4.3 Facility Design and Cost Estimate

4.3.1 Facility Design

(1) Design of River Improvement Works

(a) Main River Improvement Works

River improvement works were designed according to the river improvement plan of the priority project. The structure of river improvement works was designed taking into account the following points:

- In order to protect existing flood walls against excavation of riverbed, sheet piles (YSP-II) and earth anchors are designed.
- As measures against flood during construction, river stream was planned to be diverted constructing sheet piles in the center of river course.
- Flood wall was designed as L-shape reinforced concrete revetment, as shown in typical section.
- The width of flood wall is designed to be 0.5 m
- Foundation of flood wall is planned to be reinforced with 0.5 m deeper foundation for foot protection than foundation of flood wall in case of three sided concrete channel.

Typical cross sections of proposed river improvement works are shown in Figure-I.4.29. As for the section of concrete channel, taking into account of the impact to groundwater and water utilization, a small channel and shallow wells should be designed in a river course in order to keep groundwater recharge from river water and water utilization such as washing and bathing.

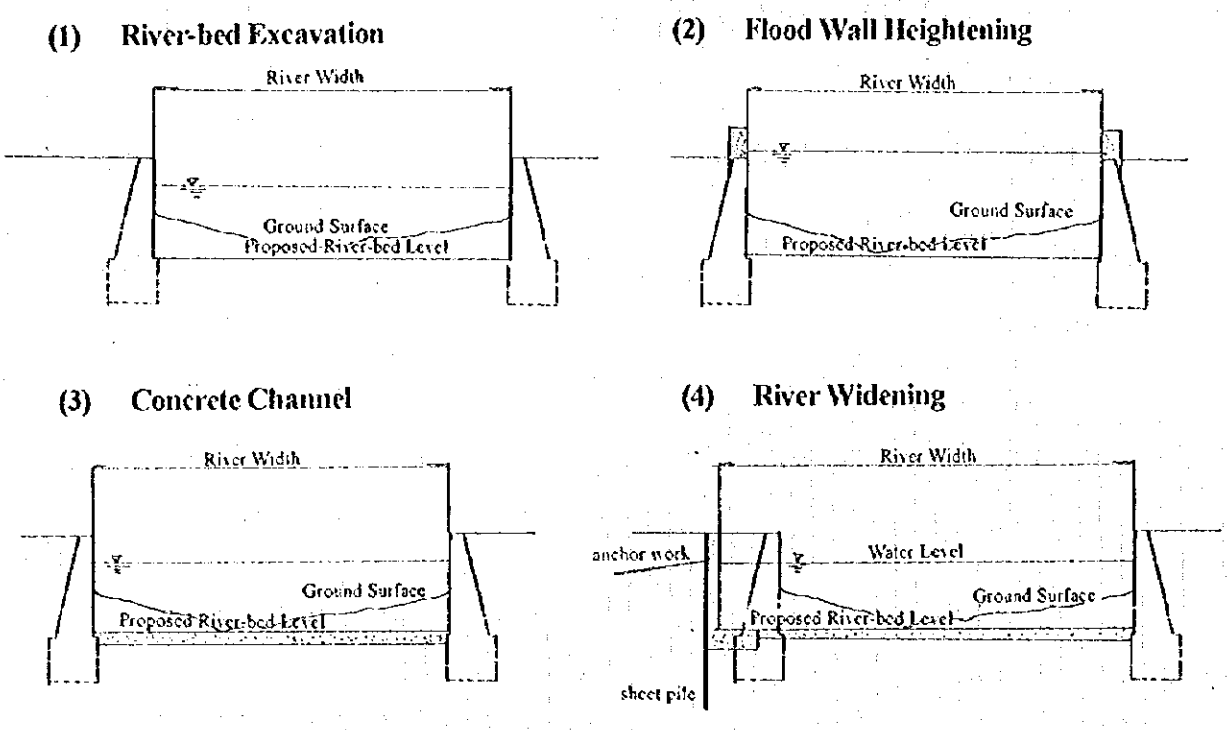


Figure-I.4.29 Typical Cross Sections of River Improvement

(b) Related Structures

All the drainage to rivers should be improved installing gates so as not to backflow to city or houses. Gates to be installed are classified into 3 types according to the sizes of drainage as follows:

- Type A (W >= 1.0 m) : Steel Slide Gate
- Type B (0.5 m <=W < 1.0 m) : Wooden Slide Gate
- Type C (W < 0.5 m) : Wooden Stoplogs

Existing bridges are classified into vehicle bridges and foot bridges. These bridges are planned to be basically reconstructed because sheet piles are planned in the center of river course for diverting river flow during construction. Studying the possibility of rehabilitation instead of reconstruction, only three vehicle bridges are possible to be rehabilitated.

(c) Construction Quantities of River Improvement Works

Construction quantities of river improvement works for each river are shown in Table-I.4.21.

Table-I.4.21 Quantities of River Improvement

Item	Ruhu	Batu Merah	Tomu	Batu Gajah	Batu Gantung	Total
Main River Improvement Works						
Riverbed Excavation (m^3)	25,900	20,600	28,000	18,800	12,300	105,600
Concrete of Flood Wall (m^3)	3,050	7,200	15,900	9,950	6,550	42,650
Sheet Pile (m)	600	1,140	1,010	920	620	4,290
Ground Anchor (number)	100	400	205	180	130	1,015
Drainage Improvement (number)						
Gate Type A	2	3	2	4	3	14
Gate Type B	13	10	17	19	6	65
Gate Type C	3	1	-	2	-	6
Bridge Improvement (number)						
Reconstruction : Foot Bridge	3	4	7	12	2	28
: Vehicle Bridge	1	-	1	1	2	5
Rehabilitation : Vehicle Bridge	-	1	2	-	-	3
Compensation						
Land Acquisition (m^2)	615	1,250	1,781	859	791	5,296
Settlement (house)	5	21	10	19	26	81

(2) Design of Batu Merah Diversion

(a) Design Condition

Design conditions of diversion works are described as follows:

- The diversion point is planned at 1k400 from Batu Merah River Mouth.
- The main river discharge of 130 m^3/sec is divided between the diversion with 70 m^3/sec and the main stream with 60 m^3/sec.
- Flow condition of the river diversion point at 1k400 is as follows:
  River width : 7.00 m Riverbed slope : 1/320

Lining : three sided concrete channel　　Manning's roughness : 0.015
Water height : 3.50m　　Froud number : 0.924

- Initial discharge to start diversion is set at 20 m^3/sec (water height is about 1 m).
- Standard cross section of the diversion tunnel is designed based on the following conditions:
  - Horseshoe shaped section is adopted.
  - Manning's roughness : n=0.023 (assuming concrete lining with n=0.015*1.5)
  - Design discharge : Q=78 m^3/sec (60 m^3/sec*1.3)
  - Planning water height : 80 % of diameter
  - Flow velocity : under 7m/sec

(b) Diversion Tunnel

The structure of diversion tunnel is shown in Table-I.4.22. The plan and standard cross section of the diversion tunnel is shown in Figure-I.4.30.

Table-I.4.22 Dimension of Diversion Tunnel

Item	Dimension	Remarks
Outlet Level	0.80m	High Tide Sea Level
Inlet Level	2.80	
Tunnel Length	900m	
Tunnel Gradient	1/450	
Diameter of Cross Section	6.00m	Horseshoe shape section

(c) Fixed Weir

The principal specifications of the fixed weir, which was planned in the river section at 1k400, are shown in Table-I.4.23.

Table-I.4.23 Condition of Fixed Weir Design

Item		Dimension
Main Stream	Weir	Fixed Weir
	Top of Weir	4.39m
	Length of Weir	10.0m
	Height of Weir	1.0m
	Overflow Depth	2.6m
Diverted Stream	Weir	Fixed Weir
	Top of Weir	5.29m
	Length of Weir	18.0m
	Height of Weir	0.9m
	Overflow Depth	1.7m

(d) Construction Quantities

Construction quantities of Batu Merah Diversion are shown in Table-I.4.24.

Table-I.4.24 Construction Quantities of Diversion

Item	Tunnel	Inlet	Outlet
Length	900m	37m	60m
Excavation	A=45.4m^2, 40,900m^3	4,100m^3	1,400m^3
Concrete	A=15.5m^2, 13,950m^3	830m^3	320m^3
Supporting Work	900m	-	-
Sheet Pile	-	-	100m

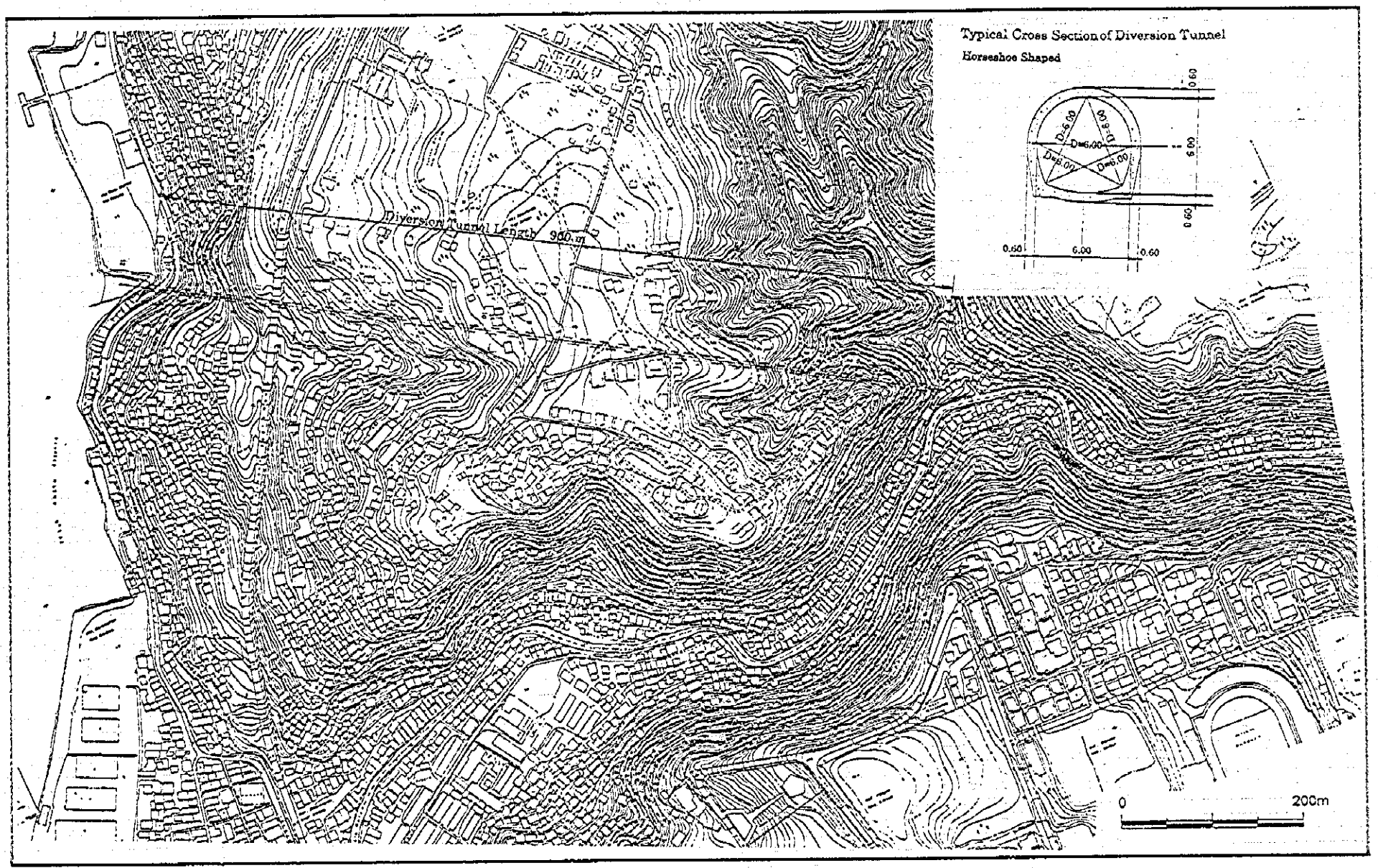


Figure-I.4.30 Plan and Standard Cross Section of Batu Merah Diversion Tunnel

(3) Design of Dams

(a) Principal Features and Design Conditions

Design of Batu Gajah Multi-purpose Dam and Batu Gantung Multi-purpose Dam is carried out. The dam plans of these dams are shown in Figure-I.4.31 and Figure-I.4.32. The principal features and design discharges of the dams are shown in Table-I.4.25 and Table-I.4.26.

Table-I.4.25 Design Condition of Dam

Details	Unit	Batu Gajah Dam	Batu Gantung Dam
Surcharge Water Level(SWL)	EL.m	70.50	102.10
Normal Water Level(NWL)	EL.m	66.60	96.80
Low Water Level(LWL)	EL.m	51.60	85.90
Effective Storage for Water Supply	m^3	955,000	639,000

Table-I.4.26 Design Flood Discharge

Details	Batu Gajah Dam		Batu Gantung Dam	
	Discharge	Scale	Discharge	Scale
Design Discharge	$90m^3/s$	30-year	$92m^3/s$	30-year
Diversion	$80m^3/s$	10-year	$82m^3/s$	10-year
Emergency Spillway	$190m^3/s$	2,000-year	$190m^3/s$	2,000-year

(b) Design of Main Dam

After geological survey of the dam sites, Quaternary Limestone was found to be distributed in the dam site and reservoir area. The dam type of rock fill dam with inclined clay core was adopted because water leakage prevention measures are necessary and because dam foundation rock strength is not expected to be strong enough.

The dam crest elevation should be decided to be safe against flood discharge, reservoir water wave by wind and earth quake and other allowance. Dam crest elevation is decided using follows formula.

[Dam Crest Elevation]=[S.W.L.]+[Emergency Spillway Depth]+[Freeboard 3m]

The major structural features of the dams are shown in Table-I.4.27.

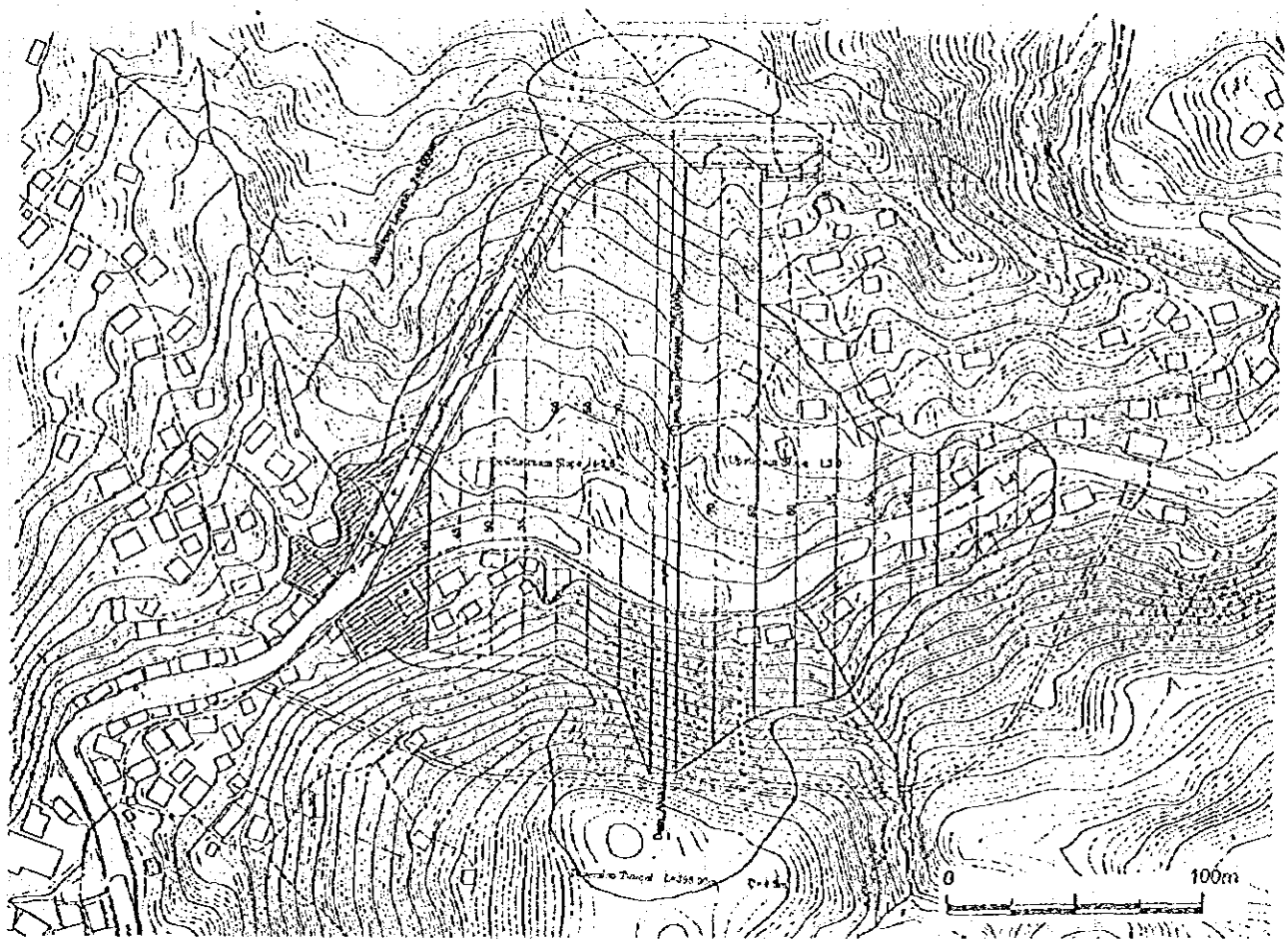
(c) Reservoir Protection

After geological survey of the dam sites, Quaternary Limestone was found to be distributed in the dam sites and reservoir areas of both rivers. Thus water leakage prevention measures, of which structure is shown in Figure-I.4.31 and Figure-I.4.32, are designed in the reservoir areas as follows:

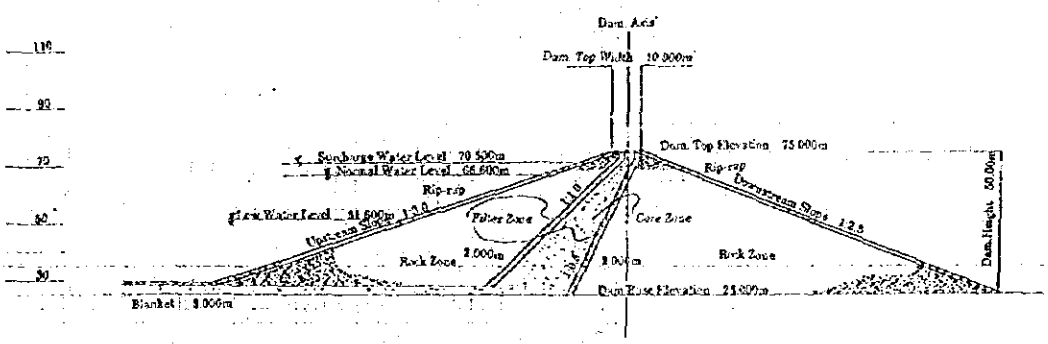
Water leakage prevention measures in the reservoir areas are follows:

- Riverbed area : Concrete channel
- Gentle slope area : Soil blanket
- Steep slope area : Shotcrete

Plan of Batu Gajah Dam



Typical Cross Section of Dam



Typical Cross Section of Water Leakage Prevention Measures

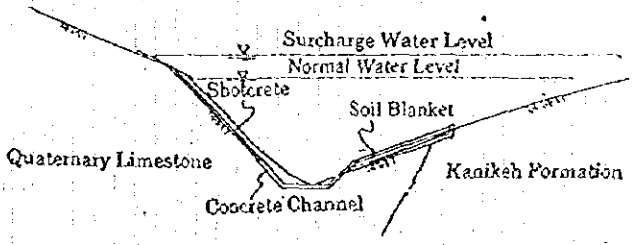
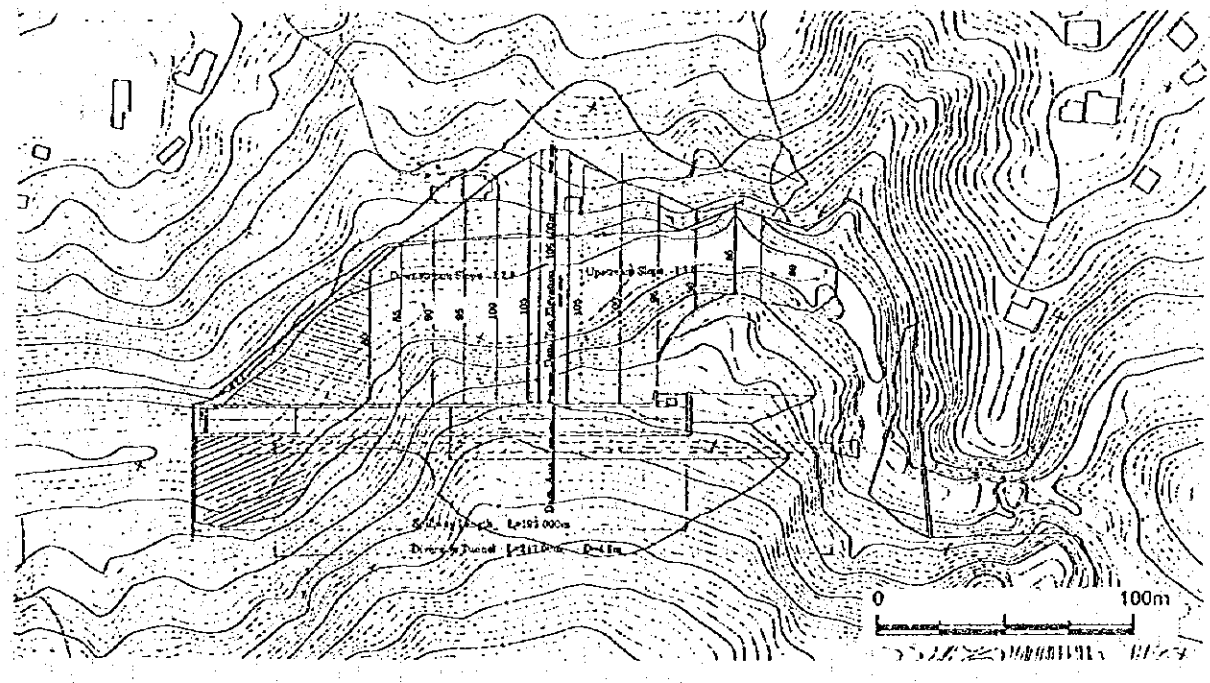
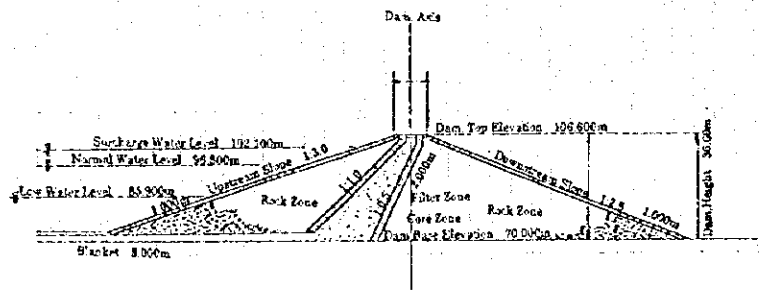


Figure-I.4.31 Batu Gajah Multi-purpose Dam

Plan of Batu Gantung Dam



Typical Cross Section of Dam



Typical Cross Section of Water Leakage Prevention Measures

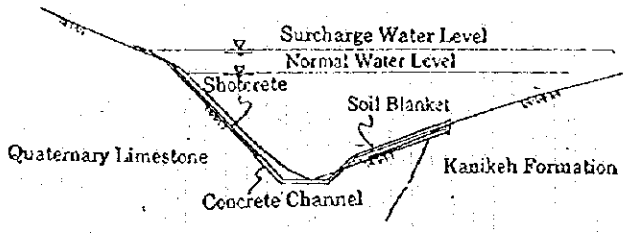


Figure-I.4.32 Batu Gantung Multi-purpose Dam

Table-I.4.27 Major Structural Features

Item	Batu Gajah	Batu Gantung
Reservoir		
Gross Storage Capacity	1,532,000m^3	1,337,000m^3
Effective Storage Capacity	1,361,000m^3	1,146,000m^3
Flood Water Level (FWL)	72.000 m	103.600 m
Surcharge Water Level (SWL)	70.5000 m	102.1000 m
Normal Water Level (NWL)	66.600 m	96.800 m
Low Water Level (LWL)	51.600 m	85.900 m
Sediment level	51.600 m	85.900 m
Effective Depth	*18.900 m*	*16.700 m*
Surface Area at SWL	0.11 km^2	0.11 km^2
Catchment Area	4.27 km^2	4.76 km^2
Dam		
Type	Rock Fill Dam with Inclined Clay Core	
Dam Crest Elevation	EL. 75.00m	EL. 106.60m
Height	50.00m	36.60m
Freeboard	3.00 m	3.00 m
Crest Length x Crest Width	*240 x 10*	*100 x 10*
Non-overflow Crest Elevation	EL. 75.00m	EL. 106.60m
Volume of Dam	597,000 m^3	159,000 m^3
Base Width	52.00m	25.00m
Dam Slope : Upstream	1 : 3.0	1 : 3.0
: Downstream	1 : 2.5	1 : 2.5
Spillway		
Type	Non Gated Type	Non Gated Type
Discharge Capacity	*190m^3/s (2,000-year)*	*220m^3/s (2,000-year)*
Emergency Spillway		
Overflow Crest Elevation	EL. 70.50 m	EL. 102.10 m
Overflow Depth	1.5m	1.5m
Length	13.5m	12.0m
Diversion Tunnel Works		
Number	1	1
Length of Tunnel	398.00m	192.00m
Inner Diameter	4.5 m	4.5 m
Total Design Capacity	66 m^3/s	74 m^3/s

(d) *Construction Quantities of the Dams*

Construction quantities of the dams are shown in Table-I.4.28

Table-I.4.28 Dam Construction Quantities

Item	Batu Gajah Dam	Batu Gantung Dam
Diversion Tunnel		
(1) Length	398.0 m	217.0m
(2) Diameter	4.5 m	4.5 m
(3) Excavation	10,800 m^3	5,900 m^3
(4) Concrete	3,550 m^3	1,940 m^3
Dam Body		
(1) Core	108,000 m^3	26,000 m^3
(2) Filter	47,000 m^3	11,000 m^3
(3) Rock	442,000 m^3	122,000 m^3
(4) Excavation	115,000 m^3	37,000 m^3
Spillway		
(1) Excavation	including in Dam Body Excavation	
(2) Concrete	12,420 m^3	10,580 m^3
Reservoir		
(1)Blanket Protection	47,000 m^2	40,000 m^2
Intake Gate	1 set	1 set
Approach (Road)	1 set	1 set
Control Building	1 set	1 set

(4) Design of Check Dam

The check dams were designed as a masonry gravity dam. Specifications of the check dams are shown in Table-I.4.29.

Table-I.4.29 Specification of Check Dams

River	Ruhu	Tomu	Batu Gajah	Batu Gantung
Dam Type	Masonry Gravity Dam			
Basement Elevation EL(m)	62.0	34.5	115.5	110.0
Dam Height (m)	3.8	4.9	6.1	3.5
Dam Length (m)	51.0	39.0	32.0	25.0
Overflow Depth (m)	4.17	1.89	2.44	2.96
Free Board (m)	0.80	0.60	0.60	0.60
Spillway Height (m)	4.97	2.69	3.04	3.56
Spillway Width (m)	17.0	15.0	10.0	8.0
Dam Volume (m^3)	1,000	800	750	300

Note: River Bed Excavation is set as 1.0m depth.

(5) Design of Land Reclamation Area

The maximum depth for the sea wall necessary to enclose the land reclamation area was assumed as - 2.0m below mean sea level. Reclamation area was assumed as + 2.0m above mean sea level. From the bathymetric map, which was surveyed and made by JICA Study Team, the available area for land reclamation and the potential volume for disposal of excavated material was calculated as shown in Table-I.4.30.

Table-I.4.30 Available Area for Land Reclamation

Name	Type	Area	Average Depth	Total Volume	Sea Wall Dimension	
					Average Height	Total Length
Wai Nitu	New Reclamation	6.56 ha	3.0 m	196,800 m^3	4.5 m	865 m

4.3.2 Construction Plan and Schedule

(1) Planning Condition

(a) Division of Project Construction

The project construction works were divided into four main construction works as follow:

[1] River Improvement Works
[2] Land Reclamation Works
[3] Diversion Tunnel Works
[4] Dam Construction Works

(b) Construction Condition

A year can be divided into dry season and rainy season in Ambon. Studying existing rainfall data, rainy season is assumed to be from May to August and dry season from September to April. River improvement works are planned to be concentrated in the dry season. The number of working days is set at 16.6 days/month for dam construction and 22.3 days/month for other construction works, taking it into account that core embankment works would be affected by rain.

(c) Transportation Route of Construction Material

Transportation route of construction material is necessary to be decided, taking into account 1) current road condition to the dam sites, 2) vehicle transportation condition.

(2) Construction Plan of River Improvement

(a) Package Division

Due to difficulties to access to the vicinity of river improvement site, river improvement sections are planned to be divided into the following 24 packages, each package of 400 m length.

Table-I.4.31 Package Division

River	Length	Packages	Excavation
Ruhu River	1,600 m	4	25,900 m^3
Batu Merah river	1,500 m	4	20,600 m^3
Tomu River	2,700 m	6	28,000 m^3
Batu Gajah River	2,200 m	6	18,800 m^3
Batu Gantung River	1,450 m	4	12,300 m^3
Total	9,050 m	24	105,600 m^3

(b) Construction Equipment and Working Days

Necessary construction equipment and working days are studied as follows :

<Riverbed Excavation>

- Construction equipment : 0.6 m^3 excavator
- Unit Excavation Quantities : 259 m^3/day (37 m^3/hour * 7 hours/day)
  : 5,775 m^3/month (Working days : 22.3 days/month)

<Excavation Work Period>

Riverbed excavation is planned to be carried out from the downstream, taking into account temporary diversion during construction. Riverbed excavation work will be carried out during 8 month of dry season from September to April.

<Concrete Placement>

Sheet piles for temporary diversion and dump truck transportation for excavated material could disturb concrete placement of flood walls due to limited construction space. Therefore concrete placement was planned to be carried out starting from the section with no affection of truck transportation. Assuming 2 parties for concrete placement, construction length per month is estimated to be 300 m/month.

(c) Construction Schedule for River Improvement Works

Construction schedule of the work items, such as placement at sheet pile, riverbed excavation and concrete placement, is shown in Table I.4.32.

Table-I.4.32 Construction Schedule for River Improvement Works

River	Excavation	Widening	Concrete Channel	Total
Ruhu River	4.5 months	2.0 months	-	6.5 months
Batu Merah River	3.6 months	8.0 months	4.7 months	16.3 months
Tomu River	4.9 months	4.0 months	8.0 months	16.9 months
Batu Gajah River	3.3 months	3.6 months	7.4 months	14.3 months
Batu Gantung River	2.2 months	2.6 months	4.9 months	9.7 months
Total	18.5 months	20.2 months	25.0 months	63.7 months

In river improvement works, 2 parties for sheet pile works, 2 parties for riverbed excavation and 4 parties for concrete placement are needed.

(d) Bridge Improvement and Drainage Improvement

Bridge improvement and drainage improvement are planned to be carried out during construction of the other river improvement works

(3) Construction Plan of Diversion Works

(a) Construction of Diversion Tunnel

Diversion tunnel is planned to be excavated from the outlet, taking into account drainage and waste soil during construction. Excavation method is adopted as whole section excavation method, because of small tunnel section, which is 6.0 m in diameter and 30 m^2 in section area. Assuming 1.5 m/day of tunnel excavation applying progress rate of other tunnel excavation works, it is estimated to take a total of 28 months (900m / 1.5m/day = 600 days) for the diversion tunnel excavation. Concrete lining works for the tunnel are planned to be carried out in parallel with excavation.

(b) Construction of Diversion Inlet

Construction of the diversion inlet is planned to be carried out after the completion of tunnel excavation, due to difficulties in transportation of waste material. It is estimated to take 4 months for construction of the diversion inlet.

(c) Construction of Diversion Outlet

Part of the diversion outlet estuary is planned to be used as temporary stock yard for construction equipment and material by placing sheet piles. These works should be the first works in the construction of diversion, even though the diversion outlet works is planned to be the final works. It is estimated to take 4 months for construction of the diversion outlet.

(4) Construction Plan of Dams

(a) Quarry Site

Core, filter and rock materials of the dams are planned to be quarried from just upstream of both dams within the same river basin, on the basis of the results from soil and rock material tests. Construction materials for both dams are planned to be taken from same quarry site. The location of the quarry site is shown in Figure-I.4.33.

(b) Access Road

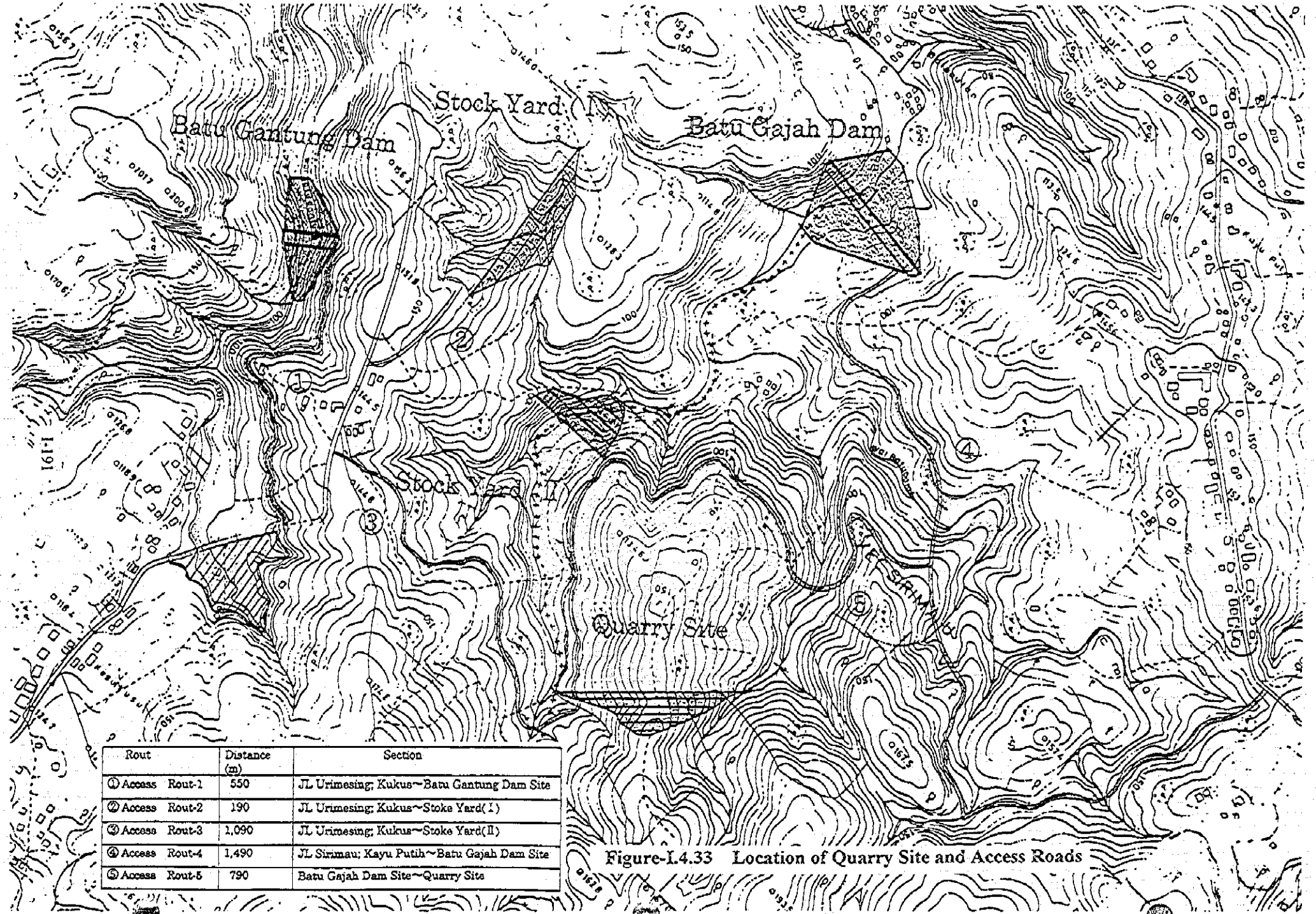
Access roads connecting both dam sites to the existing road and the quarry site are planned as shown in Figure-I.4.33. The width of access road is set at 8.0 m. Excavation quantities and construction period of access road works are shown in Table-I.4.33.

Table-I.4.33 Access Roads

Access Road	Length	Planned Excavation Volume	Construction Period
Access road No.1	550 m	8,800 m	1.5 months
Access road No.2	190 m	3,100 m	0.5 months
Access road No.3	1,090 m	17,500 m	3.0 months
Access road No.4	1,490 m	23,900 m	4.0 months
Access road No.5	790 m	12,700 m	2.0 months
Total	4,110 m	66,300 m	11.0 months

(c) Leakage Prevention Measures for Reservoirs

Leakage prevention measures for both dam reservoirs are needed. Before construction of diversion works, riverbed leakage prevention measures using concrete channel works should be implemented.



Rout	Distance (m)	Section
① Access Rout-1	550	JL Urimesing; Kukus~Batu Gantung Dam Site
② Access Rout-2	190	JL Urimesing; Kukus~Stoke Yard(I)
③ Access Rout-3	1,090	JL Urimesing; Kukus~Stoke Yard(II)
④ Access Rout-4	1,490	JL Sirimau; Kayu Putih~Batu Gajah Dam Site
⑤ Access Rout-5	790	Batu Gajah Dam Site~Quarry Site

Figure-I.4.33 Location of Quarry Site and Access Roads

(d) River Diversion Works

River diversion works are planned as tunnels, length and construction period of which are shown in Table-I.4.34.

Table-I.4.34 Length and Construction Period of River Diversion Tunnels

Dam	Tunnel Length	Progress	Construction period
Batu Gajah Dam	398.0 m	1.5 m/day	265 days
Batu Gantung Dam	192.0 m	1.5 m/day	128 days

(e) Main Dams

Excavation (31 t Bulldozer, 1.2 m^2 Excavator)

Dam	Excavation Volume	Progress	Construction period
Batu Gajah Dam	155,000 m^3	791 m^3/day	196 days
Batu Gantung Dam	37,000 m^3	791 m^3/day	47 days

Embankment (Tamping Roller : 20.7-24.5 t)

Dam	Embankment Volume	Progress	Construction period
Batu Gajah Dam	108,000 m^3	539 m^3/day	200 days
Batu Gantung Dam	26,000 m^3	539 m^3/day	48 days

(f) Spillways

Spillway works are planned to be carried out in line with embankment works of main dams.

(5) Construction Schedule

Construction schedule is shown in Figure-I.4.34, which was prepared based on the consideration of the above construction plan (1), (2), (3), (4). The construction works of the project were divided into the four components such as 1) river improvement works, 2) diversion tunnel, 3) dam construction and 4) land reclamation. These works is planned to be constructed according to the following construction schedule, of which the total construction period is 5 years (60 months) from April, 2002 to March, 2006.

- River Improvement Works of Ruhu , Batu Merah, Tomu, Batu Gajah and Batu Gantung rivers are planned to be constructed for 40 months from April, 2002 to July, 2005.
- Batu Merah Diversion Tunnel is planned to be constructed for 40 months from April, 2002 to July, 2005.
- Batu Gajah and Batu Gantung Dam construction works is planned to be constructed for 57 months from April, 2002 to December, 2006.
- Land Reclamation work near Nitu River is planned to be constructed for14 months from April, 2002 to July, 2003.

Figure-I.4.34 Construction Schedule

Item	Unit	2002						2003						2004						2005						2006						2007					
		A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F	A	J	A	O	D	F
1.River Improvement Works																																					
1.1 Preparatory Works	Ls																																				
1.2 River Bed Excavation	105,600 m3																																				
1.3 Concrete Work	42,650 m3																																				
1.4 Drainage Gate Works																																					
1.5 Bridge Improvement																																					
1.6 Sheet Pile																																					
1.7 Anchor Work																																					
2.Diversion Tunnel																																					
2.1 Preparatory Works	Ls																																				
2.2 Tunnel Excavation	40,900 m3																																				
2.3 Concrete Lining	13,950 m3																																				
2.4 Inlet Works	Ls																																				
2.5 Outlet Works	Ls																																				
3.Dam Construction																																					
3.1 Preparatory Works	Ls																																				
3.2 Access Road	4,110 m																																				
3.3 Resoriver Protection																																					
(1) Batu Gajah	Ls																																				
(2) Batu Gantung	Ls																																				
3.4 Diversion Tunnel																																					
(1) Batu Gajah	398 m3																																				
(2) Batu Gantung	192 m3																																				
3.5 Excavation																																					
(1) Batu Gajah	155,000 m3																																				
(2) Batu Gantung	37,000 m3																																				
3.6 Embankment																																					
(1) Batu Gajah	571,000 m3																																				
(2) Batu Gantung	159,000 m3																																				
3.7 Spillway																																					
(1) Batu Gajah	12,420 m3																																				
(2) Batu Gantung	10,580 m3																																				
3.8 Initial Filling	Ls																																				
4. Land Reclamation																																					
4.1 Sea Wall																																					

4.3.3 Cost Estimate

(1) General Conditions of Cost Estimate

(a) Standards for Cost Estimate

Labor and materials rates for major work items such as excavation, embankment, stone masonry, concrete etc. are based on the following standards used in Indonesia.

1) Construction Cost Estimate Standard
(Dasar Pengusunan Anggaran Biaya Bangunan)

2) Principal Manual of Works with Machinery
(Pedomon Pokok Pelaksanaan Pekerjaan dengan Menggunakan Peralatan)

(2) Composition of Project Cost

The project cost for flood control plan consists of the construction cost, compensation cost, administration cost, contingency, engineering services cost and government tax.

(a) Construction Cost
Construction cost consists of the cost required for the construction of main structure and other related works including the preparatory works.

(b) Compensation cost
Compensation cost consists of land acquisition, resettlement, temporary use of land, and compensation for properties.

(c) Administration Cost
Administration cost of the Government is assumed to be 5% of sum of construction cost and compensation cost in order to cover the cost of supervision and management by the Government staff.

(d) Contingency
Contingency consists of the price escalation and the physical contingency. Price escalation is assumed to be 2% per annum for the construction cost, compensation cost and Engineering Service cost. The physical contingency is assumed to be 5 % per annum for the construction cost, compensation cost and Engineering Service cost including price escalation.

(e) Engineering Service Cost
Engineering Service will cover the whole period of project implementation.

(c) Unit Costs and Exchange Rate

Unit costs are decided based on the current costs of labor, material, equipment cost, etc. The following currency exchange rates (as of September 1997) are employed.

US$ 1 = ¥ 120 = Rp. 2,928 ¥ 1 = Rp. 24.4

(2) Unit Cost

Unit cost of main construction work items are shown in Table-I.4.35

Table-I.4.35 Unit Cost of Main Construction Work

Work Item	Unit	Unit Price (Rp.)	Foreign (%)	Local (%)
1. River Improvement				
1.1 Preparatory Work (7%)	L.S			
1.2 River Bed Excavation	m^3	15,000	87	13
1.3 Concrete Flood Wall	m^3	737,000	25	75
1.4 Gate Work				
Type A	Piece	16,900,000	90	10
Type B	Piece	8,940,000	50	50
Type C	Piece	4,400,000	0	100
1.5 Bridge Improvement				
Reconstruction	Bridge	630,000,000	43	57
Rehabilitation	Bridge	400,000,000	39	61
Other (Path Bridge;28, Pipe Line)	L.S	448,000,000	83	17
1.6 Sheet Pile	m	1,995,000	80	20
1.7 Anchor Work	Piece	3,950,000	80	20
1.8 Check Dam	m^3	737,000	25	75
2. Diversion Tunnel Work (Batu Merah River)				
2.1 Preparatory Work (7%)	L.S			
2.2 Tunnel Excavation	m^3	62,300	60	40
2.3 Concrete Lining	m^3	884,400	25	75
2.4 Other Work				
- Excavation	m^3	15,000	87	13
- Concrete	m^3	737,000	25	75
3. Dam Construction				
3.1 Preparatory Work (7%)	L.S			
3.2 Access Road	m	151,000	87	13
3.3 Reservoir Sealing Coat	m^2	450,000	50	50
3.4 Diversion Tunnel	m	9,600,000	31	69
3.5 Excavation	m^3	14,700	83	17
3.6 Embankment	m^3	25,000	75	25
3.7 Spillway Concrete	m^3	737,000	25	75
4. Land Reclamation				
4.1 Sea Wall	m	7,140,000	80	20

(3) Cost Estimation of Construction and Land Acquisition & Compensation

The construction cost and land acquisition & compensation cost are presented in Table-I.4.37 and Table-I.4.38. The former table shows the cost by each river and the later by each work item, such as river improvement, dam construction, diversion tunnel and disposal areaa.

(4) Project Cost Estimation

Total project cost is summarized in Table-I.4.36.

Table-I.4.36 Summary of the Project Cost

Item	Local Portion (Mil. Rp)	Foreign Portion (Mil. Yen)	Total Rp. Equivalent (Mil. Rp)	Total Yen equivalent (Mil. Yen)
1. Civil Works	141,837	4,281	246,302	10,094
(a) Direct Cost	104,065	4,077	203,555	8,342
- Base Cost	90,633	3,551	177,281	7,266
- Price Escalation (2% per year)	13,432	526	26,274	1,076
(b) Physical Contingency (5% of a)	5,203	204	10,178	417
(c) Government Administration (5% of a)	10,178	-	10,178	417
(d) Government Tax (10% of (a + b + c))	22,391	-	22,31	918
2. Land Acquisition & Compensation	23,732	-	23,732	973
(a) Direct Cost	19,613	-	19,613	804
- Base Cost	17,234	-	17,234	706
- Price Escalation (2% per year)	2,379	-	2,379	98
(b) Physical Contingency (5% of a)	981	-	981	40
(c) Government Administration (5% of a)	981	-	981	40
(d) Government Tax (10% of (a + b + c))	2,157	-	2,157	89
3. Consulting Engineering Servies	17,888	585	32,015	1,312
(a) Direct Cost	14,265	557	27,719	1,136
- Base Cost	12,723	492	24,723	1,013
- Price Escalation (2% per year)	1,542	65	2,996	123
(b) Physical Contingency (5% of a)	713	28	1,386	57
(c) Government Tax (10% of (a + b))	2,910	-	2,910	119
Grand Total	183,457	4,866	302,049	12,379

[Note] Base for cost estimation : September 1997
Conversion rates : 1 US$ = Rp 2,928 = Y120 Rp/Y = 24.40 Y/Rp = 0.041

Table-I.4.37(1) Construction Cost and Land Acquisition & Compensation Cost of Each River

Unit: Rp. million

Ruhu River

Work Item	Quantity	Project Cost	Foreign Currency	Local Currency
1. Preparatory Work	1	407	193	214
2. Main Construction	-	5,807	2,758	3,049
2.1 River Improvement	1,600 m	5,807	2,758	3,049
2.2 Diversion Tunnel	-	-	-	-
2.3 Dam Construction	-	-	-	-
Sub Total (Construction Cost)	-	6,214	2,951	3,263
3. Land Acquisition	-	287	-	287
3.1 Land Acquisition	615 m²	62	-	62
3.2 Resettlement	5 house	225	-	225
Total	-	6,501	2,951	3,550

Batu Merah River

Work Item	Quantity	Project Cost	Foreign Currency	Local Currency
1. Preparatory Work	1	1,813	692	1,121
2. Main Construction	-	25,895	9,877	16,018
2.1 River Improvement	1,400 m	10,078	4,979	5,099
2.2 Diversion Tunnel	900 m	15,817	4,898	10,919
2.3 Dam Construction	-	-	-	-
Sub Total (Construction Cost)	-	27,708	10,569	17,139
3. Land Acquisition	-	2,335	-	2,335
3.1 Land Acquisition	4,250 m²	850	-	850
3.2 Resettlement	33 house	1,485	-	1,485
Total	-	30,043	10,569	19,474

Tomu River

Work Item	Quantity	Project Cost	Foreign Currency	Local Currency
1. Preparatory Work	-	1,210	454	756
2. Main Construction	-	17,282	6,486	10,796
2.1 River Improvement	2,400 m	17,282	6,486	10,796
2.2 Diversion Tunnel	-	-	-	-
2.3 Dam Construction	-	-	-	-
Sub Total (Construction Cost)	-	18,492	6,940	11,552
3. Land Acquisition	-	1,252	-	1,252
3.1 Land Acquisition	1,781 m²	802	-	802
3.2 Resettlement	10 house	450	-	450
Total	-	19,744	6,940	12,804

Table-I.4.37(2) Construction Cost and Land Acquisition & Compensation Cost of Each River

Unit: Rp. million

Batu Gajah River

Work Item	Quantity	Project Cost	Foreign Currency	Local Currency
1. Preparatory Work	1	4,650	2,459	2,191
2. Main Construction	-	66,430	35,097	31,333
2.1 River Improvement	2,200 m	11,784	4,686	7,098
2.2 Diversion Tunnel	-	-	-	-
2.3 Dam Construction	1	54,646	30,411	24,235
Sub Total (Construction Cost)		71,080	37,556	33,524
3. Land Acquisition	-	7,334	-	7,334
3.1 Land Acquisition	192,959 m²	4,229	-	4,229
3.2 Resettlement	69 house	3,105	-	3,105
Total	-	78,414	37,556	40,858

Batu Gantung River

Work Item	Quantity	Project Cost	Foreign Currency	Local Currency
1. Preparatory Work	1	3,087	1,581	1,506
2. Main Construction	-	44,092	22,327	22,327
2.1 River Improvement	1,450 m	8,382	3,466	4,916
2.2 Diversion Tunnel	-	-	-	-
2.3 Dam Construction	1	35,710	18,299	17,411
Sub Total (Construction Cost)	-	47,179	23,346	23,833
3. Land Acquisition	-	6,026	-	6,026
3.1 Land Acquisition	149,291 m²	4,811	-	4,811
3.2 Resettlement	27 house	1,215	-	1,215
Total	-	53,205	23,346	29,859

Total (excluding Land Reclamation)

Work Item	Quantity	Project Cost	Foreign Currency	Local Currency
Construction Cost	-	170,673	81,362	89,311
Land Acquisition Cost	-	14,129	-	14,129
Total	-	184,802	81,362	103,440

Table-I.4.38(1) Construction Cost and Land Acquisition & Compensation Cost of Work Items

Unit : Rp. million

Work Item	River Improvement									
	Ruhu 1,600m		Batu Merah 1400m		Tomu 2,400m		Batu Gajah 2,200m		Batu Gantung 1,450m	
	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost
1.1 Preparatory Work	1	407	1	706	1	1,210	1	825	1	587
1.2 River Bed Excavation (m^3)	25,900	389	20,600	309	28,000	420	18,800	282	12,300	185
1.3 Concrete (m^3)	3,050	2,248	7,200	5,306	15,900	11,719	9,950	7,333	6,550	4,828
1.4 Gate Work		163		145		186		247		105
Type A (piece)	2	34	3	51	2	34	4	68	3	51
Type B (piece)	13	116	10	89	17	152	19	170	6	54
Type C (piece)	3	13	1	5	-	-	2	9	-	-
1.5 Bridge Improvement		678		464		1,542		822		1,292
Type A (bridge)	1	630	-	-	1	630	1	630	2	1,260
Type B (bridge)	-	-	1	400	2	800	-	-	-	-
Type C (bridge)	3	48	4	64	7	112	12	192	2	32
1.6 Sheet Pile (m)	600	1,197	1,140	2,274	1,010	2,015	920	1,836	630	1,237
1.7 Anchor Work (piece)	100	395	400	1,580	205	810	180	711	130	514
1.8 Check Dam (m^3)	1,000	737	-	0	800	590	750	553	300	221
Sub Total (1) (Construction Cost)	6,214		10,784		18,492		12,609		8,969	
2.1 Land Acquisition (m^2)	615	62	1250	250	1,781	802	859	387	791	356
2.2 Resettlement (household)	5	225	21	945	10	450	19	855	26	1,170
Sub Total (2)	287		1,195		1,252		1,242		1,526	
Construction Cost	6,214		10,784		18,492		12,609		8,969	
Indirect Cost (25%)	1,554		2,696		4,623		3,152		2,242	
Economic Cost	7,768		13,480		23,115		15,761		11,211	
First Year	1,036		1,797		3,082		2,101		1,495	
Second Year	1,407		2,440		4,184		2,851		2,027	
Third Year	1,775		3,081		5,283		3,603		2,563	
4th Year	1,775		3,081		5,283		3,603		2,563	
5th Year	1,775		3,081		5,283		3,603		2,563	

Land Acquisition Cost : Ruhu River 100×10^3 Rp/m^2
Merah River 200×10^3 Rp/m^2
Tomu River 450×10^3 Rp/m^2
Gajah River 450×10^3 Rp/m^2
Gantung River 450×10^3 Rp/m^2

Resettlement : Rp 45×10^6/house

Table-I.4.38(2) Construction Cost and Land Acquisition & Compensation Cost of Work Items

Unit : Rp. Million

Work Item	Dam Construction				Diversion		Disposal	
	Batu Gajah		Batu Gantung		Merah		Nitu	
	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost
1.1 Preparatory Work	-	-	-	-	1	1,107	-	-
1.2 Tunnel Excavation (m^3)	-	-	-	-	40,900	2,548	-	-
1.3 Concrete Lining (m^3)	-	-	-	-	13,950	12,338	-	-
1.4 Excavation (m^3)	-	-	-	-	5,500	83	-	-
1.5 Concrete Work (m^3)	-	-	-	-	1,150	848	-	-
2.1 Preparatory Work	1	3,825	1	2,500	-	-	-	-
2.2 Access Road (m)	2,100	317	2,050	310	-	-	-	-
2.3 Reservoir Sealing Coat (m^2)	47,500	21,150	40,000	18,000	-	-	-	-
2.4 Diversion Tunnel (m)	398	3,821	217	2,083	-	-	-	-
2.5 Excavation (m^3)	155,000	2,279	37,000	544	-	-	-	-
2.6 Embankment (m^3)	597,000	14,925	159,000	3,975	-	-	-	-
2.7 Spillway Concrete (m^3)	12,420	9,154	10,580	7,798	-	-	-	-
2.8 Intake (L.S.)	1	3,000	1	3,000	-	-	-	-
3.1 Preparatory Work	-	-	-	-	-	-	1	432
3.2 Sea Wall (m)	-	-	-	-	-	-	865	6,176
Sub Total (1+2+3) (Construction Cost)	58,471		38,210		16,924		6,608	
4.1 Land Acquisition (m^2)	92,100	3,842	148,500	4,455	3,000	600	-	-
4.2 Resettlement (household)	50	2,250	1	45	12	540	-	-
Sub Total (5)	6,092		4,500		1,140		-	
Construction Cost	58,471		38,210		16,924		6,608	
Indirect Cost (25%)	14,618		9,553		4,231		1,652	
Economic Cost	73,089		47,763		21,155		8,260	
First Year	9,745		6,369		2,821		1,101	
Second Year	13,226		8,643		3,829		1,495	
Third Year	16,706		10,917		4,835		1,888	
Fourth Year	16,706		10,917		4,835		1,888	
Fifth Year	16,706		10,917		4,835		1,888	

4.4 Project Evaluation

4.4.1 Environmental Impact Assessment

The objectives of the environmental impact assessment (EIA) for the priority project are as follows:

1) To understand the present condition of the environment in the project area;
2) To identify the particular activities of the project which may induce significant impact on the environment;
3) To predict the environmental impacts and evaluate their magnitudes;
4) To propose countermeasures for a mitigation of the envisaged negative impacts;
5) To formulate plans for environmental management and monitoring.

The EIA basically follows the Indonesian environmental regulations with reference to JICA and OECF environmental guidelines. The main regulations/guidelines applied include the follows;

1) Regulation of the Ministry of Public Works, No. 69/PRT/1995 Concerning the Technical Guidelines of Environmental Impact Analysis (AMDAL) for the Public Works Projects
2) Decree of the Ministry of Public Works, No. 148/KPTS/1995 Concerning the Guidance of Environmental Management Plan (RKL) and Environmental Monitoring Plan (RPL)
3) Japan International Cooperation Agency (JICA), Environmental Guidelines for Infrastructure Projects, V. River and Erosion Control (1992)
4) The Overseas Economic Cooperation Fund (OECF), Environmental Consideration Guidelines (1996)

The EIA study covered all the project activities to be involved in the implementation of the priority projects for flood control in Ambon area. The environmental elements which had been identified by the IEE conducted in Phase I for the Flood Control Master Plan were fully studied. The following paragraphs give the outline of the EIA on each of the project activities.

Table-I.4.39 Project Components Subject to EIA Study

River	Project Components		
Ruhu	(1) River improvement	(2) Check dam	
Batu Merah	(1) River improvement	(2) Diversion tunnel	
Tomu	(1) River improvement	(2) Check dam	
Batu Gajah	(1) River improvement	(2) Multipurpose dam	(3) Check dam
Batu Gantung	(1) River improvement	(2) Multipurpose dam	(3) Check dam

Table-I.4.40 Environment Elements for EIA*

(1) Social Environment	(2) Natural Environment	(3) Environmental Pollution
- Resettlement	- Topography & Geography	- Water Pollution
- Economic Activity	- Soil Erosion	- Noise & Vibration
- Traffic & Public Facilities	- Groundwater	- Offensive Odor
- Public Health & Sanitation	- Flora & Fauna	
- Solid Wastes	- Coastal Area	

* Environment elements for the EIA are those identified by the IEE for the Flood Control Master Plan as items on which significant or possible negative impacts are envisaged from the project activities shown in Table-I.4.39.

(1) River Improvement

For river improvement, the EIA study was concentrated on resettlement & land acquisition, public health & sanitation, solid waste disposal and coastal area. The following surveys were conducted to collect information for the impact analysis:

- Interview survey to understand the status of the households who are possibly involved in the resettlement program
- Field survey on public health and sanitation
- Field survey on candidate sites for construction waste disposal
- Biotic survey for rivers and estuaries

Based on the survey results, impacts analyses were conducted and countermeasures for eliminating or reducing negative impacts were proposed. The other impacts identified by the IEE, such as economic activities, traffic & public facilities, water pollution, noise & vibration and offensive odor were also analyzed.

Of all these environmental items, resettlement is thought to be the most significant problem to be solved at the pre-construction stage of the project, since totally 81 households will possibly be affected by the plan of river improvement (Ruhu: 5, Batu Merah: 21; Tomu: 10; Batu Gajah: 19; Batu Gantung: 26). Although people have showed their understanding of the importance of flood control, they need reasonable compensation on their houses and properties and also the loss of their means of living.

In addition, Impacts on groundwater and water utilization may be expected from river improvement with three-sided concrete channel. Three-sided concrete channel may reduce groundwater recharge and may cause a decrease in well water level as well as may disturb water utilization such as washing and bathing. Thus countermeasures should be taken into account for the design of the three-sided channel structure during detail design stage. The small channels and shallow wells in a river course which were proposed in this study are one of the measures for keeping groundwater recharge and water utilization.

(2) Multipurpose Dams

For the construction of the two multipurpose dams in Batu Gajah River and Batu Gantung River, the EIA study was concentrated on resettlement & land acquisition, traffic & public facilities, solid wastes, groundwater and water pollution. The site surveys included the following items:

- Interview survey with the households who are possibly involved in the resettlement program for dam construction
- Survey on traffic condition in the related area
- Hydrogeological survey for investigating the condition of groundwater application at the downstream side of the dams
- Water quality survey for predicting the water quality in the reservoir area and investigating the suitability of dammed water for water supply
- Survey for flora and fauna at the dam sites

The number of resettlement households will be 50 for the construction of Batu Gajah Dam. For Batu Gantung Dam, only 1 house will be relocated but 1 bridge and 1 health center will be affected. For the dam construction, a large amount of construction materials will be acquired from the area near the dam sites. Land acquisition will also include these areas.

These became the main topics of the EIA. As for groundwater, since the dam site geology has high permeability, water proof measures for reservoir and dam sites is important and should be carefully designed. The impacts from dam construction is thought to be minor on well water utilization in the downstream side, but it should be taken into account, in order to reduce the influence on the groundwater or springs at the downstream side. Although water pollution is serious at the downstream of the two rivers, the water quality at the dam sites is good according to the water quality survey results. Therefore, there will be no problem for using the two dams for water supply. The impacts on flora and fauna are not significant but it is still necessary to take countermeasures for natural environment protection and improvement.

The other environment items identified by the IEE, such as economic activities, topography & geology, soil erosion, noise & vibration, were also studied.

(3) Diversion Tunnel for Batu Merah River

The main items studied for the Batu Merah diversion tunnel included resettlement & land acquisition and groundwater. The number of resettlement households for the diversion tunnel construction is estimated as 12, all at the site of the tunnel's inlet. The impacts were analyzed based on the results of an interview survey.

Hydrogeological survey was conducted for evaluating the impacts of tunnel construction on groundwater utilization at the downstream area including the existing wells along the coast. During the diversion tunnel construction, loss of groundwater from the excavated tunnel is unavoidable. However, after tunnel construction, continuous loss of groundwater will not occur since the bottom and walls of the tunnel are concrete lined. Sealing of the diversion tunnel against groundwater flow may also affect groundwater levels. In order to reduce the impacts on people who are using groundwater from that aquifer, provision of new sources for supplying drinking water has to be considered.

The other study items included economic activities, traffic & public facilities, solid waste, water pollution, noise & vibration.

(4) Check Dams

Because the check dam sites are all at the upstream mountain area where few people are living around, the impacts on the environment are thought to be minor in comparison with the other project construction work. The main environment items considered in the EIA included land acquisition, traffic facilities, solid waste, water pollution, noise & vibration. Generally speaking, the impacts are thought to be minor and can be eliminated if suitable countermeasures are taken.

(5) Land Reclamation Plan

Two land reclamation sites, one at Estuary of Nitu River and another at Estuary of Ruhu River, have been proposed as candidates for land reclamation using the solid wastes from the project construction. This is considered to be a part of this project, and environmental consideration should be given to the two proposed sites. As a result of the EIA study on the present environmental setting, site availability and the possible environmental impacts, the land reclamation site at Nitu River were thought to be the most promising site for this

project, while application of the Ruhu River site may face difficulties because it is at the narrowest point of Ambon Bay and impacts on the stability of coastal lines in both bay sides may be significant. Recommendations were given on these two sites from a viewpoint of coastal environmental protection.

(6) Considerations on Environmental Management

Environmental management is important from the pre-construction stage to the post-construction stage. This includes not only the management of environmental issues related to the project, but also those related to environmental improvement in the whole central Ambon area. Recommendations can be given as followings.

<Organization for environmental management>
Under the project office which is supposed to be organized by Ministry of Public Works, there should be a branch with at least one acting officer in charge of environmental management. This environment branch shall make plans for environmental protection and improvement, and manage all activities related to the environment. A good coordination among the project office, local government and environment agencies are also very important.

<Management of Resettlement and Land Acquisition>
Resettlement and land acquisition are very sensitive to social impacts and have to be well managed. Totally 144 households will possibly be involved in the resettlement program. Careful inventory of their houses, lands and properties, hearing on their opinion and desire are indispensable. Besides compensation, provision of locations for them to get new residential houses are also very important.

<Environmental Surveillance of Construction Work>
Construction work should follow environmental regulations. This needs a well organization of the work and also surveillance during the work. Dispute may occur with local residents on environment related issues, or complaints may come to the project office or local government. These issues need to be resolved on the basis of environmental laws and regulations.

<River Environment Management>
As one of the non-structure measures, river environment management has been proposed in the flood control master plan. This includes restriction on garbage dumping to the river, installation of sanitary facility such as septic tanks and public sewers. After the project, if people still use the river as a waste disposal site, not only environmental condition will be deteriorated, but also flood control will be affected. For example, garbage accumulation in the river will reduce the river flow capacity. In the downstream part to the five rivers, dense population causes many problems related to flood control and the environment. From a viewpoint of eliminating social impacts, resettlement is only planned at the locations where residential houses are obstacles to flood control structures. The necessary space along the river banks for river surveillance has not been taken into account. This is an unsolved problem and should be considered in the urban development plan for the future.

<Coastal Environment Management>
The environmental condition in the coastal area of Ambon Bay is similar to that at the river. Condition is worse near the estuaries of Batu Merah, Tomu, Batu Gajah and Batu Gantung.

In addition to wastes carried in to the bay by the rivers and drainage channels, people dispose wastes from residential and market areas directly to the sea. It is recommendable that coastal environment management and improvement shall be considered during and after the project. This includes garbage collection, sewerage and drainage system improvement, and regulating market and other business activities.

<Dam Area Protection>
In order to improve the biological condition and protect reservoir water quality for water supply, it is recommended that in Batu Gajah and Batu Gantung the dams and reservoirs and their surrounding areas shall be taken as natural protection areas. Reforestation around the reservoir is an important measure for this purpose.

<Environmental Education>
For an effective environment management, environmental and sanitary education is indispensable for raising public awareness of the importance of environment protection. The habit of using rivers and coastal area as receivers for all kinds of wastes should be completely abandoned, and creation of a comfortable and beautiful environment should become the target of all the residents in central Ambon area. This needs a long term education program for people of all ages and strong administrative measures such as proposing new regulations including strict penalties for environmental contamination.

<River Cleanliness and Inhabitant Participation>
River environment should be improved not only by the local government but also by the neighborhood to the rivers. In Japan rubbish in rivers is gathered periodically by river-side inhabitants at many places. The rubbish mainly consists of those things that cannot be returned to the nature easily such as empty cans, plastic bottles and vinyl bags. If these things are left alone, they will flow into the sea together with flooding water and may also contaminate the sea area. Thus river cleanliness with inhabitant participation should be well-organized with the assistance of the local government. After the river neighborhood participate river cleanliness, their consciousness to the river environment would be raised and would contribute to the river environment improvement.

(6) Considerations on Environmental Monitoring

Environmental monitoring is important for understanding the environmental conditions before, during and after the project. At the pre-construction stage, environmental monitoring aims to a understanding of the environmental settings as what has been done in the IEE and EIA for this project; during project construction, monitoring is for controlling the impacts on the environment; and after the project, for good maintenance of facilities and expanding the effect of the project. The followings are the main monitoring items.

- Traffic volume monitoring at the pre-construction stage
- Noise and vibration monitoring during the project construction
- Groundwater level monitoring in the area to be possibly affected by the diversion tunnel and the multipurpose dams
- Water quality monitoring for the multipurpose dams
- Soil erosion surveillance during and after project construction at the dam sites, diversion tunnel sites and along the rivers
- Post resettlement survey to investigate the resettled people's condition after the resettlement for project construction

4.4.2 Economic Evaluation

(1) Basis for Economic Evaluation

Economic analysis was conducted under the following assumptions:

- Price level	:	September 1, 1997
- Return period	:	30 years
- Project life	:	50 years
- Maintenance costs	:	0.5% of the total construction costs
- Residual value of dams	:	30 year equivalent value
- Shadow price	:	Equipment (85% of the market price), Material: (90%), Labor (90%)
- Growth rate of property value	:	5.0 % per annum
- Value added from sediment excavation	:	Rp 7,000 /m^3
- Construction period	:	From 1999 to 2003 for separate cases From 1999 to 2007 for the entire project
- Incremental costs and benefits for Water supply:		Rp 890 /m^3 for distribution pipes and OM costs Rp 2,500 /m^3 for water supply benefits
- Value of Reclaimed Land	:	Rp 0.4 million /m^2

<Price Level>
The price level for the estimation of costs and benefits was set as September 1, 1997. The exchange rate for the Priority Projects was fixed at Rp 2,928 to US$ 1.00 and at Rp. 24.4 to ¥ 1 for calculation purposes.

<Return Period>
The design scale was set at 30-year return period, taking into account the standard return period for flood control facilities used in Indonesia.

<Project Life>
The economic life of the project was set at 50 years; the residual value of the facilities except for that of dams is considered to be zero after 50 years when they will need to be replaced.

<Maintenance Costs>
The maintenance work is assumed to require 0.5% of the total construction costs every year. The maintenance activities will be necessary from the year following completion of construction through the duration of the project.

<Residual Value of Dams>
Since dams are supposed to last for 80 years, 30 years equivalent value will be left after 50 years project life. The value was added back to the benefit side in the end of Year 50.

<Shadow Pricing>
Taxes and duties must be deducted from financial costs in order to obtain economic costs. Taxes and import duties for construction equipment are 15% and for materials 10%. Labor costs are reduced by 10% considering the Project will employ a number of jobless people in

Ambon City.

<Growth Rate of Property Value>
The same rate as the product of per capita GDP and population increase in the Central City estimated by the study team - 5.0% per year - was applied for the growth rate of the property value.

<Value Added from Sediment Excavation>
Sediment from check dams will be sold as construction material at Rp 7,000 /m^3 every year after the completion of the construction of check dams. The amount of sediment will be 4,000 m^3/year from Ruhu River, 3,700 m^3/year from Tomu River, 1,000 m^3/year from Batu Gajah River and 3,600 m^3/year from Batu Gantung River.

<Construction Period>
Five year construction period - from 1999 to 2004 - was applied for the economic analysis of each of the five rivers, while nine year period - from 1999 to 2007 - was applied for the implementation of the entire project.

<Costs and Benefits for Water Supply>
In addition to the costs for purification facilities and pipelines, Rp 890 /m^3 was added in multi-purpose dam options as water distribution costs including distribution pipes, administration and operation, estimated from the PDAM financial report. Water loss was assumed to be 40%. On the benefit side of water supply, willingness to pay by Ambon City residents was estimated at Rp 2,500 /m^3 through field investigations. This is an actual buying price of water that people are paying to water tank lorries.

<Value of Reclaimed Land>
New land will be created at the river mouth of Nitu River through disposal of excavated material from Batu Gajah and Batu Gantung rivers. Total size of the land to be created is 6.56 ha and the price of the land is estimated at Rp 0.4 million /m^2. The economic cost for the land reclamation is Rp 8,260 million while the value to be generated in five years after completion of the flood control facilities will be Rp 26,240 million, both of which were included in the economic evaluation.

(2) Economic Analysis

(a) Economic Analysis on Each of the Five Rivers

Table-I.4.41 shows the results of economic analysis on the construction of the flood control facilities for each of the five rivers, based on the assumption that all the facilities are constructed in five years.

Construction of river improvement facilities in each of the five rivers is highly feasible, showing IRR of between 20 % to 40%. Incremental benefits from the diversion tunnel construction in Batu Merah River exceeds incremental costs at the 10% discount rate, which results in an increase in the Net Present Value. On the other hand, construction of multi-purpose dams in Batu Gajah and Batu Gantung Rivers decreases the NPV and IRR. (IRR obtained from incremental benefits and costs for dam construction are 7.9% for Batu Gajah River and 3.4% for Batu Gantung River.)

Table-I.4.41 Economic Cost, NPV, B/C and IRR of Each of the Five Rivers

Case		Economic Cost	NPV at 10%	B/C at 10%	IRR
Ruhu	River Improvement (5-year return period)	Rp 7,768 million	Rp 26,154 million	5.3	28.1%
Batu Merah	River Improvement (5-year return period)	Rp 13,480 million	Rp 88,955 million	9.6	39.1%
	River Improvement and Diversion	Rp 34,635 million	Rp 98,256 million	4.7	25.8%
Tomu	River Improvement	Rp 23,115 million	Rp 36,474 million	3.0	19.9%
Batu Gajah	River improvement (10-year return period)	Rp 15,761 million	Rp 52,938 million	5.4	28.0%
	River improvement and with Multi-purpose Dam	Rp 92,980 million	Rp 37,262 million	1.4	13.1%
Batu Gantung	River improvement (10-year return period)	Rp 11,211 million	Rp 29,932 million	4.4	25.1%
	River improvement and Multi-purpose Dam	Rp 63,104 million	Rp 3,619 million	1.1	10.5%

(b) Economic Analysis on the Project as a Whole

The following is the results of the economic analysis, on the assumption that all the priority projects are implemented in six years:

- Economic Cost : Rp 221,602 million
- IRR : 16.4%
- NPV at 10% : Rp 168,757 million
- B/C at 10% : 2.2

The project is assessed to be feasible.

(c) Economic Analysis on Alternative Combinations

The following four options in Table-I.4.42 were compared to examine the impacts of the construction of the diversion channel in Batu Merah River and the multi-purpose dams in Batu Gajah and Batu Gantung rivers on the economic returns of the project. Table-I.4.42 shows the results of economic analysis on each of the above options.

The Project is assessed to be feasible in each case. Option 1 has the highest IRR, while Option 2 has the highest NPV.

Table-I.4.42 Economic Cost, NPV and IRR of the Alternative Combinations

Item	Diversion Channel in Batu Merah River	Multi-purpose Dam in Batu Gajah River	Multi-purpose Dam in Batu Gantung River	Economic Cost (Rp. Million)	NPV at 10% (Rp. Million)	IRR (%)
Option 1	×	×	×	71,335	191,114	25.9
Option 2	○	×	×	98,202	250,195	25.4
Option 3	○	○	×	175,421	239,032	20.0
Option 4	○	×	○	144,383	181,229	19.4

Note. ×: with, ○: without

(3) Sensitivity Analysis

Sensitivity analysis was performed by changing the project costs and benefits in the following fashion:

Case 1: Property value increases at a rate of 2.5% per year, which is half the product of the estimated population and GDP growth rates in the study area
Case 2: Construction costs increase by 10%

Table-I.4.43 and Table-I.4.44 show the results of sensitivity analysis performed under the above variations. The construction of a multi-purpose dam in Batu Gantung River becomes unfeasible when the growth rate of property value dropped to 2.5% per year or the project cost increases by 10%. However, the entire project is still feasible in these cases due to the high economic returns of Ruhu, Batu Merah and Tomu rivers.

Table-I.4.43 Sensitivity Analysis on Each of the Five Rivers

Case		NPV at 10% (Rp million)		IRR	
		2.5% Growth	Costs + 10%	2.5% Growth	Costs + 10%
Ruhu	River Improvement (5-year return period)	13,863	25,555	23.5%	26.5%
Batu Merah	River Improvement (5-year return period)	50,764	87,916	33.9%	37.0%
	River Improvement and Diversion	50,219	95,585	21.4%	24.4%
Tomu	River Improvement	15,662	34,692	15.9%	18.8%
Batu Gajah	River improvement (10-year return period)	27,933	51,723	23.4%	26.4%
	River improvement and with Multi-purpose Dam	3,099	30,104	10.3%	12.4%
Batu Gantung	River improvement (10-year return period)	15,162	29,068	20.8%	23.7%
	River improvement and Multi-purpose Dam	- 13,253	- 1,383	7.6%	9.8%

Table-I.4.44 Sensitivity Analysis on the Entire Project

Case	NPV at 10% (Rp million)		IRR	
	2.5% Growth	Costs + 10%	2.5% Growth	Costs + 10%
Entire Project	48,819	156,419	12.6%	15.6%

4.5 Implementation Program

4.5.1 Implementation Schedule

The responsible agency for the project implementation is the Ambon Flood Control Project Office which will be newly established at the project site. The project is requested to be financed by the OECF (The Overseas Economic Cooperation Fund, Japan) excluding the costs for land acquisition and compensation, government administration and government tax. The project is composed of the following work items:

1) Loan procedure for OECF
2) Procurement for consulting engineering services and construction work
3) Consulting engineering services including detailed design, assistance in procurement of contractor and construction supervision
4) Construction work of five (5) packages, including 5 Rivers Improvement, Diversion Tunnel, 4 Check Dams, 2 Multipurpose Dams etc.
5) Land acquisition and compensation

The overall implementation schedule is shown in Table-I.4.45. The total required period for the main works is about ten (10) years which comprises three (3) main stages : 1) 18 months for the design, 21 months for procurement of contractors (overlaps with the design stage) and 72 months for construction.

Table-I.4.45 Implementation Schedule

Items \ Fiscal Year / Month	(1) 1998/99 Apr Sep	Oct Mar	(2) 1999/00 Apr Sep	Oct Mar	(3) 2000/01 Apr Sep	Oct Mar	(4) 2001/02 Apr Sep	Oct Mar	(5) 2002/03 Apr Sep	Oct Mar	(6) 2003/04 Apr Sep	Oct Mar	(7) 2004/05 Apr Sep	Oct Mar	(8) 2005/06 Apr Sep	Oct Mar	(9) 2006/07 Apr Sep	Oct Mar	(10) 2007/08 Apr Sep	Oct Mar
1 Loan Procedure																				
a Pledge																				
b Loan Agreement																				
2 Procurement																				
a Consulting Services																				
b Construction Work																				
- Pre-qualification																				
- T/Doc. Preparation																				
- Tender Period																				
- Tender Evaluation																				
- OECF Concurrence																				
- Contract Negotiation																				
- OECF Concurrence																				
- L/C Open																				
3 Consulting Services																				
a Survey & Design																				
b Tendering																				
c Const. Supervision																				
4 Construction																				
a Package-1																				
b Package-2																				
c Package-3																				
d Package-4																				
e Package-5																				
5 Land Acquisition																				

(1) Procurement of Consultants and Contractors

The procurement of consulting services is to be made between July 1998 and June 1999. The procurement of contractors is to commence from October 2000 and to be completed by March 2002. The recommended method for the selection of a competent consultant is the Short List method in accordance with the Guidelines for the Employment of Consultants by OECF Borrowers. However, the direct appointment of a specific consulting engineering company should be considered, as the project was studied by the JICA Study Team. For the same reasons, the contract with the consultant should be made in one package for both the design stage and construction stage, in order to assist in the coordination and smooth execution of the project.

(2) Consulting Services

The consulting engineering services are to commence from July 1999 and are to be completed in March 2008. The total required period is 105 months, which are comprised of 33 months for design, tender and procurement, and 72 months for construction supervision.

(3) Land Acquisition

The land acquisition and compensation required for construction work are scheduled to be completed by the end fiscal year 2005/06, before the commencement of the construction work.

(4) Construction Work

In accordance with the Guidelines for Procurement under OECF Loans, International Competitive Bidding (ICB) is proposed for five construction packages as shown in Table-I.4.46. ICB is will be the best method for achieving the economic and efficient implementation of these packages. In the interests of the broadest possible competition, contract packages should be reasonable size to attract bids on an international basis. Tenders will be limited to contractors who have pre-qualified and been accepted onto the short list.

Table-I.4.46 Tender Packages for Civil Works

Packaging	Scope of Works
Package - 1	- Batu Gajah Multi-purpose Dam
Package - 2	- Batu Gantung Multi-purpose Dam - Nitu River Disposal Site
Package - 3	- Batu Merah River Improvement - Batu Merah Diversion Tunnel
Package - 4	- Ruhu River Improvement - Tomu River Improvement - Ruhu Check Dam - Tomu Check Dam
Package - 5	- Batu Gajah River Improvement - Batu Gantung River Improvement - Batu Gajah Check Dam - Batu Gantung Check Dam

4.5.2 Finance and Disbursement Schedule

The total project cost is 302.049 billion Rupiah (12.379 billion Yen), estimated in September 1997 basis. Out of the total project cost, 242.839 billion Rupiah (9.952 billion Yen) will be financed by OECF loan. Other potion of the project cost: 59.211 billion Rupiah (2.427 billion Yen) will be financed by the national budget. The disbursement schedule of the project is summarized in Table-I.4.47.

Table-I.4.47 Annual Disbursement Schedule of the Project

Unit: Million Rupiah

Items			Total	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08
Consulting Engineering S.												
Construction												
Land Acquisition & Conpen.												
1 Construction Cost			246,302				49,708	50,699	51,716	52,748	27,055	14,375
a	Direct Cost		203,555				41,081	41,900	42,741	43,593	22,359	11,880
	Package - 1	- Base Cost	58,471				9,745	9,745	9,745	9,745	9,745	9,746
		- Price Esc.	9,402				1014	1230	1449	1673	1901	2134
		<Total>	67,873				10,759	10,975	11,194	11,418	11,646	11,880
	Package - 2	- Base Cost	44,818				8,964	8,963	8,964	8,963	8,964	
		- Price Esc.	6,685				933	1131	1333	1539	1749	
		<Total>	51,503				9,897	10,094	10,297	10,502	10,713	
	Package - 3	- Base Cost	27,708				6,927	6,927	6,927	6,927		
		- Price Esc.	3,815				721	874	1030	1189		
		<Total>	31,523				7,648	7,801	7,957	8,116		
	Package - 4	- Base Cost	24,706				6,177	6,176	6,177	6,176		
		- Price Esc.	3,401				643	779	919	1060		
		<Total>	28,107				6,820	6,955	7,096	7,236		
	Package - 5	- Base Cost	21,578				5,395	5,394	5,395	5,394		
		- Price Esc.	2,971				562	681	802	926		
		<Total>	24,549				5,957	6,075	6,197	6,320		
b	Contingency	5% of a	10,178				2,054	2,095	2,137	2,180	1,118	594
c	Administration	5% of a	10,178				2,054	2,095	2,137	2,180	1,118	594
d	Tax : 10% of (a + b + c)		22,391				4,519	4,609	4,701	4,795	2,460	1,307
2 Land Acquisition & Comp.			23,732			3,761	3,837	3,914	3,992	4,072	4,156	
a	Direct Cost		19,613			3,109	3,171	3,234	3,299	3,365	3,435	
		- Base Cost	17,234			2,872	2,872	2,872	2,872	2,872	2,874	
		- Price Esc.	2,379			237	299	362	427	493	561	
b	Contingency	5% of a	981			155	159	162	165	168	172	
c	Administration	5% of a	981			155	159	162	165	168	172	
d	Tax : 10% of (a + b + c)		2,157			342	349	356	363	370	378	
3 Consulting Engineering S.			32,015	4,456	4,545	1,236	3,784	3,859	3,936	4,015	4,095	2,088
a	Direct Cost		27,719	3,858	3,935	1,070	3,276	3,341	3,408	3,476	3,546	1,808
		- Base Cost	24,723	3,708	3,708	989	2,967	2,967	2,967	2,967	2,967	1,483
		- Price Esc.	2,996	150	227	81	309	374	441	509	579	325
b	Contingency	5% of a	1,386	193	197	54	164	167	170	174	177	90
c	Tax : 10% of (a + b + c)		2,910	405	413	112	344	351	358	365	372	190
Grand Total			302,049	4,456	4,545	4,998	57,329	58,472	59,645	60,835	35,306	16,463
OEC Loan Portion			242,838	4,051	4,132	1,124	46,575	47,504	48,456	49,423	27,200	14,373

[Note] Base for cost estimation : September 1997
Conversion rates : 1 US$ = Rp 2,928 = Y 120 Rp/Y = 24.4 Y/Rp = 0.041

CHAPTER 5 RECOMMENDATIONS

(1) Implementation of Priority Project

The Priority Project proposes flood control measures and water resources development for the center of Ambon city as follows:

- Ruhu River : River Improvement, Check Dam
- Batu Merah River : River Improvement, Diversion Tunnel
- Tomu River : River Improvement, Check Dam
- Batu Gajah River : River Improvement, Multi-purpose Dam, Check Dam
- Batu Gantung River : River Improvement, Multi-purpose Dam, Check Dam

The Government of Indonesia has raised the policy to support and promote development of the eastern regions, which are relatively undeveloped within Indonesia. Ambon City has long been the social and economic center of eastern Indonesia including Maluku Province. One of the projects being most urgently implemented in the effort to develop the infrastructure of Ambon is to put flood prevention measures and city water supply in place in the urban districts of the city. Therefore, implementation of the priority project proposed in this study should commence as soon as possible.

Although Ruhu Multi-purpose dam is not included in the priority project, water development is needed considering long term city water demand. The implementation of this dam should start following the priority project.

(2) Implementation of Non-structural Measures

Non-structural flood control measures were proposed in this study and aimed at 1) suppression of flood runoff, 2) improvement of flood proof function, and 3) facilitation of flood disaster prevention activities. As non-structural measures are as important as the structural measures, the non-structural measures should be implemented in line with the structural measures by establishing the special committee proposed as a coordination body.

(3) Financing the Project Cost

The total priority project cost is estimated to be 302.049 billion Rupiah (12.379 billion Yen). In order to implement the project, 59.211 billion Rupiah (2.427 billion Yen) should be financed by the national budget. The other portion of the project cost 242.838 billion Rupiah (9.952 billion Yen) could be financed by OECF loan. Thus necessary preparation and arrangement should be taken by the central government as soon as possible.

(4) Countermeasures to Land Acquisition and Resettlement

Totally 144 households will be involved in the resettlement program. Land acquisition of 8,300 m^2 in the city area and 241,000 m^2 in the upstream area is needed to implement the priority project. As these land acquisition and resettlement shall be settled by the local government, careful and appropriate measures are necessary.

(5) River Environment Management

As one of the non-structural measures, river environment management has been proposed in the flood control master plan. This includes restriction on garbage dumping in the rivers, installation of sanitary facilities such as septic tanks and public sewers. In order to improve the biological condition and protect reservoir water quality for water supply by dams, it is recommended that in Batu Gajah and Batu Gantung, the dams and reservoirs and their surrounding areas shall be taken as natural protection areas. Reforestation around the reservoir is an important measure for this purpose.

(6) Water Distribution Plan

The priority project includes water resources development with Batu Gajah and Batu Gantung Multi-purpose Dams, but does not include water distribution plan such as purification plants and distribution pipe network from the dams. Therefore, this plan should be studied and formulated as soon as possible by the local government.

(7) Continuous Effort of Collecting Hydrometric Data

For the further study of the plan on flood control and water resources development, hydrometric data, such as rainfall data and river discharge data must be collected. As hydrometric stations were installed in this Study, these data should be continuously measured, stored and processed.