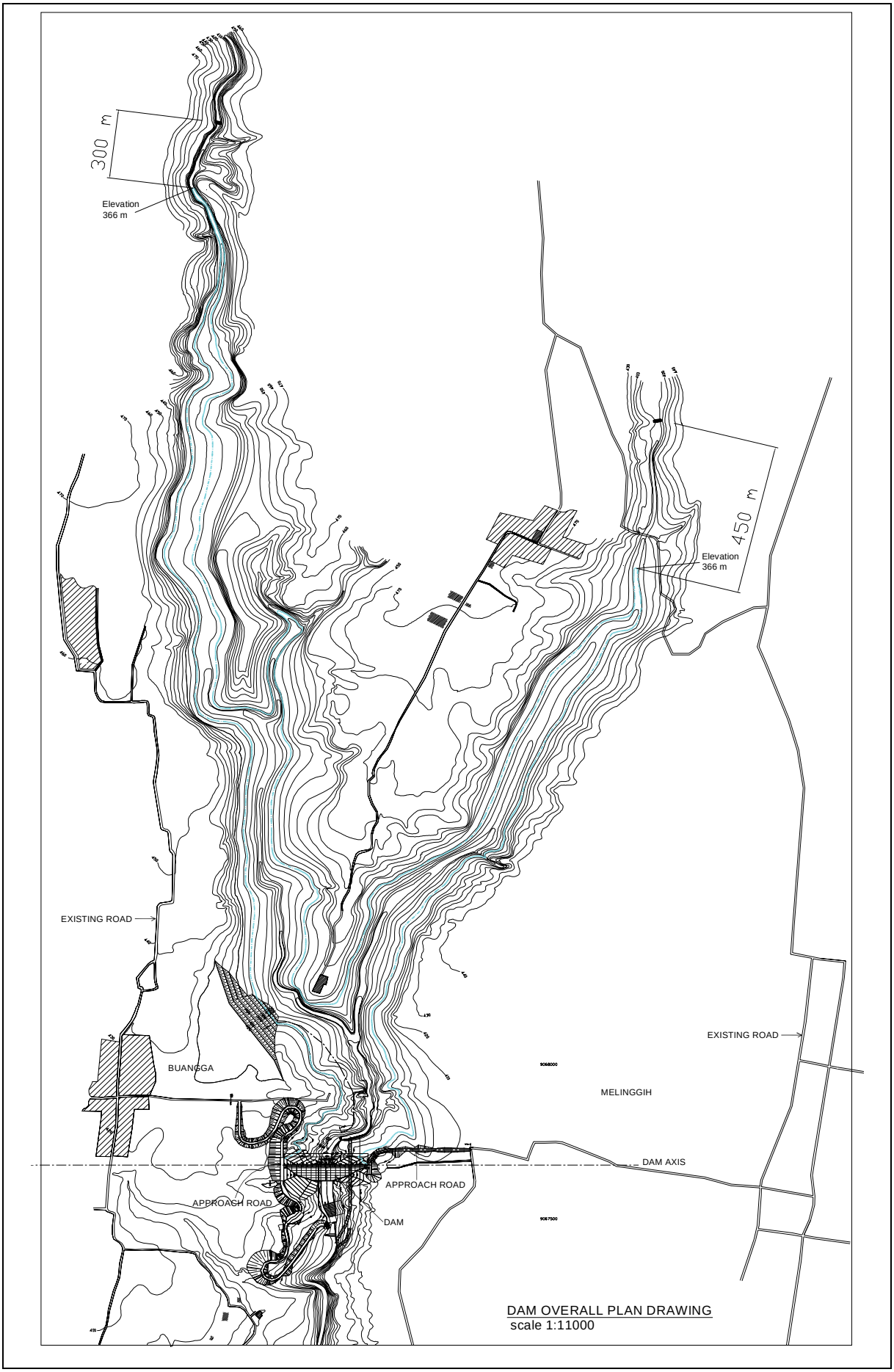


Figure-5.12 General Plan of Ayung Dam and Reservoir

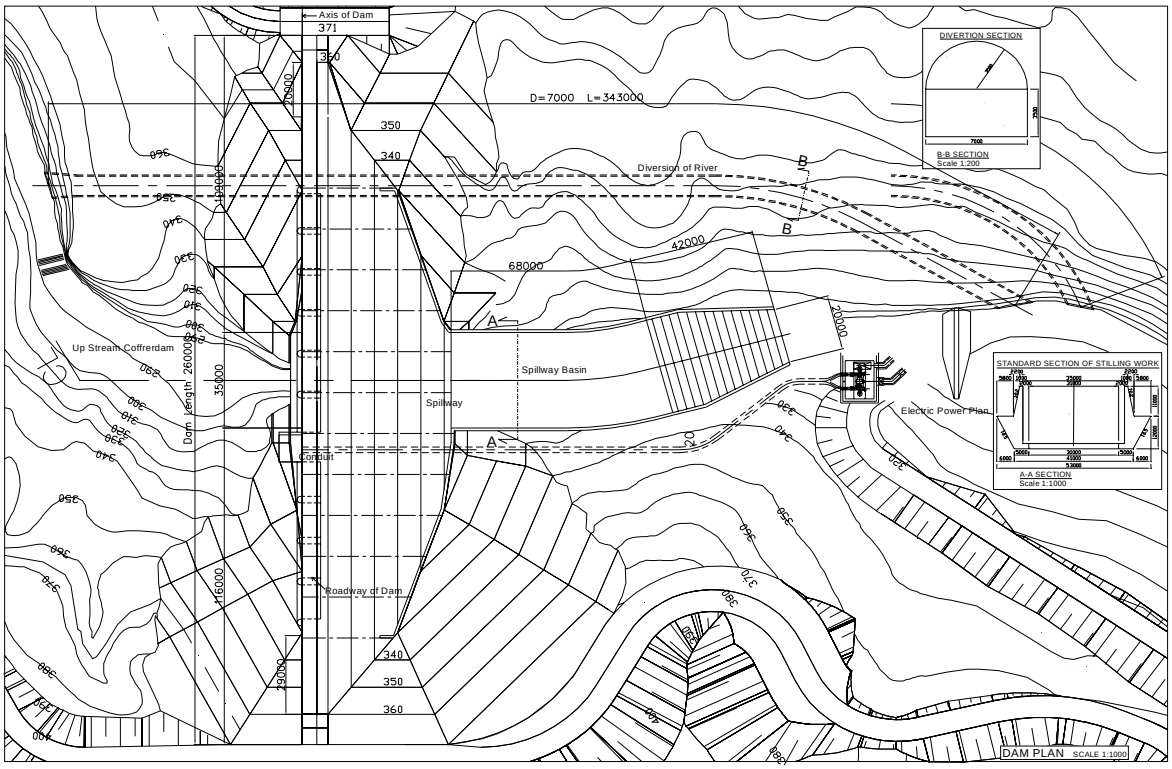


Figure-5.13 Plan of Ayung Dam

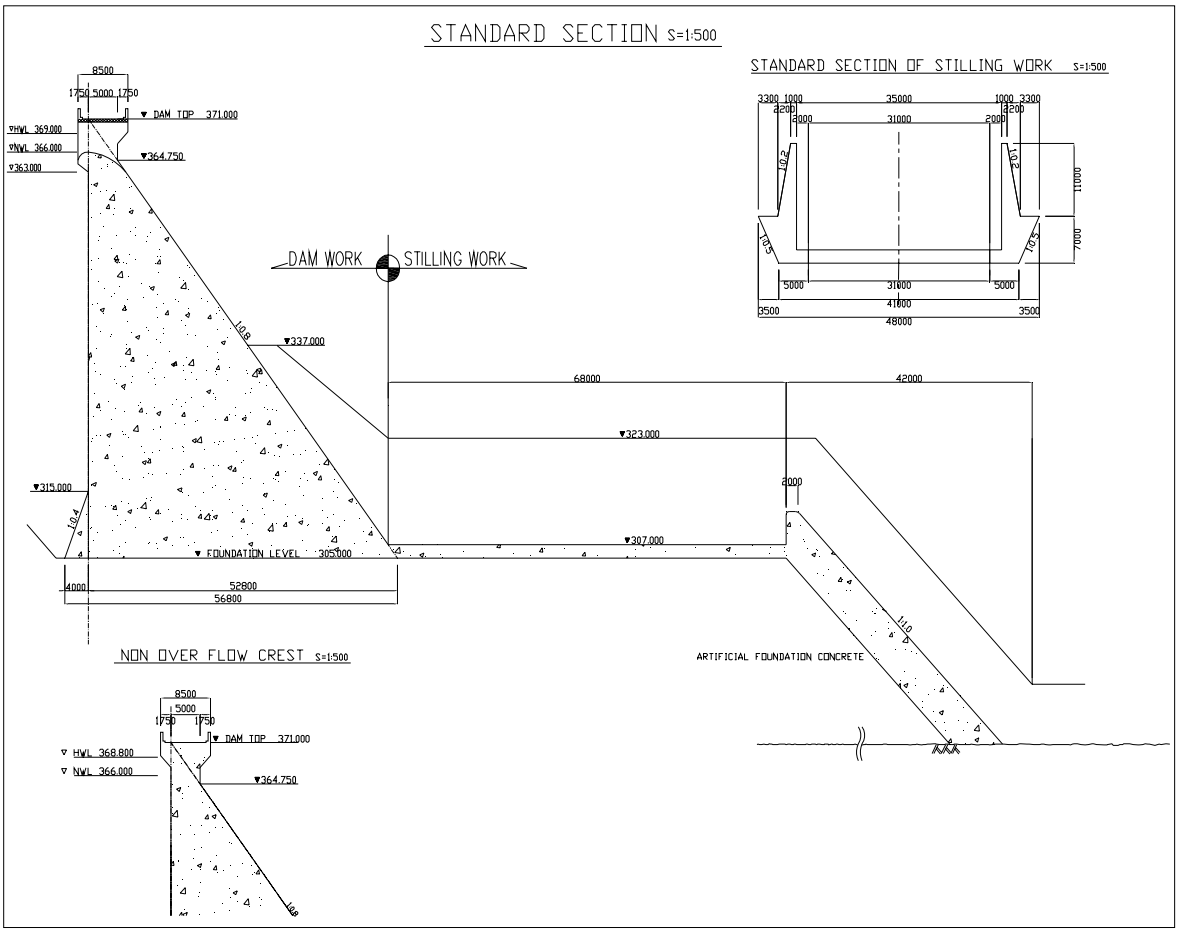


Figure-5.14 Typical Cross Section of Ayung Dam

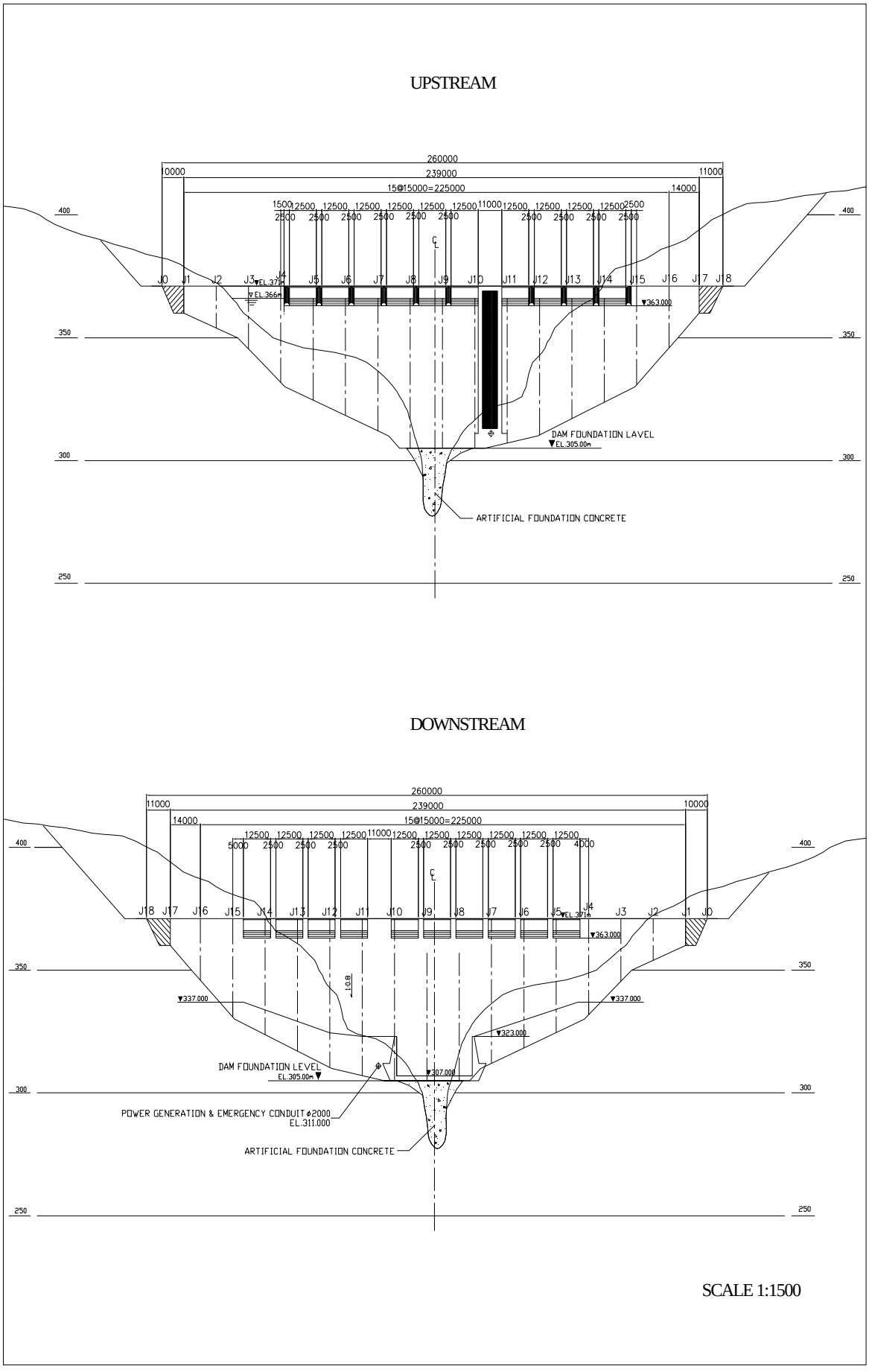


Figure-5.15 Upstream and Downstream View

5.3.4 Design for Check Dam

Specifications of check dams are summarized as shown in Table-5.9.

Table-5.9 Specifications of Check Dams

Items	Ayung River	Siap River
1. Name of River	Ayung	Siap
2. Catichments Area(km^2)	159.3	64.5
3. Design Sediment Volume(m^3)	50,300	21,100
4. Design Discharge(m^3/s)	570	240
5. Waterway Base Length(m)	20	10
6. Over flow Width(m)	6.0	5.2
7. Dam Height(m)	13.0	7.0
8. Design Storing Sediment Length(m)	1,220	990
9. Sediment Volume (m^3)	50,300	21,100

5.3.5 Reservoir Area Development Plan

In consideration of characteristics of dam location, communities near Ayung Dam, temples and holy places as well as tourism area of Ubud, development themes were stated as shown in follows:

Table-5.10 Development Zone and Images, Plans

Zone	Locations	Symbol color & Images	Development Plans
A Zone ■Dancing Stage & Circle in Lake	Meeting Point of Ayung River and Siap River	Symbol Color: (Black) (Vishnu=Water) Image : (Water) (Silent) (Dance) (Sanctification) (Feminale)	1) Dancing Stage in Lake 2) Audience Seat 3) Boat for Moving and Fishing 4) Dock 5) Fish Breeding in Lake
B Zone ■Culuture Village & Exchange Village	Ayung River Right Bank	Symbol Color: (White) (Amalgamation and Harmony) Image: (Mother Earth & Water) (Response & Motion) (Bisexual)	1) House for each theme 2) Cottage for each theme 3) Pool such like a rice field 4) Cattle cart
C Zone ■Entrance & Transit	Siap River Left Bank	Symbol Color: (Red) Image: (Fire) (Motion) (Manlike)	1) Car Space 2) Transit Zone for moving to lake 3) Observation Deck

5.3.6 Power Generation Plan

For hydro power plan of Ayung dam, however, turbine discharge for power generation can be used from minimum discharge for water use to maximum discharge with containing unavailable water flowing through the outlets. Turbine discharge shall be turn out from outlets.

Economic evaluation results by C/V method are shown in Table-5.11 and Figure-5.16.

Table-5.11 Economic Evaluation by C/V Method (V-C, C/V)

Case		Turbine Discharge (m³/s)					Remarks
		8.0	10.0	11.0	12.0(Adopted)	14.0	
Max. Output (KW)	1)	5,320	6,650	7,310	7,980	9,310	
L5output capacity (KW)	2)	4,402	4,729	4,756	4,782	4,687	
Gross Output (MWh)	3)	39,828	44,253	45,100	45,896	45,885	
Effective Output Capacity (KW)	4)	4,204	4,516	4,542	4,567	4,476	2)×(1-Stop Factor)
Net Output (MWh)	5)	38,036	42,262	43,071	43,831	43,820	3)× Utilization Factor
Value for KW (1000yen)	6)	138,115	148,375	149,222	150,038	147,057	4)×KW
Value for KWh (1000 yen)	7)	464,036	515,592	525,460	534,734	534,606	5)×KWh
Benefit (1000yen) (V)	8)	602,151	663,967	674,682	684,772	681,663	6)＋7)
Construction Cost (1000 yen) (V)	9)	793,000	916,000	979,000	1,031,000	1,139,000	
Operation Cost (1000 yen) (C)	10)	97,539	112,668	120,417	126,813	140,097	9)× Expense Rate
V-C (1000 yen)	11)	504,612	551,299	554,265	557,959	541,566	8) - 10)
C/V	12)	0.162	0.170	0.178	0.185	0.206	10)/8)
Cost per Kw (1000yen/KW)		149.1	137.7	133.9	129.2	122.3	9)/1)
Cost per Kwh (1000 yen /KWh)		19.9	20.7	21.7	22.5	24.8	9)/3)
Utilization Factor (%)		85	76	70	66	56	(3)/(1)×24×365/1000)) ×100

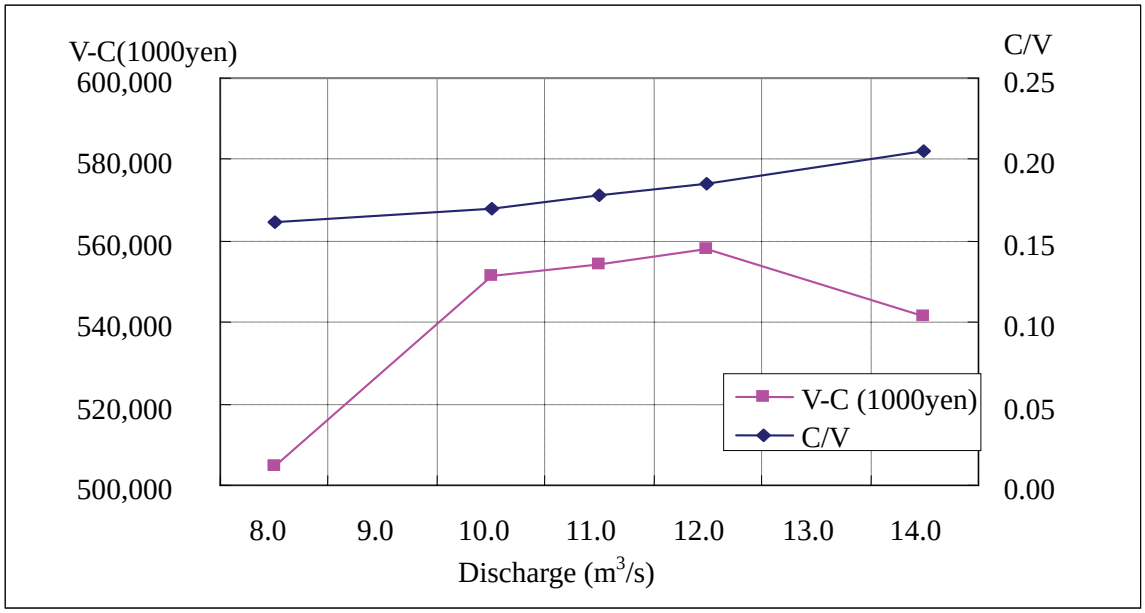


Figure-5.16 Relationship Between Discharge V-C,C/V

Optimal scale for discharge was selected as discharge case of 12m³/s with showing highest value of (V-C). Specifications of Ayung power plant are shown as Table-5.12.

Table-5.12 Specifications of Ayung Power Plant

Items	Specifications	Remarks
Intake water level	EL.366.000m	Normal water level
Tail water level	EL.282.000m	
Gross head	84.0m	
Net head	79.8m	Loss= 4.2m
Discharge	12.0m³/s	
Output capacity	7,980KW	
Net output capacity	4,570KW	L5Output×Stop Factor
Firm Capacity	4,570KW	Same as above
Gross output (year)	45,900MWh	

5.3.7 Construction Quantities

Construction quantities for Ayung Dam are shown in Table-5.13.

Table-5.13 Construction Quantities for Ayung Dam

Works Description		Unit	Quantity
1	Preparatory Works (Clearing and Grubbing etc)		
	1.1 Mobilization	Ls	1.0
	1.2 Temporary Road of Disposal Area	m	550.0
	1.3 Road works	m	2,080.0
2	Diversion Works (L=340m)		
	2.1 Diversion Length	m	340.0
	(Figure : 7.5m×7.5m Semi-Horse Shaped Tunnel)		
	2.2 Open Inlet・Outlet	site	2.0
	2.3 Coffer Dam	site	2.0
3	Permanent Works (Concrete Gravity Dam)		
	3.1 Excavation	m^3	514,000.0
	3.2 Artificial Plug	m^3	50,000.0
	3.3 Concrete Works	m^3	240,000.0
	3.4 Artificial Concrete Abutment	m^3	750.0
	3.5 Grout Works		
	1) Consolidation Grout	m	2,600.0
	2) Curtain Grout	m	29,500.0
	3) Rim Grout	m	500.0
	3.6 Crown Road of Dam	site	10.0
4	Temporary Equipment		
	1) Concrete Plant	t	750.0
	2) Tower Crane (13.5t×75m)	set	1.0
	3) Feed Plant	t/hr	150.0
5	Power Station		
	Excavation	m^3	14,000.0
	Concrete Structure	m^3	3,000.0
	Power Station (7900kw v)	set	1.0
6	Sabo Dam		
	Excavation	m^3	1,000.0
	Concrete Works	m^3	12,000.0
7	Road Works		
	1) Earth Works & Pavement	m^2	18,550.0
	2) Excavation (Rock)	m^3	5,000.0
	3) Surface Course (Concrete:25cm)	m^2	18,550.0
	5) Beacon・Signal etc	m	1,667.0
	6) Steel bridge	t	390.0
8	Disporsal Area		
	Left bank	m^3	1,250,000.0
	Right bnak	m^3	250,000.0
	Embankment (Backfulling)	m^3	1,495,000.0
9	Outlet & Electric Power Gate		
	1) Intake Gate	t	540.0
	2) Conduit Pressure Pipe	t	110.0

5.3.8 Construction Plan

(1) Out line of Construction Method

The outline of construction method and work item based on the construction quantity are shown in Table-5.14.

Table-5.14 Work Item of Construction Plan, Method and Quantity

No.	Work Item	Content and Construction Method	Construction Quantity

1	Temporary road and Improvement Work.	Construction of Temporary road	L=2,630m, B=7～8m
2	Diversion Work	Diversion tunnel shall be constructed on the left bank side to do excavation of the river bed. It shall be set up cofferdam at mouth and outflow of diversion tunnel and a river bed shall be made dry work.	L＝340m (Half-horse-shoe :7.5m×7.5m)
3	Dam Excavation	Before the diversion of river, it shall be made to finish excavation beyond the crown of dam. After the diversion of river, it shall be made to finish excavation under the crown of dam . Excavation shall be begun from the top, and onboard work and conveyance work shall be done on the river bed.	Excavation Quantity = 520,000 m^3
4	Gravity Dam (Concrete Works)	Gravity Dam shall be constructed with ELCM (Extended Layer construction method)	Concrete Works = 291,000 m^3
5	Drilling and Grouting Works	Consolidation grouting, curtain grouting and rim grouting shall be carried out.	Consolidation Grouting = 2,600m Curtain Grouting = 29,500m
6	Slope Protection Works	Protection work shall be done for cut slope of the temporary road, cut slope of dam excavation and temporary cut slope of other excavation.	
7	Disposal Area Works	It shall be thrown away in the place beyond EL370, and soil shall be done. Disposal area shall be set up in the dam right bank upper reaches part, and it shall be placed beyond EL370.	Capacity of Disposal Area = 1,450,000m^3

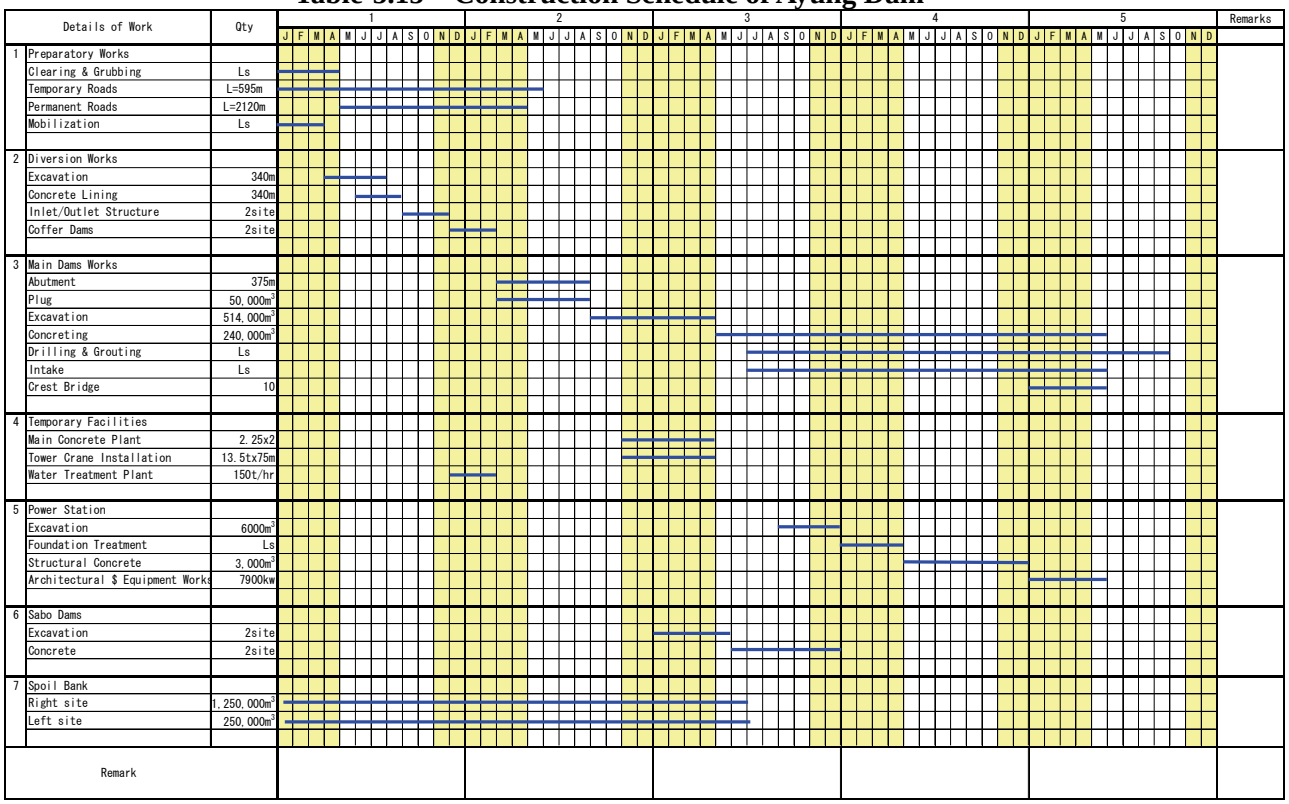
(2) Construction Schedule

Concrete Work is calculated as 312 days in total. As for items, placements days of concrete are 222days, suspensions by the structure thing execution inside dam are 60 days and placements of concrete form are 30 days.

If acceptable days for placement of concrete are made 16 days, total months of construction works are 21. 5 months and the amount of average placement for a month becomes 11,500 m^3.

The construction schedule of Ayung Dam Project is shown in the Table-5.15.

Table-5.15 Construction Schedule of Ayung Dam



5.4 Flood Control Facility for Badung River and Mati River

5.4.1 General

Badung River originated in hillside with 150m in elevation runs north to south through the center of Denpasar City on the way and flows into Benoa Straight. Area of basin is about 37.7 km^2, length is approximately 30km and rounded river gradient is about 1/500. There are houses and stores densely in the some sections which show insufficient height of dikes or narrow width along the river. Mati River originated in hillside with 80m in elevation near Sempide runs north to south, joining to Tebe River at downstream near Kuta, and flows into the Benoa Straight. Mati River is also one of typical urban river with catchments area 38.4km^2 , length 20km, and river gradient I=1/400. There are no dikes or narrow channel from Ulun Tanjung Weir in downstream to Umadui Weir in upstream. According to river improvement plan by Indonesian Government, the area which surrounded both Mati River and its right tributary Lebakmudin River in the upstream of Umadui Weir shall be designed for retarding basin for flood control.

Lately, December 12, 2005, the section between Maruti Street located in upstream and Pulau Misol Street located in downstream along Badung River hit and damaged by flood. (Refer to Figure-5.17)

Upstream Section at JL. G. Kering Street (From Right Bank Side)

Bank Slope Failure near Upstream of JL. P. Misol (From Left Bank Side)

Figure-5.17 Photos of Damage Condition by Flood December 12, 2005

5.4.2 Criteria for Plan and Design

For the flood control plan and river planning, referring to not only Indonesian standards and criteria but also the Japanese standard for flood control plan and design. Based on the recommended minimum return period of Design Flood as shown in the Flood Control Manual, return period of flood control plan for both Badung River and Mati River shall be adopted for 25 years.

5.4.3 Flood Control Project for Badung River

(1) Flow Capacity of Current Condition

Based on the topographic survey results, current river flow capacity was calculated by using non-uniform flow method. The result of river flow calculation is shown in Figure-5.30. According to this result, minimum flow capacity of current river flow is estimated as about 100 m^3/3.

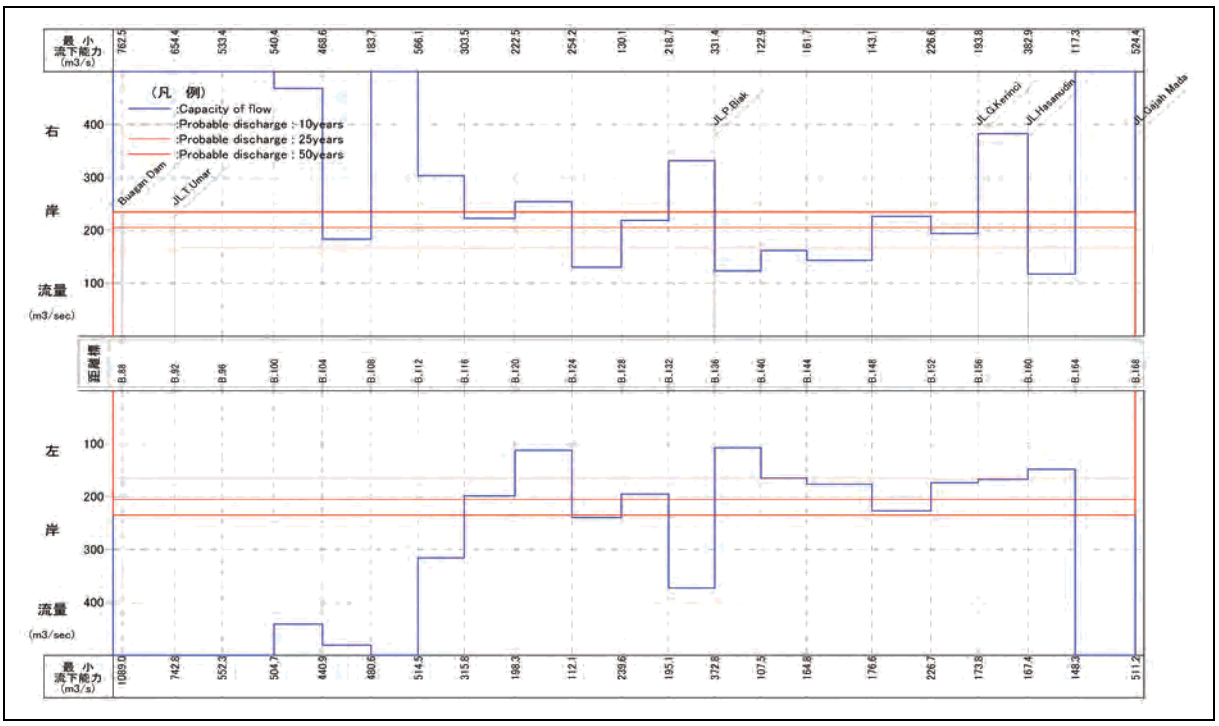


Figure-5.18 Calculation Result for Current River Flow Capacity (Badung River)

(2) Design Flood Calculation

Run-off analysis for the design flood of Badung River was executed by using rational formula in consideration with following reasons:

- ◆ The analysis model is to be required to calculate the change of land use due to urbanization in basin.
- ◆ The analysis model has applicability for calculation even in case of no discharge observation.

Peak discharge flow calculated by Rational Formula is given as follows:

$$Qp = 1/3.6 \cdot f \cdot R \cdot A$$

where, Qp : Maximum Discharge (m^3/sec),

f : Dimensionless Runoff Coefficient,

R : Average rainfall intensity within arrival time of flood(mm/hr)

A : Catchments Area (km^2)

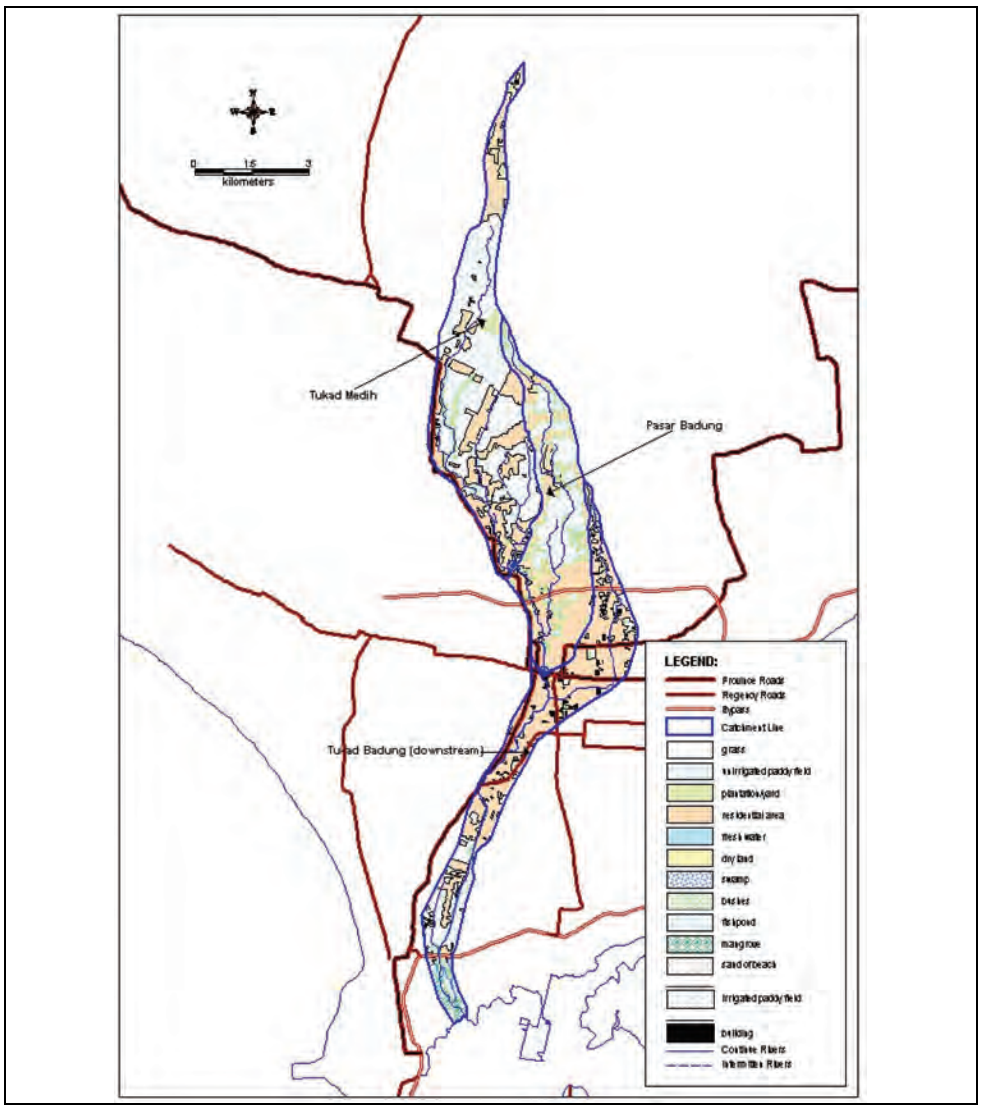


Figure-5.19 Watershed Division for Badung River Basin

<Basic Design Flood for Badung River>

Basic design flood for Badung River should be determined to be 235 m^3/sec at the base point as well as 205 m^3/sec at Buagan Weir.

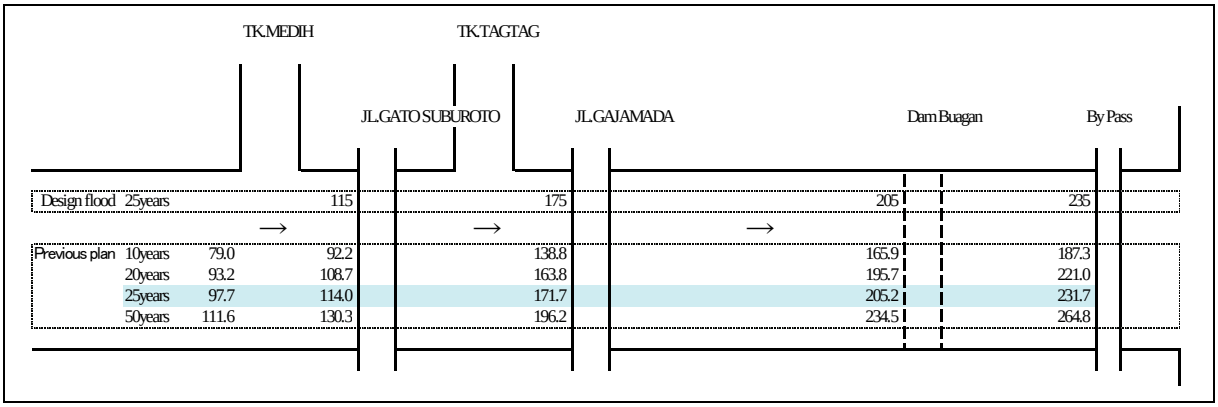


Figure-5.20 Distribution of Basic Design Discharge (Badung River)

(3) Flood Prevention Project for Badung River

Flood control plan for Basic Design Discharge of Badung River is shown as follows:

<Distribution of Design Discharge for River Improvement>

Comparing with the result between flow capacity of current river condition and planning river condition, only river course improvement including riverbed excavation and bank heightening, etc shall be adopted for Badung River. Design discharge is shown in Figure-5.21.

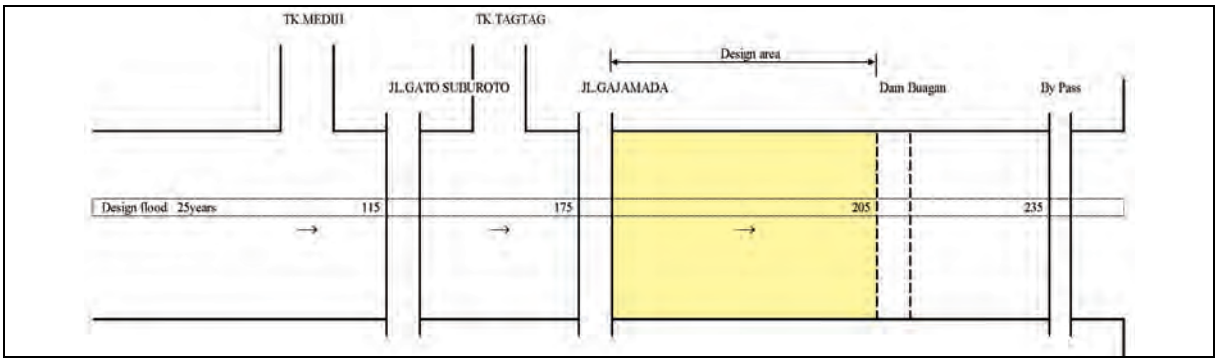


Figure-5.21 River Improvement Section for Badung River

(4) River Improvement for Badung River

<Basic Policy for Improvement>

As regarding current condition of Badung River, masonry revetments whose slope is 1:0.5 – 1:1.0 are installed on both river bank. River width ranging from 20m to 25m on average, however partially narrow river course with its width 20m is left at a bridge near B.K Tunggal Street, which would to be constrained pass for the river flow. Due to density of housing, small factories and stores located along the river, it is difficult to widen the river width.

As mentioned above, Badung River runs thorough the massed housing area as well as business area, there are no space for the widening of river. Therefore, typical cross section with the riverbed excavation and parapet wall should be adopted. Longitudinal profile should be designed to be steeper slope due to riverbed excavation. Repair work for Buagan Weir mainly operating to irrigate paddy field located in the downstream is also adopted based on the flow capacity calculation.

<Section for River Improvement and Adopted Method>

Section for river improvement should be designated from just upstream of Buagan weir (Distance mark No.88-50) to NO.194 distance mark near Maruti Street with about 5,700 m.

An adopted method for river improvement in Badung River is shown as follows;

- ◆ Riverbed excavation
- ◆ Parapet Wall on the Dike
- ◆ Repair of Existing Buagan Weir
- ◆ Plan for Longitudinal Profile

<Plan for Longitudinal Profile>

To increase river flow capacity, river excavation should be adopted. The planned gradient of section from Buagan Weir located in downstream to distance mark No.194 located in Maruti Street with distance of 5,700m was designed to be I=1/650.

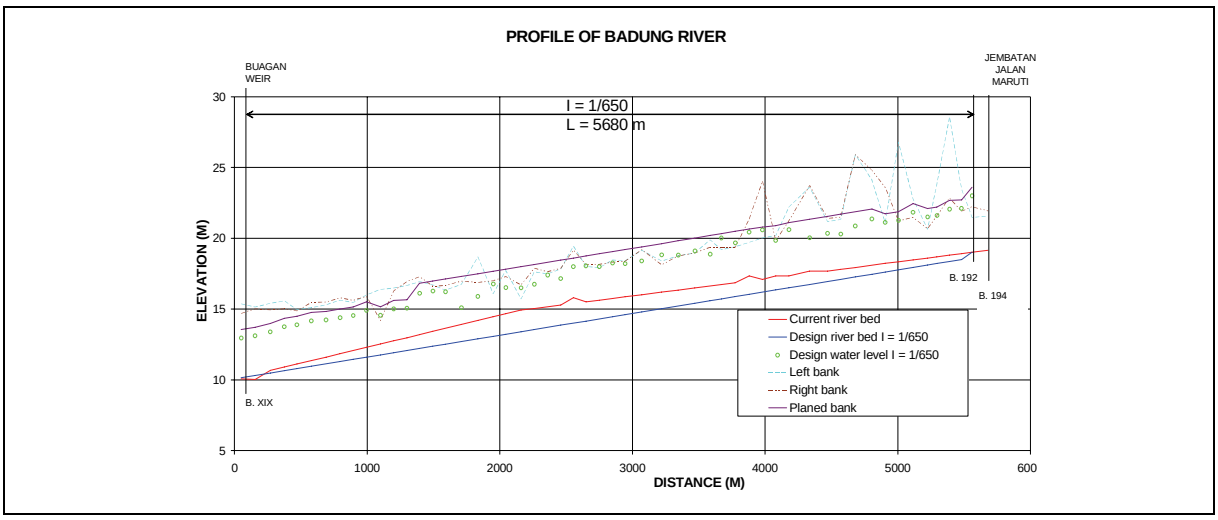


Figure-5.22 Designed Longitudinal Profile for Badung River

<Specifications for River Improvement of Badung River >

Specifications for river improvement works are shown in Table-5.16.

Table-5.16 Specifications for River Improvement of Badung River

Items	Specifications	Remarks
1) River Improvement Section and its Length	Buagan Weir (Downstream) to Mariti Street (Upstream) L=5,680 m	
2) Design Flood	205 m^3/sec	220 m^3/sec in future
3) Designed River Gradient	I=1/650	Upstream section: gradually approach to actual riverbed
4) River Width & Cross Section Shape	B= 18.5-37.5m, b=11-32 m (Trapezoid Shape with slope 1:0.5)	
5) Adopted Works	◆ Riverbed Excavation ◆ Parapet Placement ◆ Revetment	
6) Improvement Facility Works	Buagan Weir	

General plan of flood prevention project for Badung River is shown in Figure-5.23.