(3) Flood Prevention Project for Mati River

1) Flood Prevention Plan

Flood prevention plan for Mati River consists of river improvement and natural retarding basin located in upstream of Umadui Weir based on the following reasons:

- In accordance with existing improvement plan prepared by Indonesian government, river improvement had already executed from downstream to upstream except section from Ulun Tanjug Weir to Umadui Weir.
- Current land use of planned retarding basin, showing topographical decline from Mati River to Lebakmudin River, is almost paddy field with natural retarding function. Because of inundation repeated at frequent intervals in this stretch area caused to land characteristics of low lying area, the land development is at a stop. The land use condition of planned retarding basin shall be secured in the future.
- River improvement shall be carried out for the section from Ulun Tanjung Weir to Umadui Weir with banking and normalization. The existing Ulun Tanjung Weir shall be removed for the reason of nonfunctional condition.

2) Distribution of Design Discharge

Distribution of Design discharge is shown in Figure-III-4.16 with following comment.

- As the area of retarding basin shall be 150,000 m^3, with about 15 ha in area and with 1.0m in depth.
- Design discharge of 230m^3/sec after flood control basin become 170m^3/sec, which is almost same with existing plan formulated by PU. Accordingly, distribution of design discharge is determined as following Figure-III-4.16.

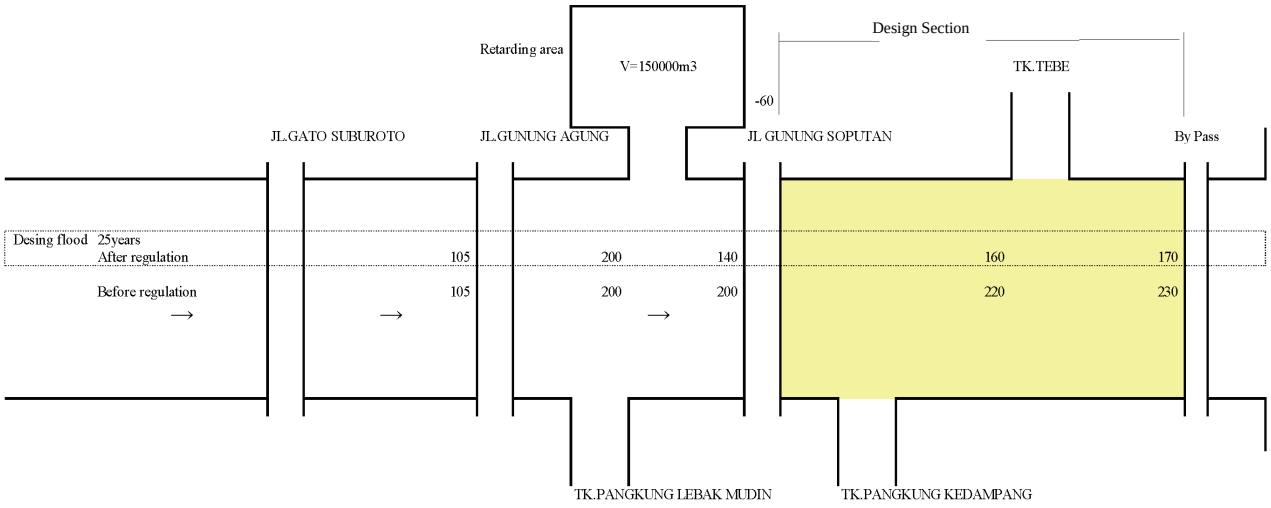


Figure-III-4.16 Distribution of Design Discharge (Mati River)

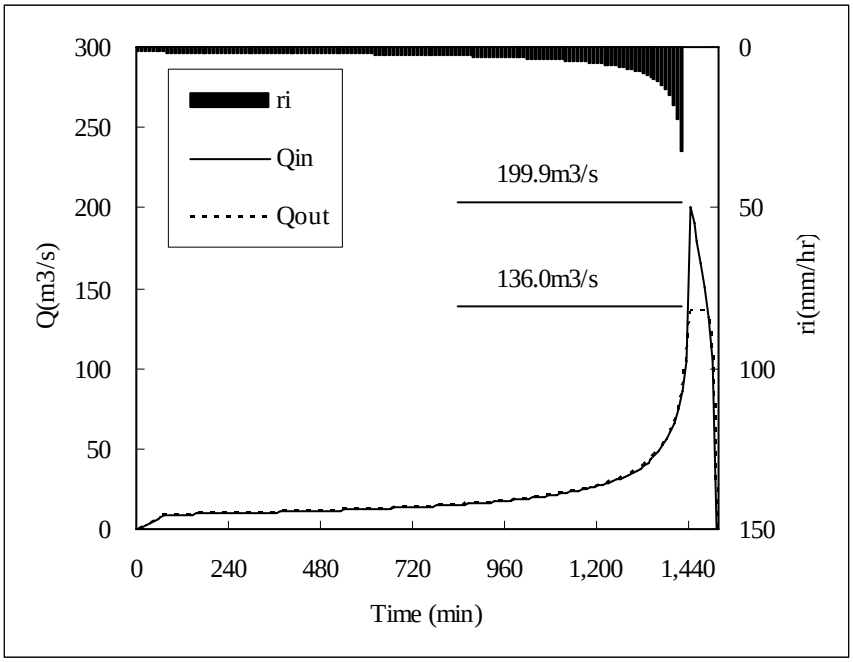


Figure-III-4.17 Calculation Result by Retarding Basin

Table-III-4.8 Calculation Result for Storing Capacity by Retarding Basin

			Retarding pond					Tukad Mati (A=38.4km2)	
no	(1) t=n・⊿t (min)	(2) ri (mm/hr)	(3) Qin (m3/s)	(4) Qout (mm/hr)	(5) Qin-Qout (m3/s)	(6) Volume_net (m3)	(7) Volume_net×1.2 (m3)	(8) Before regulation (mm)	(9) After regulation (m3/s)
130	1,290	6.92	35.1	35.1	0.0	0	0	50.5	50.5
131	1,300	7.26	36.4	36.4	0.0	0	0	52.3	52.3
132	1,310	7.64	37.9	37.9	0.0	0	0	54.2	54.2
133	1,320	8.08	39.6	39.6	0.0	0	0	56.4	56.4
134	1,330	8.58	41.5	41.5	0.0	0	0	58.8	58.8
135	1,340	9.18	43.6	43.6	0.0	0	0	61.5	61.5
136	1,350	9.88	45.9	45.9	0.0	0	0	64.5	64.5
137	1,360	10.74	48.7	48.7	0.0	0	0	68.0	68.0
138	1,370	11.82	51.9	51.9	0.0	0	0	72.0	72.0
139	1,380	13.22	55.8	55.8	0.0	0	0	76.7	76.7
140	1,390	15.13	60.5	60.5	0.0	0	0	82.4	82.4
141	1,400	17.91	66.5	66.5	0.0	0	0	89.4	89.4
142	1,410	22.50	74.4	74.4	0.0	0	0	98.4	98.4
143	1,420	32.07	85.7	85.7	0.0	0	0	111.0	111.0
144	1,430	0.00	104.5	104.5	0.0	0	0	131.1	131.1
145	1,440	0.00	199.9	136.0	63.9	19,155	22,986	226.2	162.4
146	1,450	0.00	189.8	136.0	53.8	54,463	65,356		
147	1,460	0.00	178.6	136.0	42.6	83,410	100,092		
148	1,470	0.00	165.8	136.0	29.8	105,157	126,189		
149	1,480	0.00	150.7	136.0	14.7	118,513	142,215		
150	1,490	0.00	131.6	131.6	0.0	122,916	147,499		
151	1,500	0.00	104.5	104.5	0.0	122,916	147,499		
152	1,510	0.00	0.0	0.0	0.0	122,916	147,499		

(4) Flood Prevention Project for Mati River

1) Basic Facility Plan for River Improvement

According to river flow capacity calculation result, flow capacity with 170m^3/sec have secured by river improvement for the section from river mouth to Ulun Tanjung Weir near Sunset Road in Kuta. The section with distance of 2,000m from Ulun Taung Weir to Umadui Weir, flow capacity shows small discharge with 50 m^3/sec to 100m^3/sec because of no improvement. Land use condition along the river is almost paddy field and cropping land. River water overflowed and inundated with depth of 20-30cm in the right inland area on December 12, 2005. Upstream section from Umadui Weir, river improvement with river widening is already to be finished.

As mentioned above, river improvement including retarding basin shall be adopted for flood control Plan of Mati River by taking into account the current condition of river improvement executed by Indonesian Government.

For river improvement plan, only river course improvement plan from Ulung Tanjung Weir to Umadui Weir shall be designed. Existing Ulung Tanjung Weir shall be removed because of no necessity for the

taking water of irrigation. With regard to retarding basin planned in the upstream of Umdui Weir in accordance with existing flood control plan, current land use which used for paddy field and cropping land should be conserved on the basis of precise land use regulations.

2) Section for River Improvement

Section for river improvement should be designated from just upstream of Ulun Tanjung Weir to Umadui Weirs with about 2,500 m, based on the current flow capacity result. Section of river improvement is as shown in Figure-III-4.18.

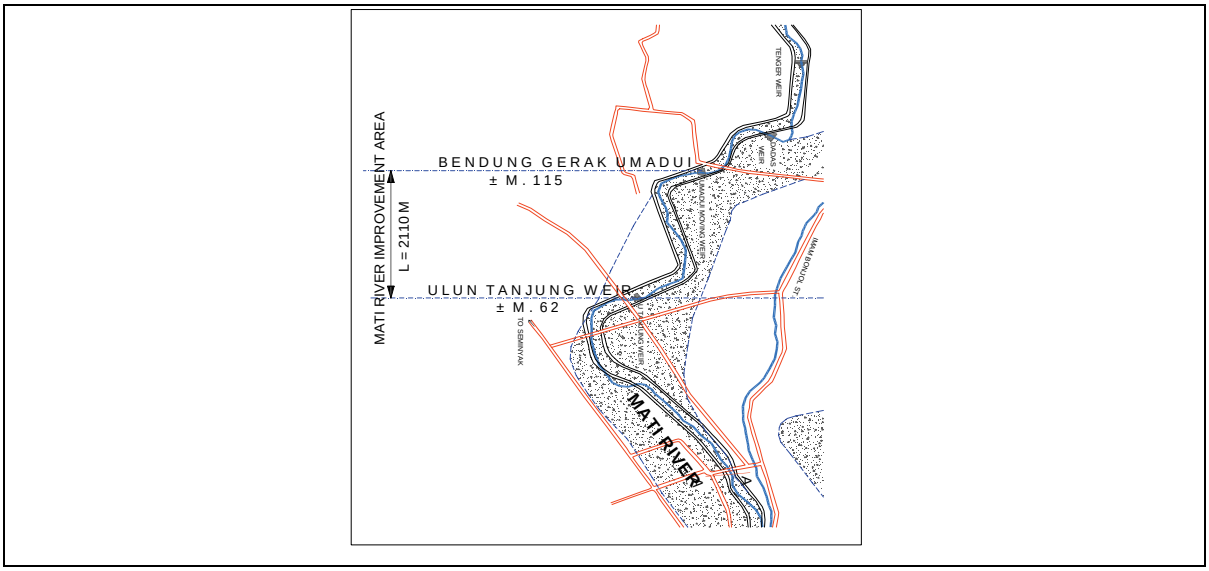


Figure-III-4.18 Plan for Section of River Improvement for Mati River

3) Adopted Method for River Improvement

An adopted method for river improvement in Mati River is shown as follows:

- Normalization Including River Widening and Banking
- Removal of Existing Ulun Tanjung Weir

4) Plan for Longitudinal Profile

Longitudinal profile plan was set to by taking into consideration with current profile prepared by topographic survey results by JICA Study Team. Longitudinal profile of Mati River is shown in Figure-III-4.19. Basically, longitudinal profile for Mati River is to be set in accordance with existing plan which is almost same with current river gradient. Rounded river gradient of the section is to be I=1/1,000.

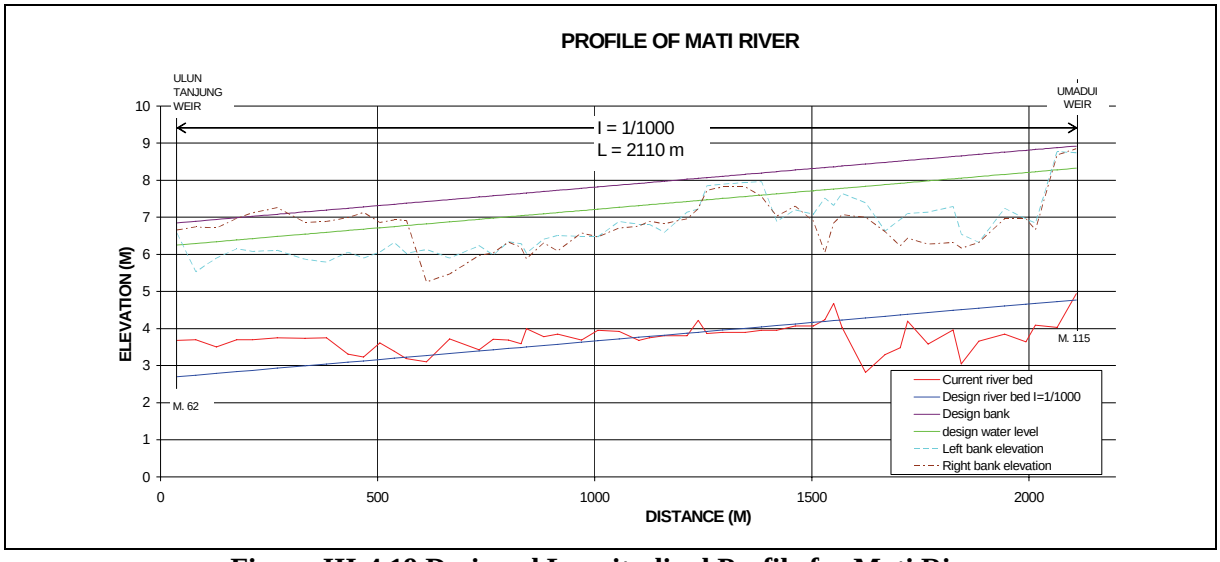


Figure-III-4.19 Designed Longitudinal Profile for Mati River

With regard to existing river gradient with 1/1,000 for planned section, specifications for river improvement works are shown in Table-III-4.9 and typical cross section is as shown in Figure-III-4.20. Cross section would be adopted with base on the existing plan.

Table-III-4.9 Specifications for River Improvement of Mati River

Items	Specifications	Remarks
1)River Improvement Section and its Length	Ulun Tanjung Weir(Downstream) to Umadui Weir (Upstream) L=2,100 m	
2)Design Flood	170 m^3/sec	After Controlling by Retarding Basin
3)Designed River Gradient	I=1/1,000	
4)River Width & Cross Section Shape	B= 22-26.35 m (Trapezoid Shape with Slope1:0.5)	
5)Adopted Works	◆ River Widening & Banking ◆ Removal of Ulun Tanjung Weir	

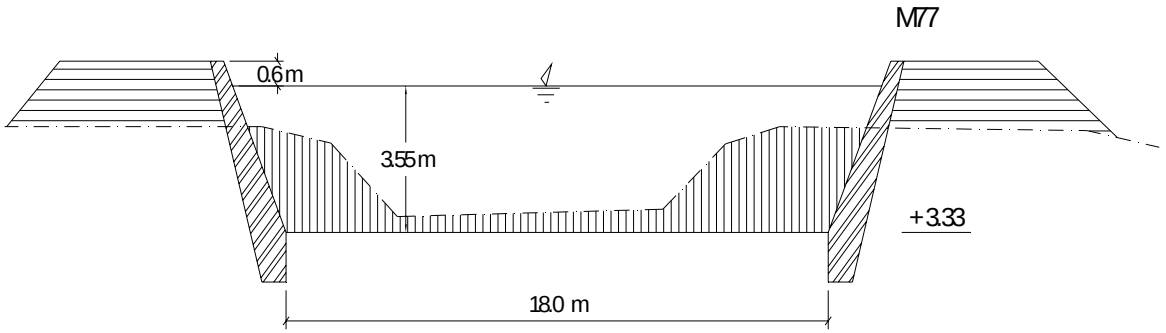


Figure-III-4.20 Typical Cross Section of Mati River

General plan of flood prevention project for Badung River is shown in Figure-III-4.21.

Outline of Works

1 Riverbed Excavation （Length = 2500m Width = 22m）
2 Retaing Wall Placement （Length = 2500m Height = 8m）
3 Removement of Existing Ulun Tanjung Weir

Existing Uma Dwi Weir
（Width＝28.5m）

Existing Ulun Tanjung Weir
（Width＝15m）

Typical Section of River Improvement

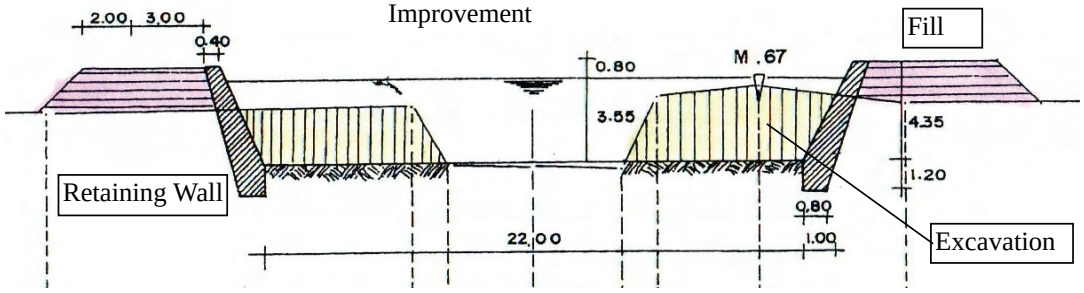


Figure-III-4.21 General Plan of Flood Prevention Project for Mati River

4.4 Work Quantities

Work quantities for river improvement project are shown as Table-III-4.10.

Table-III-4.10 Work Quantities for River Improvement Project

River Name	Description	Work Item	Parameters ・Quantities
Badung River (River Improvement Work Length 5.7 km)	River Structure	New Grand Sill	W20m×L25m×H2m
		Revetment for Low Flow Channel Works	H=1.6m
		Parapet Wall Works	(H=0.3 ～ 1.7m)
	River Bed Excavation	River bed Excavation Works	L=5,680m
	Foot Bridge JL. B.Tunggal (Dismantle and Construction)	Removal for Existing Foot Bridge Works	Steel Bridge(W3.5m×L27m)
		Placement New Bridge Works	
		Widening Works	
		Revetment	
	Buagan Weir Improvement	Improvement of Flushing Gate Foundation(1m)	Foundation of Gate Foundation(2sites)
Mati River (River Improvement Work Length 2.1 km)	River Structure	Removal Existing Weir	H2.5m×W9m
		(Uluntanjung Weir)	
		Revetment Work (H=5.5m)	L=2,110m
	River Bed Excavation	Riverbed Excavation Work	L=2,110m

Works in detail for each project are shown in Table-III-4.11.

Table-III-4.11 Work Items for River Improvement Project

River	Description		Work Item	Unit	Quantity	Remark
Badung River	River Facilities	New Grand Sill Works W=20m, L=28m	Earth Works (Excavation)	m³	100	
			Concrete Work	m³	1,000	
			Bed Protection Works (Block)	m³	200	
			Bed Protection Works (Flood Wall)	m³	1,000	
		Revetment for Low Flow Channel L＝5,680 m,H=1.6m	Concrete Work	m³	7,130	
		Parapet Wall Works L=3410m, H=0.3-1.7m	Concrete Work	m³	1,190	
		River bed Excavation Work L＝5,680m	Earth Works (Soft Rock)	m³	147,030	
	Replacement for Foot Bridges (At near JL. B. Tunggal)	Removal for Existing Bridge	Steel Bridge	m³	100	
		Placement New Bridge	Steel Bridge	m³	120	
		Widening	Earth Works (Excavation)	m³	500	
		Revetment	Concrete Work	m³	900	
	Bugan Weir Improvement	Flushing Gate Improvement		Ls	1	
Mati River	River Facilities	Removal Weir (Ulun Tanjung Weir)	Concrete Work 2.5m×9m	m³	200	Wide =15m
		Revetment L= 2,110 m,H=5.5m	Concrete Work	m³	19,200	
	Riverbed Excavation	Riverbed Excavation	Earth Works (Excavation)	m³	62,500	
	Embankment		Earth Works (Embankment)	m³	37,000	

4.5 Construction Plan

Construction Plan for Badung and Mati River improvement project shall be adopted as shown in Table-III-4.12 by taking into consideration with river and river side conditions such as bank, inspection road, housing density and river conditions, etc.

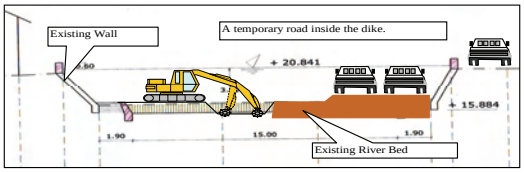
Table-III-4.12 Construction Plan for Badung and Mati River Improvement Project

Subject River	Description	Work Item	Construction Method
Badung River	Length of 5.7km from Buagan Weir located downstream to Maruti Street.	1) New Grand Sill (H=0.3-1.7m) 2) Revetment for Low Flow Channel Works (H=1.6m) 3) Parapet Wall Works (H=0.3−1.7m) 4) River bed Excavation Works and Revetment Works (L=5.7km) 5) Removal for Existing Foot Bridge Works Steel Bridge (W3.5m×L27m) 6)Improvement of Flushing Gate Foundation (1m) (Buagan Weir Improvement)	(a) Because of excavation in the river, works shall be done during Dry Seasion which water level is low. (b) Due to small width of the river, stage diversion method shall be adpted instead of simaltanious work for both sides. (c) Due to little clearance of bridges as well as small width of inspection road of both banks, excavated sand from river bed shall be conveyed to storage site located near bridges by 4 ton class truck with passaging the temporary road with width of 6m in theriver. (d) Excavation Materialis in the storage site shall be transshiped to the 10 ton class truck and shall be carried to disposal area.
Mati River	Length of 2.1km from the Ulun Tunjung Weir located downstream to the Umadui Weir.	1) Removal Existing Weir Ulun Tunjung Weir (H2.5m×W9m) 2) River bed Excavation Works and Revetment Works (L=2.1km)	(a) After diversion of water channel by trench, excavation for revetment shall be executed. (b) Excavation materials shall be conveyed by 10 ton class truck with passaging temporary road in the river. (c) Backfillimg behind retaining wall shall be executed by bollow sand.

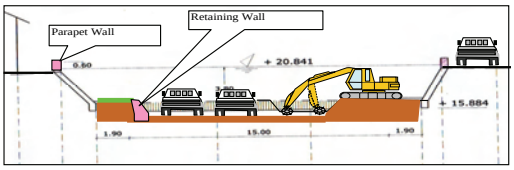
Work procedure for river improvement project is shown as Figure-III-4.22.

Badung River

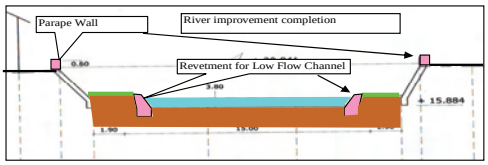
1) Setting up of temporary road in the river.



2) Revetment work by stage diversion method

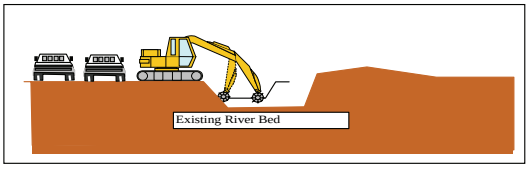


3) River improvement work

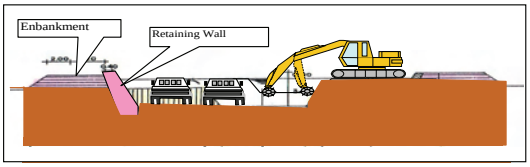


Mati River

1) Diversion work shall be done in the river before excavation



2) Conveyance of excavation materials on the temporary road



3) Backfillimg behaind wall by bollow sand.

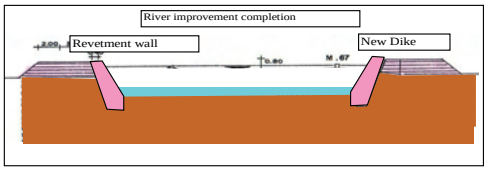


Figure-III-4.22 Work Procedure for River Improvement Project

Construction Schedule for River Improvement Project is shown in Table-III-4.13.

Table-III-4.13 Construction Schedule for River Improvement Project

Construction Year	First Year		Second year		Third Year		Fourth Year	
Season	Dry Season (May - Oct.)	Rainy Season (Nov. - April)	Dry Season (May - Oct.)	Rainy Season (Nov. - April)	Dry Season (May - Oct.)	Rainy Season (Nov. - April)	Dry Season (May - Oct.)	Rainy Season (Nov. - April)
Badung River	3mths							
Preparatory Work			18mths in total					
Ground Sill								
Earthwork (Using 2 Backhoes)				15mths in total				
River Bed Excavation								
Retaining wall								
Construction wall(small)					18mths in total			
Parapet Wall			12mths in total					
Bridge								
Dismantle & construction					6mths			
Buagan Weir								
Modify basemnt			2mths					
Mati River								
Preparatory Work	3mths							
Dismantle Urun Tanjung Weir		2mths						
Earthwork（Using 3 Backhoes)				12mths in total				
River bed (incld.wall exc.)								
Backfill behind big wall						12mths in total		
Retaining wall								
Construction wall (big)				10mths in total				

CHAPTER 5 OPERATION AND MAINTENANCE

5.1 Organizational Arrangements

(1) Overall Institutional Framework

The overall water related institutional framework in Bali will be as shown in Table-III-5.1, if the reforms of Dinas PU and other related aspects are implemented as proposed in Part II-7.4.

Table-III-5.1 Overall Water related Institutional Framework after Reforms in Bali

<table>
<tr><th rowspan="2"></th><th rowspan="2">Raw Water Provision/Allocation</th><th colspan="3">Water Supply</th></tr>
<tr><th>Construction</th><th>Water Transmission</th><th>Water Distribution</th></tr>
<tr><td rowspan="4">Province</td><td>• Water Resources Coordination Council & Sub-Council
Council/Sub-Council(s9</td><td></td><td rowspan="5">• Regional Water Production Entity (SARBAGITAKU)</td><td rowspan="4"></td></tr>
<tr><td>• Dinas PSDA ← Sub-Dinas SDAPP</td><td rowspan="2">• Dinas PU –Sub-Dinas TRP</td></tr>
<tr><td>- APBN Working Units -- construction</td></tr>
<tr><td>- Balai PSDAs -- management</td><td>- APBN Working Units</td></tr>
<tr><td rowspan="3">Regency</td><td>• Dinas PU or PSDA</td><td></td><td rowspan="3">• PDAMs & PT.TB (in Badung)</td></tr>
<tr><td>- Sedehan Agun</td><td></td></tr>
<tr><td>- Subak Coordination Unit</td><td></td></tr>
</table>

* Shaded organization: newly created or reformed

All of the proposed priority projects will be carried out by APBN Working Unit using the central government budget (or foreign soft loans handled by the central government). The Ayung multipurpose dam and flood control projects will be managed by Dinas PSDA, while the water supply projects will be administered by Sub-Dinas TRP of Dinas PU. For O&M after the construction, the multipurpose dam will be transferred to a Balai PSDA, and the water supply facilities to the new regional water production entity. Flood control after the river improvement construction works will be carried out by the same or another Balai PSDA. The discussion below focuses on the Ayung multipurpose dam project and the water supply projects, as their management will require enhanced organizational and technical capacity.

(2) Operation of the Ayung Multipurpose Dam

2 or 3 Balai PSDAs (depending on how the functions or areas will be divided) can be established simultaneously to take over O&M functions from the existing APBN Working Units overseen by Sub-Dinas SDAPP and from the relevant sections of Sub-Dinas SDAPP. Alternatively, if a step-by-step approach is preferred, efforts at the initial stage can focus on establishing one Balai PSDA, which will manage the Ayung multipurpose dam (expected to be completed in 2013) and related water allocation. This "Ayung Balai PSDA" can be later transformed into a larger body to cover other, adjoining areas and related functions. The preparation of setting up the Balai can start at the beginning of the project by formulating specific functions and tasks within the APBN Working Unit, which will be created to undertake the project. The description below assumes that such a step-by-step approach will be pursued focusing on Ayung Balai PSDA at the initial stage. Key management activities to be performed by the APBN Working Unit and later by the Ayung Balai PSDA are described in 5.2 (1) below.

Another essential organizational set-up is Water Resources Coordination Council (WWRC). A Provincial Council must be established as required by the Water Resources Law No.4/2004 soon after the relevant Government Regulation is issued. In the meantime, in view of the imminent needs to examine and discuss water allocation in the Ayung basin, a council dedicated to the Ayung river may be

created upon commencement of the dam project. The APBN Working Unit during the project, and Ayung Balai PSDA after the project, will perform the secretariat function for this "Ayung Water Resources Coordination Council." At the same time, the regencies/city are requested to re-institute *Sedehan Agung* and establish Subak Coordination Unit under Bupati/Walikota.

(3) Operation of the Water Supply Systems

As mentioned in Part II-7.4.2, the establishment of the proposed water production entity will be a pre-requisite for undertaking the proposed priority projects for water supply systems, comprising weirs, water treatment plants (WTPs) and transmission pipelines. The western and eastern water supply systems can be constructed at a later stage, but the expansion of the Ayung WTP (i.e. the central water supply system) must proceed in combination with the Ayung dam development. The WTP will be constructed in three phases, with the first unit completing in 2013 (under the current estimate), by which time the new water production entity must be ready to take over and operate the facility.

In sum, in light of the construction schedule of the Ayung project, the setting up of the organizations should follow the timeline as shown in Table-III-5.2. This arrangement is line with the Road Map for the Institutional Reform presented in Table II-7.6.

Table-III-5.2 Schedule of Preparing Organizations for the Ayung Project

		2006-2008	– 2013	- 2017	- 2021
Development (Dam & Central System)			▲	▲	▲
Province	**Dinas PSDA** – APBN WU	Setting up Dinas PSDA	Completion of the dam		
	Dinas PU/ Sub-Dinas TRP – APBN WU		Completion of WTP 1st Unit	WTP 2nd Unit	WTP 3rd Unit
Management					
Province	**Ayung WRCC**	Preparation & Setting up		Full operation	
	Ayung Balai PSDA	Preparation & Setting up		Facility take over & full operation	
Province & Regencies	**Water production entity**	Preparation & Setting up		Facility take over & full operation	
Regencies	**Sedehan Agung & Subak Coordination Unit**	Setting up			

* APBN WU: APBN Working Unit
* Ayung WRCC: Ayung Water Resource

5.2 Management Activities and Capacity Development Support

The management activities that must be undertaken (by the APBN Working Unit and subsequently by Ayung Balai PSDA) concurrently with the construction and the necessary external capacity development support are shown in Table-III-5.3.

Table-III-5.3 Management Activities and Capacity Development Support

Areas	Activities	Responsibility	External Support (Experts & Equipment)
Setting up	• Dinas PSDA (see Table-II-7--: Road Map) • Ayung Balai PSDA - Drafting relevant Provincial and internal regulations & getting them approved (incl. provisions for annual budget allocation for O&M) - Staff transfer & physical arrangements - Receiving the support of Ministry of Public Works for organizational & managerial arrangements • Ayung WWRC (to be organized by Governor supported by Dinas PSDA) - Drafting relevant Provincial regulations in consultation with the regencies/city and stakeholders & getting them approved (including provisions for annual budget allocation) - Selecting members (50% from non-government sector. Include Sedehan Agungs) - Ensure necessary budget allocation for the WWRC's activities	Bali Province, Dinas PSDA	
Water quantity management	• Measurement & analysis of water use in the Ayung • Development & maintenance of water allocation system and water resources information system	Dinas PSDA Working Unit (2007/08 – 2011/12) ⇩ Ayung Balai PSDA (2012/13-)	• Hydrologist • Hydro-geologist • GIS/information system expert • Agriculture & irrigation expert * GIS network & computer soft * Water measurement equipment
Water allocation/ reallocation	• Development of water allocation plan • Development of cropping plans (with Dinas Agriculture) • Organizing socialization and discussion through Ayung WWRC • Facilitating adoption of annual water allocation and cropping plans		
O&M of the dam	• Development of O&M system comprising setting up observation network, data collection, decision criteria for discharge, operation of control equipment, communication/reporting system, prevention system, etc.		• Dam and river O&M expert
Watershed management	• Development land conservation plan & system (incl. clarification of responsibilities of other related government bodies like Dinas Forestry)		• Land conservation expert
Water quality control	• Introducing water quality measurement & control system		
Water Resources Information System	• Development and maintenance of database which includes hydrological conditions, water licences issued, water quality, facilities and conditions, land use conditions, weirs and *subaks*, etc.		• Hydrologist • GIS/information system expert
Support to Subaks	• Support to *Sedehan Agung*s and Subak Coordination Units in organizing functions and tasks. • Facilitating in-depth stakeholders' consultations • Support to *Sedehan Agungs* and subaks in their participation in the Ayung WRCC • Facilitating identification of equitable solutions	Dinas PSDA/Ayung Balai PSDA, Ayung WRCC	• Sociologist/Subak expert • Agro-economist

CHAPTER 6 COST ESTIMATE

6.1 Condition of Cost Estimate

Unit prices used for the cost estimation of the projects are determined based on the ”Degree of Governor of Bali No. 17 year 2004 for Goods and Services Prices Standard for Government Needs of Bali Province” and ”Journal for Construction Material and Interior Edition XXII”.

Unit prices not covered by the above information are obtained by quotations from manufactures, suppliers or distributors of products required for projects or estimation from the prices of the similar projects in the past in Indonesia.

Cost estimation for the Study is based on the costs and prices in Indonesian (Rp.) at the mean of one year in 2005, which exchange rate of 1 US$ = 9,750 Rp. = 110.75 JPY is applied for conversion of currencies. Estimated conditions are shown in the Table-III-6.1.

Table-III-6.1 Conditions of Cost Estimate

Breakdown	Conditions of Cost Estimate
(1) Construction Cost	Labor, material and equipment costs for construction
(2) Land Acquisition and Compensatoin	3% of the construction cost for reservoir project, 2% of construction cost for other projects
(3) Government Administration Expense	5% of the construction cost
(4) Engineering Service	10% of the construction cost
(5) Contingency	10% of construction cost, land acquisition and compensation, administration expense and engineering services
(6) Government Tax etc	The government tax in Indonesia is the Value Added Tax (10%) which is not included for project cost estimation.

6.2 Project Cost

The total project cost is about 1.7 trillion Rp. (19.4 billion yen) as shown in Table-III-6.2.

The breakdown of the project cost is as follows; the cost of the Multi-purpose Ayung Dam Project is 1.1 trillion Rp (12.3 billion yen), the project cost of the Water Supply System Project for Southern Bali Area is 0.48 trillion Rp. (5.5 billion yen) and the cost of the Flood Control Project for Badung and Mati River is 0.14 trillion Rp. (1.6 billion yen).

Table-III-6.2 Project Cost of Priority Project

(Unit: million Rp.)

Project	Direct Cost	Land Acquisition	Administration	Engineering Fee	Sub Total	Contingency	Project Cost
Ayung Dam	837,127	25,114	41,856	83,713	987,810	98,781	1,086,591
Water Supply Project	370,854	12,384	18,543	37,085	438,866	43,887	482,753
-West Water Supply System	87,957	1,759	4,398	8,796	102,910	10,291	113,201
-Central Water Supply System	136,996	7,707	6,850	13,700	165,252	16,525	181,778
-East Water Supply System	145,901	2,918	7,295	14,590	170,704	17,070	187,775
River Improvement Project	110,024	2,200	5,501	11,002	128,727	12,873	141,600
Badung River	56,274	1,125	2,814	5,627	65,840	6,584	72,424
Mati River	53,750	1,075	2,687	5,375	62,887	6,289	69,176
Grand Project Cost	1,318,005	39,698	65,900	131,800	1,555,403	155,541	1,710,944

Note) Central Water Supply System is based on the Water Supply plan of 600lit/s.

6.3 Operation and Maintenance Cost

6.3.1 Ayung Dam Project and Water Supply Project

Operation and maintenance (O&M) cost of the projects is estimated based on the actual cost of PDAMs of Bali province and data of Japan as shown in Table-III-6.3. O&M cost of treatment plant of Western and Eastern Water Supply System comes out higher than that of Central system caused by transmission pumping system necessary to be installed. Chemical cost for water purification is estimated at 176Rp/m^3 which is drawn from averaged purification cost between upstream river water and downstream river water.

Table-III-6.3 Estimated O&M Cost

Items		Multi-purpose Ayung Dam	Water Supply System for Southern Bali Area		
			Western	Eastern	Central
Bases	General O&M for Dam	0.2% of construction cost	-	-	-
	Operation cost for Intake/Treatment	-	30kWh/(lit/sec)/day		20kWh/(lit/sec)/day
	Electricity Price	-	750 Rp/kWh		
	Chemical cost for Water Treatment	-	176 Rp/m^3 : average cost between upstream river and downstream river (respectively 88 Rp/m^3、264 Rp/m^3)		
	Repair/Maintenance	3% of Electric Equipment/Machinery Cost			
O&M Cost (Rp. million)		3,874	5,459	5,459	9,880

(1) Flood Control Project of Badung and Mati River

Operation and maintenance (O&) cost of the projects is estimated is estimated as shown in Table-III-6.4.

Table-III-6.4 Estimated O&M Cost

Item	Badung River	Mati River	Total
Base	0.5% of construction cost		-
O&M Cost (Rp. million)	362	346	708

CHAPTER 7 PROJECT IMPLEMENTATION

7.1 Institutional Formalities and Organization

The organization for the implementation of the priority project (including Multipurpose Ayung Dam Project, Water Supply Project for SARBAGI Area, Flood Control Project for Badung and Mati Rivers) is shown in Figure-III-7.1.

There are two implementation units. The water resources development unit is responsible for the Ayung Dam Project and Flood Control Project. Water supply development unit is responsible for the Water Supply Project for SARBAGI Area. The former unit is under the management of Directorate of General of Water Resources, Central Government or under the management of DINAS-PU (or DINAS-PSDA). The latter unit is under the management of DINAS-PU, Bali Province.

There is Project Management Unit to be established by two Directorate General, namely DG – Water Resources and DG - Resettlement and Housing. The project is steered by the Central Government Committee.

Figure-III-7.1 Organization for Project Implementation

7.2 Implementation Schedule

If the priority project starts in the year of 2006, it will complete in the year of 2012. Refer to Figure-III-7.1

Table-III-7.1 Implementation Schedule for Priority Project

Items	2006			2007		2008		2009		2010		2011		2012		2013	
1. Preparation	XX	XX	XX														
2. Engineering Services				XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX		
3. Procurement of Contractor				XX	XX												
4. Construction																	
A) Ayung Dam						XX	XX	XX	XX	XX	XX	XX	XX	XX	XX		
B) Western System (IPA)						XX	XX										
C) Central System (IPA)														XX	XX		
D) Eastern System (IPA)						XX	XX	XX	XX	XX	XX						
E) River Improvement for Badung River						XX	XX	XX	XX	XX	XX	XX	XX				
F) River Improvement for Mati River						XX	XX	XX	XX	XX							
5. Land Acquisition				XX	XX							XX	XX				

7.3 Financial Disbursement Schedule

Total project cost of the priority project amounts 1,711 Billion Rp. The financial disbursement schedule is shown in Table-III-7.2.

Table-III-7.2 Disbursement Schedule of the Project

(Unit: Billion Rp.)

Projects	Total Cost	2008	2009	2010	2011	2012
Dam and Water Supply	1,569.3	100.4	418.5	187.5	388.2	474.7
◆ Ayung Dam	1,086.6	64.9	292.8	143.8	292.2	292.9
◆ Western System	113.2	24.0	89.2	-	-	-
◆ Central System	181.8	-	-	-	-	181.8
◆ Eastern System	187.7	11.5	36.5	43.7	96.0	-
Flood Control	141.6	25.3	45.9	48.8	21.6	-
◆ Badung River	72.4	10.5	18.7	21.6	21.6	-
◆ Mati River	69.2	14.8	27.2	27.2	-	-
Total	1,710.9	125.7	464.4	236.3	409.8	474.7

CHAPTER 8 ENVIRONMENT AND SOCIAL STUDY

8.1 Environment Study

8.1.1 Outline of Study

Environment study was conducted for the purpose of following items shown in Table-III-8.1 in the targeted area of priority project from January 2006 to February 2006.

Table-III-8.1 Outline of Environment Study

Purpose	Study Items	Items in Detail
1) To grasp existing conditions	1) Geophysics-chemical component	1) Climate 2) Air Quality 3) Physiographic 4) Hydrology 5) Space, Land and Soil
	2) Biology Component	1) Terrestrial Flora and Fauna 2) Aquatic Flora and Fauna
	3) Socio-economic Environment	1) Demography Aspect 2) Economy 3) Socio-Cultural 4) Community Health
2) To predict significant and important impact	1) Activity impact prediction on pre-construction phase 2) Activity impact prediction on construction phase 3) Activity impact prediction on operation phase	
3) To evaluate significant and important impact	1) Analysis toward significant and important impact 2) Analysis as basic environmental feasibility	1) Holy analysis 2) Significant impact

The study results in detail are shown in Supporting Report and its Appendix. Only the study results of biology component including flora and fauna are shown in this chapter.

8.1.2 Study Result of Biology Component

(1) Terrestrial Flora and Fauna

<Terrestrial Flora>

The investigation area is Ayung Dam Development Project, which is located between two regencies, Gianyar regency and Badung Regency. For terrestrial flora and fauna sampling is divided into two stations, those are West Ayung station includes Badung Regency and East Ayung (Siap River) includes Gianyar Regency, with sampling method of systematic quadrat method. Total of determined plots/quadrats for East and West Ayung stations are 20 plots with measure of 20m x 20m. For East Ayung station, vegetation samplings are conducted at two locations, those are upstream of inundation/south of bridge (Dusun Susut, Buahan Kelod Village, Gianyar Regency and the second location is under Tangluk Temple (Dusun Susut, Buahan Kelod Village, Payangan Sub district, Gianyar Regency) is a local point between East and West Ayung's flow.

While the sampling for West Ayung Station is taken at four locations, those are; location 1) Dusun Petang, Petang Village, Petang Sub district, Badung, location 2) Dusun Kasihan, Pangsan Village, Petang Sub district, Badung, location 3) Dusun Buangga, Getasan Village, Petang Sub district, Badung and location 4) Dusun Anggungan, Carangsari Village, Petang Sub district, Badung.

These project plan locations have resembled ecosystems so that the terrestrial flora which grows around the project plan is similar. Types of terrestrial flora (vegetation) which is identified at East Ayung Station (area around Siap River) and West Ayung (Ayung Dam Development Project) are included in Table-III-8.2 and Table-III-8.3. The analysis and calculation are implemented as shown in following procedures.

The result of inventory and each plot population calculation were analyzed to get the Relative Dominant (SDR) and Diversity Index as well as type comparison which had economic, endemic and protected

value also local and regional value. The formula is shown in as follows:

$$\text{a. Frequensy} = \frac{\text{Total of spots found from certain species}}{\text{Total of all monitoring spots}} \quad (8.1)$$

$$\text{b. Density} = \frac{\text{Total of certain species found}}{\text{Total of all species found}}$$

$$\text{c. Domination} = \frac{\text{Total of certain species canopy}}{\text{Wide of quotation area}}$$

$$\text{d. Fr} = \frac{\text{Frequency of certain species}}{\text{Frequency of all species}} \times 100\%$$

$$\text{e. Kr} = \frac{\text{Density of certain species}}{\text{Density of all species}} \times 100\%$$

$$\text{f. Dr} = \frac{\text{Domination of one species}}{\text{Domination of all species}} \times 100\%$$

$$NP = Fr + Kr + Dr$$

Where: INP : Important Value Index (%)
- NP>20 % : High important value
- 10<NP<20 : Moderate important value
- NP < 10 % : Low important value

Fr : Relative frequency (%)
Kr : Relative density (%)
Dr : Relative domination (%)

From 44 vegetation types which have been identified at Ayung Dam development plan site (East Zone) at Buahan Kelod Village, Payangan Subdistrict, Gianyar regency, apparently, there are 17 types categorized as endanger species, consist of 3 nationally endanger species: cempaka putih *(Michelia champaca)*, boni *(Antidesma bunius)* and pangi (*Pangium edule*) and 14 types are rare in Bali (Table-III-8.2). While the result of vegetation analysis shows that from 44 identified trees, there are only 2 types which have high important value (NP>20 %) those are: toop *(Arthocarpus elasticus*, NP = 36.0 %) and kaliandra (*Calliandra sp*, NP = 23.40 %), 8 types have moderate important value (10<NP<20) and 30 types categorized as low important value (NP < 10 %).

From 46 types of vegetations/terrestrial flora which have been identified at the location of Ayung Dam Project development plan (West Zone) at four village locations (Petang, Pangsan, Getasan, Carangsari) Petang Subdistrict, Badung Regency, apparently there are 23 types which are categorized as endanger species, including 4 types of national endanger species; cempaka putih *(Michelia champaca)*, pangi *(Pangium edule)*, pule *(Alstonia scholaris)* and bayur *(Pterospermum indicum*), 19 type are rare in Bali (Table-III-8.3).
While from the result vegetation analysis shows that from 46 types of trees which have been identified, there are only 2 types have high important value(NP>20 %), those are: kayu adeng *(Dysoxylum, sp*, NP = 26.759 %) and toop *(Arthocarpus indicus*, NP = 25.436 %), 4 typs have moderate important value (10<NP<20) and 38 types have low important value (NP<10 %).

Table-III-8.2 Result of Vegetation Analysis (Terrestrial Flora) (East Ayung Dam)

No	Local Name	Latin Name	Freq. Rel	Den. Rel	Dom. Rel	NP
1	Toop	*Arthocarpus elasticus**	10.00	9.45	16.55	36.00
2	Kaliandra	*Calliandra sp*	3.75	11.71	6.13	21.59
3	Duren	*Durio zibhetinus*	3.75	5.40	8.60	17.75
4	Gamal	*Glerecidia sepium*	2.50	9.00	4.74	16.24
5	Tulang katak	*Polianthia lateriflora*	5.00	4.50	6.20	15.70
6	Salak	*Salaca edulis*	2.50	6.75	5.69	14.94
7	Kelapa	*Cocos nucifera*	3.75	4.50	5.56	13.81
8	Kopi robusta	*Coffea robusta*	2.50	3.60	2.27	10.37
9	Nangka	*Arthocarpus integra*	3.75	3.15	3.44	10.34
10	Bambu	*Bambusa sp*	2.50	2.70	4.96	10.16
11	Suren	*Toona sureni*	2.50	4.50	2.40	9.40
12	Pisang	*Musa paradisiaca*	2.50	3.60	2.02	8.12
13	Sentul	*Sandoricum koetjape**	3.75	1.35	1.83	6.93
14	Gintungan	*Buschovia javanica**	2.50	1.35	1.87	5.72
15	Oo baas	*Ficus variegata**	2.50	1.35	1.83	5.68
16	Albesia	*Albesia sp*	2.50	1.35	1.48	5.33
17	Kakao	*Theobroma cacao*	1.25	3.60	0.41	5.26
18	Kayu adeng	*Dysoxylum sp*	2.50	1.35	1.20	5.05
19	Uduh	*Caryota mitis**	2.50	1.80	0.44	4.74
20	Kayu sugih	*Pleomele angustifolia*	2.50	1.80	0.37	4.67
21	Advokat	*Persea americana*	1.25	1.80	1.51	4.56
22	Sandat	*Cananga odorata**	2.50	0.90	1.07	4.47
23	Udu	*Lendera sp**	2.50	0.90	1.01	4.41
24	Angsana	*Pterocarpus indicus*	1.25	1.35	1.77	4.37
25	Bunut	*Ficus glabella**	1.25	0.90	1.58	3.73
26	Aren	*Arenga pinnata**	1.25	0.90	1.51	3.66
27	Canging	*Erythrina subumbrans*	1.25	0.90	1.32	3.47
28	Pangi	*Pangium edule***	1.25	0.90	1.20	3.35
29	Sente	*Hamalomena javanica*	2.50	0.45	0.28	3.23
30	Boni	*Antidesma bunius***	1.25	0.90	0.75	2.90
31	Dapdap	*Erythrina variegata*	1.25	0.90	0.75	2.90
32	Kutat	*Planchonia valida**	1.25	0.45	1.04	2.74
33	Leci	*Litchi glabella*	1.25	0.45	0.78	2.48
34	Temen	*Graptophyllum pictum*	1.25	0.90	0.31	2.46
35	Mangga	*Mangifera indica*	1.25	0.45	0.72	2.42
36	Kepundung	*Baccaurea sp**	1.25	0.45	0.69	2.39
37	Majegau	*Dyzoxylum densiflorum**	1.25	0.45	0.60	2.30
38	Trembesi	*Samanea samman*	1.25	0.45	0.56	2.26
39	Cempaka putih	*Michelia champaca***	1.25	0.45	0.53	2.23
40	Johar	*Cassia siamea*	1.25	0.45	0.53	2.23
41	Waru	*Hibiscus tiliaceus**	1.25	0.45	0.50	2.20
42	Mahoni	*Swietenia macropylla**	1.25	0.45	0.47	2.17
43	Jambu taluh	*Eugenia sp*	1.25	0.45	0.37	2.07
44	Soka alas	*Ixora paludosa*	1.25	0.45	0.18	1.88
		Total	**98.75**	**99.91**	**96.97**	**295.63**

Notes:

**	: Nationally rare	Freq Rel	: relatife frequency (%)	high NP	: NP> 20 %
*	: rare in Bali	Den Rel	: relatif density(%)	moderate NP	: 10<NP<20%
		Dom Rel	: relatif domination(%)	low NP	: NP< 10 %
		NP	: Important Value (%)		

Table-III-8.3 Result of Vegetation Analysis (Terrestrial Flora) (West Ayung Dam)

No	Local Name	Latin Name	Freq Rel	Den Rel	Dom Rel	NP
1	Kayu adeng	*Dysoxylum sp*	5.600	10.804	10.355	26.759
2	Toop	*Arthocarpus elasticus**	7.200	7.537	10.699	25.436
3	Aren	*Arenga pinnata**	4.800	3.015	4.709	12.524
4	Peji	*Cystostachys sp*	3.200	5.025	2.754	10.979
5	Oo baas	*Ficus sp**	4.000	2.512	4.158	10.670
6	Duren	*Durio zibethinus*	2.400	3.517	4.544	10.461
7	Bayur	*Pterospermum indicum***	3.200	2.763	4.007	9.970
8	Uduh	*Caryota mitis**	3.200	2.512	3.263	8.975
9	Pisang	*Musa paradisiaca*	2.400	3.768	2.065	8.233
10	Bengkel	*Nauclea purpurescens**	2.400	2.753	2.891	8.044
11	Bambu	*Bambusa sp*	3.200	3.266	1.542	8.008
12	Pilang	*Acasia leucocephala*	2.400	2.010	3.442	7.852
13	Kaliandra	*Calliandra sp*	1.600	4.773	1.404	7.777
14	Cempaka	*Michelia champaca***	3.200	2.261	2.340	7.801
15	Pakusarang burung	*Asplenium nidus*	3.200	2.512	1.721	7.433
16	Kelapa	*Cocos nucifera*	1.600	2.512	3.194	7.306
17	Gamal	*Glerecidia sepium*	1.600	3.768	1.721	7.089
18	Kakao	*Theobroma cacao*	1.600	3.768	1.101	6.469
19	Bayur	*Pterospermum indicum**	2.400	1.507	2.519	6.426
20	Rotan	*Calamus rottan*	2.400	1.256	2.575	6.231
21	Gintungan	*Buschovia javanica**	2.400	1.256	2.451	6.107
22	Iseh	*Pometia tomentosa**	2.400	1.758	1.872	6.030
23	Tulang katak	*Polianthia laterifolia*	2.400	1.507	1.996	5.903
24	Kutat	*Planchonia valida**	1.600	1.758	2.409	5.767
25	Sente	*Hamalomena javanica*	1.600	2.512	1.542	5.654
26	Bunut	*Ficus glabela**	2.400	1.256	1.941	5.597
27	Lateng	*Laportea stimulans*	1.600	2.753	1.129	5.482
28	Lamtoro	*Leucaena glauca*	1.600	2.261	1.239	5.100
29	Kopi robusta	*Coffea robusta*	1.600	2.512	0.963	5.075
30	Wani	*Mangifera caesia**	2.400	1.256	1.239	4.895
31	Pule	*Alstonia scholaris***	1.600	0.753	1.542	3.895
32	Juwet	*Eugenia cumini**	1.600	1.005	1.239	3.844
33	Albesia	*Albezia procea*	1.600	0.753	0.963	3.316
34	Kepohpoh	*Buchanania arborescens**	1.600	0.753	0.826	3.179
35	Suren	*Toona sureni*	1.600	0.753	0.509	2.862
36	Sandat	*Cananga odorata**	1.600	0.502	0.716	2.818
37	Udu	*Lendera sp**	1.600	0.502	0.619	2.721
38	Mangga	*Mangifera indica*	0.800	0.502	1.266	2.568
39	Kayu sambuk	*Meliosma pinnata**	0.800	0.753	1.005	2.558
40	Majegau	*Dysoxylum densiflorum**	0.800	0.502	0.771	2.073
41	Sentul	*Sandoricum koetjape**	0.800	0.502	0.660	1.962
42	Nangka	*Arthocarpus integra*	0.800	0.502	0.578	1.880
43	Pangi	*Pangium edule***	0.800	0.502	0.578	1.880
44	Rambutan	*Nephelium lapaceum*	0.800	0.502	0.344	1.646
45	Jempinis	*Azadarachta indica**	0.800	0.251	0.302	1.353
46	Asam	*Tamarindus indicus*	0.800	0.251	0.275	1.326
		Total	**99.999**	**99.954**	**99.972**	**299.926**

Notes:

**	: Nationally rare	Freq Rel	: relatife frequency (%)	high NP	: NP> 20 %
*	: rare in Bali	Den Rel	: relatif density(%)	moderate NP	: 10<NP<20%
		Dom Rel	: relatif domination(%)	low NP	: NP< 10 %
		NP	: Important Value (%)		

<Terrestrial Fauna>

The species richness of terrestrial fauna at the study area is rather high, those are 35 types of birds, 7 types of mammals and 8 types of insects/arthropodes. Most of the fauna found at the study area are the common types found in Jawa and Bali, and the distribution is very wide, and topographically, they are cosmopolitant, they are able to live on lowland (coastal area) to plateau (2000 m) above the sea surface.

Data collection at the study area is using direct and indirect semi-census method. The census methods are cruising method and statitionnaire method (by installing trap and or net) at the sampling area. The analysis of terrestrial fauna was qualitatively implemented.

More detail description about terrestrial fauna which is successfully investigated during the research is shown on Table-III-8.4 and Table-III-8.5. Quantitive analysis shown in Table-III-8.5 was classified with difinition as follows:

5 : Population > 50 (Abundant found during the research)
4 : Population 31-50 (Quite a lot found during the reseach)
3 : Population 15-30 (A lot found during the research)
2 : Population 6-14 (Only a few found during the research
1 : Population < 5 (Very rare found during the research)

In accordance to characteristic analysis and status of the terrestrial fauna, with its reference of valid laws in Indonesia, there are 9 types of protected animals(status “L” in Table) by the Indonesian Government are found at the study area as shown in Table-III-8.4.
Those types consist of 7 types of birds: Kuntul Kerbau (*Bulbulcus/Egretta ibis* : Cattle Egret (Eng), Kuntul kecil (*Egretta garzetta* : Little Egret (Eng), Cekakak Jawa (*Halcyon cyanoventris* : Javan Kingfisher), Cekakak Sungai (*Halcyon chloris*: White-Collared Kingfiher), Alap-alap api (*Falco moluccensis*: Spotted Kestrel), Elang Hitam (*Ictinaetus malayensis* : Black-Eagle), and Elang Brontok (*Spizatus cirrhatus* : Changeable Hawk-Eagle), and two types of mammals, Landak (*Hystrix brachyura* : Southeast-Asian Porcupine), and Trenggiling (*Manis javanica* : Pangolin).
These types are protected by Indonesian Government based on the criterias shown as below:
(1) very small population,
(2) drastic degradation on the individuals at the environment,
(3) limited distribution (endemic),
(4) top carnivora and megaherbivora,
(5) breeding in groups,
(6) doing migration.

The purposes are: avoid extinction, keep the genetic purity and species diversity, protect from wild hunting, illegal trade, as well as to keep the balance and preservation.
According to those above, *cekakak jawa*(*Halcyon cyanoventris*: Java Kingfisher) categorized as endemic in Java and Bali.

Table-III-8.4 Types of Terrestrial Fauna around Ayung River and Siap River at Buangga-Payangan

No	Local Name	Scientific Name	General Name	Status	Explanation and Its Distribution
A.	**Bird (Aves)**				
1	Tekukur biasa	*Streptopelia chinensis*	Spotted-Dove	TL	Widely and generally distributed in South East Asia until the Lesser Sundas. Many in Java and Bali, they are raised, and many are found at the study area (> 100)
2.	Delimukan zamrud	*Chalcophaps indica*	Emerald Dove	TL	Live wildly and general in Asia until Australia, for Java and Bali, they are rarely found. At the study area, there are 3-5 birds, fast fly upon the river stream
3	Merbah Cerukcuk	*Pycnonotus goiavier*	Yellow-vented Bulbul	TL	Live wildly and general, the distribution covers South East Asia, Philipine, Cape of Malaysia, Big Sunda and Lombok. There are a lot in java and Bali, as well as at the study area.
4	Cucak Kutilang	*Pycnonotus aurigaster*	Sooty-headed Bulbul	TL	Live wildly and general, the distribution covers South China, South East Asia (except Cape of Malaysia) and Java. For Java and Bali, this species is the most widely distributed and there are a lot of it. It is traded and raised.
5	**Kuntul Kerbau**	***Bulbulcus/ Egretta ibis***	**Cattle Egret**	**L**	Widely distributed throughout the world, there are many of it in Bali, come to the location/study are only to get foods. Its nest is at Petulu Gianyar (± 6-8 km if a line is stretched out in the east). The base of the protection law: Regulation of Wild Animal Protection, year 1931 (types of Egretta) and Government of Republic of Indonesia Regulation no. 7/1999.
6	**Kuntul kecil**	***Egretta garzetta***	**Little Egret**	**L**	Live wildly, with the distribution areas at Africe, Europe, Asia and Australia. This type of birds is found a lot at the ricefields in the dawn: only to find foods. Its nest is at Petulu Gianyar (± 6-8 km if a line is stretched out in the east). The base of the protection law: Regulation of Wild Animal Protection, year 1931 (types of Egretta) and Government of Republic of Indonesia Regulation no. 7/1999.
7	Blekok sawah	*Ardeola speciosa*	Javan Pond -Heron	TL	It is wild and general, its distribution covers Cape of Malaysia, Indo-Chinese, Sulawesi (Celebes) and Big Sunda. It is general in Java and Bali and many are found at the rice fields, river and coastline/river's estuary; only to get some foods.
8	Kareo padi	*Amaurornis phoenicurus*	White-breaste d Waterhen	TL	It is wild and general, its distribution covers India, South China, South East Asia, Philippine, Sulawesi, Big Sunda and the Lesser Sunda. In Bali and at the study area, it can be found a lot at the riverside and its nest is on the trees.
9	Berbik rawa	*Gallinago megala*	Swinhoe' s Snipe	TL	It is breeded in East Asia, in the winter it immigrates to the south to Australia. Wild and can be found at the rice fields before the planting season or the rice has not become ripe yet.
10	Walet sapi	*Collocalia esculenta*	Glossy Swiftlet	TL	Wild and flying around
11	**Cekakak Jawa**	***Halcyon cyanoventris***	**Javan Kingfisher**	**L**	The base of the protection law: Regulation of Wild Animal Protection 1931 (written as Alcedinidae), and Government of Republic of Indonesia Regulation No.7/1999. It is endemic in Java and Bali. Wild and widely distributed until the elevation of 1.000 m in Java and Bali. The population is relatively small, and at some places they have been disappeared. The voice and colour are attractive.

No	Local Name	Scientific Name	General Name	Status	Explanation and Its Distribution
12	**Cekakak sungai**	***Todirhamphus/Halcyon chloris***	**White-Collared Kingfisher**	**L**	The base of the protection law: Regulation of Wild Animal Protection 1931 (written as Alcedinidae), and Government of Republic of Indonesia Regulation No.7/1999 (written as all families of Alcedinidae). Wildly distributed from South Asia and South East Asia, Indonesia, Irian Islands and Australia. This king of prawn is the most general in Sumatera, Java and Bali. The populations have been decreasing/relatively small, quite difficult to be raised or breed.
13	Bentet kelabu	*Lanius schach*	Long-Tailed Shrike	Tl	General and distributed in Iran, China, South East Asia, Philippine, Malaysia, Big Sunda and Lesser Sunda. Abundant in Sumatera, Java and Bali. There are may of it is trapped to be traded and raised.
14	Bondol Jawa	*Louchura leucogastroides*	Javan Munia	TL	Generally distributed in Sumatera, Java, Bali and Lombok. The populations are a lot, as the pest.
15	Bondol Peking	*Lonchura punculata*	Scaly-breasted Munia	TL	Generally distributed in India, China, South East Asia, Philippine, Malaysia, Big Sunda and Lesser Sunda, at the study area, the population is abundance, often becomes pest for rice.
16	Kacamata biasa	*Zosterops palpebrosus*	Oriental White eye	TL	Generally distributed at North India – South China, South East Aisa, Malaysia, and Big Sunda, in Java and Bali is abundance, including at the study area
17	Bubut besar	*Centropus sinensis*	Greater Coucal	TL	Live wildly, with the distributions in India, China, Sout East Aisa, Philippine, Kalimantan, Sumatera, Nias, Mentawai, Java and Bali. It is rarely found. Attractive and characteristic voice. Rarely found at the study area.
18	Bubut alang-alang	*Centropus bengalensis*	Bulbul/Lesser Coucal	TL	Live wildly, with the distribution in India, China, South East Asia, Philippine, Kalimanta, Sumatera, Java and Bali, Sulawesi, maluku as well as Lesser Sunda. Generally is found at the lowland to 1000 m. At the study area is also rarely found (4-6)
19	Meninting besar	*Euicurus leschenaulti*	White-crowned Forktel	TL	The distribution covers North India, South China, South East Asia, Cape of Malaysia, and Big Sunda. At Java and Bali, as well as at the study area, these birds are found usually in couples; male and female. Generally they are found at the rocky rivers, covered by the trees.
20	Kucica kampung	*Copsychus saularis*	Magpie robin	TL	Distribution: India, South China, Philippine, South East Asia, Cape of Malaysia and Big Sunda. In Bali, this bird is general. However, the populations have been drastically decreasing due to hunting and over exploitation.
21	Kerak kerbau	*Acridotheres javanicus*	Javan Myna	TL	General species for Java and Bali. The general distribution covers East Asia, South East Asia, Java and Bali.
22	Kepudang Kuduk Hitam	*Oriolus chinensis*	Black-naped Oriole	TL	Distribution: India, China, South East Asia, Big Sunda and Lesser Sunda (Java and Bali). At the study area is also rarely found due to the exploitation and trading.
23	Sri Gunting batu	*Dicrurus paradiceus*	Greater Racket-tailed Drongo	TL	Distribution: India, China, South East Asia, and Big Sunda. It is widely and generally distributed at the lowland forest up to the altitude of 1400 m. At the study area, this is very rare
24	Empuloh Jenggot	*Alophoixus bres*	Grey-cheeked Bulbul	TL	Distribution: Cape of Malaysia, Palawan and Big Sunda. It is wide and generally distributed in Java and Bali. It can be found a lot at the study area. Most of them are being traded and raised.
25	Wiwik Kelabu	*Cacomantis merulinus*	Plaintive Cuckoo	TL	Distribution: East India, South China, Kalimantan, Sumatera, Java, Bali, Sulawesi and Philippine. It is rarely found at the study area.

No	Local Name	Scientific Name	General Name	Status	Explanation and Its Distribution
26	**Alap-alap sapi**	***Falco moluccensis***	**Spotted Kestrel**	**L**	Base of Law: Decree of Minister of Agriculture No. 421/Kpts/Um/8/1970, and Government of Republic of Indonesia Regulation PP RI No 7 /1999 (written as all types from Accipitridae family). Distribution: Java, Sulawesi, Maluku and Lesser Sunda. In Bali, they are very rare.
27	**Elang Hitam**	***Ictinaetus malayensis***	**Black-eagle**	**L**	Base of Law: Decree of Minister of Agriculture No. 421/Kpts/Um/8/1970, and Government of Republic of Indonesia Regulation PP RI No 7 /1999 (written as all types from Accipitridae family). The distribution covers India, China, South East Asia, Philippine, Big Sunda and Lesser Sunda, particularly at the plateau of 2000 m. At the study area only 1 bird was found. Based on the information from local community, it is very rare.
28	**Elang Brontok**	***Spizatus cirrhatus***	**Changeable Hawk-eagle**	**L**	Base of Law: Decree of Minister of Agriculture No. 421/Kpts/Um/8/1970, and Government of Republic of Indonesia Regulation PP RI No 7 /1999 (written as all types from Accipitridae family). The distribution covers India, South East Asia, Sulawesi, maluku, and Big Sunda, At the study area there were only 2 birds which can be found around Siap River. Based on the information from the local community, this species is very rare.
29	Caladi Tilik	*Picoides mollucensis*	Sunda Woopecker	TL	Distribution covers India, South East Asia, Kalimantan, Sumatera, Java and Lesser Sunda. In Java and Bali is distributed at the lowland.
30	Pelatuk Tunggir-Emas	*Chrysocolaptes lucidus*	Greater Galdenback	TL	Distribution covers India, China, Philippine, Kalimantan, Sumatera, java and Bali, particularly at the lowland, open forest. At the study area, only 2-4 birds which can be found at Buangga-Petang. Based on the information from local community, this species is very rare
31	Cipoh Kacat	*Aegithina tiphia*	Common Iora	TL	Distribution covers India, China, South East Asia, Palawan, Cape of Malaysia and Big Sunda. It is general and widely distributed in Java and Bali at the lowland up to 1000 m. It is found in quite big numbers and flying in groups.
32	Anis merah	*Zoothera citrina*	Orange-headed Thrush	TL	One of the most favorite chirping bird and it is often involved in contest. Distribution: Pakistan-South China, South East Asia, Cape of Malaysia and Big Sunda. In Bali, it is found at plateaus or mountainous areas. The study area is its habitat and nesting are for the red species. Many people hunt their nest to get the young birds to be traded.
33	Gelatik Batu Kelabu	*Parus major*	Great Tit	TL	Paleartic Distribution. India, South East Asia, Cape of Malaysia and Big Sunda. In Java and Bali, it is found in quite big numbers.
34	Burung Madu pengantin	*Nectarinia sperata*	Purple-throated Sunbird	TL	Paleartic Distribution. India, South East Asia, Cape of Malaysia and Big Sunda. In Java and Bali, it is found in quite big numbers.
35	Burung Madu Sriganti	*Nectarinia jugularis*	Olive-backed Sunbird	TL	Distribution: China, South East Asia, Philippine, Malaysia and Indonesia, as well as Irian Island and Australia. In and around Java, it is general and widely distributed.
B. Reptilia					
1	Biawak	*Varanus salvator*	Monitor Lizard	TL	Wild, found at the riverside and tree.
2	Kadal	*Mabouya multifascieta*	Lizard	TL	Wild, quite often be found
3	Tokek	*Gecko gecko*	House Lizard	TL	Wild, predicted from their voices
4	Ular hijau	*Tremeresurus alborabrus*	Green snake	TL	Wild, found in bamboos trees

No	Local Name	Scientific Name	General Name	Status	Explanation and Its Distribution
5	Ular Cobra	*Naja sp*	Cobra	TL	Wild, interview (W)
C.	**Mamalia**				
1.	**Landak**	***Hystrix brachyura***	**Southeast –Asian Porcupine**	**L**	Decree of Minister of Agriculture No. 247/KPTS/Um/4/1979, Considering the Decision of Addition to Kinds of Protected Wild Animals. Government of Republic of Indonesia regulation considering the Preservation of Kinds of Plants and Animals..
2	**Trenggiling /Peusing**	***Manis javanica***	**Pangolin**	**L**	Regulation of Wild Animal Protection, year 1931 Government of Republic of Indonesia Regulation No.7/1999. The distribution of this mammal covers Nias, Pagai Islands, Sumatera, Riau, Lingga, Bangka, Belitung, Natuna, Karimata, Kalimantan, Java and Bali.
3	Tupai/bajing	*Callosciurus sp*	Squirrel	TL	- Wild, quite a lot
4	Tikus	*Mus musculus*	Mouse/rat	TL	- Wild, around the rice fields
5	Lubak/Musang	*Paradoxurus hermaproditus*	Civet	TL	- Wild, its existence is from the feces and interview (W)
6	Kalong/ Kelelawar	*Pteropus sp*	Bat	TL	- Wild, it is gliding at the coconut's stems and from interview (W)
D.	**Arthopoda**				
1	Kupu-kupu	*Danaus sp*	Butterfly	TL	This type of arthropod is wild, it was found in small numbers to the environs were rice fields, it is predicted that it can be more found if its environs were planted with crops.
2	Kupu-kupu	*Eurema lacteola*	Butterfly	TL	
3	Kupu-kupu	*Mycalesis mineus*	Butterfly	TL	
4	Kupu-kupu	*Neptis hylas*	Butterfly	TL	
5	Kupu-kupu	*Leptosia nina*	Butterfly	TL	
6	Kupu-kupu	*Parantica sp*	Butterfly	TL	
7	Capung	*Odonata spp*	Dragonfly	TL	
8	Tawon	*Vespula sp*	Bee	TL	

Legend:

TL :Unprotected

L :Protected (Regulation of Wild Animal Protection, year 1931; Decree of Minister of Agriculture No. 421/Kpts/Um/8/1970 and No. 247/KPTS/Um/4/1979, Considering the decision of Addition to Kinds of Protected Animals as well as Government of Republic of Indonesia regulation No 7 year 1999, considering Preservation of Kinds of Plants and Animals

W :The result of interview with the community at the study area..

Table-III-8.5 Result of Terrestrial Fauna Qualitative Analysis at Buangga – Payangan

No	*Local Name*	Scientific Name	Common Name	Qualitative Weight	Explanation
A. Birds (Aves)					
1.	Tekukur biasa	*Streptopelia chinensis*	Spotted-Dove	5	> 50
2.	Delimukan zamrud	*Chalcophaps indica*	Emerald Dove	1	< 5
3	Merbah Cerukcuk	*Pycnonotus goiavier*	Yellow-vented Bulbul	5	> 50
4	Cucak Kutilang	*Pycnonotus aurigaster*	Sooty-headed Bulbul	3	15-30
5	Kuntul Kerbau	*Bulbulcus/Egretta ibis*	Cattle Egret	3	15-30
6	Kuntul kecil	*Egretta garzetta*	Little Egret	3	15-30
7	Blekok sawah	*Ardeola speciosa*	Javan Pond -Heron	2	6-14
8	Kareo padi	*Amaurornis phoenicurus*	White-breasted Waterhen	2	6-14
9	Berbik rawa	*Gallinago megala*	Swinhoe' s Snipe	2	6-14
10	Walet sapi	*Collocalia esculenta*	Glossy Swiftlet	4	31-50
11	Cekakak Jawa	*Halcyon cyanoventris*	Javan Kingfisher	2	6-14
12	Cekakak sungai	*Todirhamphus/Halcyon chloris*	White- Collared Kingfisher	2	6-14
13	Bentet kelabu	*Lanius schach*	Long-Tailed Shrike	3	15-30
14	Bondol jawa	*Lonchura leucogastroides*	Javan Munia	5	> 50
15	Bondol Peking	*Lonchura punculata*	Scaly-breasted Munia	4	31-50
16	Kacamata biasa	*Zosterops palpebrosus*	Oriental White eye	4	31-50
17	Bubut besar	*Centropus sinensis*	Greater Coucal	2	6-14
18	Bubut alang-alang	*Centropus bengalensis*	Bulbul/Lesser Coucal	3	15-30
19	Meninting besar	*Euicurus leschenaulti*	White-crowned Forktel	2	6-14
20	Kucica kampung	*Copsychus saularis*	Magpie robin	1	< 5
21	Kerak kerbau	*Acridotheres javanicus*	Javan Myna	1	< 5
22	Kepudang Kuduk Hitam	*Oriolus chinensis*	Black-naped Oriole	1	< 5
23	Sri Gunting batu	*Dicrurus paradiceus*	Greater Racket-tailed Drongo	1	< 5
24	Empuloh Jenggot	*Alophoixus bres*	Grey-cheeked Bulbul	4	31-50
25	Wiwik Kelabu	*Cacomantis merulinus*	Plaintive Cuckoo	1	< 5
26	Alap-alap sapi	*Falco moluccensis*	Spotted Kestrel	1	< 5
27	Elang Hitam	*Ictinaetus malayensis*	Black-eagle	1	< 5
28	Elang Brontok	*Spizatus cirrhatus*	Changeable Hawk-eagle	1	< 5
29	Caladi Tilik	*Picoides mollucensis*	Sunda Woopecker	1	< 5
30	Pelatuk Tunggir-Emas	*Chrysocolaptes lucidus*	Greater Galdenback	1	< 5
31	Cipoh Kacat	*Aegithina tiphia*	Common Iora	3	15-30
32	Anis merah	*Zoothera citrina*	Orange-headed Thrush	2	6-14
33	Gelatik Batu Kelabu	*Parus major*	Great Tit	1	< 5
34	Burung Madu pengantin	*Nectarinia sperata*	Purple-throated Sunbird	3	15-30
35	Burung Madu Sriganti	*Nectarinia jugularis*	Olive-backed Sunbird	2	6-14
B. Reptile					
1	Biawak	*Varanus salvator*	Monitor Lizard	2	6-14
2	Kadal	*Mabouya multifascieta*	Lizard	4	
3	Tokek	*Gecko gecko*	House Lizard	2	6-14
4	Ular hijau	*Tremeresurus alborabrus*	Green snake	1	< 5
5	Ular Cobra	*Naja sp*	Cobra	-	-
C. Mamalia					
1	Landak	*Hystrix brachyura*	Southeast –Asian Porcupine	-	-
2	Trenggiling /Peusing	*Manis javanica*	Pangolin	-	-
3	Tupai/bajing	*Callosciurus sp*	Squirrel	3	15-30
4	Tikus	*Mus musculus*	Mouse/Rat	2	6-14
5	Lubak/Musang	*Paradoxurus hermaproditus*	Civet	-	-

No	*Local Name*	Scientific Name	Common Name	Qualitative Weight	Explanation
6	Kalong/ Kelelawar	*Pteropus sp*	Bat	3	15-30
D. Arthopoda					
1	Kupu-kupu	*Danaus sp*	Butterfly	2	6-14
2	Kupu-kupu	*Eurema lacteola*	Butterfly	2	6-14
3	Kupu-kupu	*Mycalesis mineus*	Butterfly	2	6-14
4	Kupu-kupu	*Neptis hylas*	Butterfly	2	6-14
5	Kupu-kupu	*Leptosia nina*	Butterfly	2	6-14
6	Kupu-kupu	*Parantica sp*	Butterfly	3	6-14
7	Capung	*Odonata spp*	Dgragonfly	3	15-30
8	Tawon	*Vespula sp*	Bee	3	15-30

Legend

TL : Un-Protected

L : Protected (Peraturan Perlindungan Binatang Liar, Tahun 1931; Surat Keputusan Menteri Pertanian No. 421/Kpts/Um/8/1970
dan No. 247/KPTS/Um/4/1979, Tentang Penetapan Tambahan Jenis-jenis Binatang Liar Yang dilindungi serta Peraturan Pemerintah RI. No 7 tahun 1999, tentang Pengawetan Jenis Tumbuhan dan Satwa.)

W : Interview result to the community nearby

Range of weighing :

1 = population < 5 (very rare found during the research)
2 = population 6-14 (only a few found during the research)
3 = population 15-30 5 (a lot found during the research)
4 = population 31-50 (quite a lot found during the reseach)
5 = population > 50 (abundant found during the research)

(2) Aquatic Flora and Fauna

<Perifiton/ Plankton Community>

Perifiton/plankton community is the terminology given to certain group of microscopic sized aquatic organisms, which is suspended organism in the water, or around the substrate with a very limited motion ability (non-moving); consists of plants or microscopic animals. The existence of perifiton/plankton as one of the important indicator to assest the beginning condition of a particular waters ecosystem, such as fertility level or pollution level in certain waters.
The investigation result of perifiton/plankton community at three Ayung River stations which are impacted areas of Ayung River Multifunction Dam is shown at Table-III-8.6 until Table-III-8.7.

Station I : Ayung River II Br Susut, Buahan Kelod Village Payangan Sub district

Station II : Ayung River I Br. Petang, Petang Village Petang Sub district/ Bali Fantasi Rafting

Station III : Ayung River Br. Buangga, Getasan Village, Petang Sub district

Perifiton sampling was using quotation method, by filtering water sample of 500 litre. The filtered water was collected in one bottle with volume of 50 ml. The sample water was preserved with compound and 4 % formalin and 75 % lugol, afterwards it was identified and its abundance was calculated microscopically at the laboratory.

Calculation formula of perifiton abundance is shown as follows:

$$N = Q1/Q2 \times V1/V2 \times 1/P \times 1/A \times n \quad (8.2)$$

Where: N : Abundance of plankton organism per liter
Q1 : Wide of glass cover (400 mm2)
Q2 : Wide of view (1.7663 mm2)
V1 : Volume of water sample (50 ml)
V2 : Volume of water monitored underneath the microscope (0.25)
P : Total of view (25 times)
A : Volume of filtered water (250 liter)
n : Total of monitored plankton individual

The perifiton and plankton abundance at three monitoring stations are not equally distributed, it is between 972-1,602 cell/individual per liter. The highest plankton abundance can be obtained from

Station I (Ayung River at Susut) of 1,602 individual per liter and the lowest is obtained from Station II (Ayung River Petang Village) of 972 cell/individual per liter. The perifiton/plankton abundance at those three stations are categorized as low abundance because the value is less than 2,000 individual per liter (Sigala ,1991). The prominent plankton composition at those three stations: phytoplankton community: *Synedra acus, Fragilaria sp, Navicula sp, Pinnularia sp, Melosira sp, Tabellaria sp, Spirogyra protecta, Anabaena sp, Pediastrum* and *Straurastrum sp*, and zooplankton community consists of *: Cyclops, Branchionus, Keratella, Volvox, Monas sp, Arcella,* and *Tintinnidium sp*. Among those species there are some that are sensitive to eutrification process: *Pediastrum sp,* and *Straurastrum sp,* and it is rather dangerous if there was blooming of plankton in it.

Analysis of plankton, macrozoobenthos and fish structure by index analysis approach such as diversity index of Shannon-Wiener, equitability and domination index. The calculation of Shannon-Wiener's diversity index was using two basics logaritm. To simplify the calculation, a transformation from $\log_2$ to 10 basics logaritm was conducted (Legendre and Legendre 1983 dalam Bengen 2000).
Formulation of Shannon-Wiener's Diversity Index is shown as below:

$$\mathbf{H = - \sum pi \log_2 pi} \qquad (8.3)$$
$$\mathbf{H = 3{,}322 \{Log\ N - (nilog\ ni)/N\}}$$

Where :

H	:	Diversity index (Shannon-Wiener)
N	:	Total of individual in the community ($\sum$ni)
Ni	:	Total of species individual/I type
pi	:	Proportion of individual waspecies (ni/N)

The equitability index as an approach which describes different species distribution in the community, which is calculated with formula:

$$\mathbf{E = H / H\ max} \qquad (8.4)$$

Where:

H	:	Diversity index (Shannon-Wiene)
H_{max}	:	$\log_2 S$, --- S : Total of Species (taxa).

The calculation of species domination index with the formula is shown as below:

$$\mathbf{Id = \sum (pi)^2} \qquad (8.5)$$

Where:

Id	:	Species domination index
pi	:	Proportion of individual waspecies (ni/N)

In order to implement the index analysis and make a conclusion, various index were used as shown in Table-III-8.6.

Table-III-8.6 Explanation for Each Index for Analysis of Plancton

Index	Explanation
Diversity Index (H)	
H < 1.0	The diversity belong to low category, poor, very low productivity as the indication of heavy pressure and unstable ecosystem.
1.0 < H < 3.322	The diversity belong to medium category, adequate productivity, quite balance ecosystem condition, medium ecologic pressure.
H > 3.322	Very high diversity, steady ecosystem stability, endures of ecologic pressure.
Equitability Index (E)	
E < 0.5	The equability is low category; it means that individual distribution of each species in the community is not balance and unstable ecosystem.
0.5 < E < 0.75	The equability belongs medium category; it means that individual distribution of each species is quite balance and somewhat stable ecosystem.
E > 0.75	The equability belongs to high category, it means that individual distribution of each species in the community is very balance and very stable ecosystem.
Domination Index (Id)	
Id < 0.4	There is no domination, balance species development
0.4 < Id < 0.8	There is light domination, light-medium ecologic pressure
Id > 0.8	There is real domination, seriously polluted condition

The diversity plankton which are shown by Shannon-Wiener's diversity index is between 4.4235 – 4.8416 units, it means that the plankton diversity at Ayung River I and II is categorized as the high one. The diversity index's value is bigger than 3 units which are high categorized (Kreb, 1978). This value indicates that the ecosystem is quite good for plankton/perifiton community's development.
The equitability index for all stations is between 0.9648 – 0.9898 unit, it means that the equitability in the community is very high/equal. This value indicates that the balance of primary energy in plankton comunity is very good, there is no ecologic pressure at the plankton community level.
The domination index value is very low, between 0.0365 – 0.0514 unit, it means that there is no domination or pressure from certain species or perifiton/plankton community.

Table-III-8.7 Composition and Abundance of Plankton/Perifiton Community at Station I Ayung River II (Banjar Susut, Buahan Village, Payangan Sub district Gianyar Regency)

No	Plankton Species	Repeatation of Monitoring View																									Total	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Ind.	Ind./ L
A.	**Phytoplankton**																											
1	*Genatozygon sauleatum*	-	-	-	1	-	-	-	-	1	-	-	-	2	-	-	-	-	-	-	-	1	-	-	-	-	5	45
2	*Spirogyra protecta*	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	4	36
3	*Fragilaria sp*	-	-	-	2	-	-	1	-	1	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-	1	8	72
4	*Asterionella sp*	2	-	-	1	-	1	-	-	1	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	7	63
5	*Synedra acus*	-	-	1	-	1	-	-	-	1	-	-	-	-	2	-	-	-	1	-	-	-	2	-	-	2	10	90
6	*Synedrra tabulata*	-	1	-	-	1	-	2	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	6	54
7	*Navicula sp*	1	-	-	-	-	2	-	-	-	-	-	-	-	1	-	-	-	-	-	-	2	-	-	1	1	8	72
8	*Nitzschia acicularia*	-	-	-	2	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	1	6	54
9	*Sueirella elegana*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	4	36
10	*Anabaena sp*	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	4	36
11	*Closterium setaceum*	-	-	-	2	-	-	1	-	1	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-	1	8	72
12	*Closterium rectimarginatum*	2	-	1	-	-	-	-	1	-	-	-	-	-	2	-	-	-	1	-	-	-	2	-	-	1	10	90
13	*Scenedesmus aematus*	-	1	-	-	-	-	2	-	-	-	-	1	-	-	-	-	-	-	2	-	-	-	-	1	-	7	63
14	*Pachicladoz sp*	-	-	-	1	-	1	-	-	1	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	5	45
15	*Pediastrum simplex*	-	-	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	2	-	-	2	8	72
16	*Aphanizozenon flosaquae*	-	-	-	-	1	-	2	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	5	45
17	*Oscilatoria sp*	1	-	-	1	-	-	-	-	-	-	-	1	-	1	-	-	-	1	-	1	-	-	1	-	-	7	63
18	*Campilodiscus hiberpicus*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	4	36
19	*Nitzschia acicularia*	-	-	-	1	-	-	-	-	1	-	-	-	2	-	-	-	-	-	-	-	1	-	-	-	-	5	45
20	*Nitzschia myssanensis*	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	4	36
21	*Pinnularia nobilia*	-	-	-	2	-	-	1	-	1	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-	1	8	72
22	*Tabellaria fanestrata*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	4	36
23	*Milosira granulata*	-	2	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	5	45
24	*Cyclotella sp*	-	-	-	-	-	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2	5	45
25	*Chaetoceros sp*	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	2	5	45
B	**Zooplankton**																											
26	*Cyclops sp*	-	-	-	-	-	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2	5	45
27	*Chlamydomonas*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	2	-	-	-	-	-	-	-	1	-	4	36
28	*Branchionus sp*	-	2	-	-	1	-	1	-	-	2	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	8	72
29	*Monas ceronifera*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	4	36
30	*Tintinridium sp*	-	2	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	5	45
Total Individual of All Species (N) :																												**1,602**
Total of Species (S) :																												**30 Kinds**
Diversity Index (H) :																												**4.8416**
Equitability Index (E) :																												**0.9867**
Domination Index (Id.) :																												**0.0365**

Table-III-8.8 Composition and Abundance of Perifiton/Plankton Community at Station II Ayung River I (Br. Petang Tengah, Petang Village, Petang Subdistrict)

No	Plankton Species	Repeatation of Monitoring View																									Total	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Ind.	Ind./ L
A.	**Phytoplankton**																											
1	*Navicula sp*	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	27
2	*Nitzschia acicularia*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	9
3	*Sueirella elegana*	1	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	5	45
4	*Anabaena sp*	-	2	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	3	2	-	-	2	1	-	-	12	108
5	*Pediastrum sp*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	9
6	*Scenedesmus sp*	-	-	-	2	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	`1	5	45
7	*Spirogyra sp*	2	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	4	36
8	*Closterium sp*	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	3	27
9	*Straurastrum sp*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2	-	-	3	-	-	8	72
10	*Melosira granulata*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2	3	27
11	*Cyclotella sp*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	3	27
12	*Rhizosolenia sp*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	1	-	-	-	3	27
13	*Fragilaria sp*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	1	-	3	27
14	*Asterionella sp*	-	2	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	36
15	*Synedra acus*	-	-	-	1	-	1	-	-	1	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	5	45
16	*Synedrra tabulata*	-	-	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	2	-	-	2	8	72
17	*Microspora sp*	-	1	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	4	36
18	*Ulothrix sp*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	1	-	-	-	-	3	27
B.	**Zooplankton**																											
19	*Bosmina sp*	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	3	27
20	*Chlamydomonas*	1	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2	5	45
21	*Monas ceronifera*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	18
22	*Arcella sp*	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	1	-	-	1	-	-	-	5	45
23	*Tintinridium sp*	1	-	-	-	1	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	1	-	-	1	-	6	54
24	*Cyclidium glaucopa*	-	2	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	36
25	*Eucyclops sp*	1	-	-	1	-	1	-	-	1	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	5	45
																										Total Individual of All Species (N) :		**972 sell**
																										Total of Species (S) :		**25 kinds**
																										Diversity Index (H) :		**4.4567**
																										Equitability Index (E) :		**0.9898**
																										Domination Index (Id.) :		**0.0514**

Table-III-8.9 Composition and Abundance of Perifiton/Plankton Community at Station III (Ayung River, Br. Buangga, Getasan Village, Petang Sub district, Badung Regency)

No	Plankton Species	Repeatation of Monitoring View																									Total	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Ind.	Ind./ L
A.	**Phytoplankton**																											
1	*Melosira granulata*	1	-	-	1	-	-	1	-	-	2	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	8	72
2	*Cyclotella sp*	-	-	2	-	-	2	-	-	-	-	-	1	-	1	-	-	-	-	1	-	1	-	-	-	2	10	90
3	*Rhizosolenia sp*	1	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	1	-	-	-	-	-	-	-	4	36
4	*Fragilaria sp*	-	1	-	-	-	2	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1	-	-	6	54
5	*Asterionella sp*	-	-	-	1	-	-	-	2	-	1	-	-	1	-	2	-	-	-	-	-	-	1	-	2	-	10	90
6	*Synedrra tabulata*	-	-	-	1	-	-	-	2	-	1	-	-	1	-	-	-	-	1	-	1	-	-	1	-	-	8	72
7	*Tabellaria fracculosa*	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	1	-	-	5	45
8	*Navicula sp*	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	1	-	-	-	-	1	-	5	45
9	*Nitzschia acicularia*	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	1	-	-	`-	4	36
10	*Ntizschia sp*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	2	4	36
11	*Sueirella elegana*	-	1	-	-	-	2	-	-	-	-	1	-	-	-	-	-	2	-	-	-	1	-	-	-	-	7	63
12	*Anabaena sp*	-	2	-	-	-	-	-	-	2	-	-	1	1	-	-	1	-	-	-	1	-	-	2	-	-	10	90
13	*Pediastrum sp*	-	1	-	-	-	-	-	-	-	1	-	-	`1	-	-	-	1	-	-	1	-	-	-	-	-	5	45
14	*Scenedesmus sp*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	1	-	-	1	5	45
15	*Straurastrum sp*	-	-	-	-	-	-	2	-	1	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	5	45
16	*Genatozygon sauleatum*	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	4	36
17	*Spirogyra protecta*	-	3	-	-	1	-	-	-	-	1	-	3	-	1	-	-	2	-	-	1	-	1	-	-	-	13	117
18	*Fragilaria sp*	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	4	36
19	*Asterionella sp*	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	1	-	-	-	-	2	5	45
B	**Zooplankton**																											
20	*Cephalodella auricalata*	1	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	1	-	-	-	-	1	-	5	45
21	*Stentor roszeli*	1	-	-	-	-	-	-	-	1	-	1	-	-	2	-	-	-	-	-	-	-	2	-	-	`-	7	63
22	*Monas ceronifera*	-	2	-	-	-	-	-	-	2	-	-	1	1	-	-	1	-	-	-	1	-	-	2	-	-	10	90
23	*Keratella sp*	-		-	3	-	2	-	-	-	1	-	-	`1	-	-	-	1	-	-	1	-	-	-	-	-	9	81
																											Jumlah Total Individu Semua Jenis (N) :	**1,377**
																											Jumlah Total Jenis (S) :	**23 kinds**
																											Indeks Keanekaragaman Jenis (H) :	**4.4235**
																											Indeks Keseragaman Jenis (E) :	**0.9648**
																											Indeks Dominansi Jenis (Id.) :	**0.0499**

<Macrozoobenthos Community>

Macrozoobenthos community is a terminology given to a group of organism which lives on the surface or for those which burry themselves in the wtaers bed, and the size is more 1.0 mm. Investigation in this component based on sampling instrument representation, and identification book availability and also impact requirement.

Qualitatively in this Amdal study of Ayung Dam, it is declared that benthic habitat conditions on the four sampling stations are not goodand supporting the life of benthos organism, especially macrozoobenthos, because the stream is very swift and river discharge in rainy season therefore it is significantly flushing sediment or bottom substrate tube which are benthos' habitat. In the deeper zone, it is predicted that benthos development is very difficult because the minimum of sun lihting and available food sources.

Species abundance and composition which are obtained from the investigation toward macrozoobenthos community, and diversity index, equitability or domination as shown on Table-III-8.10.

Table-III-8.10 Abundance and Composition of Macrozoobenthos Community at Ayung River (Amdal Study of Ayung River Multifunction Dam Development Plan)

No	Group/Family	Scientific Name (Species)	Common Name	Local Name (Indonesian Name)	Macrozoobenthos Sampling Station			
					I	II	III	IV
A.	**Aquatic Insect**							
	1. Ephemeroptera							
	- Baetidae	*Baetis sp* (Leach)	Mayfly nymph	Insekta air	8	18	-	5
	- Ephemerellidae	*Ephemerella sp* (Walsh)	Stonefly nymph	Insekta air	3	5	16	-
	2. Odonata							
	- Zygoptera	*Hetairena sp* (Hagen)	Caddisfly	Larva capung	35	23	5	15
	- Anisoptera	*Hagenius sp* (Selys)	Caddisfly	Larva capung	11	4	14	3
	3. Plecoptera	*Isoperla sp* (Banks)	Caddisfly	Larva capung	8	13	8	5
		Acroneuria sp (Pictet)	Caddisfly	Larva capung	-	-	11	23
	4. Hemiptera	*Notonecta sp*	Caddisfly	Larva capung	13	30	20	16
	5.Coleoptera							
	- Dytiscidae	*Capelatus sp* (Erichson)	Water penny		6	2	7	2
	- Elmidae	*Ancyronix sp* (Erichson)	Water penny		-	-	4	11
B	**Moluscca**							
	1. Thiaridae	*Melanoides torulosa*	River snail	Siput air	20	8	2	28
		Tarebia granifera	River snail	Siput air	13	8	5	-
		Thiara winteri	River snail	Siput air	3	3	8	3
	2. Sphaeriidae	*Sphaerium simile*	River snail	Siput air	-	-	-	4
	3. Ampullaria	*Pila ampullacea*	River snail	Keong air	2	-	-	1
	4. Pleuroceridae	*Goniobasisi sp*	River snail	Siput air	13	8	5	-
C	**Crustacea**							
	1. Palaemonidae	*Macrobranchium rosenbergii*	*Freshwater prawn*	Udang galah	5	8	4	-
		Pontonides sp	*Freshwater shrimp*	Udang krosok	12	18	25	-
	2. Potamidae	*Stoliozia sp*	*Freshwater crab*	Kepiting	23	3	3	-
		Johora sp	*Freshwater crab*	Kepiting	4	11	13	8
				Total Individual of All Species (N) :	**179**	**162**	**150**	**123**
				Total of All Species (S) :	**16**	**15**	**16**	**13**
				Macrozoobenthos Diversity Index (H) :	**3.6290**	**3.5458**	**3.6873**	**3.1536**
				Macrozoobenthos Equitability Index (E) :	**0.4849**	**0.9076**	**0.5101**	**0.4542**
				Domination Index (ID) :	**0.096**	**0.1582**	**0.0917**	**0.1328**

Explanation :
Station I : Ayung River II Br Susut, Buahan Kelod Village Payangan Subdistrict,
Station II : Ayung River I Br. Petang, Petang Village Petang Subdistrict/ Bali Fantasi Rafting
Station III : Ayung River Br. Buangga, Getasan Village, Petang Subdistrict
Station IV : Ayung River Br Anggungan, Carangsari Village, Abiansemal Subditrict

The abundance of macrozoobenthos at those four locations are low, it is between 123 – 179 individuals per area (1.6 m^2). The prominent species are insect group (dragonfly larve) and mollusca: *Thiara winteri, Thiara scabra, Pila ampullacea, Melanoides terulosa,* and crustacea : udang galah (*Macrobranchium rosenbergii*), and river crab (*Johora* sp). Among those species, the existence of Freshwater Giant Prawn are a lot.

The diversity value of macrozoobenthos community at the location is between 3.1536 – 3.6873 units. This is high diversity value. Equitability value is nearly equal in Ayung River. It is between 0.4542 – 0.9076, it means that the equitability level is from low until the high one. From four stations, there is only one station which categorized as the high one, it is in Petang, around Bali Fantasi Rafting (more than 0.75 unit). Domination index value is very low, it is between 0.0917- 0.1582, it means that there is no domination.

<Necton Community (Fish, crab and prawn)>

Generally, the necton community is the closest aquatic biology component for human (society), because fish, crab and prawn have been the longest and oftenly consumed by human as animal protein source from aquatic ecosystem; therefore if this community is disturbed or degradated because of a certain project, the impact will be significant for the community whose earnings are by catching fish, crab and prawns at Ayung River.
The investigation result is obtained from the description of fish, crab and prawn community structure at Ayung River as shown in Table-III- 8.11 and invetigation result for fishes is shown in Figure-III-8.1.

Table-III- 8.11 Abundance, Composition, Diversity, Equitability, Domination of Necton (Fish, Crab, and Prawn) at Ayung River

No	Family	Scientific name	Common Name	Local Name	Sampling Location			
					Station I	Station II	Station III	Station IV
A.	**Fish Community**							
1	Cyprinidae	*Tor tambra / Labeobarbus tambra*	Carps	Tembera (Ind.), Nyalian Bangkal (Bali)	12	9	2	6
2		*Rasbora sp*	Carps	Wader (ind.), Nyalian (Bali)	41	28	26	61
3		*Osteochilus hasselti*	Carps	Nilem	4	-	-	2
4	Aplocheilidae	*Aplocheilus panchax*	Tinheads	Kepala timah	24	2	10	-
5	Poeciliidae	*Xiphophorus helleri*	Livebearers	Ikan seribu (Ind), Ikan Pedang (Bali)	34	11	6	9
6	Anguillidae	*Anguilla marmorata*	Freshwater Eels	Sidat/Moa kembang (Ind.), Julit (Bali)	2	2	4 (Anakan)	3
		Anguilla bicolor/ A. spengeli	Freshwater Eels	Moa (Ind), Kulen (Bali)	1	-	-	-
		Anguilla cellebesensis	Freshwater Eels	Menguling (Ind), Kulen Kuning (Bali)	-	-	-	2
	Claridae	*Clarias batrachus*	Walking Catfish	Lele	-	-	-	1
7	Ophiocephali dae	*Ophiocephalus striatus/Channa striata*	Snakeheads	Gabus/kehung (Ind), Jeleg (Bali)	1	-	-	-
8	Balitoriidae	*Glaniopsis sp*	Hillstream Loaches	Selusur (Ind.), Jajung (Kepe-kepe)	2	3	2	14
9	Eleotrididae	*Butis sp*	*Sleepers/Gudgeons*	Belosoh (ind.), Boboso (Bali)	2	1	1	4
B	**Crustacea (Decapoda)**							
10	Palaemonidae	*Macrobranchium rosenbergii*	Freshwater prawn	Udang galah	4	5	8	32
		Palaemonetes sp	Shrimps	Udang kresek	3	-	2	19
		Pontonides sp	Shrimps	Udang terestes (Bali)	14	34	38	9
11		*Stoliozia stoliockana*	Crabs	Kepiting	5	2	4	2
		Johora sp	Crabs	kepiting	3	-	3	5
				Total of trapped fishes (S) :	**152**	**97**	**106**	**169**
				Total Individual of All Species (N) :	**15**	**10**	**12**	**14**
				Fish Diversity Index(H) :	**3.0236**	**2.5170**	**2.7552**	**2.9115**
				Fish Equitability Index (E) :	**0.7739**	**0.7577**	**0.7685**	**0.7647**
				Fish Domination Index (ID) :	**0.1663**	**0.2326**	**0.2113**	**0.1945**

Explanation :
Station I : Ayung River II Br Susut, Buahan Kelod Village Payangan Sub district"
Station II : Ayung River I Br. Petang, Petang Village Petang Subdistrict/ Bali Fantasi Rafting
Station III : Ayung River Br. Buangga, Getasan Village, Petang Subdistrict
Station IV : Ayung River Br Anggungan, Carangsari Village, Abiansemal Sub district

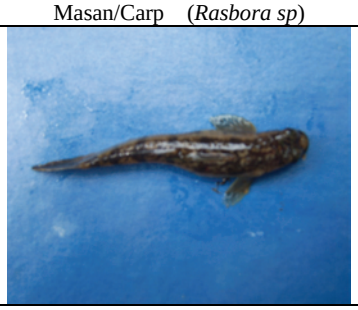
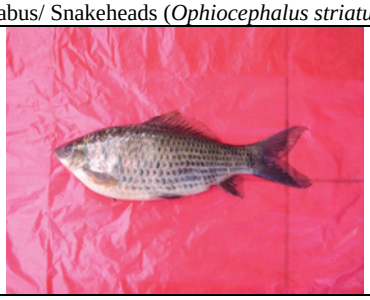
		
Masan/Carps (*Tor tambra*)	Sidat/freshwater Eel(*Anguilla spengelli*)	Masan/Carp (*Rasbora sp*)
		
Gabus/ Snakeheads (*Ophiocephalus striatus*)	Lele/ Walking Catfish (*Clarias batrachus*)	Kepe-kepe (*Glaniopsis sp)*
		
Ikan Nilem/Carps (*Osteochilus hasselti*)	Moa/Freshwater Eel (*Anguiila marmorata*)	Kepiting/Crab (*Johora* sp)
		
Udang Galah/freshwater prawn (*Macrobranchium rosenbergii*)	Terestes (*Pontonides sp*)	Moa/freshwater Eel (*Anguiila marmorata*)

Figure-III-8.1 The Investigation Result of Necton Community at Ayung River and Siap River, Ayung Dam Plan, Buangga

At Ayunhg River, the fish species richness is relatively low, it is 11 species, with species abundance is between 97 – 169 individuals per sampling area. Species which are quite abundant are Nilem (*Osteochilus hasselti*), Masan-masan (*Rasbora* sp dan *Tor tambra*), kepala timah (*Xiphophorus helleri*), sidat (*Anguilla marmorata*), and beboso (*Butis sp*).

Beside that, there are giant prawn and crab (river) found, those are: udang galah (*Macrobranchium rosenbergii*), udang kresek (*Palaemonetes sp*), and trestes (Bali) (*Pontonides sp*), and also giant crab (*Johara* sp and *Stolizia* sp). The existence of this resources is quite abundant.

The diversity value is between 2.5170-3.0236, it means that the fish diversity is categorized as the moderate to high deversity. The equitability index is between 0.7577-0.7739 categorized as high equitability. The domination index is between 0.1663-0.2326, it means tha the domination is categoraized as low equitability.

Refers to the Governmental Regulation of Republic of Indonesia No.7, 1999 considering Preservation of Plants and Animals, that in the aquatic biology components which are successfully investigated, endanger species of necton (fish, prawn and crab in Ayung River) are not found and or protected by Government of Republic of Indonesia.

Component of aquatic flora and fauna in Ayung River is a very strategic and important environment component to have considerations in the relation of Ayung River Development Plan.

8.1.3 Environmental Issues of the Project

In accordance with the report issued by the Environmental Social Consideration Council (ESCC) of JICA, the Study Team recommend following analysis, additional study and field reconnaissance for the next phase.

1) Study on the disappearance and variation of ecological system, especially on disappearance of vegetation, terrestrial biota and aquatic biota by submerging of reservoir due to the construction of dam as well as accesses road.
2) Study on the variation of ecological system, influence of erosion, coastal change and agricultural land change caused to hydrological change in downstream of dam.
3) Ecological characteristics analysis based on the comparison between study area and another area in Bali as well as in Indonesia.
4) Evaluation and mitigation countermeasures not only for Java Kingfisher but for protected species as well as rare species described in the "red list" of International Union for Conservation of Nature and Natural Resources.
5) Flora study on the existence of the special purpose such as for medicine and for food.
6) Influence study caused by labor inflow to local community and ecological system near the project area during construction
7) Necessity of further EIA study during different season of this Feasibility study period.
8) Additional study including identification on the mammals.
9) EIA study for the construction materials sites.
10) Riverbed fluctuation in the downstream of dam
11) Influence on coastal erosion.

8.2 Second Social Study

8.2.1 Outline of Study

Second social study was conducted for the purpose of grasp of people's opinions to the proposed priority projects and to reflect them to the plan and design as well as grasp of social conditions of the people affected by the proposed project.
The information /data collected in the study comprising of primary as well as secondary data. Primary data/information was obtained by questionnaire and interview through RRA (Rural Rapid Appraisal) technique. The respondents for individual interview which were selected at random from lists of persons/farmers provided by heads of relevant villages/subaks ranged from 70-130 persons for each site. And as a whole, it amounted to 400 persons.

8.2.2 Study Result

(1) Social Conditions

Social conditions of respondents are summarized in Table-III-8.12 to Table-III- 8.15.

Table-III-8.12 Social Conditions of Respondents (Basic Information)

Description		Study Sites			
		Ayung River	Sungi / Penet River	Petanu River	Badung-Mati Rivers
Identity of Respondents	**Average age of respondents**	49	45	46	47
	Religion				
	Hindu	100 %	97.8 %	100 %	97.3 %
	Islam		2.2 %		2.7 %
	Education				
	No schooling	10.8 %	10.0 %	10.0 %	6.4 %
	E+M+H*)	86.2 %	87.8 %	82.9 %	88.2 %
	University	3.0 %	2.2 %	7.1 %	5.5 %
	Main income sources				
	Agriculture	65 %	56.7 %	34.3 %	26.4 %
	Trading/ Business	16 %	23.3 %	32.9 %	53.6 %
	Civil servant/Army	5 %	3.3 %	10.0 %	7.3 %
	Others	14 %	16.7 %	22.8 %	12.7 %
	Family size	3.8 persons	3.7 persons	3.9 persons.	3.9 persons
	Working family members	2.0 persons	2.2 persons	2.3 persons	2.0 persons
	Properties Owned @				
	TV set	0.95	1.06	1.04	1.15
	Radio	0.84	0.72	0.70	0.70
	Motor bike	0.96	1.40	1.30	1.65
	Car	0.06	0.02	0.06	0.09
	Electric fan	-	0.60	-	0.90
	Bicycle.	-	0.80	0.80	0.78

Note: *) Elementary, Middle and High School graduate. @ Average unit per household;

Table-III-8.13 Social Conditions of Respondents (Housing Conditions)

Description		Study Sites			
		Ayung River	Sungi / Penet River	Petanu River	Badung-Mati Rivers
Energy for cooking#)					
	Firewood	72.3 %	66.6 %	72.9 %	10.9 %
	Gas	29.2 %	43.3 %	21.4 %	58.2 %
	Kerosene	22.3 %	27.8 %	41.4 %	50.0 %
Energy for lighting					
	Electricity	98.0 %	100.0 %	100.0 %	100.0 %
	Kerosene lamp	2.0 %			
Housing condition	**Wall**				
	Brick	42.3 %	63.3 %	52.9 %	60.0 %
	Concrete	49.3 %	34.7 %	45.7 %	35.5 %
	Wood			1.4 %	
	Bamboo/Others	8.4 %			4.5 %
	Floor				
	Ceramic	53.0 %	61.1 %	50.0 %	70.9 %
	Cement	37.0 %	37.8 %	48.6 %	28.2 %
	Others	10.0 %	1.1 %	1.4 %	0.9 %
	Roof				
	Tile	97 %	95.5 %	92.8 %	91.8 %
	Others	3 %	4.5 %	7.2 %	8.2 %

Note: #) Marked all the applied

Table-III-8.14 Social Conditions of Respondents (Health and Sanitation)

Description		Study Sites			
		Ayung River	Sungi/Penet River	Petanu River	Badung-Mati Rivers
Health and Sanitation Condition	**Toilet Facilities #)**				
	House toilet	84.6 %	95.6 %	84.3%	99.1 %
	River	10.0 %	2.2 %	12.9%	0.9 %
	Backyard	9.2 %	1.1%	7.1 %	
	Share with neighbor	3.9%			
	Others	1.0%	1.1 %		
	Water for bathing /washing #)				
	PDAM	7.7 %	6.7 %	74.3 %	35.5 %
	Well	60.0%	92.2 %	4.3%	66.5 %
	River	7.7 %	5.4 %	34.2 %	
	Spring	60.0 %			
	Water for cooking/drinking#)				
	PDAM	53.1 %	6.7 %	54.3 %	32.7 %
	Dug well	36.2 %	78.9 %	5.7 %	31.8 %
	River /spring	10.7 %	6.7 %	44.3 %	
	Tube well	3.1 %	11.1 %		30.9 %
	Bottled water	0.8 %	1.1 %		4.6 %
	Water treatment before consumed				
	Boiled	89.2 %	94.4 %	84.3%	99.1 %
	Not boiled	9.2 %	2.2 %	12.9%	0.9%
	Boiled occasionally	1.6 %	3.4 %	2.8%	
	Garbage disposal #)				
	Burned	66.2 %	62.2 %	90.0 %	57.3 %
	Buried at house yard	11.5 %	2.2 %		
	Collected at garbage box	11.5 %	23.3 %	27.1 %	43.6 %
	Thrown into river/canal	7.7 %		4.3 %	
	Thrown to backyard	2.3 %			
	Others	9.2 %	20.0 %		10.0 %

Note: #) Marked all the applied

Table-III- 8.15 Social Conditions of Respondents (Economic Conditions)

Description			Study Sites			
			Ayung River	Sungi / Penet River	Petanu River	Badung-Mati Rivers
Income	Total		RP1,219,461	RP947,222	RP 1,115,000	RP 1,313,638
	Per capita		RP318,397	RP253,268	RP 282,995	RP 336,830
Consumption expenditure	Total		RP 1,158,246 (95.0 %)	RP 737,022 (77.8 %)	RP 912,121 (81.8 %)	RP1,092,091 (83.1 %)
	Per capita		RP 304,802	RP 197,065	RP 231,503	RP 280,023
	Breakdown	Food /drink	44.0 %	58.9%	49.4 %	47.67%
		Transportation	20.2 %	10.1 %	10.4 %	14.3 %
		Education	11.3 %	3.4 %	11.2 %	10.0 %
		Health/medication	3.9 %	5.3 %	5.0 %	3.2 %
		Rituals	12.3 %	10.9 %	11.5 %	9.3 %
		Telephone	3.4 %	3.0 %	4.1 %	6.0 %
		Electricity	3.7 %	8.0 %	5.4 %	8.1 %
		PDAM water	1.2 %	0.3 %	3.0 %	1.4 %

(2) Ayung Multipurpose Reservoir

< Religious Ritual>

There are several places of sacred values near Ayung River. One important temple (Tangluk Temple) belongs to Customary Village of Susut-Buahan in the Payangan Sub district, Gianyar Regency. About 200 households are involved in this temple's activities. It has close relation with the holy spring found very close to the site plan of the reservoir. To perform rituals, it needs holy water from the above mentioned holy spring which would be submerged if the reservoir is built. This holy spring is also often used by many people from outside the village even from other regencies to visit this holy spring.
The community can not decide whether or not the existing holy spring can be replaced by other springs which may not be submerged by the project, unless a higher authority e.g. the Council of Hindu Religion and the high priest would guarantee for the "safety" of this replacement and yet this should be socialized to the community concerned.
Other religious rituals/places which must be taken into consideration for planning and design are as follows.

- Stone cave used as a place for meditation
- Ashes after cremation ceremony is thrown to Ayung River
- Chinese Cemetery

<Economic Activities>

The area around as well as in the river is not used only for religious rituals, but also for certain economic activities. Important activities are related to tourism such as rafting and villa/hotel. At upstream there are found 3 rafting business: Bali Discovery, Bali Fantasi, and Bali Holiday. The most potentially affected is Bali Holiday with its route starting from Kesianan Hamlet of Pangsan Village and finish at Buangga Hamlet of Getasan Village. It takes around one hour. There are about 50 employees consisting of local residents of both hamlets mentioned above. The company gives contribution amounts to RP 150,000 per month to the Customary Village, and also RP 150,000 to be equally shared by the owners of land being used for passing through of its customers.
Two villas namely Ubud Hanging Garden and Vila Nandini are found close to the project site. These villas make best use of the view of the river side at the eastern part of the Siap tributary. If the water surface would be below the foot of the bridge of Susut it would be no problem.

<Daily Household Activities>

In the past, river played important role for providing domestic water use such as bathing, washing, water source for cooking and drinking, playing and swimming for children. A few people still use the river at points easily accessed for bathing and washing and taking water for cooking as revealed by the survey result that about 6% of the total sample of 130 persons still using river as a source for bathing and washing; and 1.5% for cooking and drinking. The people having land adjacent or extended to edge of the river can plant fruit trees within the river demarcation and take the harvest but must be responsible to preserve it for the sustainability of the natural environment around the river. Moreover, they also can take edible green leaves for vegetable, grasses for the cattle, and firewood.

<Opinion/Attitude towards Project Plan>

About 56.2 % of the total respondents did not know yet about the plan of project in Ayung River, 44.8 % said they knew it already. About 57% could understand, whereas the rest 43 % still did not understand the potential benefit of the project. Several possible benefit mentioned by the respondents are among others to increase irrigated area, increase domestic water supply, and some other else.
More than 58 % of the total sample agreed with the project plan whereas 42 % still doubtful/worried about the project especially related to land acquisition, loss of job, unfair compensation, etc. Of the 30 respondents who gave their opinions concerning the form of compensation, more than 73 % of them expected exchange with other land of similar type; the rest said it would depend upon consensus among owners of the land. A few owners of land required that their land should be priced not too far below RP 50 millions per are.

The local residents proposed that the project will consider the followings.

- Recruitment of the local people during the construction stage;
- Supply electricity and clean water to local community;
- More intensive socialization on the project specification to local community since most of them did not know yet about the project plan;
- The new habitat for the monkey (black and gray monkey) needs to be created if the existing habitat is to be disturb due to the reservoir in order the monkey will not annoy the villagers and disturb the fruit gardens of the local people;
- The quality/strength of the reservoir should be guaranteed for people's safety;
- The project implementer should provide a place for nganyut ritual somewhere along the river;
- A new bridge and road over the river to connect Petang and Payangan should be built so that the local people can take a shorter way to travel.

(3) Sungi/Penet River Raw Water Development (Western System)

<Current Use of River by Local Community>

River waters at the confluence points are believed to be sacred in Bali. In case of the confluence point between Sungi and Penet Rivers, it is often used for spiritual cleansing ceremony *(meruwat*) by local people. As the intake is to be located downstream of this confluence point, it is worried if the project might adversely affect this sacred location for such kind of activity.

The paddy fields adjacent to the project sites (its intake and WTP), belong to the command area of Sub subak *(tempek)* of Kelakah within the Let Cemagi Subak. This subak has a temple called Lesung Temple but located rather far from the project site, so it would not be affected.

It is still common every where in Bali, though practiced by only a few people particularly those who have no access to PDAM water or dug well, to use rivers for washing, bathing, cooking, and even for toilet. Some people also throw garbage in to the rivers.

It is a common practice that the people having land adjacent or extended nearby the edge of the river are allowed to plant fruit trees within the river demarcation and take the harvest but must be responsible to preserve it for the sustainability of the natural environment around the river. Moreover, they also may take edible green leaves for vegetable, grasses for the cattle, and small trees for firewood.

<Opinion/Attitude towards Project Plan>

The total respondents who did not know yet about the plan of the project accounted to around 84 %, but nearly 16 % said they knew it already. Only 23 % could understand, whereas the rest 77 % still did not understand the potential benefit of the project. Several possible benefits of the project according to the respondents are among others to increase water supply for bathing/washing, for drinking water, for irrigation water and for tourism activity.

The greater percentage of respondents (65.6 %) had no objection to the project plan, but the rest 34.4 % still doubtful because they believed that the project would take their land with unfair compensation and make them loss job.

The subak heads proposed that the project should not cut the water supply during construction of access road and not to decrease water supply to the subak after operation, provide job opportunity for farmers, the existing road used by the farmers/subak needs widening. The village heads and local residents hoped that the local community would be able to share the project benefit through PDAM water faucet installed at hamlet hall. The project also is expected to employ local workers to the extent possible, to assist the upgrading of villages road adjacent to the project, fair compensation for the land acquisition, assistance to the existing temples located close to the WTP, and so on.

(4) Petanu River Raw Water Development (East System)

<Current Use of River by Local Community>

About 150 m to the east of the planned intake, there exists a holy spring at the adjacent to Anakan Temple. The anniversary ceremony of this temple is on the dark moon of the fourth month (around

October) every year for three days duration exactly the same time with the anniversary ceremony of the Dalem Ulun Setra Temple (a village temple for the death) of Saba Village. The holy spring of Anakan Temple is used for various kinds of religious rituals.
The Er Jeruk Temple located at Sukawati Village at downstream of Petanu River close to the beach. This temple is managed by the Subak-gede of Sukawati assisted by the Customary Village of Sukawati. The anniversary festival of this temple is performed 35 days after *Galungan* Festival (a religious ritual to symbolically celebrate the "victory of the good deed against evil").
Besides used by the subaks for irrigation purpose, both sides of the river are also used by local people especially the farmers to take grasses and green leaves to feed their cattle. At certain points of the river bank is used by local people for quarrying. The local people also sometimes use the river for fishing just for hobby. Springs found along the river course are quite useful besides for rituals, also still important water sources to some people for bathing, washing, and even for cooking and drinking.
A hotel called Lor Inn having 35 units of villas with land area of around 4.5 ha is found nearby the project site but will not be directly affected. The hotel owned by Limited Company of Petanu Utama has 100 employees. A deep tube well is used as a source of water supply.
The cropping pattern practiced by the farmers at Sukawati Subak-gede is paddy-paddy–*palawija.* The important crops for *palawija (*secondary crops) are corn, soy bean, cassava, etc. The Sukawati Subakgede is responsible for the management of Er Jeruk Temple as mentioned above. This subak also has several subak temples located surrounding the project site but not directly affected.

<Opinion/Attitude towards Project Plan>

Only 11.4 % of total respondents have known about the planned project which is to be located down stream of Petanu River. The majority said they did not know yet. Only about 21.4% could understand, whereas the rest 78.6 % still did not understand the potential benefit of the project. Several possible benefit mentioned by the respondents are among others to increase irrigated area, increase domestic water supply, for tourism activity, etc.
The respondents who agreed with the planned project account to 71.4 %, whereas 28.6 % still doubtful because they worry about the project especially related to land acquisition, loss of job, unfair compensation, and pollution during construction phase. Of the 8 respondents representing landowners, with regard to compensation for their land, four of them are expected exchange with other land of similar type, two preferred exchange with land of any type, and two expected cash money. They proposed that the land should be valued at market price, or at least between RP 50 millions and RP 100 millions per are.
The major expectation of respondents are among others it must be beneficial to the local community, also useful for irrigation, should not pollute environment, and many others. The subak heads proposed that the project should not decrease the water supply to the subak during the construction as well as after operation. To the extent possible, they request additional irrigation water supply especially for Cengceng Subak. Many respondents also proposed the following points:

- Since Petanu River is believed to very sacred, it is necessary to perform proper ritual prior to carrying out any activity especially related to the construction of the project;
- The use of local workers should be given priority during project implementation;
- Further socialization is necessary to local people (of Saba and Sukawati villages);
- The installment of transmission pipe should not disturb the existing irrigation canal and other subak's facilities;
- When the project is operational, the clean water supply for Er Jeruk Temple as well as for local community including some amount of donation during temple festival should be provided;
- Land acquisition should be carried out in a transparent manner.

(5) Badung & Mati River Flood Control

<Current Use of River by Local Community>

Badung River flows through the crowded city of Denpasar, a civic center of Bali Province and Mati River flows through Kuta area with a famous beach frequently visited by many tourists from various parts of the world. No wonder the dominant activities of the people living along the rivers are business

and other services. A few people still sometimes used the rivers for fishing just for hobby and also to a limited extent especially at upper stream even for bathing and washing.
The paddy lands located at upper stream and lower stream from Umadui Bridge have important role as temporary natural retaining basin for the Mati River. The lands are still productive for farming activities, but the surrounding paddy land areas are planned to be converted to housing or for other non farming purpose. Considering the high land price, it is worried that the owners of the lands functioning as retaining basin would be tempted to sell their lands under Land Consolidation (LC) program.
There are many subaks taking water from one of several existing weirs along the river courses of both rivers. The subaks' land areas have been declining significantly because of conversion to other uses brought about by rapid development of tourism and urbanization. For example, Mergaya Subak which formerly had 372 ha of rice lands, now its land area remains only 100 ha. Again, the land area of Tegalantung Subak at present remains only 35 ha from its earlier size of 150 ha. Meanwhile, Cuculan Subak from the former size of 200 ha has declined to become only 100 ha, whereas a drastic change occurred at Lobengan Subak which was from 200 ha, now remains only 5 (five) ha. The cropping pattern is generally paddy-paddy-paddy/*palawija* at Mergaya Subak in which the important *palawija* crops are soy bean, and vegetables. For both Tegalantang and Cuculan Subaks, the farmers here grow twice paddy and once secondary crop / *palawija* a year. The dominant *palawija* crops are soy bean and flowers. Other subaks such like Lobengan Subak grow three times paddy a year. Most farmers in the said subaks are generally more than 50 years old, since the younger farm family members prefer working off-farm especially in tourism sector.
The farmers from the above mentioned subaks complained about the inorganic garbage coming from upstream and polluted irrigation water brought about by garment industry. The garbage often blocked the irrigation canal which caused inundation at the surrounding area and the farmers were compelled to clean the canal many times which is really a burden for them.

<Opinion/Attitude towards Project Plan>

Only 11.8 % of total respondents have known about the planned project which is to be located at the rivers Badung and Mati for flood mitigation purpose. The majority (more than 88%) said they did not know yet about this project. Only 35.4% could understand, whereas the rest 64.6 % still did not understand the potential benefit of the project. Several possible benefit mentioned by the respondents are among others for flood mitigation, improve water quality for bathing and washing, increase irrigation water, new job opportunity, etc.
The greatest majority of respondents (77.3%) agreed with the planned project, whereas 22.7 % were still doubtful. Many respondents still worry about the project. Reasons for their worries are especially related to land acquisition, loss of job, unfair compensation, and pollution during construction phase. As for compensation of the lands, one of the following forms is accepted: cash money, exchanged with land of similar kind, exchanged with land of any type. Or, it depends on consensus among the owners. The land's value should range from Rp 75 millions to Rp 180 millions per m^2.

CHAPTER 9 PROJECT EVALUATION

9.1 Technical Evaluation

The proposed priority projects including the water supply project for southern Bali, multi-purpose Ayung Dam project and river improvement project for Badung and Mati River were well planned according to the following technical information, standards, judgment and proper planning procedures. Therefore the priority projects are assessed to be technically feasible as a result.

1) The information related to socio-economic conditions, topographical and hydro-geological conditions, hydrological conditions, environmental conditions, water use conditions and so on were collected from the data and information that the Government of Indonesia as well as Bali Province owned. These information and data were applied to the Feasibility Study after precise examination and careful selection. And the standards established by the Government of Indonesia were applied for the design of main facilities and works. To obtain more detailed information, 5 drilling bore holes at Ayung Dam site and soil tests at 3 sites for the planned water treatment plants were carried out during the Feasibility Study. In addition, for the dam design, the international standards such as International Committee on Large Dams and Japanese Standard were also used when necessary.
2) Regarding the water supply project for southern Bali, the water supply for western system with 300 lit/s (25,900m^3/day) development shall be started to construct firstly and eastern system with 300 lit/s (25,900m^3/day) also shall be started respectively. Due to the large production capacity with 1,800 lit/s (155,000m^3/day) development of central system, stage construction method for the mechanical equipment and water treatment plant shall be adopted with the adjusted supply for demand 600 lit/s (51,800 m^3/day) in each by three staging, whereas full construction for the weirs and infrastructures shall be executed at one stage. Though the location of water sources was selected through the stakeholders' meetings, further explanation and coordination with related bodies shall be required before the commencement of detail design and construction.
3) For the multipurpose Ayung Dam project, on the basis of the calculation results of required capacity, the capacity of 9,000,000m^3, which is estimated based on 15 years return period with twice drought occurrence, shall be adopted in consideration for the safety of water supply, reservoir scale and frequency of drought occurrence, etc. According to the reservoir operation simulation, because the annual inflow volume to the reservoir was estimated around 300 to 400 million m3, it was realized that water level of reservoir shall go up easily even in the decrease of water level due to the supply for water use in drought. In addition, because of good water quality and large turnover rate of reservoir, it is unlikely that enrichment and turbid water in Ayung reservoir will occur. Check dams constructed at upstream in Ayung River and Siap River will store the sediment inflow, and the stored sediment at check dam shall be intermittently excavated to secure the planned sediment volume.
4) There is no available road for the passage between Badung Regency and Gianyar Regency near the dam site which is located at the boundary of the Regencies. In the dam plan, access roads and bridges of dam top will be utilized for the inter-passage between them. Moreover, the reservoir development plan was studied for the purpose of the distribution of the economic benefit to the communities of Ayung Dam. Further detail study shall be needed through the discussion of stakeholders' meetings in the future.
5) Based on the results of study and geological survey for Ayung Dam, dam site and dam type were carefully selected. In order to obtain more detailed information and data, further study at the upstream and downstream of dam axis shall be needed in the next design stage.
6) To cope with the river flooding and inland inundation, also to mitigate flood damages in Badung and Mati River, the design flood return period was adopted basically for 25 years. Due to urbanization in Badung and Mati River basin, run-off volume shall be increased in the future. With regard to planned retarding basin in the upstream of Umdui Weir in Mati River, current land use for paddy field and cropping land should be conserved on the basis of precise land use regulations.

7) In the implementation of the projects mentioned above in Bali, holy places shall be taken into

account. There are many holy places naturally founded such as meeting points of rivers, wells near rivers, strange rocks, caves, and air holes, and artificially founded such as temples, small shrines and small old cemeteries in the project areas. For avoiding the sufferings to the holy places at the sites, various technical measures were taken into consideration in design and planning of the projects. Discussion with related bodies such as Hindu association, leader of communities on holy places was repeatedly conducted in the study and it will be necessary in the next design stage also.

8) For the environmental conservation in the implementation of the project, the project sites for the dam shall be without quarry sites, and the construction materials shall be procured from the existing quarry sites in Bali. Restricted plastering method with low vibration and small noise was adopted for the excavation of dam project. Moreover, slope protection with greening was also designed for cut slope of road and dam. Furthermore, construction machinery with low vibration and small noise was applied to the river improvement project in Badung River and Mati River.

JICA Study Team had meetings with related bodies and explained the project plans. Especially to the communities near the planned project sites, plans of the projects were thoroughly explained through the stakeholders' meetings at six times during the study. The project plans were formulated based on the proper technical judgment stated above, but the selected priority projects should be reviewed and revised if necessary in accordance with the additional data and information on geological and hydrological data and topographic survey results.

9.2 Economic and Financial Evaluation

Economic evaluation of feasibility study is carried out on the following 3 projects which were selected as priority in the Master Plan study:

- Multipurpose Ayung Dam Project
- Water Supply Project for Southern Bali
- Flood Control Project for Badung and Mati Rivers

9.2.1 Assumptions and Benefits

Economic evaluation is calculated based on the economic cost and benefit. The following assumptions are applied to estimate the economic cost and benefit as shown in Table-III-9.1.

For the economic evaluation, 10% to 12% of opportunity cost of capital is generally applied. In Indonesia, 12% of opportunity cost of capital is commonly utilized for economic evaluation of the public projects, so that the same opportunity cost of capital is applied to this feasibility study. And 30 years of evaluation time horizon is applied to this feasibility study.

Table-III-9.1 Assumptions

Items	Assumptions	
1. Prices	As of end 2005	
2. Exchange Rate	1 US$ = Rp.9,750 1 US$ = 110.75 Yen	Average of middle rate of each month end of Year 2005
3. Conversion Factor	Conversion rate of 0.9 for local portion cost	
4. Economic Life		
1) Dam	80 years	
2) Water Treatment Plant	40 years	
3) Water transmission/distribution pipeline	40 years	
4) Electrical Equipment and Machinery	30 years	
5) Pumping Motors	15 years	
6) Facilities for thermal generation plant	30 years	
5. Replacement Cost	Pumping motors: to be replaced in every 15 years	
6. Salvaged Value	The residue value of investment cost: to be salvaged at the 30^{th} year.	

Source: Study Team

Table-III-9.2 Benefits

Benefit Items	Assumptions
A. For Multipurpose Ayung Dam Project	
1. Central Water Supply	Same as B
2. Hydropower Generation	Alternative annual cost of thermal power plant construction: Rp.116.8billion (Note) Study Team estimate based on US$1million/MW of Indonesia Power
	Alternative annual cost of thermal power plant operation and maintenance: Rp.139.1billion (Note) Study Team estimate based on Rp.2,000/kWh of Indonesia Power
	Trade for clean development mechanism (CDM) on CO_2 emission right (CO_2 emission right): Rp.3.2billion (Note) 742g/kWh x US$7/t-$CO_2$
3. Irrigation Water Supply	Without-case: soybean product (Rp.1.4million/ha) With-case: paddy product (Rp.5.2million/ha) (Note) Study Team estimate based on information of Food Crops Agriculture Service of Bali Province
B. For Water Supply Project for Southern Area of Bali	
1. Domestic Water	Rp.2,000/m^3 3% of presumed household income of Rp.1,800,000/month. Household consumption: 27 m^3/month (Note) Household income is estimated by the Study Team based on the GRDP and interview. Actual data of 3 PDAMs and PT.TB in year 2005
2. Commercial/Public /Institutional Water	Rp.3,700/m^3 for all target area (Note) Actual data of PDAM Badung and PT.TB in year 2005
3. Industrial Water	Rp.7,620/m^3 for all target area (Note) Actual data of PDAM Badung and PT.TB in year 2005
C. Flood Control Project	
1. Annual Average Benefit	Expected annual flood damage decreased by the project See Chapter 9.2.3.(4)

Source: Study Team

Note: ( ) shows benefit by trade for clean development mechanism (CDM) on CO_2 emission right for the Calculation of EIIR.

9.2.2 Economic Cost

The project cost has to be converted into economic cost applying the conversion factor of Table-II-9.1 to local portion of the financial cost.

Thus, the economic cost of Multipurpose Ayung Dam Project is set up as shown in Table-II-9.3. However, the project aims multipurpose dam for water supply to Central System, hydroelectric power generation and irrigation. Accordingly, the cost of the project is separated and allocated to respective purpose as presented in Table-III-9.3 by applying cost allocation method of multipurpose dam based on the justifiable expenditure and alternative costs of respective objectives that is generally utilized in Japan.

Table-III-9.3 Economic Cost of Multi-purpose Ayung Dam Project

Cost	Ayung Dam [1)] (Rp.billion)	Cost allocated to (Rp.billion)		
		1. Water Supply (Central System)	2. Hydroelectric Power Generation[1)]	3. Irrigation Water
Financial Cost	1,086.6	263.6	617.5	205.5
Economic Cost	1,010.0	243.4	576.8	189.8

Note: 1) Cost for electric power generation facilities and equipment is included.

Source: Study Team

The financial cost of Water Supply Project for Southern Area of Bali and Flood Control Project is converted into economic cost in the same manner as shown in Table-III-9.3.

Table-III-9.4 Economic Cost of Water Supply Project and Flood Control Project

Cost	Water Supply Project for Southern Area of Bali (Rp.billion)				Flood Control Project (Rp.billion)		
	Western System	Central System	Eastern System	Total	Badung River	Mati River	Total
Financial Cost	113.2	759.5	187.8	1,060.5	72.4	69.2	141.6
Economic Cost	108.8	731.0	175.9	1,015.7	65.5	62.5	128.0

Note: 1) Cost of Central System includes allocated cost of Multipurpose Ayung Dam presented in Table-II-10.3.
2) Economic cost of each Water Supply System includes distribution pipeline cost, respectively estimated at 2.6billion for Western, 15.5billion for Central, and 2.6billion for Eastern.

Source: Study Team

9.2.3 Economic Evaluation of the Projects

(1) Multipurpose Ayung Dam Project

The project aims for 1) municipal water supply to Central System, 2) hydroelectric power generation, and 3) irrigation water supply.

The economic evaluation is analyzed based on all data previously mentioned, and the result of the evaluation is presented in Table-III-9.5. As shown in Table, an economical benefit of hydropower generation consists of alternative cost of thermal power construction and operation cost. In case of including benefit by trade for clean development mechanism (CDM) on CO_2 emission right, calculation result is shown in Table-III-9.5. EIRR of both projects exceed 12% of opportunity cost of capital, and the both projects are judged to be economically feasible.

Table-III-9.5 Result of Economic Evaluation of the Projects

Items	Multipurpose Ayung Dam Project	Water Supply Project for Southern Area of Bali
EIRR	14.0% (14.2%)	12.5%
B/C	1.17 (1.18)	1.04

Source: Study Team
Note: ( ) shows EIIR in case of including CDM benefit

(2) Water Supply Project for Southern Area of Bali

The aim of the project is to supply municipal water to southern area of Bali by integrating 3 systems of 1) Western System, 2) Central System, and 3) Eastern System. EIRR of the project shows 12.5% as shown in Table-III-9.5 that exceeds the 12% of opportunity cost of capital. Also B/C Ratio shows 1.04 that exceeds 1.0. Accordingly, Water Supply Project for Southern Area of Bali is judged to be economically feasible.

(3) Sensitivity Analysis

<B/C Ratio by Discount Rate Variation>

In this feasibility study as well as in master plan study, B/C ratio of both projects results in only slightly higher than the break even point of 1.0.

12% of opportunity cost of capital is applied to economic evaluation of this feasibility study because, in Indonesia, the same cost is commonly utilized for economic evaluation of the public projects. However, a large investment cost is indispensable at initial stages to develop water resources projects. On the other hand, benefit of the project is a relatively small size, even though the benefit is generated continuously over the long period. For this kind of project, 12% of opportunity cost of capital might be considered rather too high to attain economical viability.

Safe and stable water resources development is an important national project in order to secure and fulfill “basic human needs”. So the Government financing and external soft loan is suggested in Chapter 9.3 as priority procurement measures for the initial investment cost. The weighted-average interest rate of the Government finances and foreign soft loan is estimated at 4%, which could be considered the lowest level of opportunity cost of capital for this project. Thus, sensitivity analysis is conducted here by applying tree alternative opportunity costs of capital that are; 1) 4% - the above cost, 2) 8% - mean cost between 4% and 12% that is applied to the master plan, and 3) 10% - lowest cost among 10% and 12% that are generally applied for public projects in the world. As a result, respective B/C ratios are confirmed to sufficiently surpass the breakeven point of 1.0 as shown in

Table-III-9.6.

Table-III-9.6 Result of Sensitivity Analysis on B/C Ratio

Items	Discount Rate	Multipurpose Ayung Dam Project	Water Supply Project for Southern Bali
Sensitivity Analysis	10%	1.4	1.2
	8%	1.7	1.4
	4%	2.6	2.0

Source: Study Team

<EIRR by Demand Variation>

In this feasibility study, the same 3 material factors utilized in the master plan study that compose water demand projection are also selected and applied to this sensitivity analysis.

Population Growth

The projected growth is set up at 1.18% (middle growth) until 2010 and 1.05% (lowest growth) from 2011 by referring to the Spatial Plan of Bali Province. In this sensibility analysis, the following 3 types of growth that are applied to the Spatial Plan of Bali Province are also applied until the target year of 2025;

Scenarios		Remarks
1) High 1	1.26%	Spatial Plan of Bali Province
2) High 2	1.18%	Spatial Plan of Bali Province
3) Low	1.05%	Spatial Plan of Bali Province

The result of sensitivity analysis is presented in Table-III-9.7. For both projects, EIRR of above variation 1) and 2) shows slightly higher than EIRR of Feasibility Study. Even though EIRR of above variation 3) shows lower than EIRR of Feasibility Study, its EIRR still exceeds the 12% of opportunity cost of capital 12%.

Manufacturing Industry Growth

The projected growth rate is set up at 5.5% until 2005, and 7% from 2006 by referring to the Spatial Plan of Bali Province. In this sensibility analysis, the following 2 types of scenarios are applied.

Scenarios		Remarks
1) High	8.4%	Spatial Plan of Bali Province from 2006
2) Low	5%	30% lower than the projection from 2006

The result of sensitivity analysis is presented in Table-III-9.7. For both projects, EIRR of above variation 2) shows lower than EIRR of Feasibility Study; however, its EIRR still exceeds the 12% of opportunity cost of capital 12%.

Foreign Tourist Increase

The projected increase rate is set up at 4.5%. In this sensibility analysis, the following 2 types of scenarios are applied.

Scenarios		Remarks
1) High	5%	10% higher than the projection
2) Low	4%	10% lower than the projection

The result of sensitivity analysis is presented in Table-III-9.7. For Water Supply Project for Southern Area of Bali, EIRR of above variation 2) shows slightly bellow the 12% of opportunity cost of capital. The tourism water demand in 2025 decreases by 1.3% (78lit/sec) compared to the demand in Master Plan. However, EIRR deteriorates by 5.1% for Water Supply Project. This is because the benefit of industrial sector including tourism is larger than that of other sectors, which means tourism sector is much more sensitive to the demand variation. Tourism sector is the most important industry in Bali Province, so that the Government expects to improve and accelerate more the attractiveness of tourism resources in Bali Island.

Table-III-9.7 EIRR by Sensitivity Analysis

Variation	Multipurpose Ayung Dam	Water Supply for Southern Bali
1. Demand Variation		

1.1 Population Growth		
1) high 1: 1.26%	14.4%	12.8%
2) high 2: 1.18%	14.3%	12.6%
3) low: 1.05%	14.2%	12.3%
1.2 Manufacturing Industry Growth		
1) high : 8.4%	14.3%	12.7%
2) low: 5.0%	14.0%	12.2%
1.3 Foreign Tourist Increase		
1) 5%	14.3%	12.7%
2) 4%	14.0%	11.9%
2. Cost Variation		
1) disregard for contingency	15.3%	13.8%

Source: Study Team

<EIRR by Cost Variation>

Generally the physical contingency is taken into consideration in estimating the project cost by adding to its construction cost. In Feasibility Study as well as in Master Plan, 10% of physical contingency is applied. In this regard, the physical contingency is an additional cost provided for unforeseen incidents. Accordingly, this analysis is conducted by disregarding this physical contingency.

The result of sensitivity analysis is presented in Table-III-9.7. It is obvious that EIRR of both projects shows sufficient economic viability.

(4) Flood Control Project

Flood control benefit is generally defined as the reduction of potential flood damage by the project. The reduction can be obtained from the difference of the flood damages between with- and without-project conditions. The flood damages are estimated from probable direct damage to houses and business related facilities (estimated at 10% of house damage), and indirect damage (estimated at 10% of direct damage).

<House Value of Badung Regency and Denpasar City>

Total value of houses in Badung Regency and Denpasar City in 2005 is estimated as shown in Table-III-9.8.

Table-III-9.8 Value of House

Area	<20m^2	20-49m^2	50-99m^2	100-149m^2	150m^2<	Total
1. Number of Household by House Size						
Badung Reg.	12,737	19,728	41,499	7,758	5,750	87,470
Denpasar City	36,120	38,211	30,651	13,097	15,184	133,263
2. House Construction Price						
Rp./m^2	562,000	803,000	1,124,000	1,606,000	2,088,000	-
3. Value of House (Rp.billion)						
Badung Reg.	143	547	3,476	1,551	1,801	7,518
Denpasar City	406	1,059	2,567	2,619	4,756	11,407

Source: 1) Measurement and Technical Planning of Sungi River and Mati River in Final Report of Water Management and Flood Control in Bali1997/98, Public Work Dept. of Bali Province, 2) Bali in Figures 2003 & 2004, BPS of Bali Province, , and 3) Study Team

<Flood Damage>

Flood area ratio in the residential area is estimated at 8% in Badung Regency and 25.5% in Denpasar City by taking into consideration of regional population density. Flood damage to houses by area is estimated by applying the flood area ratio and direct damage ratio adopted in Japan, and summarized in Table-III-9.9.

Table-III-9.9 Direct Flood Damage by Area

Area	Direct Damage Ratio		Flood Area Ratio in the Residential Area	Flood Damage (Rp.billion)
	House	Household Inventory		
Badung Reg.	8.3%	8.6% (for reference)	8.0%	50.0
Denpasar City			25.5%	241.6

Note: Direct damage under the condition of less than 50cm floor level inundation
Source: 1) Manual for River Works in Japan, Ministry of Construction of Japan, and 2) Study Team

<Economic Analysis>

Benefit is defined as the reduction of probable damage under with- and without-project conditions on 25-year probable flood. The annual benefit accruing from implementation of the Project under the current condition of 2005 and future conditions of 2015 and 2025 is estimated for economic evaluation as presented in Table-III- 9.10. Obviously, benefit of future years will become larger because of increasing number of houses derived from growing population and business activities.

Economic evaluation is made considering all mentioned above. EIRR of the project results in 15.0% as shown in Table-III- 9.10 that exceeds the 12% of opportunity cost of capital. B/C ratio of the project shows 1.2 that exceeds 1.0. Accordingly, Flood Control Project is assessed to be economically feasible.

Table-III- 9.10 Benefit and Result of Economic Evaluation

Items		Under the Current condition	Under the Future Condition	
		Year 2005	Year 2015	Year 2025
Annual Average Benefit (Rp. billion)	Houses	12.8	15.6	17.2
	Business Facilities	1.3	1.6	1.7
	Indirect	1.4	1.7	1.9
	Total	15.5	18.9	20.8
Economic Evaluation	EIRR	15.0%		
	B/C Ratio	1.2		

Source: Study Team

9.2.4 Financial Consideration

(1) Multipurpose Ayung Dam Project

The project cost of Rp.1,086.6 billion has to be separated and allocated to relevant projects of 1) Central Water Supply System of Water Supply Project for Southern Area of Bali, 2) hydro power generation and 3) irrigation water supply. Accordingly, financial consideration of Multipurpose Ayung Dam Project should be made separately as follows:

- Electricity power of Bali is generated 100% by thermal plant of Indonesia Power, an exclusive national electric power company. However, the supply capacity is not sufficient to meet whole demand of Bali, so that the frequent cutoff of power supply has occurred in Bali. On the other hand, operation cost of the thermal plant has jumped in 2005 because of the worldwide higher oil prices than ever. So, Indonesia Power, by joining the Multipurpose Ayung Dam Project, could obviously expect to supply more stably and achieve extremely lower operation cost. If Indonesia Power joins the project, the company bears the project cost of its own power plant. As to the multipurpose dam project cost, the cost sharing would be a subject of discussion among respective organizations of Central Government.
- Though beneficiaries of irrigation water supply developed by the multi-purpose dam project have to bear the adequate proportional project cost, the prudent dialogue and discussion with the parties interested such as SUBAK is necessary to resolve it.

(2) Water Supply Project for Southern Bali

The project cost amounts to Rp.1,086.6billion including allocated cost of Rp.263.6billion from Multipurpose Ayung Dam Project. Obviously, the project cost is far beyond the financial capability of the Provincial Government because annual revenue of the Provincial Government was Rp.904billion in 2004 including previous year's surplus. Accordingly, financing of Central Government loan and/or foreign soft loan would be inevitable in implementing the project. These loans might be suggested in Table-III- 9.11

Table-III- 9.11 Finance for Southern Bali Water Supply Project

Loan	Portion	Expected Interest	Weighted	Expected Loan Term

		Rate	Average Rate	including Grace Period
Central Government Loan	20%	14%*	4%	Roll over for 30 years
Foreign Soft Loan	80%	1.5%		30 years

Note: * Government Bank loan for investment purpose

Annualized cost can be regarded as annual due amount of repayment and interests of loan, which can be calculated based on the above loan conditions that are 1) the loan amount of Rp.1,060.5, 2) weighted average interest rate of 4%, and 3) loan term of 30 years. Annualized project cost of the above loan will be Rp.59.2billion, which accounts for 6.5% of annual revenue of the Provincial Government.

(3) Flood Control Project

The project cost of Rp.141.6billion is also so big for the financial capability of Provincial Government, so that, on this, financing from Central Government and/or foreign soft loan may be required. .

9.3 Social Evaluation

In the implementation of the projects' plan, it is of primary important to take special attention to the potential social impacts of water resources development projects. Especially during pre-construction stage of the project, most impacts that need to be solved in order to facilitate smooth implementation of the project are social aspects in nature. Any development project should not only technically and economically feasible, environmentally friendly, but also must be acceptable and required by local community. The four prioritized projects are Ayung Reservoir Multipurpose, Petanu River Raw Water Development, Penet River Raw Water Development, and Badung-Mati Rivers Flood Control. Social evaluation of each project is described below based on information obtained from stakeholders' meetings and results of social survey in the study site where the project is to be located.

9.3.1 Multipurpose Ayung Dam Project

The project plan is welcome by most of the stakeholders and they seem to be very eager that the project should be realized soon provided that several critical issues like compensation for land acquisition, and holy spring would have been already settled. Concerning the holy spring used for religious ritual that will be submerged, at the moment, the local people could not give any decision whether or not it can be replaced by another spring located some where along the river course. They did not like to take responsibility of any consequence of their decision. They want to hear the explanation from the competent persons or authority on this difficult matter. It is necessary therefore, prior to detail design, the Hindu Council of Gianyar, the head of desa adat (customary law village) of Susut, the local priest (pemangku) of Tangluk Temple, and the project planner altogether organize a meeting to get a consensus concerning this particular matter. Hopefully, there is still a great possibility that a consensus may be achieved through patient persuasion, to clearly inform about the benefit of the project, and be ready to accommodate needs and aspiration of local people.

No problem of access road, since it is already available from Petang to Payangan (its width is about 6 m) not included the drainage canals of both sides of the road. In connection with the access road possibly no land or other assets acquisition is required.

Concerning the land to be submerged still need further identification with special regard to the precise location, size, and owners of the land. Further socialization and negotiation about the value or terms of compensation is still needed. However, a greater percentage (almost 58%) of the interviewed landowners wants other similar type of land. The rest of the respondents said that they just follow the other owners through consensus. In general, most of them are ready to give their land to be used for the project site. However, since the land to be submerged mostly owned by the desa adat, the land acquisition may not be so big a problem, if the head of desa adat would accept the compensation for the land acquisition. During the interview with the head of desa adat (Susut Village), he also expresses his readiness to allow the project take the land.

To avoid conflict after project has been in operation, the fair sharing of project benefit should be guaranteed between upstream and down stream resident on one side, and between resident of Badung Regency and Gianyar Regency on the other, especially with special regard to clean water supply, electricity and employment opportunity.

New habitat of the black monkey at the surrounding of the project site should be endeavored in order

they will not disturb the existing fruit garden as well as the villagers themselves.

There are many other requests raised by the participants as reflection of their worries which need to be considered such like the followings:

- The compensation to the workers of the rafting business especially due to the loss of job of some local people;
- Further detail explanation concerning the definite specification of the project including the project benefit to the local residents especially living very close to the site;
- The use of local people by the project implementer;
- A guarantee of safety of the physical structure;
- A guarantee of irrigation water supply for the subaks down stream;
- After the completion of the project, the business opportunity should not be licensed only to investor from outside whereas the local community would get nothing and the fair sharing of project benefit should be guaranteed between upstream and down stream resident on one side, and between resident of Badung Regency and Gianyar Regency on the other;
- Agreement or contract document between related villages' heads and project implementer concerning important matters such as compensation before the project get started, is of primary important as reference for its implementation.

The social survey at the project site revealed that there are many respondents still do not know about the project plan, so that most of them expressed their worries if the project would bring negative impact to the local community. However, further socialization concerning the project plan at least during the preparation of detail design may help them better understand especially its future benefit to Bali community in general and local residents in particular.

Judging from the above information, it can be concluded that the project may be quite acceptable by the local people if the counter measures to such issues that make the local people worry about the project which may adversely affect them could be provided.

9.3.2 Raw Water Development Project in Petanu River (Eastern System)

The stakeholders also quite welcome the project plan and since its location is at downstream its implementation will be not so difficult. However, a few minor problems still necessary to be clarified and solved such like holy springs, and land acquisition.

As regard to land acquisition will not be so big a problem. However, the land of about 0.75 ha located at Glumpang Hamlet of Sukawati Village to be used for the site of Water Treatment Plant (WTP) needs to be first informed to the landowners. Coordination with related parties like head of related subak, head of hamlet and head of the village should also be regarded is important to avoid misunderstanding and miscommunication. The procedure must be carried out in a transparent, accountable, fair, and honest manner. If possible, the land should be valued according to market price.

The local people are worried about the possibility of the existing holy springs to be submerged if intake is to be built. They suggested that the surface of river water should be kept at the same level as at the present condition. The local people worried about the safety of the intake structure. The quality /strength of construction need to be guaranteed. It was informed that usually around the months of January, February and March every year especially during heavy rain, river water over flows up to Bridge of Pinda River.

During dry season the subak of Sukawati is in need of irrigation water. This subak requests a small share of the water from the project. During limited water discharge (dry season), it is worried if the project would disturb water supply of the upstream subaks through collusion with dam keeper. During construction work, the irrigation canal should not be disturbed so that the planting schedule can proceed as usual. When the project has been already in operation, there should be certain kind of contribution to the local community in form of: clean water to the Er Jeruk Temple; donation from the project to Villages of Saba and Sukawati and Er Jeruk Temple;

Other important requests that need to be considered are (i) quick realization of the Master Plan for upstream areas and Unda River by clearly define the pattern of distribution and management of the available water among SARBAGITAKU regions (this was raised by a representative from Gianyar PDAM); (ii) the construction of a drainage from Gelumpang Hamlet toward Petanu River and Oos

River to minimize the inundation problem.

It seems clear that most of the points mentioned above are just expectation from the stakeholders, and no serious problem being found. Those requests may not be so difficult to fulfill by the project implementer and through good coordination of relevant agencies any adjustment could be made to suit the local condition. Hence, this project is also socially feasible since quite acceptable by the stakeholders including the residents living close to the project site.

9.3.3 Raw Water Development Project in Penet River (Western System)

Since the project site is located at downstream of the river, the project plan is quite welcome by most of the stakeholders especially the subaks and they seem to be very eager that the project should be realized as soon as possible. Initially, the project was to be located at upper stream of the river but since many subaks opposed it, then the site is to be moved to the down stream.

The access road to the project site is not a problem. It can use the existing subak road that enters from the Mengwi -Tanah Lot Road direct to the site (Village of Mengening). The better alternative is to modify it in order to be straight rather than to exactly following the present subak road since it will become much shorter and no problem of house and family temple being adversely affected. It is about 2 km long and it may be used for public transportation but the rice fields surrounding the new road should be protected and prohibited to change it to other non farming uses. In other words, the "green space" policy needs to be implemented around this new road. In addition, the existing irrigation canals, water division structures and small rice field temples need to be carefully taken into consideration during making detail design in order not to become dysfunctional. The new road needs land acquisition, but this may not be a very serious problem, since the compensation can be negotiated with the owners of the land. The land of around 0.75 ha to be used as the site of the WTP belongs to the government and currently is tilled by 2 farmers, but they need compensation for loss of the job.

After completion of the project, the villagers surrounding the project especially from Cemagi and Munggu Villages need a share of the project's benefit in form of public clean water facilities to be placed at Banjar Hall, Temple, etc. The PDAM is expected to provide certain contribution either in cash or in kind during important event such as temple ceremony. Several other requests were raised by the stakeholders are listed below:

- A small road to a cemetery owned by Christian residents needs upgrading and widening, since it is used also by non Christian residents;
- A small road of about 200 m toward a small temple is needed. The local people are ready to give the land for that road, but assistance is required for its construction;
- The road to the beach is required for the procession of religious ritual, but needs widening. Assistant from the project is required and this may be incorporated with the construction of access road to the project site;
- During construction stage, it is proposed to use local workers according the skills they posses, and the planting schedule of the subaks should not be disturbed.

As compared to Ayung Reservoir Multipurpose Project and Petanu River Raw Water Development Project, it seems likely that the Penet/Sungi River Raw Water Development Project is much easier to implement since almost no serious problem being identified. Most of the requests as noted above could also be fulfilled through negotiation between local residents and project's implementer and related agencies. In conclusion, the Penet/Sungi River Raw Water Development Project is feasible from the social point of view since it is supported by most of the stakeholders including the related subaks.

9.3.4 Flood Control Project for Badung-Mati Rivers

Flooding from Badung and Mati Rivers almost occurs every year, so the people living in Denpasar and surrounding areas are expecting very much that the flood could soon be control or mitigated. Thus from the stakeholders' meetings it can be concluded that most of the people strongly support the project.

The project requires acquisition of land for retarding basin of around 15 ha located at Umadui Weirs in Mati River. It was suggested that the matter needs to be tackled by related government agencies and socialization as well as negotiation with the landowners concerning the compensation problems for the

acquisition of their land should be carried out in such a way so that it can satisfy the owners without making them always as a "victim" of the development project. The subaks want that the intakes of Batannyuh, Buagan, and Margaya in Badung River should be kept functioning to irrigate the subaks' paddy fields taking water from those intakes. At the same time efforts to minimize sedimentation need to be done.

Important factors responsible for the floods are said to be as followings: garbage thrown to the river and drainage canals, changing uses of paddy land to other usage, the river channel is used for planting certain kind of crops like banana, cassava, coconut trees, etc., and many buildings and houses protruding over both edges of the river completely ignoring the rule concerning river border.

Both rivers are also polluted, and the major causes of river pollution are garbage, sewage disposal from small industries like garment, printing, automotive repair shop, and restaurants located very close to both sides of the rivers. It was proposed that PROKASIH (Clean River Program) plan should cover the entire river, not only at lower stream but also the upper stream as well and should be followed by strict law enforcement. Important proposal raised by participants especially in relation to flood mitigation for further consideration are among others:

- To build a connecting canal from Tebe Creek to Badung River along Imam Bonjol Street;
- The land along River Mati from Bias Temple up to Pulau Roon Bridge (at Br. Pengiasan) needs acquisition so that river embankment construction can be continued until Pulau Roon Bridge;
- Other relevant garbage management improvement is needed, such like: installing "garbage trap" at certain places; putting the sign prohibiting the throwing of garbage, at several point including the text of Government Regulation to be followed by intensive control and strict law enforcement; the lamps along the river should be kept functioning; the customary village (desa pakraman/ adat) administrators may be empowered by giving a role in controlling the behavior of the resident concerning garbage disposal; manpower, salary, and facilities of the Garbage Collecting Crew should be enhanced or improved; the land consolidation project (LC) at Semile, Melangi, and Mergaya should not block the irrigation canals of the existing subak; to record the river discharge at certain places during the normal condition; upstream of Mati River especially East of Br. Teges at Purnawira settlement needs stronger embankment.

The project can be considered as socially acceptable, being no one may likely reject this flood control project since it contains mostly activities of excavation, and embankment strengthening without widening so that no need for removal of human settlement. However, one crucial problem remains to be solved: whether or not the existing land which is required for retaining basin can be guaranteed not to be converted to non farming purpose. Further coordination efforts with related agencies such like Regional Planning Board, National Land Agency, Public Works, etc., is considered very important to confirm the future use of the concerned land. Local Government Regulation (Denpasar City) is needed to preserve the existing land functioning as natural retarding basin and therefore any effort to carry out Land Consolidation (LC) project in this area should not be tolerated; without retarding basin and under present condition it may be difficult if not impossible to solve the flooding problems in Denpasar and its surrounding areas.

It is necessary to emphasize here that many project needs land acquisition. Former experiences in handling land acquisition problems have been criticized as disadvantageous to the land owners. For the sake of "national development and public interest", the owners were ready to give up their land to be used for investment project. Many of them are frustrated because they feel they have been cheated by the project implementer as actually the land was not used for the project but for housing and owned by somebody else. They considered themselves as "the victims of development". This expression was raised by a participant of stakeholders' meeting in Denpasar. And similar criticism was also published in a local newspaper recently. Hence, land acquisition needs to be handled through negotiation in a transparent, accountable, fair and honest manner.

For smooth implementation of any project, it should be kept in mind, that it is a common practice in Bali, during construction phase, the project implementer should first consult the high priest or persons regarded as competent in dealing with spiritual and religious matters. Prior to starting of construction, a ritual needs to be performed. The expert on this matter will give advise about what kinds of materials or kind of offerings should be prepared and what the best day to perform such ritual. Also, to change

the use of paddy fields to non paddy farming and non agricultural purpose must follow the special ritual and this also needs advise from the priest or other competent persons. Neglecting this tradition and religious ritual according the belief of Hindu Balinese, may result in unexpected events that inhibit the smooth running of any activities carried out in the location.

9.4 Environmental Evaluation

Environmental Impact Assessment (EIA) Study conforming the relevant laws, regulations and guidelines of Indonesia has been conducted on a provisional basis since formal EIA Study is not required during the planning stage of a project (master plan and feasibility study stage as in this study) for the 4 significant priority projects of feasibility study. Certified Indonesian multidisciplinary expert team, as required by the Indonesian EIA guidelines, conducted the EIA Study with technical guidance from the JICA Study Team.

Based on the findings of the EIA study environmental evaluation of priority projects is made as briefed below. EIA study was not conducted for the flood control projects since they are short length in accordance with applied standard for the survey. Still, environmental evaluation is made covering all 3 types of feasibility projects as given below.

- Ayung Dam Project
- Water Supply Projects (Western, Central and Eastern Projects/Systems)
- Flood Control Projects of Badung and Mati Rivers.

Potential environmental impacts and mitigation measures are dealt with principally focused on significant social issues of pre-construction phase and long-term adverse effects of project operation phase. Still, effects during construction phase are also considered as appropriate. Nevertheless, short-term adverse effects directly attributed to procurement, transportation of construction materials and equipment and the subsequent execution of construction works are not dealt with.

Construction works for all three types of projects involve conventional methods that have already been widely used in Bali. Even for dam, the largest project component, currently Telaga Tunjung dam is under construction. So with the adoption of conventional *good engineering practice* during the planning and execution of the construction works, short-term adverse effects of construction can be minimized, if not entirely eliminated.

9.4.1 Ayung Dam Project

(1) Pre-construction Phase

The most significant social issue of pre-construction phase is the requirement for any resettlement of population involving housing compensation consequent to inundation with dam water. The planned location of dam is uninhabitable since it is a steep sloping terrain and hence no resettlement of population is involved. Social issues which described in Section 9.3.1 are also evaluated as manageable through dialogues among stakeholders.

(2) Construction Phase

Short-term adverse effects on aquatic biota (fauna and flora) due to some increased turbidity of dredging works and also surrounding terrestrial biota due to land clearing and other construction activities is inevitable. However, the surrounding terrestrial environment shall be restored with re-plantation (reforestation) once construction works is over (*good engineering practice*), while the water environment of the dam shall be duly managed as dealt with under item (3) on Post-construction phase of below to ensure good aquatic ecology in dam.

There exist nine terrestrial fauna species, seven birds and two mammals, protected by Indonesian Law. Protected bird species are scientifically common except cekaka jawa while the two mammals are threatened. Still, the range of distribution (habitat) of all nine fauna species covers several surrounding islands and countries (in particular, Java Island and Malaysia).

The two protected mammal species, classified as threatened since their population is low, are Southeast-Asian porcupine (*Hystrix brachyura*) and Pangolin (*Manis javanica*). Some habitat of these mammals will be lost consequent to dam inundation since they live in cave/hole/crack of the steeply sloping Ayung and Siap riversides. Still there remains a large extent of area with similar

characteristics along Ayung and Siap rivers. These mammals are highly responsive and swim well and are expected to escape inundation by moving to alternative terrestrial habitats located elsewhere in the surrounding sloping terrains. Moreover, inundation area by dam of only about 75 ha is extremely small in comparison to the available sloping terrains to serve as alternative habitat. Accordingly, potential adverse effects on both of these threatened mammal species by dam is evaluated as not significant.

In fact the protection of Ayung Dam basin, which is in fact the terrestrial ecosystem of the dam, against further development as delineated under item (3) of post-construction phase of below, in turn would ensure long-term protection of terrestrial habitats for all nine of these protected terrestrial fauna species and hence their long-term survival.

(3) Post-Construction (Operation) Phase

<Natural Environmental Aspect>

Potential Eutrophication and Sedimentation of Dam

The most significant long-term adverse effect the dam might encounter is the deterioration of its aquatic ecology represented by potential eutrophication and hence deterioration of dam water quality in addition to potential rapid sedimentation. It is extremely important to employ proactive long-term management and monitoring measures based on *precautionary principle* to mitigate such occurrence. The mitigation measures will focus integrally both on the basin of dam (218 km^2), which is its terrestrial ecosystem, and the aquatic environment of dam (aquatic ecosystem of dam). Eutrophic water is not amenable for conventional potable water treatment.

The measured phosphorus level of around 0.01 mg/l in the river water just upstream of dam is marginally sufficient to result in potential eutrophication of stored dam water. Still, shallow stationary (lentic) water bodies due to their effective sunlight penetration into water are more prone to eutrophication in comparison to deep ones. Considering the deep-water depth of the dam of more than 50m and only the marginal availability of the primary nutrient (phosphorus) no eutrophication in dam water is anticipated. Still, as precautionary measure both against eutrophication and rapid sedimentation of dam it is planned as a must to protect the terrestrial ecosystem of the dam (total area 218 km^2) against any further significant future development including intensive agricultural development. The long-term objective will be to achieve pristine aquatic environment in dam.

The protection of terrestrial ecosystem of Ayung Dam is beneficial for the protection of the nine protected terrestrial fauna species noted under item (2) of above.

It is noted that as structural measure of controlling sediment inflow to the dam, 2 check-dams at the upstream river reaches to the dam inlet is provided in the two rivers of Ayung (main river) and Siap (tributary of Ayung). Regular removal (dredging) of the accumulated sediment materials, in principle at the end of each rainy season, is required to ensure effective functioning of the check-dams. Sediments materials removed could be beneficially used as construction materials. Accordingly, regular removal of the accumulated materials could be contracted out to some construction materials sourcing company.

The required protection measures for the terrestrial ecosystem of Ayung Dam so as to control both nutrient input and sediment input to the dam are given below.

- Legislation to declare the area (terrestrial ecosystem of dam) as strictly protected against any significant future development oriented change in land-use including intensive agriculture and large-scale hotel and villa developments
- Promotion of organic farming for the existing agricultural lands in the area including exploration of sales opportunities for such organic produce targeting upscale hotels and restaurants
- Promotion of eco-tourism in the area including the surroundings of the dam
- Maintenance of all public owned lands in the area as conserved forestation with reforestation as appropriate with primary focus on critically sloping terrains
- Promotion to maintain even privately owned lands of critically sloping terrains in the area as conserved forestation with reforestation as required

Water Quality Monitoring in Dam

Regular water quality monitoring program in dam is necessary to effectively undertake the necessary protection measures in timely manner against any potential dam water quality deterioration (including eutrophication). A tentative monitoring program to determine the overall water environmental condition of dam with respect to physical, biological, bacteriological and eutrophication potential aspects is proposed below. This monitoring is to be carried out by Balai PSDA (new organization proposed in the Master Plan).

- Locations of monitoring: Minimum of 4 locations, 2 locations near the water inlet river reaches of Ayung and Siap Rivers, 1 location at center of dam and 1 location near the water outlet of the dam.
- Frequency and parameters of monitoring: Frequency of monitoring recommended is on a monthly basis with the minimum of following parameters of monitoring: Temperature, pH, TDS (EC), turbidity, SS, DO, BOD, COD, T-N, T-P, Coliform (total and fecal) level and Phytoplankton density.
- Target dam water quality: The recommended long-term target of water quality of dam, so as to attain pristine aquatic environment, with respect to the basic parameters of BOD (prime indicator of biological pollution) and T-P (prime indicator of potential eutrophication) is set as given below.
  - For BOD the annual average value will not exceed 3 mg/L.
  - For T-P the annual average value will not exceed 0.005 mg/L.

With these protection, management and monitoring measures integrally focused both on the terrestrial and aquatic ecosystems of the dam not only the potential eutrophication and rapid sediment inflow into the dam could be mitigated but also the long-term target of pristine aquatic environment in dam could be attained.

9.4.2 Water Supply Projects

(1) Social Aspects of Pre-construction Phase

The most significant social issue of pre-construction phase is the requirement for any resettlement of population involving housing compensation consequent to the provision of project facilities of water supply systems, basically for the provision of water treatment plants. The locations of treatment plants for both the Western and Eastern projects (systems) are open rice fields that are uninhabited. In case of the Central Project the planned location already lies within the property line of existing IPA Ayung. Accordingly, no resettlement is involved.

Moreover, any social conflict with existing irrigation water user (farmer) rights is avoided for both the West and East projects with direct river water intakes by selecting the intake locations at the most downstream river reaches. Water user rights conflict does not exist for the Central Project since stored water released from the Ayung Dam will be the raw water for intake. Accordingly, no water user rights conflict is involved.

(2) Post-Construction (Operation) Phase

<Potential Adverse Effects of River Water Intake with Weirs>

Reduced discharge at downstream of intake and its potential adverse effects on river ecology may be significant and shall be mitigated. This case is not applicable for the Central System since the intake water taken from the weir is the one that was released from the Ayung Dam and hence there is no net reduction in discharge at downstream of weir. However, this might be an issue for the other two weir intakes (Western and Eastern systems). Still, the amount of intake is planned with due amount of remaining water for release as environmental flow at downstream to sea. Accordingly, in-built design mitigation measure is used in determining the quantity of water intakes.

Another potential adverse ecological effect due to weir intake, which should be the case with all existing weirs in Bali rivers since they have no fish ladders, is the potential inhibition of fish migration upstream. However, for the two systems of West and East, since the existing weirs in the rivers (Penet and Petanu rivers) are located at far upstream of the intake weirs of this project and also nekton (fish) sampling results indicated that fish migration occurs upstream of the intakes, it has been decided to provide fish ladders for both weirs as in-built design mitigation measure.

Fish ladder for the weir of Central System in Ayung River was not incorporated since there exist many

weirs, all without fish ladders, right from the very upstream of the weir of this project (existing Peraupan Weir, Mambal Weir and others)) and also at downstream (existing Oongan Weir and Waribang PDAM Intake with Rubber Dam) and hence provision of fish ladder only for this weir is not expected to facilitate any significant fish migration in river.

<Generation of Waste Sludge at Water Treatment Plants>

The production of clean water from raw river water also results in waste sludge (residuals) generation principally as settled matter in the sedimentation tank of the water treatment plant. Nevertheless, such sludge could be easily dewatered and dried in earthen ponds or other simple drying beds and beneficially used as soil conditioner or material for land reclamation. Still they have no beneficial use as agricultural soil due to their lack of nutrient value.

The design of the three water treatment plants by these projects (Western, Central and Eastern Systems) incorporates sludge-drying facilities as a precautionary measure against river water environmental degradation and also as good engineering practice of waste sludge management. The dried sludge could be beneficially used as soil conditioner or material for land reclamation.

The waste sludge generated at each water treatment plant will be managed and brought to the authorized final disposal place by each Water Supply Company (PDAM).

<Wastewater Generation Consequent to Consumption of Supplied Water>

In general, about 80% of water consumed is discharged as wastewater. In the absence of sewerage system such discharged wastewater finally ends up in surface river waters resulting in water environmental degradation as evident from the current status of Badung and Mati rivers.

This surface water environmental degradation issue is being addressed by the ongoing DSDP as the initial phase of sewerage system development for Denpasar and Kuta areas. Accordingly, as the long-term mitigation measure against potential surface water environmental degradation it is imperative to make the necessary plans in future to expand the sewerage system to cover the new water service areas as per these projects as well.

9.4.3 Flood Control Projects

The planned river improvement works in the urban river reaches of Badung and Mati rivers are basically routine maintenance works to ensure the river flow capacity of the rivers. Portions of river improvement works in these rivers have already been accomplished recently. These two river reaches have undergone similar drainage improvement works many times in the past and potential adverse effects are considered as easily manageable and insignificant. Still, there exists two significant issues of social aspects and dredged material management aspects that would require due justification and hence illustrated below.

(1) Social Aspects of Pre-construction Phase

The entire river improvement reach of Badung river is surrounded with residential developments located right adjacent to their both river bank areas and hence no river widening work is possible without resettlement of population and demolition of houses located along banks. This is regarded as socially impractical and the entire river improvement works planned is basically composed only of deepening of riverbed and provision of floodwall (parapet walls).

Planned river improvement reaches of Mati River is still located in relatively low population density area surrounded with open fields including agricultural lands (rice fields). Some of such agricultural lands are planned to be reserved as retarding areas of flood control, nonstructural measure. Also the planned river improvement works would involve river-widening works as well since no residential settlement is involved and required land could be easily acquired.

(2) Dredged Material Management Aspects of Construction Phase

The most significant environmental issue concerned to these river improvement works (in construction phase) is the management of dredged riverbed material since these urban riverbeds are potentially contaminated.

Still during annual flood discharge of rainy season the surface layers of these riverbeds where settled contaminants accumulate should be naturally flushed off to sea thereby resulting in clean riverbeds.

Accordingly, by planning the dredging works just after the end of rainy season uncontaminated riverbed material could be dredged that could be beneficially used for land reclamation and others. In fact this environmentally preferred timing of dredging is in agreement with the timing of *good engineering practice* for conducting flood control related construction works. It is natural to carryout the river improvement works just after the end of rainy season and terminate it well before the start of rainy season so as to avoid any interference with flood discharge due to the construction (river improvement) works itself. Accordingly, dredging work can easily avoid dredging of significantly contaminated material.

The dredged materials produced by river bed excavation during construction period will be managed and brought to the authorized final disposal place(s) by the contractor(s). according to the method accepted by the Project Implementation Agency (Provincial Government).

9.4.4 Conclusion of Environmental Evaluation

It is concluded that there are potential adverse environmental effects consequent to the implementation of the priority projects, in particular, the Multipurpose Ayung Dam Project and the Water Supply Projects (Western, Central and Eastern Water Supply Projects/Systems). There are inevitable adverse effects for the species of not only terrestrial fauna and flora but aquatic fauna and flora due to construction. Based on the EIA study results to be implemented by AMDAL, countermeasures such as tree planting and water quality conservation for the mitigation against adverse effects should be curried out during construction as well as after construction. Detailed environmental study such as the location of nesting ground and the flight activities on endemic bird in Bali also shall be needed before construction of Ayung Dam Project. Accordingly, the proposed priority projects should be implemented carefully by adopting the proper countermeasures to minimize, to mitigate and to avoid adverse environmental effects.

9.5 Overall Evaluation

The overall evaluations classified both benefits and costs on quantified items and both beneficial effects and adverse effects on non-quantified items for Ayung Dam and SARBAGI water supply project are tabulated in Table-III-9.12.

Table-III-9.12 Overall Evaluation for Ayung Dam and SARBAGI Water Supply Projects

<table>
<tr><td>Items</td><td>Benefits</td><td>Costs</td></tr>
<tr><td rowspan="2">Quantified Items</td><td>1) Beneficial effects of water supply
Household water supply
Commercial and public water supply
Industrial water supply
2) Hydropower generation (46,000 Mwh/year)
3) Expansion of double-cropping area resulting from irrigation water supply(310 ha)</td><td>1) Construction cost (including reservoir sediment management and environmental expenditures)
2) Land acquisition and compensation
3) Government administration expense
4) Engineering services
5) Contingency
6) Operation & Maintenance cost</td></tr>
<tr><td colspan="2">Evaluation: The projects are economically feasible, since economic internal rate of return (EIRR) would be 14.0% for the multipurpose dam and 12.5% for the water supply in SARBAGI area.</td></tr>
<tr><td rowspan="2">Non-quantified Items</td><td>Beneficial Effects</td><td>Adverse Effects</td></tr>
<tr><td>1) Effects of installation of facilities
・ Avoidance of damage from water disruption through stable water supply
・ Reduction of health damage through prevention of waterborne infectious diseases
・ Improvement of living environment for users
・ New transportation route by using the road of dam crown
・ Use of dam body, reservoir, etc. for education and sports
・ Creation of tourism and other new business opportunities with secondary effects
・ Improvement of local living standards through increase in users of reservoir
・ Increase in asset value
2) Effects of project implementation
・ Expansion of employment opportunities</td><td>1) Effects on environmental aspect
・ Sludge generation from water purification treatment
・ Noise and vibration during construction
・ Topographical change due to creation of reservoir
・ Eutrophication and sedimentation in reservoir
・ Disappearance and alteration of existing ecosystems
・ Effects on endangered and precious wildlife species
・ Ecosystem change due to hydrological changes in downstream sections
・ Change of river channel in downstream
2) Effects on social and economic aspects
・ Decrease in tourists for existing tourism operations
・ Effects of worker influx on local community
・ Effects on existing sacred sites (sacred water, shrine, etc.)</td></tr>
</table>

	・ Increase in local sales through influx of workers	
	1) Prevention and Mitigation of Adverse Effects ・ Sludge will be used for banking and backfilling, as well as used as land improvement material. ・ Although generation of vibration and noise is inevitable, this will be minimized by the use of low-noise, low-vibration construction machines. ・ The effects of worker influx are considered to be small, because employment of local workers is prioritized. ・ The effects of change of topography will be minimized through restoration of vegetation on excavated slopes, use of methods minimizing excavation for construction roads, etc. ・ Although the possibility of eutrophication is low according to the relationship between "phosphorus load" and "mean water depth of reservoir x reservoir rotation rate," monitoring will be executed. Sedimentation will be managed by the installation of check dams at the upstream of reservoir. ・ The effect of disappearance and change of existing ecosystems will be small, because the environmental study concerning the priority project has confirmed the presence of similar ecosystems in many cases. ・ Although the effects of the project on endangered and precious species identified in the environmental study will be small, monitoring and evaluation of environmental effects will be performed during implementation of the project. ・ The effect of the change of ecosystems due to the hydrological changes in downstream will be small, because the discharge from the dam will maintain a stable flow condition throughout the year without large fluctuation. ・ Although the change of river channel is expected to occur in the form of degradation of riverbed, the effect will be minimal because it mostly consists of bedrock. Monitoring will be performed. ・ The starting point used by an existing rafting company will be affected. The alternative of moving of site to a downstream will be suggested. ・ The effects on sacred sites or holy place will not involve large temples or shrines. However, because a wind cave and sacred water will be affected, negotiation with the Hindu association and local community has started. 2) Evaluation of Beneficial and Adverse Effects ・ Because the implementation of the water supply project will provide water supply satisfying the demand, the effect of water supply restriction on the daily living of citizens will be reduced and interruption of operation of factories and other facilities will be avoided. ・ The improvement of water quality will result in the improvement of public health and reduction of waterborne infectious diseases. This will lead to the reduction of healthcare cost. A decrease in worker absence and other losses is also expected from the decrease in diseases. ・ The new transportation route using the road on dam crown will facilitate local traffic and eliminate the need for a detour route. It can also be used for the access to tourist destinations from Ubud and other neighboring cities. ・ The development of a culture village, friendship village, educational facilities, commercial facilities, etc. using the dam body and reservoir area will provide new opportunities for regional revitalization, education, tourism development, employment, and increase in income. ・ The implementation of the above projects will be effective in stopping the outflow of local population and promoting local commercial activities. ・ The items expected to cause adverse effects on environmental and social aspects will be addressed with conservation, protection, avoidance, replacement, and other measures during the implementation of the project. ・ According to the qualitative comparison between beneficial and adverse effects outlined in the above, adverse effects are sizable, but they are slightly exceeded by beneficial effects.	
Evaluation	The economic internal rate of return (EIRR) would be between 12.5% and 14.0%, exceeding the discount rate of 10 to 12% used as the basis for evaluating economic feasibility of Indonesian water resource projects by the World Bank and the Asian Development Bank. Therefore, the project is considered economically as feasible. Although adverse effects are expected in non-quantified effects, beneficial effects are considered to exceed them. In overall evaluation, implementation of this project is considered as appropriate.	

The overall evaluation for flood control project in Badung and Mati River is shown in Table-III- 9.13.

Table-III- 9.13 Overall Evaluation for Flood Control Project in Badung and Mati River

<table>
<tr><td>Items</td><td>Benefits</td><td>Costs</td></tr>
<tr><td rowspan="2">Quantified Items</td><td>Reduction of damage in flooding area
(approx. 3,000 ha)
(houses, household goods, farmland)</td><td>1) Construction cost (including environmental expenditures)
2) Land acquisition and compensation
3) Government administration expense
4) Engineering services
5) Contingency
6) Operation & maintenance cost</td></tr>
<tr><td colspan="2">Evaluation: The projects are economically feasible, since economic internal rate of return (EIRR) would be 15.0%.</td></tr>
<tr><td rowspan="2">Non-quantified Items</td><td>Beneficial Effects</td><td>Adverse Effects</td></tr>
<tr><td>1) Facility effects
・ Improvement of safety through reduction of damage by flood
・ Reduction of damage from interruption of business operation
・ Reduction of damage from interruption of traffic
・ Creation of new waterfront environment
・ Upgrading land use in surrounding areas resulting from reduction of damage by flood
2) Effects of project implementation
・ Offer for job opportunities</td><td>1) Effects on environmental aspect
・ Effects of construction work on existing ecosystems including fishes and vegetations
・ Effects of vibration and noise from construction work
・ Generation of turbid water from construction work
2) Effects on social and economic aspects
・ Effects on existing sacred sites (sacred water, shrine, etc.)
・ Restriction on land use in Retarding Basin of Mati River</td></tr>
<tr><td colspan="3">1) Prevention and Mitigation of Adverse Effects
・ Although effects on fishes are expected, such effects will be small because the continuity between upstream and downstream areas will be maintained by the work divisions during construction. The effects on plants can be avoided by means of transplanting.
・ Although generation of vibration and noise is inevitable, this will be minimized by the use of low-noise, low-vibration construction machines.
・ Turbid water will be managed by the use of a sedimentation pond and water quality checking before discharge.
・ The effects on existing sacred areas will be addressed through negotiation with the local community and Hindu association, including possible construction of substitute facilities.
・ While the restriction on land use is important for the purpose of ensuring the flood control function, this will involve adverse effects such as prohibition of development in the retarding basin.
2) Evaluation of Beneficial and Adverse Effects
・ River improvement in the project scale with once for 25 years will enhance the reliability of flood control.
・ The improved safety will result in reduced occurrence of interruption of business operation and traffic.
・ Adopt of an environment conscious cross-section will create new waterfront environment.
・ The improvement of the reliability of flood control will cause increase in asset value such as rising of land prices, encouraging more advanced land use.
・ According to the qualitative comparison between beneficial and adverse effects, adverse effects on the environment are expected, but they are slightly exceeded by beneficial effects such as improvement in the degree of safety.</td></tr>
<tr><td>Evaluation</td><td colspan="2">The economic internal rate of return (EIRR) would be 15.0%, indicating economical feasibility. Although adverse effects are expected in non-quantified effects, beneficial effects are considered to exceed them. In overall evaluation, implementation of this project is considered appropriate.</td></tr>
</table>

As a result of the overall evaluation, the priority projects are feasible to be implemented immediately from technical, economical & financial and social & environmental aspects. However, as the environmental study done by the Study Team is supplementary one, the executing agencies of the projects shall implement the AMDAL (Regal Environmental Assessment in Indonesia).