment	cu.m	27,000	55%	45%		0	0	0
	Sodding	sq.m	14,000	0%	100%		0	0	0
1.3.2	Stone Works						0	0	0
	Wet Rubble Masonry	cu.m	300,000	8%	92%		0	0	0
	Riprap	cu.m	100,000	5%	95%		0	0	0
	Gravel Bedding	cu.m	78,000	51%	49%		0	0	0
	Gabion Mattress	cu.m	270,000	3%	97%		0	0	0
1.3.3	Concrete Works						0	0	0
	Concrete	cu.m	480,000	35%	65%		0	0	0
	Reinforcement Bar	ton	8,900,000	80%	20%		0	0	0
1.3.4	Pile Works						0	0	0
	PC Concrete Pipe Pile (ϕ =450)	m	440,000	50%	50%		0	0	0
	Steel Sheet Pile	sq.m	1,300,000	50%	50%		0	0	0
1.3.5	Rubber Gate						0	0	0
	Rubber Gate Sets	L.S	13,726,000,000	90%	10%		0	0	0
1.3.6	Miscellaneous			72%	28%		0	0	0
1.4	SEDIMENT TRAP WORKS						0	0	0
1.4.1	Sediment Trap Works						0	0	0
	Bamboo mess Type 1 (h=1.0 m)	m	170,000	0%	100%		0	0	0
	Bamboo mess Type 2 (h=2.0 m)	m	290,000	0%	100%		0	0	0
1.4.2	Miscellaneous			0%	100%		0	0	0
1.5	APPURTENANT WORKS						160,800,000	107,200,000	268,000,000
1.5.1	Bridge Works						153,000,000	102,000,000	255,000,000
	Br. Type-1(W=4.00m)	m	19,000,000	60%	40%		0	0	0
	Br. Type-1(W=7.00m)	m	37,000,000	60%	40%		0	0	0
	Heightening of Bridge	L.S	255,000,000	60%	40%	1	153,000,000	102,000,000	255,000,000
1.5.2	Waterway	L.S	850,000,000	20%	80%		0	0	0
1.5.3	Miscellaneous			60%	40%		7,800,000	5,200,000	13,000,000
1.6	MISCELLANEOUS WORKS			58%	42%		27,840,000	20,160,000	48,000,000
(2)	LAND ACQUISITION						0	116,000,000	116,000,000
2.1	Compensation for Houses(urban)	nos	18,000,000	0%	100%	5	0	90,000,000	90,000,000
2.2	Compensation for Houses(rural)	nos	7,700,000	0%	100%		0	0	0
2.3	Land Acquisition for Residential Land	sq.m	2,000	0%	100%	5,500	0	11,000,000	11,000,000
2.4	Land Acquisition for Agriculture Land	sq.m	3,000	0%	100%	5,000	0	15,000,000	15,000,000
(3)	ADMINISTRATION COST 5% of (1)+(2)			0%	100%		0	61,000,000	61,000,000
(4)	ENGINEERING SERVICE COST 10% of (1)			100%	0%		111,000,000	0	111,000,000
(5)	SUB TOTAL = (1)+(2)+(3)+(4)						733,494,000	661,506,000	1,395,000,000
(6)	PHYSICAL CONTINGENCY 10% of (5)						73,849,400	66,150,600	140,000,000
	GRAND TOTAL						807,343,400 (Rp.mil. 807) (US$'000 84.1)	727,656,600 (Rp.mil. 728)	1,535,000,000 (Rp.mil. 1,535)

Note :

1 JPYen1=Rp. 77.4

2 US$1=Rp. 9600

3 1. PREPARATORY WORKS 10%
2. CHANNEL WORKS 3%
3. WEIR WORKS (Topadu River) 5%
5. APPURTENANT WORKS 5%
6. MISCELLANEOUS WORKS 5%

Table 5.5.3 BROKEN-DOWN COST OF BBT RIVER IMPROVEMENT (7/7)

No.	ITEM	UNIT	UNIT COST	RATE		Tapodu River with Tapodu Gate			
							AMOUNT		TOTAL
			D.C.(Rp.)	F.C.(%)	D.C.(%)	Q'TY	F.C.(Rp.)	D.C.(Rp.)	D.C.(Rp.)
(1)	DIRECT COST						42,383,267,000	30,191,733,000	72,575,000,000
1.1	PREPARATORY WORKS			58%	42%		3,853,297,000	2,744,703,000	6,598,000,000
1.2	CHANNEL WORKS						10,126,690,000	14,294,310,000	24,421,000,000
1.2.1	Earth Works						8,078,950,000	7,940,050,000	16,019,000,000
	Excavation	cu.m	20,000	55%	45%	536,000	5,896,000,000	4,824,000,000	10,720,000,000
	Embankment	cu.m	27,000	55%	45%	147,000	2,182,950,000	1,786,050,000	3,969,000,000
	Sodding	sq.m	14,000	0%	100%	95,000	0	1,330,000,000	1,330,000,000
1.2.2	Stone Works						415,560,000	3,940,440,000	4,356,000,000
	Bank Protection (Type-1)	m	2,770,000	3%	97%		0	0	0
	Wet Rubble Masonry	cu.m	300,000	8%	92%	14,000	336,000,000	3,864,000,000	4,200,000,000
	Riprap	cu.m	100,000	5%	95%		0	0	0
	Gravel Bedding	cu.m	78,000	51%	49%	2,000	79,560,000	76,440,000	156,000,000
	Gabion Mattress	cu.m	270,000	3%	97%		0	0	0
1.2.3	Concrete Works						981,600,000	677,400,000	1,659,000,000
	Bank Protection (Type-2)	m	1,660,000	8%	92%		0	0	0
	Concrete Dike (Type-3)	sq.m	490,000	35%	65%		0	0	0
	Concrete	cu.m	480,000	35%	65%	1,600	268,800,000	499,200,000	768,000,000
	Reinforcement Bar	ton	8,910,000	80%	20%	100	712,800,000	178,200,000	891,000,000
1.2.4	Sluice, Drainage Sluice Works						351,960,000	1,324,040,000	1,676,000,000
	U/s. Sluice.	L.S	320,000,000	21%	79%	2	134,400,000	505,600,000	640,000,000
	Drainage sluice str. (2gates x 2m x 1.5m)	L.S	518,000,000	21%	79%	2	217,560,000	818,440,000	1,036,000,000
	Sluice Gate (2m x 1m)	Pc.	80,000,000	21%	79%		0	0	0
	Drainage sluice str. (1m x 1m)	L.S	150,000,000	21%	79%		0	0	0
1.2.5	Miscellaneous			42%	58%		298,620,000	412,380,000	711,000,000
1.3	WEIR WORKS						21,496,520,000	8,443,480,000	29,940,000,000
1.3.1	Earth Works						650,100,000	531,900,000	1,182,000,000
	Excavation	cu.m	20,000	55%	45%	51,000	561,000,000	459,000,000	1,020,000,000
	Embankment	cu.m	27,000	55%	45%	6,000	89,100,000	72,900,000	162,000,000
	Sodding	sq.m	14,000	0%	100%		0	0	0
1.3.2	Stone Works						22,500,000	427,500,000	450,000,000
	Wet Rubble Masonry	cu.m	300,000	8%	92%		0	0	0
	Riprap	cu.m	100,000	5%	95%	4,500	22,500,000	427,500,000	450,000,000
	Gravel Bedding	cu.m	78,000	51%	49%		0	0	0
	Gabion Mattress	cu.m	270,000	3%	97%		0	0	0
1.3.3	Concrete Works						5,188,800,000	3,457,200,000	8,646,000,000
	Concrete	cu.m	480,000	35%	65%	8,000	1,344,000,000	2,496,000,000	3,840,000,000
	Reinforcement Bar	ton	8,900,000	80%	20%	540	3,844,800,000	961,200,000	4,806,000,000
1.3.4	Pile Works						2,255,000,000	2,255,000,000	4,510,000,000
	PC Concrete Pipe Pile (ϕ =450)	m	440,000	50%	50%	7,000	1,540,000,000	1,540,000,000	3,080,000,000
	Steel Sheet Pile	sq.m	1,300,000	50%	50%	1,100	715,000,000	715,000,000	1,430,000,000
1.3.5	Rubber Gate						12,353,400,000	1,372,600,000	13,726,000,000
	Rubber Gate Sets	L.S	13,726,000,000	90%	10%	1	12,353,400,000	1,372,600,000	13,726,000,000
1.3.6	Miscellaneous			72%	28%		1,026,720,000	399,280,000	1,426,000,000
1.4	SEDIMENT TRAP WORKS						0	0	0
1.4.1	Sediment Trap Works						0	0	0
	Bamboo mess Type 1 (h=1.0 m)	m	170,000	0%	100%		0	0	0
	Bamboo mess Type 2 (h=2.0 m)	m	290,000	0%	100%		0	0	0
1.4.2	Miscellaneous			0%	100%		0	0	0
1.5	APPURTENANT WORKS						5,084,400,000	3,389,600,000	8,474,000,000
1.5.1	Bridge Works						4,842,000,000	3,228,000,000	8,070,000,000
	Br. Type-1(W=4.00m)	m	19,000,000	60%	40%	230	2,622,000,000	1,748,000,000	4,370,000,000
	Br. Type-1(W=7.00m)	m	37,000,000	60%	40%	100	2,220,000,000	1,480,000,000	3,700,000,000
	Heightening of Bridge	L.S	255,000,000	60%	40%		0	0	0
1.5.2	Waterway	L.S	850,000,000	20%	80%		0	0	0
1.5.3	Miscellaneous			60%	40%		242,400,000	161,600,000	404,000,000
1.6	MISCELLANEOUS WORKS			58%	42%		1,822,360,000	1,319,640,000	3,142,000,000
(2)	LAND ACQUISITION						0	2,045,000,000	2,045,000,000
2.1	Compensation for Houses(urban)	nos	18,000,000	0%	100%		0	0	0
2.2	Compensation for Houses(rural)	nos	7,700,000	0%	100%	50	0	385,000,000	385,000,000
2.3	Land Acquisition for Residential Land	sq.m	2,000	0%	100%	35,000	0	70,000,000	70,000,000
2.4	Land Acquisition for Agriculture Land	sq.m	3,000	0%	100%	530,000	0	1,590,000,000	1,590,000,000
(3)	ADMINISTRATION COST 5% of (1)+(2)			0%	100%		0	3,731,000,000	3,731,000,000
(4)	ENGINEERING SERVICE COST 10% of (1)			100%	0%		7,258,000,000	0	7,258,000,000
(5)	SUB TOTAL = (1)+(2)+(3)+(4)						49,641,267,000	35,967,733,000	85,609,000,000
(6)	PHYSICAL CONTINGENCY 10% of (5)						4,964,226,700	3,596,773,300	8,561,000,000
	GRAND TOTAL						54,605,493,700 (Rp.mil. 54,605) (US$'000 5,688.1)	39,564,506,300 (Rp.mil. 39,565)	94,170,000,000 (Rp.mil. 94,170)

Note :

1 JPYen1=Rp. 77.4

2 US$1=Rp. 9600

3 1. PREPARATORY WORKS 10%
2. CHANNEL WORKS 3%
3. WEIR WORKS (Topadu River) 5%
5. APPURTENANT WORKS 5%
6. MISCELLANEOUS WORKS 5%

Table 5.5.4 DISBURSEMENT SCHEDULE

1) Bone-Bolango-Tamalate River Improvement (Unit Rp.million)

Work items	Cost		2003	2004	2005	2006	2007	2008	2009
1 Direct cost	F.C.	47,871	0	0	14,361	16,755	16,755	0	0
	D.C.	44,708	0	0	13,412	15,648	15,648	0	0
2 Land acquisition	F.C.	0	0	0	0	0	0	0	0
	D.C.	2,642	0	793	925	925	0	0	0
3 Administration	F.C.	0	0	0	0	0	0	0	0
	D.C.	4,761	952	952	952	952	952	0	0
4 Engineering	F.C.	9,258	1,852	1,852	1,852	1,852	1,852	0	0
	D.C.	0	0	0	0	0	0	0	0
(Sub-total: 1thru 4)	F.C.	57,129	1,852	1,852	16,213	18,606	18,606	0	0
	D.C.	52,111	952	1,745	15,289	17,525	16,600	0	0
5 Phisical contingency	F.C.	5,713	185	185	1,621	1,861	1,861	0	0
	D.C.	5,211	95	174	1,529	1,752	1,660	0	0
(Sub-total: 1thru 5)	F.C.	62,842	2,037	2,037	17,834	20,467	20,467	0	0
	D.C.	57,322	1,047	1,919	16,818	19,277	18,260	0	0
6 Price contingency	F.C.	0	0	0	0	0	0	0	0
	D.C.	26,169	105	403	5,567	8,947	11,148	0	0
TOTAL	**F.C.**	**62,842**	**2,037**	**2,037**	**17,834**	**20,467**	**20,467**	**0**	**0**
	(US$'000 eq)	**6,546.0**	**212.2**	**212.2**	**1,857.7**	**2,132.0**	**2,132.0**	**0.0**	**0.0**
	D.C.	**83,491**	**1,152**	**2,322**	**22,385**	**28,224**	**29,408**	**0**	**0**
	Total	**146,333**	**3,189**	**4,359**	**40,219**	**48,691**	**49,875**	**0**	**0**

2) Tamalate Floodway

Work items	Cost		2003	2004	2005	2006	2007	2008	2009
1 Direct cost	F.C.	6,572	0	0	0	0	1,972	2,300	2,300
	D.C.	8,994	0	0	0	0	2,698	3,148	3,148
2 Land acquisition	F.C.	0	0	0	0	0	0	0	0
	D.C.	953	0	0	0	286	334	334	0
3 Administration	F.C.	0	0	0	0	0	0	0	0
	D.C.	826	0	0	165	165	165	165	165
4 Engineering	F.C.	1,557	0	0	311	311	311	311	311
	D.C.	0	0	0	0	0	0	0	0
(Sub-total: 1thru 4)	F.C.	8,129	0	0	311	311	2,283	2,612	2,612
	D.C.	10,773	0	0	165	451	3,197	3,647	3,313
5 Phisical contingency	F.C.	813	0	0	31	31	228	261	261
	D.C.	1,077	0	0	17	45	320	365	331
(Sub-total: 1thru 5)	F.C.	8,942	0	0	343	343	2,511	2,873	2,873
	D.C.	11,850	0	0	182	496	3,517	4,011	3,644
6 Price contingency	F.C.	0	0	0	0	0	0	0	0
	D.C.	8,990	0	0	60	230	2,147	3,095	3,458
TOTAL	**F.C.**	**8,942**	**0**	**0**	**343**	**343**	**2,511**	**2,873**	**2,873**
	(US$'000 eq)	**931.4**	**0.0**	**0.0**	**35.7**	**35.7**	**261.6**	**299.2**	**299.2**
	D.C.	**20,840**	**0**	**0**	**242**	**727**	**5,664**	**7,106**	**7,102**
	Total	**29,782**	**0**	**0**	**584**	**1,069**	**8,175**	**9,979**	**9,975**

3) Sediment Trap Works in Lake Limboto

Work items	Cost		2003	2004	2005	2006	2007	2008	2009
1 Direct cost	F.C.	639	0	0	320	320	0	0	0
	D.C.	1,204	0	0	602	602	0	0	0
2 Land acquisition	F.C.	0	0	0	0	0	0	0	0
	D.C.	289	0	145	145	0	0	0	0
3 Administration	F.C.	0	0	0	0	0	0	0	0
	D.C.	107	21	21	32	32	0	0	0
4 Engineering	F.C.	184	46	46	46	46	0	0	0
	D.C.	0	0	0	0	0	0	0	0
(Sub-total: 1thru 4)	F.C.	823	46	46	366	366	0	0	0
	D.C.	1,600	21	166	779	634	0	0	0
5 Phisical contingency	F.C.	82	5	5	37	37	0	0	0
	D.C.	160	2	17	78	63	0	0	0
(Sub-total: 1thru 5)	F.C.	905	51	51	402	402	0	0	0
	D.C.	1,760	24	182	856	698	0	0	0
6 Price contingency	F.C.	0	0	0	0	0	0	0	0
	D.C.	648	2	38	283	324	0	0	0
TOTAL	**F.C.**	**905**	**51**	**51**	**402**	**402**	**0**	**0**	**0**
	(US$'000 eq)	**94.3**	**5.3**	**5.3**	**41.9**	**41.9**	**0.0**	**0.0**	**0.0**
	D.C.	**2,408**	**26**	**221**	**1,140**	**1,021**	**0**	**0**	**0**
	Total	**3,313**	**76**	**271**	**1,542**	**1,423**	**0**	**0**	**0**

GRAND TOTAL 1)+2)+3)	**F.C.**	**72,689**	**2,087**	**2,087**	**18,579**	**21,212**	**22,978**	**2,873**	**2,873**
	(US$'000 eq)	**7,571.7**	**217.5**	**217.5**	**1,935.3**	**2,209.6**	**2,393.6**	**299.2**	**299.2**
	D.C.	**106,739**	**1,178**	**2,543**	**23,767**	**29,971**	**35,072**	**7,106**	**7,102**
	Total	**179,428**	**3,265**	**4,631**	**42,346**	**51,183**	**58,050**	**9,979**	**9,975**

Table 5.6.1 STANDARD ACTIVITIES FOR RIVER MAINTENANCE (1/4)

No.	Item / Sub Item To Be Maintained	Scope of Works and Maintenance Frequency								Remarks
		D	W	2W	M	3M	6M	Y	3Y	
I.	**River and Structure**									Scope of Works:
										C = Cleaning
1.1	River Channel and Flood Plain				C					R = Repair
										S = Sodding
1.2	Earth Dike :									P = Painting
	- Dike Body		M			R		G		L = Lubricating
	- Crest of Dike		M		C	R				G = Geodetical Survey
	- Slope of Dike		M		C, S	R				M = Monitoring
										O = Overhoul
1.3	Gabion Dike :			C	R, M			G		
1.4	Slope Protection :									Frequency :
	- Stone Masonry			C	R, M					D = Daily
	- Gabion			C	R, M					W = Weekly
	- Concrete				C			R		2W = Two Weekly
										M = Monthly
1.5	Retaining Wall :									3M = Three Monthly
	- Wooden Pile				M	R		G		6M = Six Monthly
	- Sheet Pile				M		R	G		Y = Year
										3Y = Three Yearly
1.6	Groyne :									
	- Wooden Block				M		R			
	- Gabin				M			R		
	- Concrete Block						M			
1.7	Check Dam :									
	- Gabion				C, M	R				
	- Concrete				C	M		R		
1.8	Flood Spillway									
	- Gabion				C, M	R				
	- Concrete				M	C		R		
1.9	Drainage Gate / Flap :									
	- Wood			C, L			R	P	O	
	- Steel			C, L				R, P	O	
1.10	Flood Pump			C			R		O	
1.11	Sabo Dam :									
	- Main Dam and Sub Dam				C					
	- Apron and Spillway			C		M	R			
	- Drip Hole			C		R				
	- Wing Wall			C		R				
	- Scouring Protection			C	R	R				
1.12	Ground Sill			C		R				

Table 5.6.1 STANDARD ACTIVITIES FOR RIVER MAINTENANCE (2/4)

No.	Item / Sub Item To Be Maintained	Scope of Works and Maintenance Frequency								Remarks
		D	W	2W	M	3M	6M	Y	3Y	
II.	**Dam and Reservoir**									Scope of Works:
										C = Cleaning
2.1	Dam :									R = Repair
	- Dam Crest			C, R						S = Sodding
	- Dam Slope			C, R						P = Painting
	- Rip Rap				C, R					L = Lubricating
	- Drain			C, R						G = Geodetical Survey
	- Parapet			C, R						M = Monitoring
										O = Overhoul
2.2	Inspection Gallery :									
	- Inspection Corridor			C, M	R					
	- Hollow Jet Valve			C, L	R				P	Frequency :
	- Illunination System			M, R						D = Daily
										W = Weekly
2.3	Intake :		C	M, L	R					2W = Two Weekly
	- Intake Gate		C	M		R		P	O	M = Monthly
	- Trash Rack							P		3M = Three Monthly
										6M = Six Monthly
2.4	Spillway:									Y = Year
	- Spillway Structure			C	R					3Y = Three Yearly
	- Spillway Gate	M	C		L, R			P	O	
	- Spillway Channel			C	R					
	- Stilling Basin			C	R					
2.5	Reservoir :									
	- Reservoir Area			C				G		
	- Tidal Area			M	C					
	- Trash Boom			C	R			P		
2.6	Diversion Tunnel :				C, M	R				
2.7	Control Station :									
	- Housing	C				R			P	
	- Equipment	C				R				
	- Garden	C								
2.8	Green Belt				M		C			

Table 5.6.1 STANDARD ACTIVITIES FOR RIVER MAINTENANCE (3/4)

No.	Item / Sub Item To Be Maintained	Scope of Works and Maintenance Frequency								Remarks
		D	W	2W	M	3M	6M	Y	3Y	
III.	**Barrage / Weir**									Scope of Works:
										C = Cleaning
3.1	Weir / Barrage Body			C, R				C		R = Repair
										S = Sodding
3.2	Left and Right Wing				C, R					P = Painting
										L = Lubricating
3.3	Weir / Barrage Pilar				C		R			G = Geodetical Survey
										M = Monitoring
3.4	Bridge		C		R				P	O = Overhoul
3.5	Stilling Basin			C	R					
										Frequency :
3.6	Scouring Protection			C	R					D = Daily
										W = Weekly
3.7	Weir / Barrage Gate	M	C	L	R			P	O	2W = Two Weekly
										M = Monthly
3.8	Trash Rack		C	M		R		P		3M = Three Monthly
										6M = Six Monthly
3.9	Gate Hoist Unit		C	R	L					Y = Year
										3Y = Three Yearly
3.10	Coverage				C	R			P	
3.11	Stoplog				C, L	R			P	
3.12	Staff Gauge	M	C					R	O	
3.13	Dike									
	- Dike Body		M			R				
	- Dike Slope		M		C, S	R				
	- Dike Crest		M		C	R				
3.14	Control Station :									
	- Housing	C				R			P	
	- Equipment	C				R				
	- Garden	C								

Table 5.6.1 STANDARD ACTIVITIES FOR RIVER MAINTENANCE (4/4)

No.	Item / Sub Item To Be Maintained	Scope of Works and Maintenance Frequency								Remarks
		D	W	2W	M	3M	6M	Y	3Y	
IV.	**Structure Facility**									Scope of Works:
										C = Cleaning
4.1	Water Level Recorder Unit:									R = Repair
	- Authomatic		C	L	M		R		O	S = Sodding
	- Manual	M	C				P	R		P = Painting
										L = Lubricating
4.2	Ring Gauge Unit :									G = Geodetical Survey
	- Authomatic		C	L	M		R			M = Monitoring
	- Manual	M	C				R			O = Overhoul
4.3	Inspection Road / Bridge		C		M		R			
										Frequency :
4.4	Housing	C				R		P		D = Daily
										W = Weekly
4.5	Office Building	C				R		P		2W = Two Weekly
										M = Monthly
4.6	Workshop / Warehouse	C				R			P	3M = Three Monthly
										6M = Six Monthly
4.7	Radar and Anthenna				C			R		Y = Year
										3Y = Three Yearly
4.8	Data Processing Unit	C					R			
4.9	Communication Equipment		C		R					
4.10	Topographic Survey Equipment				C			R		
4.11	Water and Sediment Measuring	Clean After Use								
	Equipment									
4.12	Temperature Regulator				C		R			
4.13	Guard House	C					R		P	
4.14	Office Yard	C								

Table 5.6.2 IMPLEMENTATION AND O&M OF FLOOD MITIGATION FACILITIES IN LBB BASIN

No	Flood Mitigation Fasilities	Location		Responsibility				Remarks
		Kabupaten Gorontalo	Kota Gorontalo	Central	Province	Kabupaten	Kota	
1	RIVER IMPROVEMENT							P = Planning D = Design L = Land Acquisition C = Construction O = Operation M = Maintenance Related Dinas: - River Imp = Dinas PU - Floodway/Dischannel = Dinas PU - Lake Limboto Manag.= Dinas PU - Watershed Mang.= Dinas Kehutanan/Pertanian - Flood Management = Other
1.1	Bone River Improvement	✓	✓				L,C,O,M	
1.2	Tamalate River Improvement	✓	✓					
1.3	Bolango River Improvement	✓	✓		D			
1.4	Biyonga River Improvement	✓	-	P	L			
1.5	Alo & Pohu River Improvement	✓	-	D*)	C**)	L,C,O,M		
1.6	Meluopo River Improvement	✓	-	C*)	O**)			
1.7	Marisa River Improvement	✓	-		M**)			
1.8	Rintenga River Improvement	✓	-					
2	FLOODWAY/DIVERSION CHANNEL				D**)			
2.1	Tamalate River Floodway	✓	✓	P	L	L,C,O,M	L,C,O,M	
2.2	Biyonga Realignment	✓	-	D*)	C**)	L,C,O,M	-	
2.3	Alopohu Realignment	✓	-	C*)	O**)	L,C,O,M		
					M**)			
3	LAKE LIMBOTO MANAGEMENT							
3.1	Ring Dike	✓	✓	P	D,L,C,O,M	L		
3.2	Control Gate	-	✓	D*)			L	
3.3	Sand Trap	✓	✓	C*)		L	L	
4	WATERSHED MANAGEMENT	✓	✓	P	D	C,O,M	C,O,M	
5	FLOOD MANAGEMENT	✓	✓	P	D	C,O,M	C,O,M	

*Note: *) if Province is not capable **) if Kabupaten / Kota is not capable*

Table 5.8.1 DAMAGEABLE PROPERTY AND FLOOD DAMAGE IN BENEFICIAL AREAS OF BBT RIVER IMPROVEMENT PROJECT UNDER PRESENT SOCIO-ECONOMIC CONDITIONS

Item	Return Period (Year)				
	2	5	10	20	50
I. Affected Population and Area					
1 Affected Population (1000)	7	11	17	20	26
2 Area Inundated (km2)	24	26	28	29	32
II. Inundated Property					
1 Buildings (Nos)	2,076	3,317	5,213	5,891	7,890
a. Housing Units	1,823	2,882	4,470	5,040	6,713
b. Manufacturing	121	197	302	334	453
c. Trading	105	200	390	460	651
d. Educational	12	17	28	35	46
e. Medical	16	21	23	23	28
2 Agricultural Land (ha)	1,012	1,070	1,183	1,255	1,354
a. Irrigated Field	936	981	1,078	1,148	1,243
b. Rainfed Field	51	64	80	82	87
c. Fishpond	25	25	25	25	25
III. Estimated Value of Damaged Property (Rp. Million in Economic Terms)					
1. Direct Damage	13,626	19,432	30,239	43,863	68,003
(1) Facilities	6,414	10,402	18,487	28,740	46,971
a. Housing Units	3,468	5,402	10,914	18,368	30,115
b. Manufacturing	975	1,629	2,526	3,321	5,286
c. Trading	245	454	870	1,306	2,332
f. Education	1,091	1,875	2,656	3,732	6,078
g. Health	143	208	259	284	351
h. Other Facilities	491	833	1,262	1,729	2,809
(2) Agricultural Production	4,067	4,546	4,774	5,002	5,339
a. Irrigated Field	3,389	3,855	4,069	4,272	4,583
b. Rainfed Field	111	125	138	163	190
c. Fishpond	567	567	567	567	567
(3) Infrastructure	3,144	4,484	6,978	10,122	15,693
2. Indirect Damage	1,499	2,158	3,402	4,926	7,658
(1) Household	66	95	176	282	453
(2) Business Losses	71	120	202	258	404
(3) Other Damages	1,363	1,943	3,024	4,386	6,800
3. Total	15,125	21,591	33,640	48,789	75,660
IV. Annualized Damage Value under Present Conditions (Rp. Million in Economic Terms)					
				14,843	

Table 5.8.2 DAMAGEABLE PROPERTY AND FLOOD DAMAGE IN BENEFICIAL AREAS OF BBT RIVER IMPROVEMENT PROJECT UNDER FFUTURE SOCIO-ECONOMIC CONDITIONS

Item	Return Period (Year)				
	2	5	10	20	50
I. Affected Population and Area					
1 Affected Population (1000)	8	13	21	23	31
2 Area Inundated (km2)	24	26	28	29	32
II. Inundated Property					
1 Buildings (Nos)	2,463	3,936	6,187	6,992	9,364
a. Housing Units	2,163	3,420	5,305	5,982	7,966
b. Manufacturing	143	233	359	396	538
c. Trading	124	237	463	546	772
d. Educational	14	20	33	41	55
e. Medical	19	25	27	27	33
2 Agricultural Land (ha)	1,012	1,070	1,183	1,255	1,354
a. Irrigated Field	936	981	1,078	1,148	1,243
b. Rainfed Field	51	64	80	82	87
c. Fishpond	25	25	25	25	25
III. Estimated Value of Damaged Property (Rp. Million in Economic Terms)					
1. Direct Damage	32,788	50,009	83,737	126,411	202,187
(1) Facilities	20,364	33,022	58,690	91,241	149,120
a. Housing Units	11,011	17,151	34,650	58,314	95,606
b. Manufacturing	3,096	5,171	8,018	10,542	16,783
c. Trading	779	1,442	2,762	4,147	7,403
f. Education	3,465	5,952	8,432	11,848	19,295
g. Health	454	661	821	902	1,114
h. Other Facilities	1,559	2,645	4,007	5,488	8,919
(2) Agricultural Productio	4,858	5,446	5,723	5,998	6,408
a. Irrigated Field	4,180	4,754	5,019	5,268	5,652
b. Rainfed Field	111	125	138	163	190
c. Fishpond	567	567	567	567	567
(3) Infrastructure	7,567	11,540	19,324	29,172	46,659
2. Indirect Damage	3,713	5,684	9,573	14,355	22,942
(1) Household	208	301	559	895	1,441
(2) Business Losses	225	382	641	819	1,282
(3) Other Damages	3,279	5,001	8,374	12,641	20,219
3. Total	36,501	55,693	93,310	140,765	225,129
IV. Annualized Damage Value under Future Conditions (Rp. Million in Economic Terms)					
				38,368	