The rocks on the slope which are about to fall and any remained or unused materials on the berm such as rebound materials of the shotcrete shall be delivered to and disposed of at a specified spoil bank, using a small tractor shovel and a 8 ton dump truck.

The period of the shotcreting, amounting to 1,900 m^3 (≑ 13,000 m^2 x 0.15 m) is estimated about fourteen (14) months.

The whole schedule of the rehabilitation works related to the left bank open-cut excavation slope is illustrated in Table 11.1.

11.3. Cost Estimates and Tentative Implementation Schedule of the Proposed Rehabilitation Project

For each implementation program as mentioned in 11.2 above, the construction cost was roughly estimated and its result is tabulated in Tables 11.3 through 11.7. The total cost of the proposed rehabilitation project is shown in Table 11.2.

The annual cost disbursement is exhibited as per Table 11.8, and the implementation schedule of the proposed rehabilitation project is shown in Table 11.9.

11.4. Loss of Power Generation Due to Decrease in the Reservoir Water Level During Implementation of the Proposed Rehabilitation Project

Among the proposed rehabilitation schemes, the rock filling work on the dam upstream face slope is sure to affect the operation of the Binga Power Plant since this work has to be carried out with the reservoir water level kept at L.W.L. in the dry season to avoid the underwater construction, and the others have no relation with the output of the plant because each scheme is able to be put into effect irrespective of the reservoir water level.

In regards to the period in a particular year for implementing the above rock filling work, a six months period starting from December to May was selected because the mean monthly inflow to the Binga reservoir was found comparatively small according to the monthly mean inflow records in the past 20 years from 1967 through 1986. The average inflow amount for this particular period was 28.6 m^3/sec., while for the rest of a year, it was 106.0 m^3/sec. The former is less than the maximum discharge of 92.0 m^3/sec. utilized for the Binga Power Plant, thus being able to keep the L.W.L. of the reservoir.

The Binga reservoir operation for the power generation should be based on the concept that water is stored up to the H.W.L. during the months of August and September in the rainy season, then the power plant is operated with the reservoir water level being kept at the H.W.L. up to the end of the next dry season or the end of April or May next year, and thereafter, the plant is operated continuously until the water level shall have reached the L.W.L. in July.

In view of the above, the power plant is forced to be operated with the L.W.L. instead of the H.W.L. which is otherwise expected during the rehabilitation works on the dam upstream face slope, thereby the power generation decreases so much. The mean monthly power generation during a period of 1977 through 1986 is shown in the following table in which the mean during December to May indicates 124.3 GWh. The loss of power generation for the same period can be obtained as 124.3 x (1-2.742/3.202) = 17.9 GWh, accordingly. The values of 2.742 and 3.202 above designate the utility raito of the plant (m^3/KWh) at the H.W.L. (EL.575 m) and L.W.L. (EL.555 m) respectively.

Mean Monthly Power Generation

(During 1977 through 1986)

(GWh)

Month	Generated Power	Month	Generated Power
Dec.	25.8	June	27.5
Jan.	16.8	July	42.0
Feb.	20.5	Aug.	64.5
Mar.	19.0	Sept.	72.4
Apr.	19.6	Oct.	58.1
May	22.6	Nov.	47.0
Sub-total	124.3	Sub-total	311.5
	Total		435.8

Table 11.1 Tentative Work Schedule of Binga Dam Rehabilitation Project

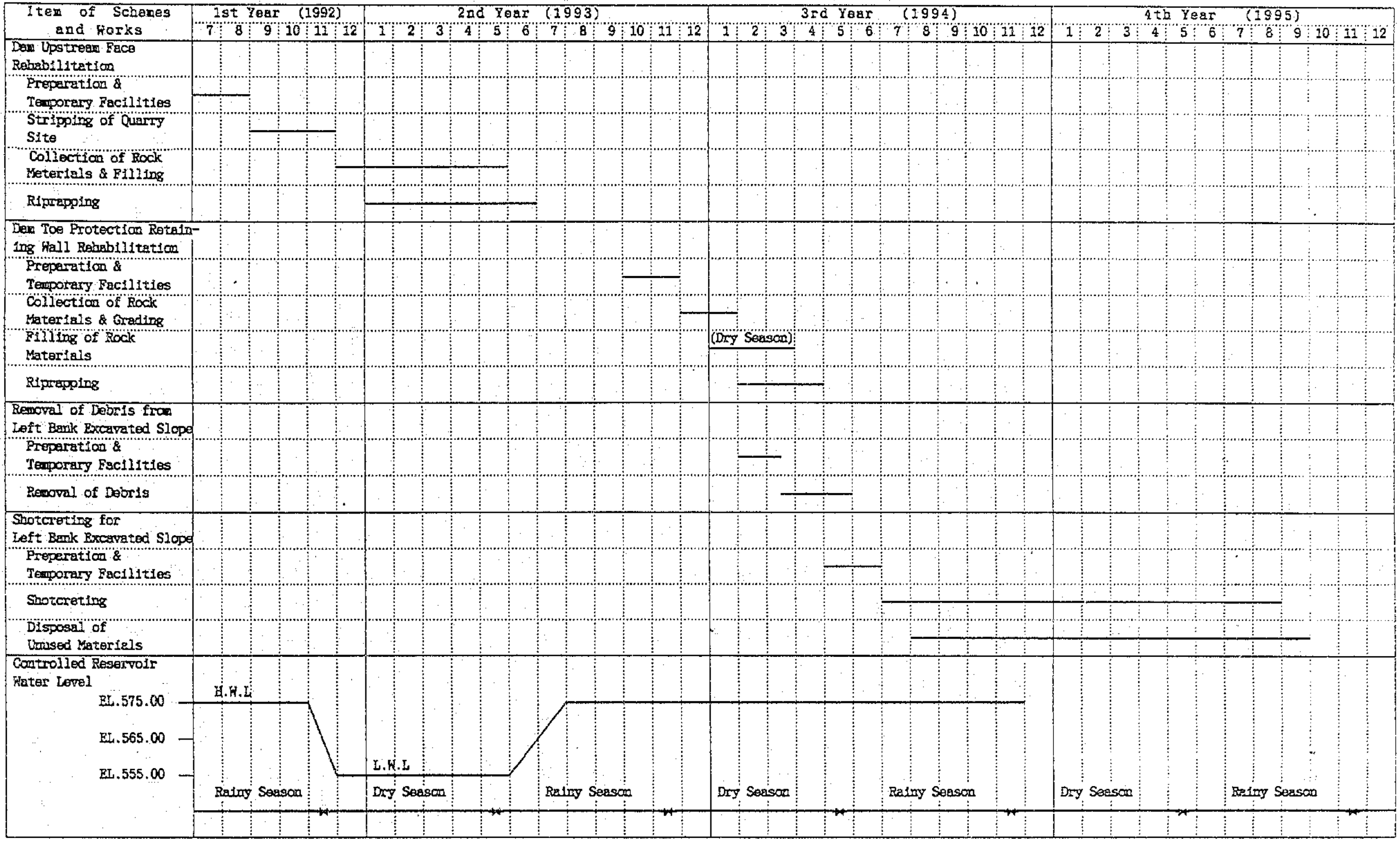


Table 11.2 Summary of Cost Estimates of Binga Dam Rehabilitation Project

Unit : US$

Item	Amount	Remarks
1. Cost for Rehabilitation Work		
Dam Upstream Face Rehabilitation	1,310,000	
Dam Toe Protection Retaining Wall Rehabilitation	481,000	
Removal of Debris from Left Bank Excavated Slope	61,000	
Shotcreting for Left Bank Excavated Slope	898,000	
Sub-total	2,750,000	
2. Cost for Investigation		
Survey	28,000	
Drilling	105,000	
Seismic Prospecting	14,000	
Various Tests	23,000	
Sub-total	170,000	
3. Right of Way	0	
4. Engineering	165,000	(1.×0.06)
5. NAPOCOR Administration	60,000	(1.×0.02)
6. Contingency	555,000	(1.×0.20)
7. Total	3,700,000	

Table 11.3 Cost Breakdown of Dam Upstream Face Rehabilitation

$ 1,310,000

Item	Specification	Unit	Q'ty	Unit Price	Amount	Remarks
Direct Cost						
Stripping of Quarry Site		m^3	25,000	4.3	107,500	Including clearing & waste disposal
Removal of Debris from Quarry	Collection & Hauling	m^3	15,000	8.6	129,000	Including waste disposal
Filling of Rock Materials	Collection, Hauling & Filling	m^3	50,500	11.8	595,900	Including rearrange-ment of the existing slope and riprap work
Miscellaneous Works		L.S	1		41,600	
Sub-total					874,000	
Indirect Cost						
Temporary Facilities	(25%)	L.S	1		218,000	
Field Administration	(10%)	L.S	1		87,000	
General Administration	(15%)	L.S	1		131,000	
Sub-total					436,000	
Total					1,310,000	

Table 11.4 Cost Breakdown of Dam Toe Protection Retaining Wall Rehabilitation

$ 481,000

Item	Specification	Unit	Q'ty	Unit Price	Amount	Remarks
Direct Cost						
Removal of Debris from Quarry	Collection & Hauling	m^3	15,000	8.6	129,000	Including waste disposal
Filling of Rock Materials	Collection, Hauling & Filling	m^3	15,000	11.8	177,000	Including riprap work
Miscellaneous Works		L . S	1		15,000	
Sub-total					321,000	
Indirect Cost						
Temporary Facilities	(25%)	L . S	1		80,000	
Field Administration	(10%)	L . S	1		32,000	
General Administration	(15%)	L . S	1		48,000	
Sub-total					160,000	
Total					481,000	

Table 11.5 Cost Breakdown of Removal of Debris from Left Bank Excavated Slope

$ 61,000

I t e m	Specification	Unit	Q'ty	Unit Price	Amount	Remarks
Direct Cost						
Removal of Debris		m^3	7,700	5.0	38,500	Including waste disposal
Miscellaneous Works		L . S	1		2,000	
Sub-total					40,500	
Indirect Cost						
Temporary Facilities	(25%)	L . S	1		10,300	
Field Administration	(10%)	L . S	1		4,100	
General Administration	(15%)	L . S	1		6,100	
Sub-total					20,500	
T o t a l					61,000	

Table 11.6 Cost Breakdown of Shotcreting for Left Bank Excavated Slope

$ 898,000

Item	Specification	Unit	Q'ty	Unit Price	Amount	Remarks
Direct Cost						
Shotcreting	15cm Thick with Mesh	m^3	1,900	253.0	480,700	
Removal of Unused Materials	Debris & Rebound Materials	m^3	1,900	5.0	9,500	Including waste disposal
Miscellaneous Works		L.S	1		107,800	
Sub-total					598,000	
Indirect Cost						
Temporary Facilities	(25%)	L.S	1		150,000	
Field Administration	(10%)	L.S	1		60,000	
General Administration	(15%)	L.S	1		90,000	
Sub-total					300,000	
Total					898,000	

Talbe 11.7 Program of Investigations for Binga Dam Rehabilitation Project

Place / Item	Dam Upstream Face	Dam Downstream Toe	Quarry Site	Left Bank Excavated Slope	Total: Quantity	Total: Unit Price	Total: Amount
Survey	Cross Sectional Survey (EL.555 m to Dam Crest, 20 m interval): 20,000 m²	Topographic Survey : 40,000 m²	Topographic Survey : 20,000 m²	Topographic Survey : 30,000 m²	Topographic Survey : 110,000 m²	(0.25$/m²)	$ 28,000
Drilling			300 m (50 m × 6 holes)			(350$/m)	105,000
Seismic Prospecting			900 m (150 m × 9 holes)			(15$/m)	14,000
Various Tests			Rock Test L.S.			L.S.	23,000
Total							170,000

Table 11.8 Yearly Expenses for Binga Dam Rehabilitation Project

(Unit : US$)

Item	Total Cost	1990	1991	1992	1993	1994	1995
1. Cost for Rehabilitation Work							
Dam Upstream Face Rehabilitation	1,310,000			250,000	1,060,000		
Dam Toe Protection Retaining Wall Rehabilitation	481,000				140,000	341,000	
Removal of Debris from Left Bank Excavated Slope	61,000					61,000	
Shotcreting for Left Bank Excavated Slope	898,000					360,000	538,000
Sub-total	2,750,000			250,000	1,200,000	762,000	538,000
2. Cost for Investigation	170,000	110,000	60,000				
3. Right of Way	0						
4. Engineering	165,000	30,000	100,000	35,000			
5. NAPOCOR Administration	60,000	10,000	10,000	10,000	10,000	10,000	10,000
6. Contingnency	555,000	10,000	20,000	50,000	240,000	150,000	85,000
7. Total	3,700,000	160,000	190,000	345,000	1,450,000	922,000	633,000

Table 11.9 Tentative Implementation Schedule of Binga Dam Rehabilitation Project

Item	1988	1989	1990	1991	1992	1993	1994	1995
	2 4 6 8 10 12	2 4 6 8 10 12	2 4 6 8 10 12	2 4 6 8 10 12	2 4 6 8 10 12	2 4 6 8 10 12	2 4 6 8 10 12	2 4 6 8 10 12
Feasibility study	—							
Application to NEDA for Loan		···						
Loan Agreement		···	···					
Further Investigations			—	—				
Design & Prequalification			—	—				
Bidding & contract				—	—			
Dam Upstream Face Rehabilitation					—	—		
Dam Toe Protection Retaining Wall Rehabilitation						—	—	
Left Bank Excavated Slope Rehabilitation							—	—

Table 11.10 Tentative Work Schedule of Binga Dam Rehabilitation Project

(Dam Upstream Face Only)

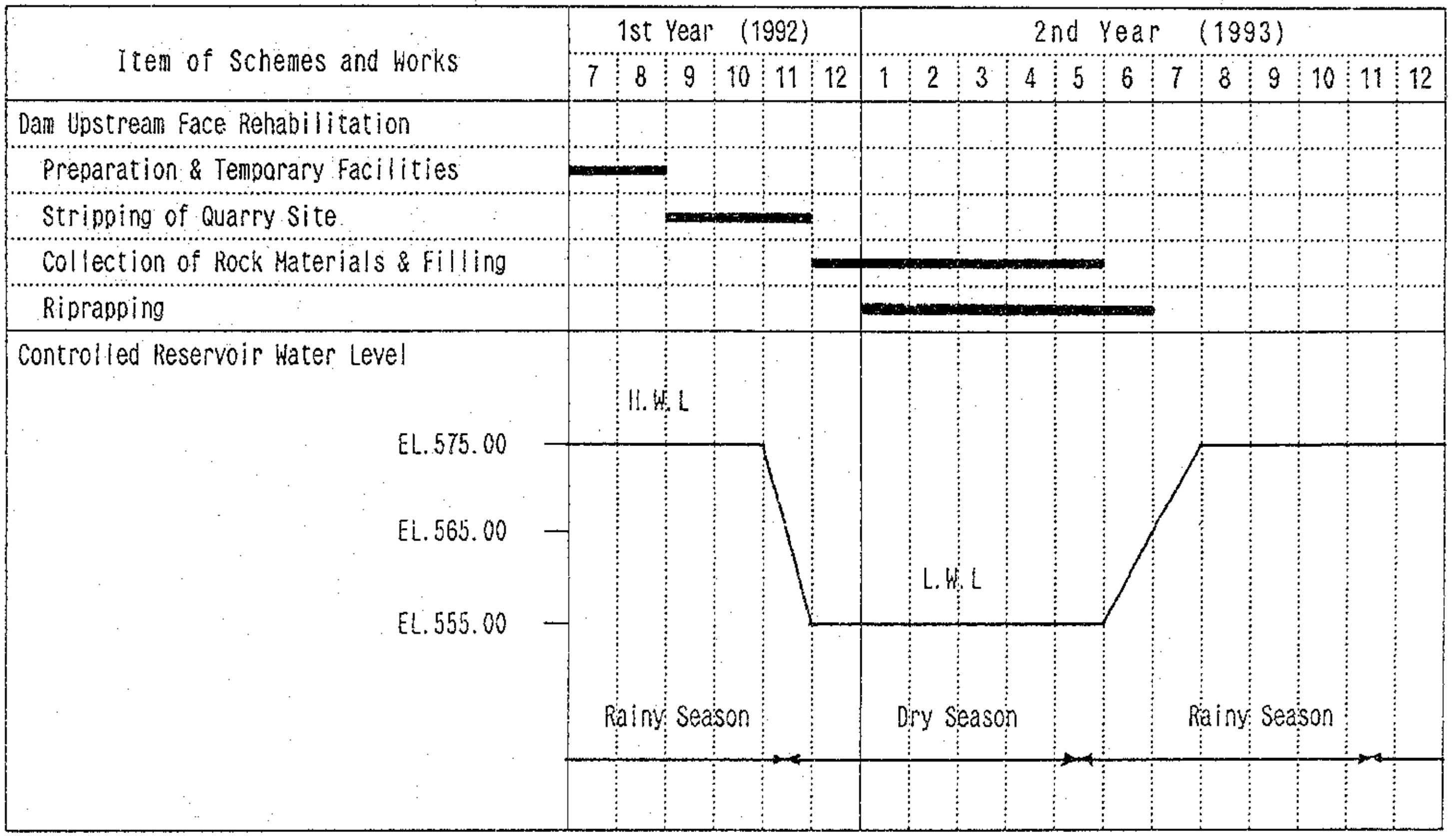


Table 11.11 Summary of Cost Estimates of Binga Dam Rehabilitation Project

(Dam Upstream Only)

Unit : US$

I t e m	Amount	R e m a r k s
1. Cost for Rehabilitation WOrk		
Dam Upstream Face Rehabilitation	1,310,000	
2. Cost for Investigation		
Survey	20,000	
Drilling	105,000	
Seismic Prospecting	14,000	
Various Tests	21,000	
Sub-total	160,000	
3. Right of Way	0	
4. Engineering	80,000	(1.×0.06)
5. NAPOCOR Administration	30,000	(1.×0.02)
6. Contingency	260,000	(1.×0.20)
7. Total	1,840,000	

Table 11.12 Program of Investigations for Binga Dam Rehabilitation Project

(Dam Upstream Face Only)

Place / Item	Dam Upstream Face	Dam Downstream	Quarry Site	Total		
				Quantity	Unit Price	Amount
Survey	Cross Sectional Survey (EL.555 m to Dam Crest, 20m interval): 20,000m²	Topographic Survey : 40,000m²	Topographic Survey : 20,000m²	Topographic Survey : 80,000m²	(0.25 $/m²)	$ 20,000
Drilling			300 m (50 m× 6 holes)		(350 $/m)	105,000
Seismic Prospecting			900 m (150 m× 9 holes)		(15 $/m)	14,000
Various Tests			Rock Test L.S.		L. S.	21,000
Total						160,000

Table 11.13 Yearly Expenses for Binga Dam Rehabilitation Project

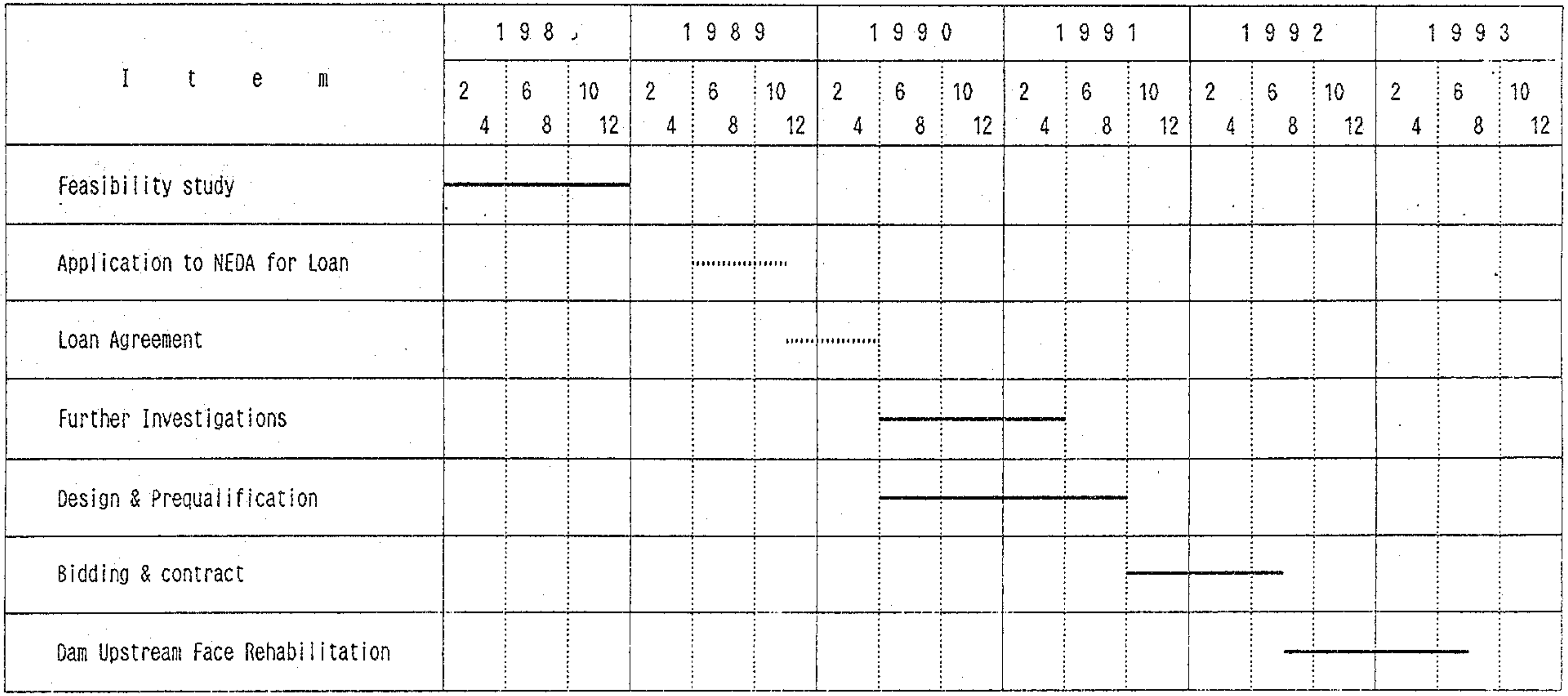
(Dam Upstream Face Only)

(Unit : US$)

I t e m	Total Cost	1990	1991	1992	1993	1994	1995
1. Cost for Rehabilitation Work							
Dam Upstream Face Rehabilitation	1,310,000			250,000	1,060,000		
2. Cost for Investigation	160,000	100,000	60,000				
3. Right of Way	0						
4. Engineering	80,000	20,000	40,000	20,000			
5. NAPOCOR Adiministration	30,000	5,000	5,000	10,000	10,000	0	0
6. Contingnency	260,000	10,000	20,000	20,000	210,000	0	0
7. Total	1,840,000	135,000	125,000	300,000	1,280,000	0	0

Table 11.14 Tentative Implementation Schedule of Binga Dam Rehabilitation Project

(Dam Upstream Face Only)



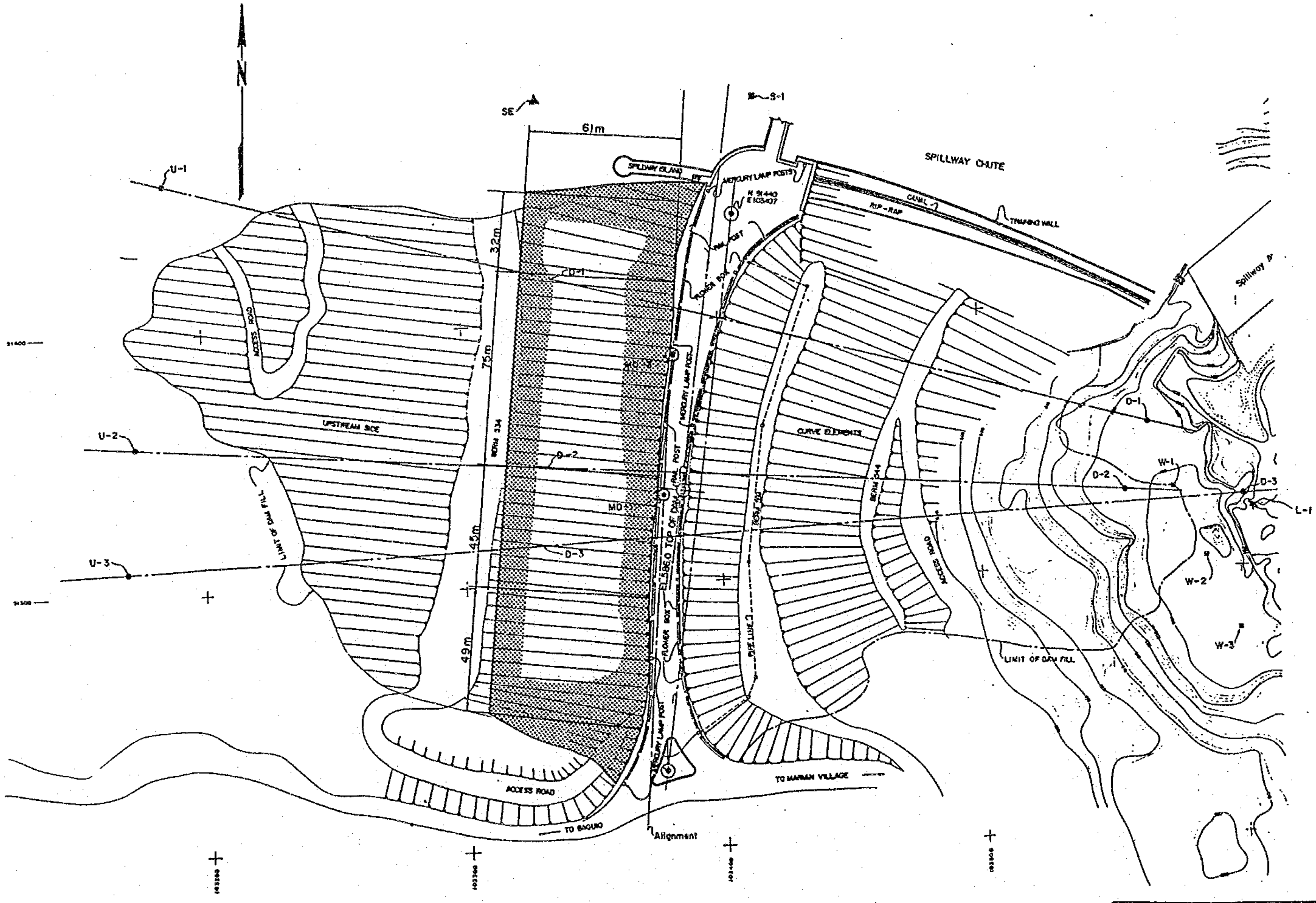


Fig. 11.1

As Built | Survey

THE BINGA DAM REHABILITATION PROJECT	
Plan of Dam Embankment	
SCALE.	DATE
THE JAPAN INTERNATIONAL COOPERATION AGENCY	

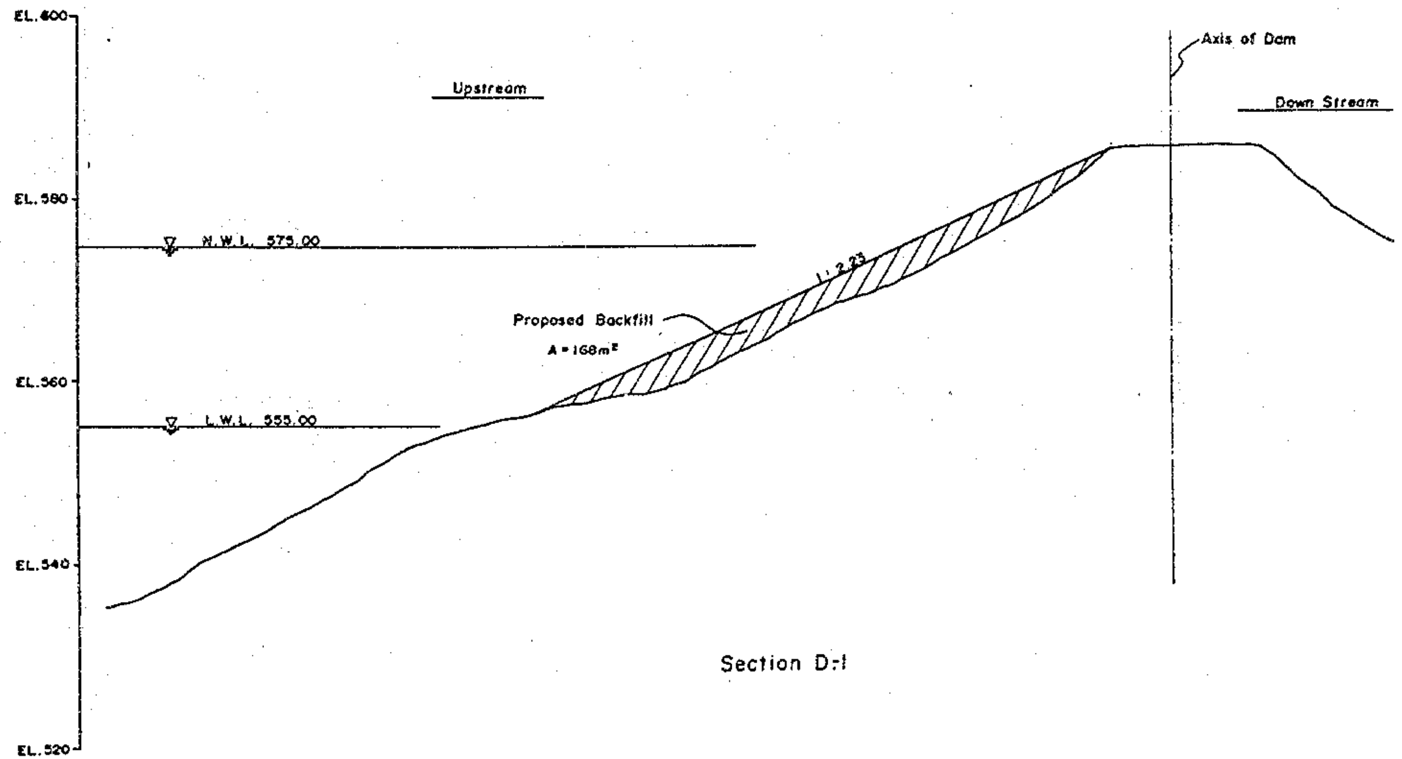


Fig. 11.2 Section of Dam Embankment (Section D1)

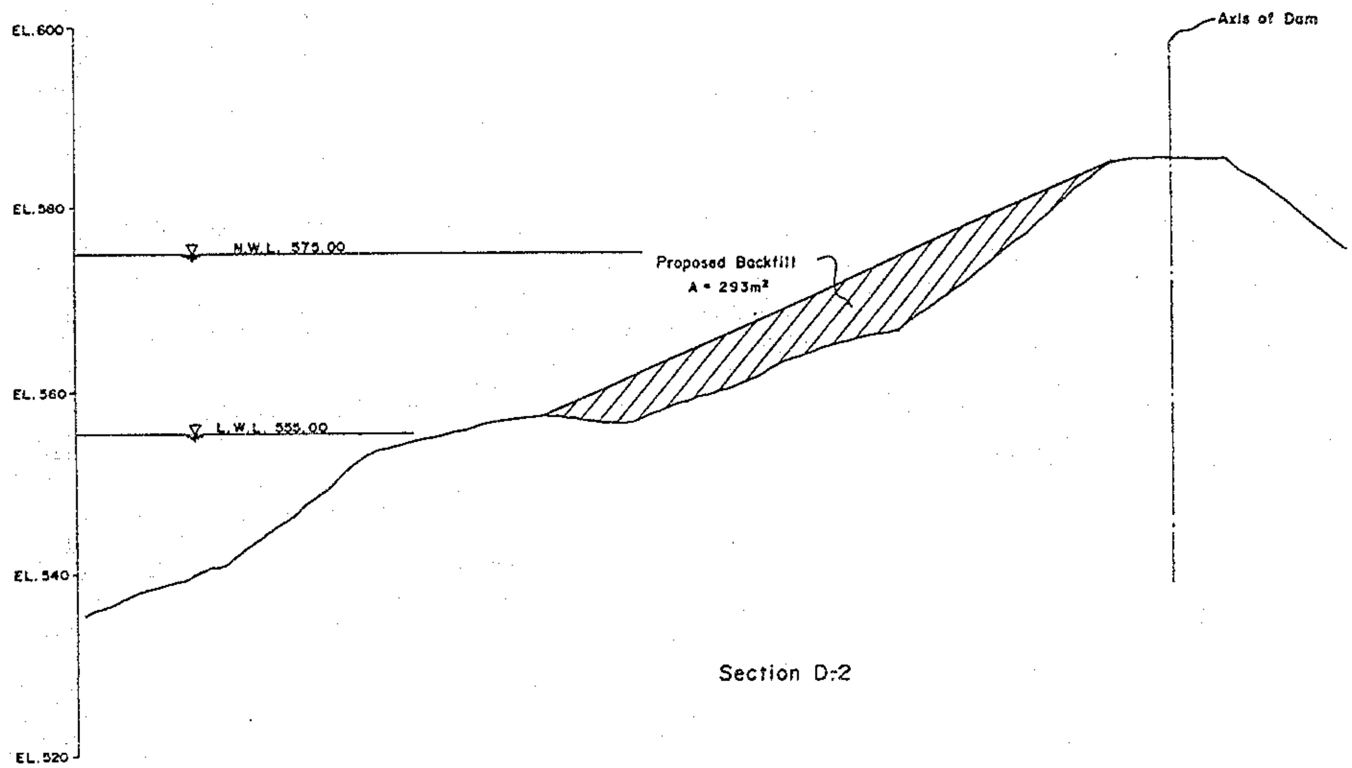


Fig. 11.3 Section of Dam Embankment (Section D2)

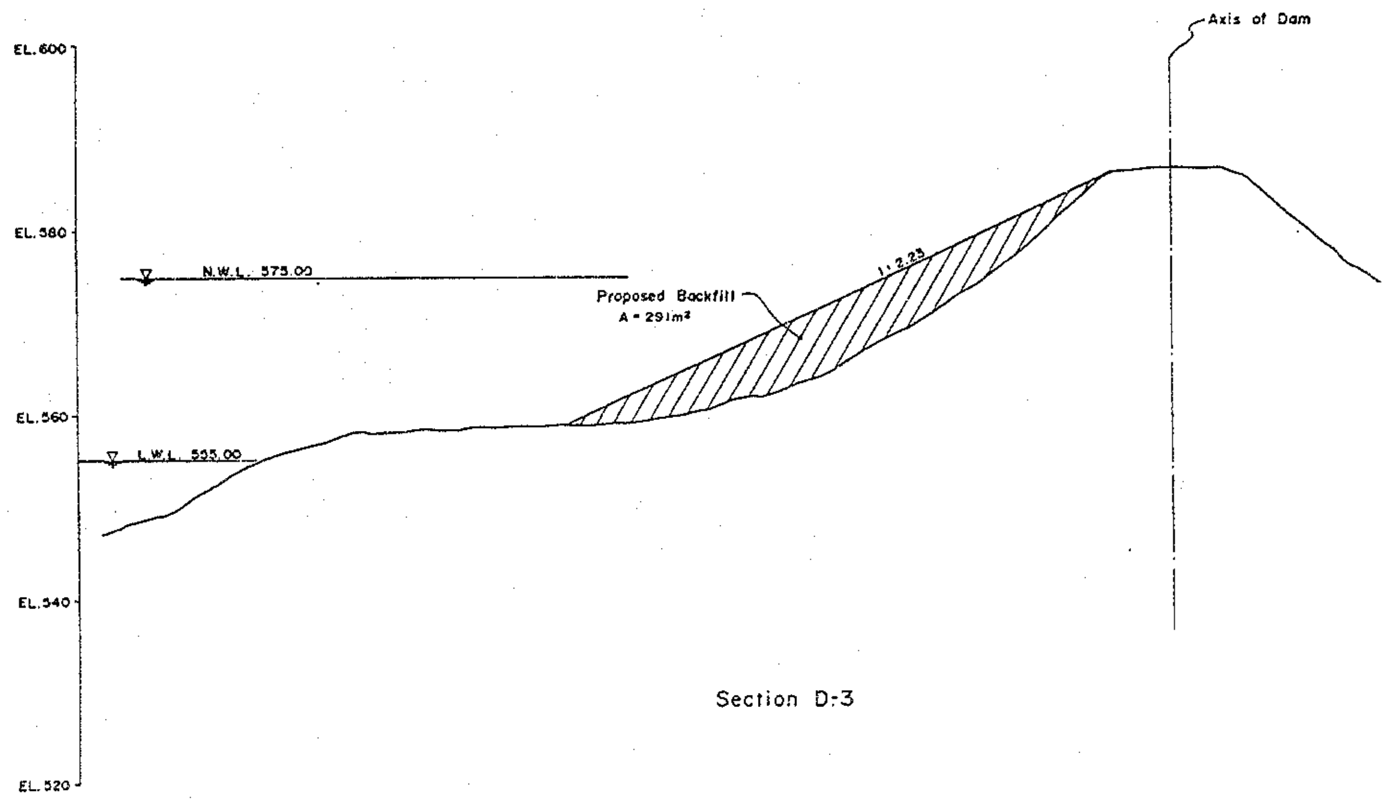


Fig. 11.4 Section of Dam Embankment (Section D3)

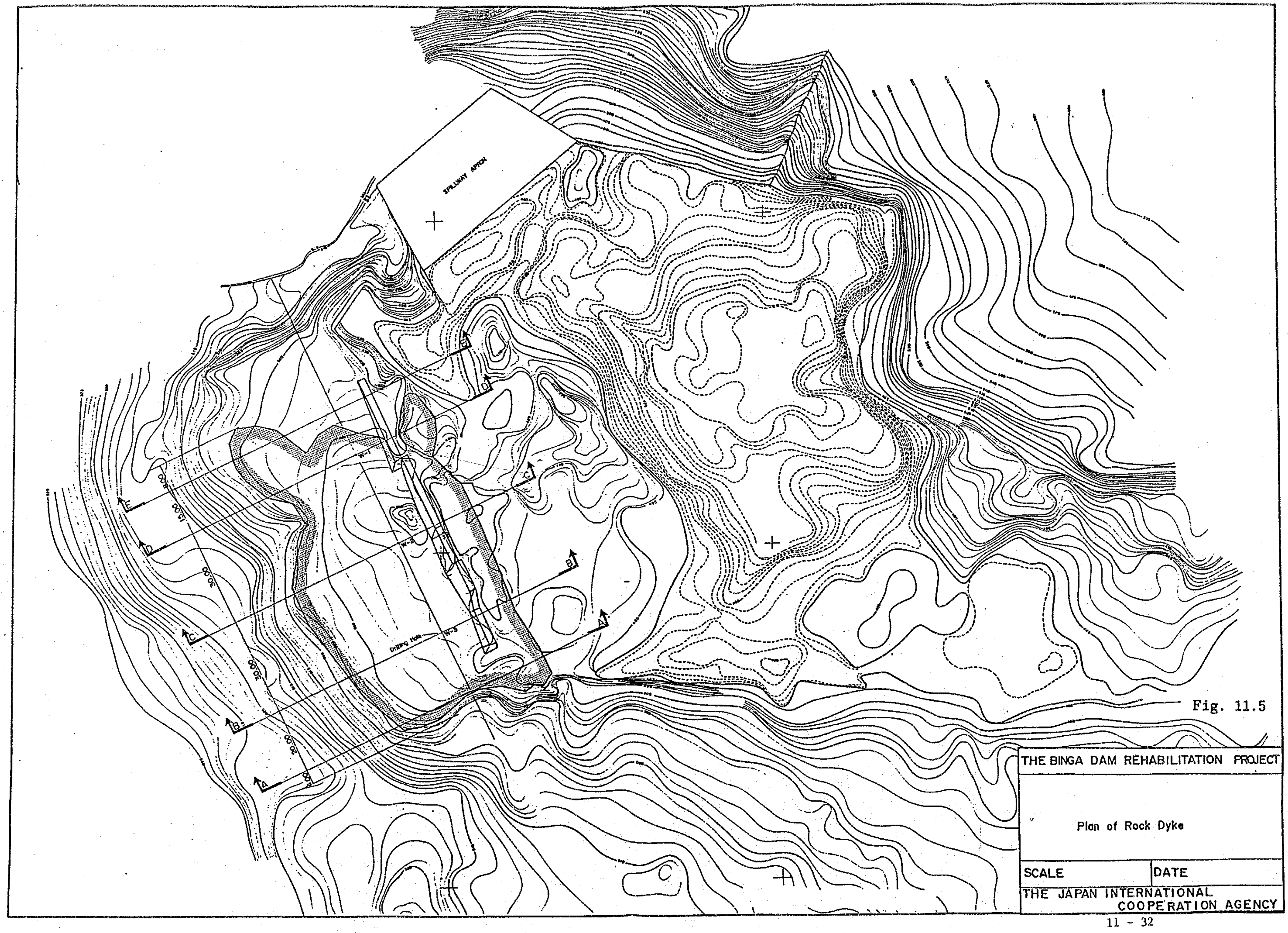


Fig. 11.5

THE BINGA DAM REHABILITATION PROJECT

Plan of Rock Dyke

SCALE	DATE

THE JAPAN INTERNATIONAL COOPERATION AGENCY

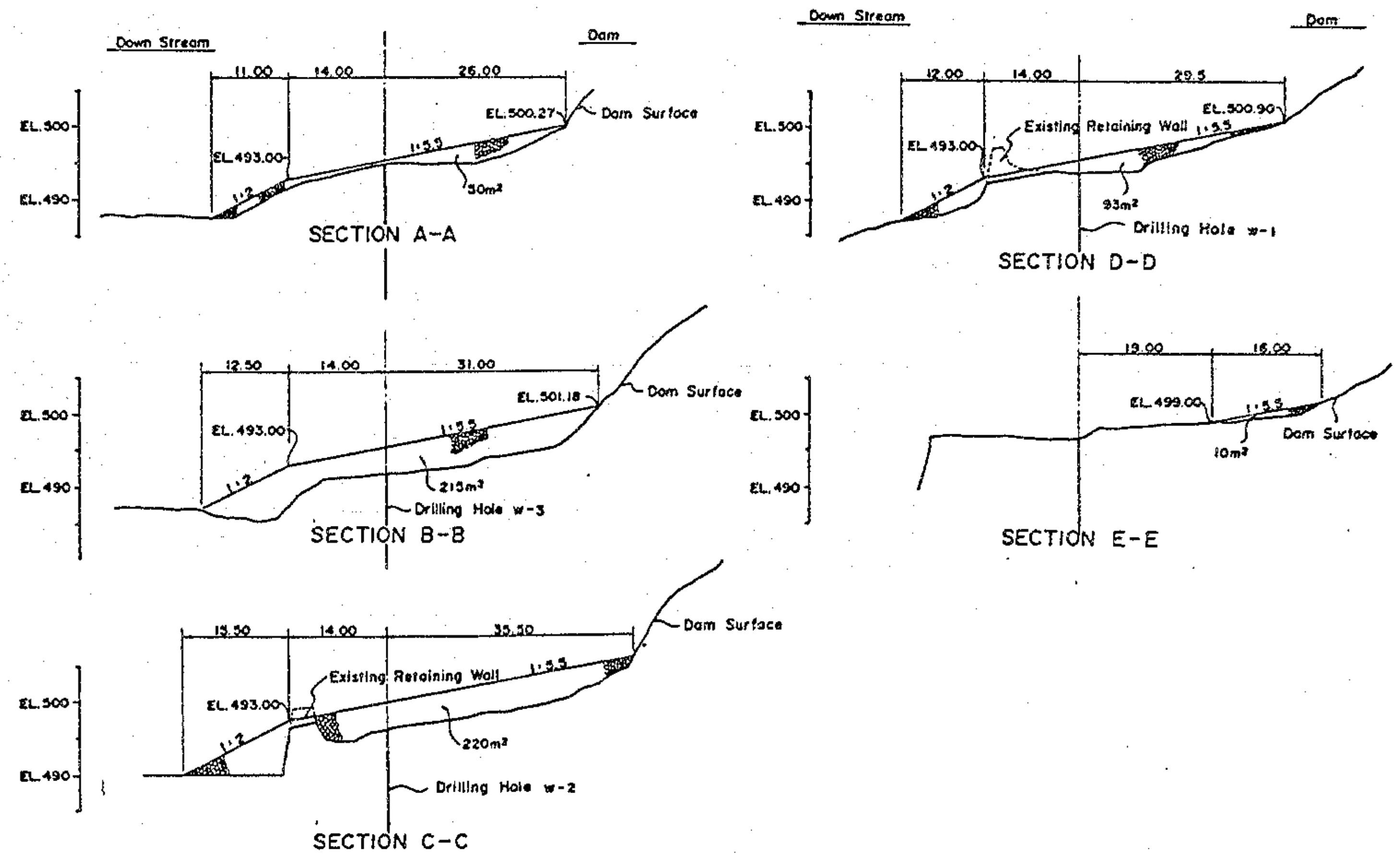


Fig. 11-6 Section of Rock Dyke

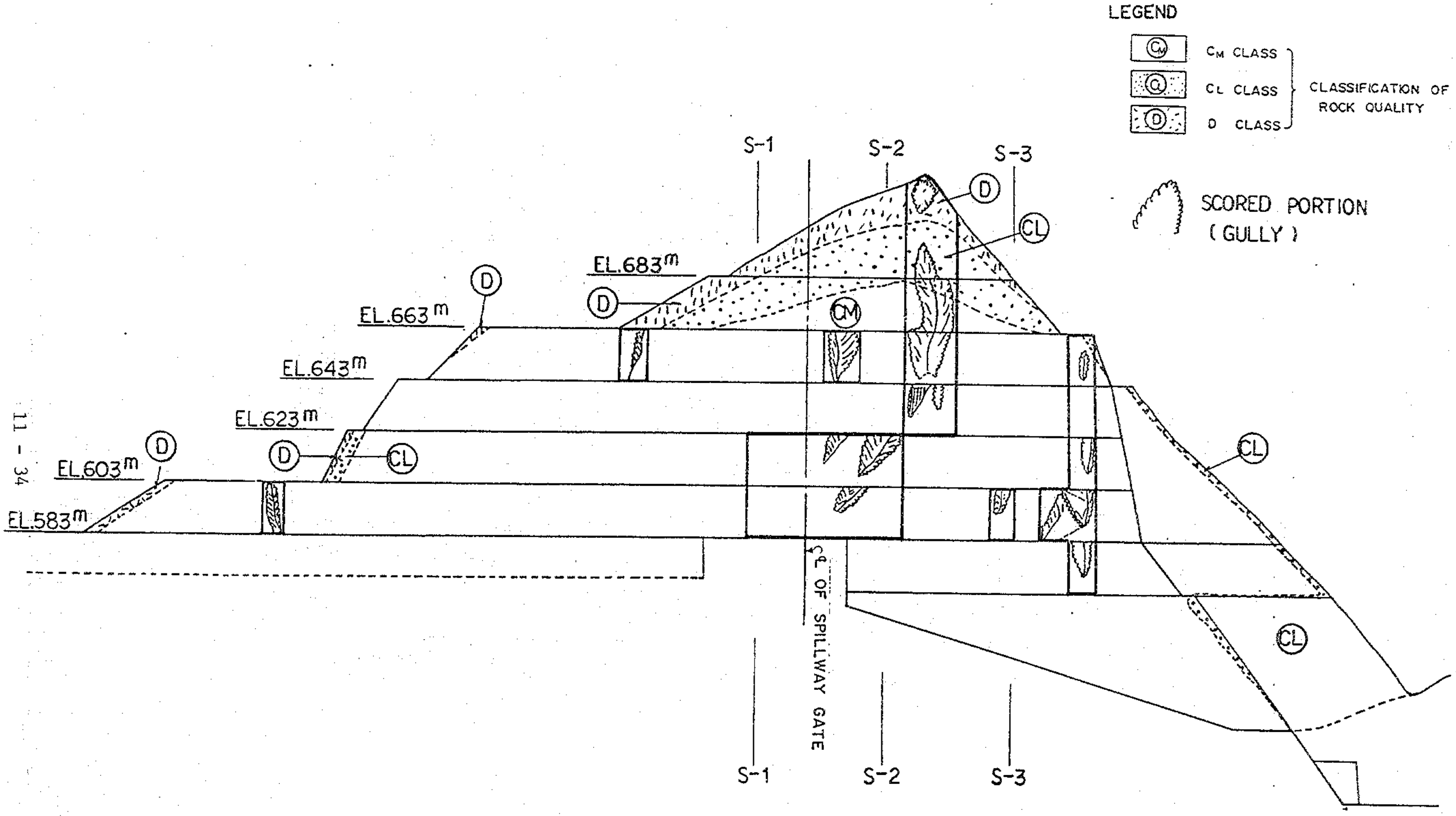
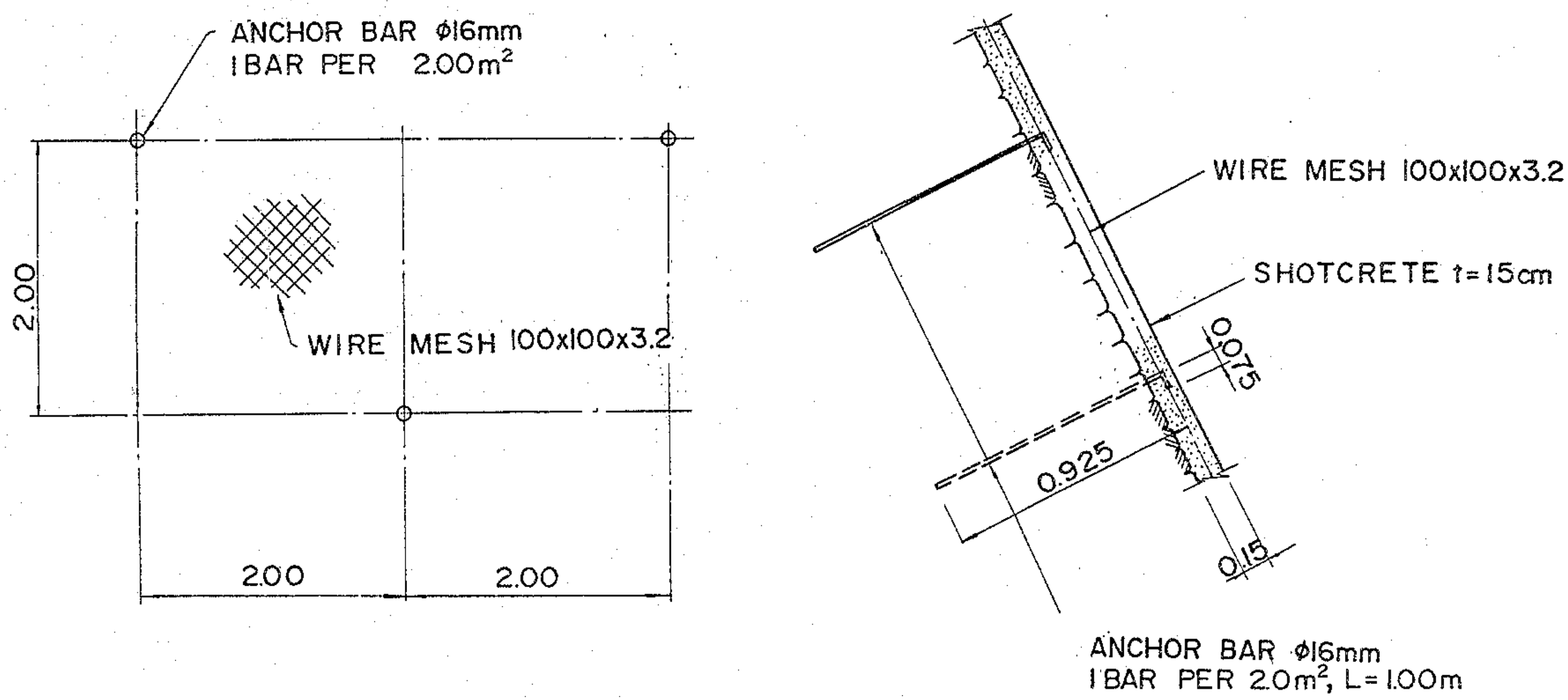


Fig. II-7 Area of the Slope to be Shotecreted



TYPICAL SECTION OF SHOTCRETE

Fig.11-8 Typical Section of Shotcrete

12. ECONOMIC ANALYSIS

12. Economic Analysis

12.1. Project Costs and Loss of Power Generation Associated with the Project

Shown below are annual cost disbursements of the Binga Dam Rehabilitation Project and estimated loss of power generation caused by a decrease in the reservoir water level incidental to implementation of the Project.

C.Y.	Cost of the Project (US$ x 10^3)	Loss of Capacity (MW)	Loss of Energy (GWh)
1990	160	-	-
1991	190	-	-
1992	345	Max. 34.7	3.7
1993	1,450	Max. 30.4	14.2
1994	922	-	-
1995	633	-	-
Total	3,700	-	17.9

The maximum load of the Grid in 1992 is expected to reach 3,773 MW at generation end, the above loss of capacity accounts for no more than 1.0% thereof accordingly. This loss of capacity is expected to occur over a period of six months from December, 1992 through May, 1993. As it is temporary in nature, no additional capacity is particularly required to be input to the Grid. However, the loss of energy should be replenished by some other alternative power source. This issue is discussed in the latter part of the section.

12.2. Capacity and Annual Generated Energy of the Binga Power Plant

The Binga Dam Rehabilitation Project consists of:

1) Dam Upstream Face Rehabilitation,

2) Dam Toe Protection Retaining Wall Rehabilitation, and

3) Left Bank Excavated Slope Rehabilitation.

Since the implementation of the above each rehabilitation scheme will yield no direct profit, it is impossible to make a usual economic analysis or a cost-benefit analysis of the individual scheme.

As far as an investment to the rehabilitation project is concerned, however, it is not allowed to invest money without any discussion on the economic and financial analysis. It goes without saying that the investment should not exceed the economic and financial values of the Binga Power Plant which are valued in terms of the plant capacity and annual generated energy.

In appraising the value of the Binga Power Plant, the following figures were used for the plant capacity, annual generated energy and the plant factor calculated therefrom.

	Generation End	Sending End
Plant Capacity (MW)	100	99.7
Annual Generated Energy (GWh)	435.8	434.5
Plant Factor (%)	49.75	49.75

N.B.: Annual generated energy was obtained by averaging the actual records of the past 10 years from 1977 through 1986

12.3. Unit Prices Applied to Appraisal on the Binga Plant Value

The Binga plant value is appraised on the basis of the costs of other alternative power sources which could substitute in terms of the plant capacity and annual generated energy. For this purpose, the typical power sources listed in "NAPOCOR Power

Development Program, June, 1988" were considered as the alternative power sources. The main features of these power sources related to calculations of the fixed costs are tabulated in Table 12.1. Table 12.2. exhibits the annual fixed costs at sending end of the relevant power sources expressed in US$/kW-year. In this table, the station use rate was assumed by JICA study team.

Further, shown in Table 12.3 are the main features of the alternative power sources and the existing oil-fired thermal plant related to calculations of the variable costs. In this table, the features related to the economic analysis were assumed by JICA study team, and related to the financial analysis were extracted from the said NAPOCOR Power Development Program.

Tables 12.4 and 12.5 show the results of calculations of the variable costs according to Table 12.3, which values are used for the economic and financial analyses. In these tables, the variable O/M ratio and station use rate were assumed by JICA study team. Aside from the above, the variable cost of the geothermal power plant was calculated as shown in Table 12.6.

From the calculation results shown in Tables 12.2, 12.4 and 12.5, the total cost per kW is obtained with the plant factors used as parameters, as represented in Tables 12.7 and 12.8 and Figs. 12.1 and 12.2. In this connection, the variable cost of the geothermal power plant used for the economic analysis was regarded as nil in view of utilization of free domestic resources.

12.4. Economic and Financial Analyses

12.4.1. Evaluation of Power Loss

The loss of power generation due to a decrease in the reservoir water level during the rehabilitation work can be evaluated in terms of the variable cost of the existing oil-fired thermal power plant. In this connection, the Bataan power plant with a higher thermal efficiency as compared to the others is operated with the most priority given, and therefore the loss of power generation at Binga would probably be made up for by the power plants with a rather low thermal efficiency such as Manila, Sucat and Malaya. Based on the above concept, the loss of power generation at Binga is evaluated as follows:

C.Y.	Economic Value (USx10^3$)	Financial Value (USx10^3$)
1992	104	116
1993	399	445

12.4.2. Annual Levelized Cost Calculated for the Proposed Rehabilitation Works

The annual levelized costs of the proposed rehabilitation works and the loss of power generation caused thereby are shown in economic and financial terms as below:

C.Y.	Economic Cost (USx10^3$)	Financial Cost (USx10^3$)
1990	160	160
1991	190	190
1992	449	461
1993	1,849	1,895
1994	922	922
1995	633	633
Present Worth	5,381.2	5,458.8
Annual Levelized Cost	876.1	888.7

N.B.: - Present worth was calculated with a discount rate of 14%, the standard year of 1995.

- The above present worth was levelized with a discount rate of 14% applied over a period of 15 years from 1996 through 2010.

12.4.3. Appraisal on the Binga Plant Value

The appraisal on the Binga plant value in terms of the plant capacity and the annual generated energy can be done in comparison with economic and financial costs of the most economical alternative power source. The discount rate used for the appraisal shall be 14%.

As is apparently seen in Figs. 12.1 and 12.2, the geothermal power plant is found relatively costly. In order to conduct a severe appraisal, the geothermal was put aside, instead, the gas turbine and the coal-fired were considered for the applicable alternative power sources.

(1) Appraisal in Terms of Gas Turbine Costs

The appraisal on the Binga plant value in terms of the gas turbine cost revealed the following result:

	Economic Cost (USx10^3$)	Financial Cost (USx10^3$)
Plant Capacity (99.7 MW)	6,557.3	6,557.3
Annual Generated Energy (434.5 GWh)	17,587.3	22,990.7
Total	24,144.6	29,548.0

(2) Appraisal in Terms of Coal-Fired Costs

In appraising the Binga plant value in terms of the coal-fired cost, it should be reminded that the plant factor is as large as 70.27%. If the Binga plant capacity (99.7 MW) be replaced by that of the coal-fired plant, the variable cost is cheaper than that of the existing oil-fired plant, thus the coal-fired plant is able to be operated up to the ceiling plant factor of 70.27%. In this case, the annual generated energy indicates 613.7 GWh. Since the Binga plant produces an annual energy of 434.5 GWh, the balance 179.2 GWh is regarded as the saved energy of the oil-fired plant which bears the costly variable cost.

As the result of the above appraisal, the following figures were obtained:

	Economic Cost (US$x10^3)	Financial cost (US$x10^3)
Plant Capacity (99.7 MW)	23,082.5	23,082.5
Annual Generated Energy		
Coal-fired (613.7 GWh)	10,922.0	12,656.3
Oil-fired (△179.2 GWh)	△5,038.6	△5,614.3
Total	28,965.9	30,124.5

To compare the above two appraised costs, the former, the gas turbine cost, is smaller than the latter, the coal-fired cost.

12.4.4. Justification for Implementation of the Project

The cost relating to the proposed Binga dam rehabilitation project is compared with the Binga plant value as follows:

	Economic Analysis ($US\$ \times 10^3$)	Financial Analysis ($US\$ \times 10^3$)
- Cost		
Present worth as of 1995 (C1)	5,381.2	5,458.8
Annual levelized cost during 1996 thru 2010 (C2)	876.1	888.7
- Binga plant value per year (B)	24,144.6	29,548.0
- Ratio		
R1 = C1/B (%)	22.29	18.47
R2 = C2/B (%)	3.63	3.01

As shown above, the ratio of the cost relating to the proposed rehabilitation project to the Binga plant value per year indicates about 23% with the single payment present worth as of 1995 applied, and about 3.7% with the capital recovery cost over a period of 15 years applied. In the meanwhile, the Binga dam rehabilitation project is assessed in terms of enhancement of the safety factor as follows:

The current dam indicates the safety factor of 1.0 against a 79 year return period (T1) earthquake as mentioned in the foregoing Section 7 "Dam Stability". Further, it was revealed that the present safety factor against earthquake would be enhanced by the implementation of the project up to that corresponding to a 400 year return period earthquake. This means that structures which can resist a 79 year return period external force are reinforced by the rehabilitation work so as to resist a 400 year return period external force.

Probability (P) of an external force of a 'T' year or longer return period acting on the structure during the rest of its life time 'L' years is expressed:

$$P = (1 - e^{-L/T})$$

Besides, supposing that the structure which can resist a 'T' year return period external force would lose its original function or its entire value if it be given a force of a longer than "T" year return period, an expected value of such a damage (Y) can be obtained from probability of the damage multiplied by the value of the structure (A). Hence, the following equation is established:

$$Y = P \times A$$

This equation, however, considers no time factor. For instance, a value of damage expected two years hence is deemed to be the same as that ten years hence. The time factor is such that values expected in different years should be rectified on a certain standard year using a discount rate (i). Accordingly, the value two years hence is set as $A.P/(1+i)^2$, and the value ten years hence as $A.P/(1+i)^{10}$. Taking this time factor into account, 'P' in the above equation can be approximately replaced by 'q' shown below:

$$q = \frac{1/T}{\ell n\{(1+i)/(1-1/T)\}} \{1 - \exp(-\frac{i + (1/T)}{1 + i} \cdot L)\}$$

Hence,

$$Y = q \cdot A$$

where,

T : Return period of an external force causing failure of the structure (year)

L : Remaining life time of the structure (year)

i : Discount rate

A : Value of the structure (annual levelized value)

Y : Expected value of the damage (annual levelized value)

Then, in the case where the structure is remedied so as to resist the external force of 1/T2 probability instead of 1/T1, a decrease of the expected value of the damage can be sought as benefit, being represented by B = Y1 - Y2 = (q1 - q2) · A. If putting into this equation T1 = 79 years, T2 = 400 years, L = 15 years (corresponding to the rest of life time from 1996 to 2010), and i = 0.14, we can obtain q1 = 0.076 and q2 = 0.016, and then, on the assumption that the Binga plant value (A) stands at US$24,145/year, B = (q1 - q2) x A = 0.060 x A = US$1,450 x 10^3.

From the above, it is found out that a decrease of the levelized expected value of the damage, that is an expected annual benefit (B) to be brought about by the rehabilitation work is larger than the levelized cost of the project C2 = US$876.1 x 10^3 or B/C2 is represented by 1.66. Hence, the proposed rehabilitation project can be justified from the economic point of view.

With regard to the value of the structure 'A' as employed in the above process, only the plant value equivalent to the cost of the most economical alternative power source to replace the Binga plant was considered for this time. However, disadvantage brought about by failure of the Binga dam to the regional society in both mental and physical aspects should be as well taken into account. Such disadvantage is sure to give an adverse impact on the regional society which can not be valued in the monetary term because its valuation is placed at one's disposal. In this sense, the plant value employed here can be regarded as the minimum one accordingly.

12.4.5. Economic Analysis on the Proposed Measures for Removing the Sediments

The Binga power plant is located just downstream of the Ambuklao dam for which the report "Ambuklao Dam Rehabilitation Project" was prepared and submitted by JICA to NAPOCOR in March, 1988. In this report, a scheme of removing sediments from the riverbed at and downstream of the Ambuklao tailrace outlet was studied, and the method of dredging was proposed as one of the suitable methods, giving a suggestion that the above sediment problem should be further investigated in relation to sedimentation at the upper reaches of the Binga reservoir.

In compliance with the above suggestion, another method of removing the sediments around the Ambuklao tailrace outlet was studied in the framework of the Binga Project; the method of flushing away the sediments by an artificial flood from the Ambuklao spillway. Following hereunder is a comparative study of the above two methods i.e. methods of dredging and flushing.

The construction cost and increment of power generation owing to reduction of the riverbed level for the former, and loss of power generation due to a dead discharge and increment accrued thereby for the latter are shown in the table below:

Comparison Between Dredging and Flushing Methods

C.Y.	Method of Dredging		Method of Flushing	
	Construction Cost	Increment of Energy	Loss of Energy	Increment of Energy
	(USx10^3$)	(GWh)	(GWh)	(GWh)
1996	1,330	2.6	49.0	3.0
1997		2.7	49.0	3.0
1998	730	2.7	49.0	3.0
1999		2.7	49.0	3.0
2000	730	2.7	49.0	3.0
2001		2.7	49.0	3.0
2002	730	2.7	49.0	3.0
2003		2.7	49.0	3.0
2004	730	2.7	49.0	3.0
2005		2.7	49.0	3.0
2006	730	2.7	49.0	3.0
2007		2.7	49.0	3.0
2008	730	2.7	49.0	3.0
2009		2.7	49.0	3.0
2010	730	2.7	49.0	3.0

From the above comparison, it was found out that irrespective of loss and increment of power generation, the difference between both methods is found relatively small, and also that the method of flushing can be implemented intentionally in the rainy season when the plant has a large reserve capacity. Therefore evaluation on both methods was not done from the viewpoint of the fixed cost for the plant capacity but from the viewpoint of the variable cost for the power generation.

According to the above table, the present worth as of 1995 was calculated with the discount rate 14% applied, and the variable cost set as 28.117 US$/MWh for the economic analysis and 31.330 US$/MWh for the financial analysis. The result of the calculation is shown below:

Results of Calculations for Present Worth as of 1995

	Economic Cost	Financial Cost
Method of Dredging		
Construction Cost (USx10^3$)	2,962.7	2,962.7
Increment of Energy (USx10^3$)	△463.8	△516.8
Total (USx10^3$) C1	2,498.9	2,445.9
Method of Flushing		
Loss of Energy (USx10^3$)	8,462.3	9,429.3
Increment of Energy (USx10^3$)	△518.1	△577.3
Total (USx10^3$) C2	7,944.2	8,852.0
Ratio (C2/C1)	3.2	3.6

As shown above, the method of flushing entails a large loss of power generation incidental to the dead discharge from the spillway, thus indicating more than three times the amount of loss caused by the method of dredging.

12.5. Summary and Conclusions

As stated above, implementation of the Binga Dam Rehabilitation Project would cost approximately US$3,700x$10^3$ and will force the power generation to be reduced temporarily because the reservoir water level must be lowered as required to perform the relevant works.

The above total cost including that equivalent to loss of the power generation amounts to as much as US$5,381x$10^3$. However, taking into consideration that the effects of the proposed rehabilitation would last long after the completion of the works, the annual levelized cost of the rehabilitation work shows US$ 876 x 10^3. This amount accounts for 3% or so of the Binga plant value per year or US$24,145x$10^3$/year. Subsequently, the above annual levelized cost is compared with the decrease of the expected value of the damage, that is an expected annual benefit, amounting to US$1,450 x 10^3 which can be achieved in enhancement of the safety factors of the relevant structures by the rehabilitation work. The comparison shows the ratio of about 1:1.6, which apparently gives the economic justification to this project.

As regards the measures for removing the sediments around the Ambuklao tailrace outlet, the method of flushing away the sediments by an artificial flood was studied and compared with the method of dredging which had been studied in the Ambuklao Dam Rehabilitation Project. As a result, it has turned out that the former method involves a large loss of power generation due to the dead discharge from the spillway, and hence, is much less advantageous than the latter method.

12.6. Economic Analysis - Supplement

The economic analysis in the foregoing sections was based on the project cost including the left bank excavated slope rehabilitation scheme and the dam toe protection retaining wall rehabilitation scheme as well as the dam upstream face rehabilitation scheme.

In this section, however, the economic analysis is done from a different standpoint that the above former two schemes should be implemented in the framework of the regular maintenance program, thus focusing on the rehabilitation cost only for the dam upstream face scheme, and also that the Binga plant value is appraised, only in terms of the generated energy (KWh), on the basis of the variable cost of the oil-fired thermal plant.

12.6.1. Estimated Cost of Dam Upstream Face Rehabilitation Scheme and Loss of Generated Energy

Shown below are annual cost disbursements of the scheme, amounts of lost energy due to being forced to reduce the reservoir water level during the works, and power costs corresponding thereto, and shown further below are the present worth of those costs as of 1995 and the annual cost levelized over a period of 15 years from 1996 to 2010.

The present worth and the annual levelized cost are calculated with the same discount rate (i) 14% as for the foregoing section, and the unit price per KWh to value the lost energy refers to the variable cost of the oil-fired thermal plant, 28.117 US$/MWh shown in Table 12.4.

C.Y.	Estimated Cost of the Scheme (US$/$10^3$)	Lost Energy (GWh)	Power Cost of Lost Energy (US$$10^3$)	Total Cost (US$$10^3$)
1990	135	-	-	135
1991	125	-	-	125
1992	300	3.7	104	404
1993	1,280	14.2	399	1,679
Total	1,840	17.9	503	2,343
Present Worth	2,579.0	-	672.6	3,251.6
Annual Levelized Cost	419.9	-	109.5	529.4

12.6.2. Appraisal of the Binga Plant Value

The Binga plant value is appraised, only in terms of the generated energy, with the variable cost of the existing oil-fired thermal plant applied. The result is:

- Annual generated energy (at sending end) : 434.5 GWh
- Variable cost of the oil-fired thermal plant : 28.117 US$/MWh
- Binga plant value (A) : 12,216.8 x 10^3US$

12.6.3. Economics

In the case where the Binga plant value (A) is set as 12,216.8 x 10^3US$, a decrease of the levelized expected value of the damage, that is an expected annual benefit (B) to be brought about by the proposed rehabilitation scheme is calculated using the same formulae as appeared in the foregoing section 12.4.4. The result of calculations gives B = 0.060 x A = 733 x 10^3US$, indicating B/C = 1.38.

The outcome of the economic analysis-supplement is as well justifiable, accordingly.

Table - 12.1 Main Features of Alternative Power Sources Related to Calculations of Fixed Costs

Plants	Commissioning Year	No. of Units	Installed Capacity (MW)	Total Construction Cost (₱)	($)	Total($)	Lead Time (Years)	Forced Outage (%)	Maintenance (Weeks)	Fixed O/M.Cost ($/kW-year)
Gas-turbine A	1989	4 x 50	200	321.5	61.9	-	1.0	-	-	-
B	1989	6 x 50	300	472.5	90.0	-	1.0	-	-	-
Gas-turbine	1991	4 x 50	200	321.5	61.9	-	1.0	-	-	-
Sub-total	-	14 x 50	700	1,115.5	213.8	266.92	1.0	8	2	0.50
Coal A	1997	2 x 300	600	1,209.9	435.3	-	3.0	-	-	-
B	1998	2 x 300	600	1,202.5	465.5	-	3.0	-	-	-
C	1999	2 x 300	600	976.7	422.6	-	3.0	-	-	-
D	2000	2 x 300	600	1,126.3	434.8	-	3.0	-	-	-
Sub-total	-	8 x 300	2,400	4,515.4	1,758.2	1,973.22	3.0	17	8	14.50
BACMAN-I Geo	1991	2 x 55	110	526.3	70.0	-	3.0	4	6	0.21
-II Geo	1992	2 x 55	110	716.0	82.9	-	3.0	4	6	0.21
Tongonan Geo A	1995	8 x 55	440	3,471.8	628.5	-	4.0	4	6	28.39
B	1996	8 x 55	440	2,925.0	495.1	-	4.0	4	6	28.39
Sub-total		20 x 55	1,100	7,639.1	1,276.5	1,640.27	(3.0)	4	6	(22.75)

Note : PDP A-11 and A-25

Table - 12.2 Fixed Cost

Plants	Installed Capacity (MW)	Construction Cost(c) ($/KW)	Construction Period(k) (year)	Life Time (n) (year)	Residual Value Rate (z) (P.U)	Forced Outage Rate (%)	Maintenance days/year (days)	Station Use Rate (P.U)	Fixed O/M Cost (m) ($/KW-Year)	Annual Fixed Cost ($/KW-year) Discount Rate (i) 0.10	0.12	0.14	0.16	Plant Factor(%)
Gas-turbine	14 x 50	381	1	20	0.1	8	14	0.010	0.50	50.91	58.20	65.77	73.56	88.47
Coal-fired	8 x 300	822	3	30	0.1	17	56	0.085	14.50	171.41	200.55	231.52	264.17	70.27
Geothermal	20 x(50)	1,640	3	30	0.1	4	42	0.100	22.75	279.50	328.38	380.35	435.11	84.95

Note : Annual Fixed Cost ($/KW-year) = $\left[c \times \left\{ \sum_{K=k-1}^{0} \frac{R_K}{100}(1+i)^K \times \frac{i(1+i)^n}{(1+i)^n-1} - z\frac{i}{(1+i)^n-1} \right\} + m \right] \div \left[\left(1-\frac{\text{Forced Outage Rate}}{100}\right)\left(1-\frac{\text{Maintenance days}}{365}\right)(1-\text{Station Use Rate}) \right]$

Disbursement Ratio (R_K) of Construction Cost

Plants	R_6	R_5	R_4	R_3	R_2	R_1	R_0	R_{-1}
Gas-turbine	–	–	–	–	–	–	100	–
Coal-fired	–	–	–	–	$\frac{100}{3}$	$\frac{100}{3}$	$\frac{100}{3}$	–
Geothermal	–	–	–	–	$\frac{100}{3}$	$\frac{100}{3}$	$\frac{100}{3}$	–

Total Construction Cost (unit : 10^6) (Jan. 1988 Price)

Plants	L.C (P)	F.C (US$)	Equivalent US$
Gas-turbine	1,115.5	213.8	266.92
Coal-fired	4,515.4	1,758.2	1,973.22
Geothermal	7,639.1	1,276.5	1,640.27

Table - 12.3 Main Features of Alternative Power Sources Related to Calculations of Variable Costs

Plants	Fuel Cost ($/Unit) Economic	Fuel Cost ($/Unit) Financial	Heat Content (MMBTU/unit) Economic	Heat Content (MMBTU/unit) Financial	Heat Rate (MBTU/MWh)	(Thermal Efficiency) (%)
Gas-turbine	20 $/bbℓ	28.64 $/bbℓ	5.80 *	6.35	11,500	(29.67)
Oil-fired	15 $/bbℓ	16.95 $/bbℓ	6.12 **	6.21		
Manila - 1					10,203	
- 2					10,188	
Sucat - 1					10,789	
- 2					11,440	
- 3					12,221	
- 4					11,811	
Malaya - 1					10,788	
- 2					9,926	
Sub-total					(10,908)	(31.28)
Bataan - 1					9,694	
- 2					9,386	
Sub-total					(9,484)	(35.98)
Coal-fired	42 $/tone	44.72 $/tone	24.73***	22.70	9,484	(35.98)
Geothermal					17,084	(19.97)

Note : * = 9,200 Kcal/ℓ , ** = 9,700 Kcal/ℓ , *** = 6,700 Kcal/kg

Others = PDP A-11, A-15

Table - 12.4 Variable Cost (Economic)

Plant type	Fuel Cost ($/Unit)	Heat content (MMBTU/Unit)	Fuel cost ($/MMBTU)	Heat rate (MBTU/MWh)	(Thermal Efficiency) (%)	Variable O/M Ratio (%)	Station use rate (%)	Variable cost ($/MWh)
Gas-turbine	20 $/bbℓ	5.80	3.45	11,500	(29.67)	1	1.0	40.477
Oil-fired								
(Manila, Sucat, Malaya)	15 $/bbℓ	6.12	2.45	10,908	(31.28)	1	4.0	28.117
(Bataan)	15 $/bbℓ	6.12	2.45	9,484	(35.98)	1	4.0	24.446
Coal-fired	42 $/t	24.73	1.70	9,484	(35.98)	1	8.5	17.797
Geothermal	-	-	-	17,084	(19.97)	-	10.0	0.000

Note : Variable cost at Sending End ($/MWh) = $\frac{\text{Fuel cost (\$/MBTU)} \times \text{Heat rate (MBTU/MWh)} \times (1 + \text{Variable O/M Ratio} \times 10^{-2})}{1 - \text{Station Use rate} \times 10^{-2}}$

Table - 12.5 Variable Cost (Financial)

Plant type	Fuel Cost ($/Unit)	Heat content (MMBTU/Unit)	Fuel cost ($/MMBTU)	Heat rate (MBTU/MWh)	(Thermal Efficiency) (%)	Variable O/M Ratio (%)	Station use rate (%)	Variable cost ($/MWh)
Gas-turbine	28.64/bbℓ	6.350	4.51	11,500	(29.67)	1	1.0	52.913
Oil-fired								
(Manila, Sucat, Malaya)	16.95/bbℓ	6.210	2.73	10,908	(31.28)	1	4.0	31.330
(Bataan)	16.95/bbℓ	6.210	2.73	9,484	(35.98)	1	4.0	27.240
Coal-fired	44.72/t	22.700	1.97	9,484	(35.98)	1	8.5	20.623
Geothermal	-	-	-	17,084	(19.97)	-	10.0	19.254

Note : Variable cost at Sending End ($/MWh) $= \dfrac{\text{Fuel cost (\$/MBTU)} \times \text{Heat rate (MBTU/MWh)} \times (1 + \text{Variable O/M Ratio} \times 10^{-2})}{1 - \text{Station Use rate} \times 10^{-2}}$

Table - 12.6 Steam Cost Calculation on Geothermal

Conditions of Evaluation

Generating End Price in 1988	=	0.3639 ₱/KWh
Station Use Rate	=	0.1
Forced Outage Rate	=	0.04
Maintenance Days per Year	=	42
Max. Limit	=	50

Steam Cost Calculation

Sending End Price in 1988

Sent - out Energy $= 50\ MW \times (1-0.04) \times (1-\frac{42}{365})$

$\times 0.9 \times 8.76h = 363.375\ GWh$

Steam Cost $= 363.375 \times 0.3639 \div 0.9 = 146.925 \times 10^{6}$ ₱

146.925×10^{6} ₱ $\div 21 = 6.996 \times 10^{6}\ \$$

Unit Steam Cost $= 6.996 \div 363.375 = 19.254\ \$/MWh$

Note : PDP P.49 Table - 21

Table - 12.7 Total Economic Cost ($/kW-year)

	Plant Factor				
Plants	0.0	0.2	0.4	0.6	0.8
Gas-turbine	65.77	136.69	207.60	278.52	349.43
Oil-fired	0.00	49.26	98.52	147.78	197.04
Coal-fired	231.52	262.70	293.88	325.06	356.24
Geothermal	380.35	380.35	380.35	380.35	380.35

Note

(1) Discount Rate : 14 %

(2) Oil-fired : Manila, Sucat, Malaya

Table - 12.8 Total Financial Cost ($/kW-year)

	Plant Factor				
Plants	0.0	0.2	0.4	0.6	0.8
Gas-turbine	65.77	158.47	251.18	343.88	436.58
Oil-fired	0.00	54.89	109.78	164.67	219.56
Coal-fired	231.52	267.65	303.78	339.91	376.05
Geothermal	380.35	414.08	447.82	481.55	515.28

Note

(1) Discount Rate : 14 %

(2) Oil-fired : Manila, Sucat, Malaya

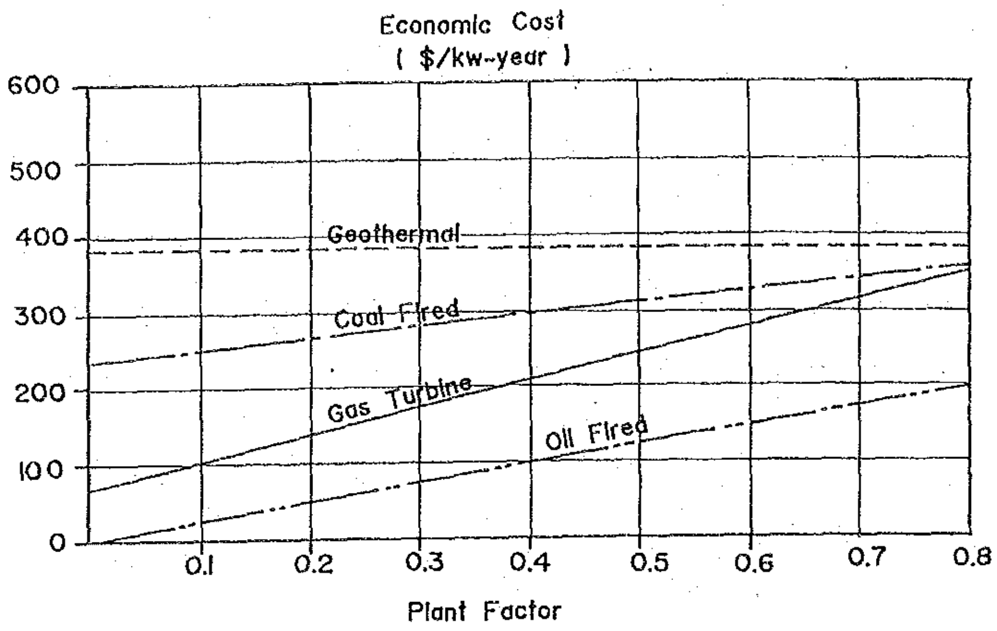


Fig.12.1 Economic Cost

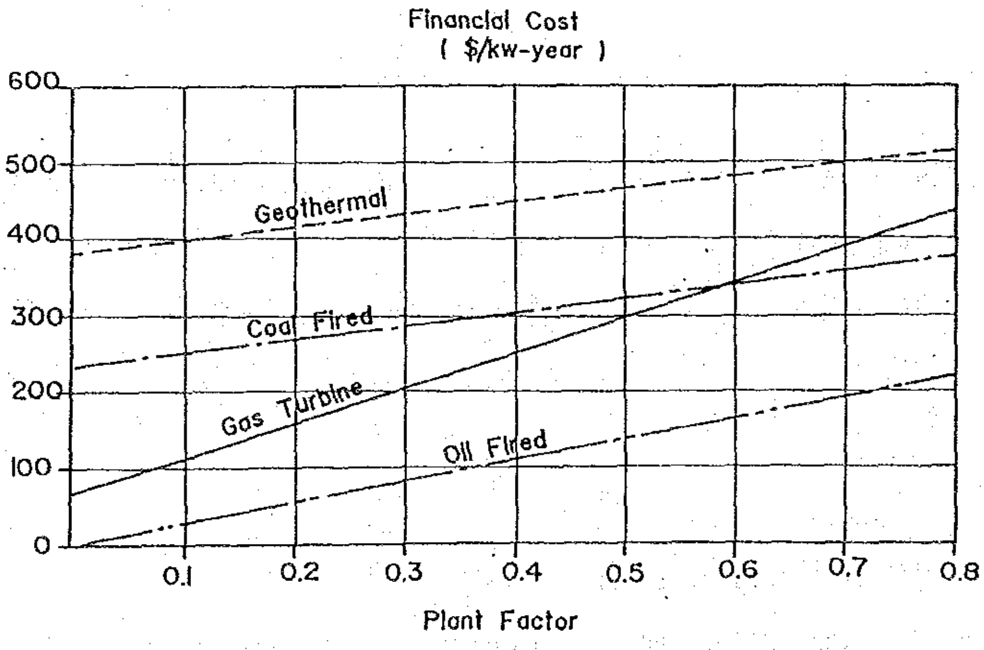


Fig.12.2 Financial Cost

13. DAM SAFETY CONTROL SYSTEM

13. Dam Safety Control System

13.1. General

Continuous inspection and surveillance are essential in maintaining the project facilities in good operating condition. This will make the facilities to act to the best of their functions, stably and efficiently, and to obtain the desired results for plant investment.

The JICA Study Team had an opportunity to investigate the present conditions of the existing hydro power facilities in the Northern Luzon area of the Philippines. As a result of the investigation, it was concluded that the operation and maintenance of these facilities did not appear to be quite satisfactory. It was found that there was a big possibility for improvement in maintenance and operation of the hydro power system of the Philippines.

There are big differences between Japan and the Philippines in terms of power consumption, weather conditions, and scale and organization of power generation facilities. Taking into account the above differences, it was realized that there were big possibilities for more effective utilization of the facilities by improving the maintenance and operation organizations and by investing money on it.

If the above would lead to a certain increase in the production of the facilities, this could be equal to the investment required for installation of additional power facilities.

The improvement of the existing facilities is financially justified as the planned maintenance and operation costs, on a capital basis, would be one tenth of the investment required for provision of additional power facilities.

Although increase in power demand in the Philippines for the last few years have been low, the potential is still large, and it is obvious that in the future will increase considerably.

In anticipation of the expansion of the power facilities in the future, it is indispensable to improve and expand on the maintenance and operation of the existing power generating facilities. This will add to the efficient operation not only of the current but also of future power facilities which would be added to the system.

13.2. NAPOCOR Head Office

The current operation and maintenance situation of the hydro power facilities varies from plant to plant. Many of the existing plants have been in service for many years and, thus, are considered to be very old from operational point of view, others are newly constructed and, thus, in service for relatively few years and, apparently without serious problems.

For smooth operation of these facilities it is necessary to regularly analyze the maintenance, inspection and surveillance results, and to establish yearly and long-term maintenance programs. Budgeting and maintenance work including inspection, surveillance and repair work, should be carried out in accordance with the maintenance programs.

Besides, continuous surveillance by monitoring the behaviour of large and important civil structures should be made. The results should be analyzed regularly by specialized civil engineers.

For efficient execution of these tasks, it is recommended that a maintenance division/group be established in the Hydro Power Projects Department of the Head Office. A number of civil engineers as required should be assigned to the above maintenance division/group. (Refer to Figs.13.1and 13.2)

13.3. Northern Luzon Regional Center

The Northern Luzon Regional Center of NAPOCOR, under which jurisdiction the Binga power plant is placed, plays a leading role in power supply to the Luzon Grid. In this capacity, the Center is responsible for the operation and maintenance of five hydro power plants with total capacity of 863 MW which includes such plants as Ambuklao, Angat and Magat.

The Center comprises about 1,591 NAPOCOR staff, mostly electrical and mechanical engineer. The five hydro power plants managed by the Center are located in four regions. It is maintained and operated by 1,120 operational staff (operation 455, maintenance 665) including engineers assigned to each power facilities.

The Center does not have any civil engineer except for the two hydrologists posted at the Angat power plant for flood forecasting and warning system operation. The Center has under its jurisdiction several large dams and other civil facilities. As such, it is responsible for surveillance and maintenance of these facilities. However, it is surprising that it does not include in its organization civil engineers with experience and background in surveillance and maintenance of such structures. This means that such surveillance and maintenance of the facilities is not done by civil engineers who are familiar with this type of work.

If the dams and other related civil structures are not properly surveyed and maintained, any serious problems which could certainly develop in the future, could be taken care of only at greater expense.

Therefore, it is recommended that at least two civil engineers and three assistant engineers be detailed for maintenance, surveillance and inspection of the civil structures of the hydroelectric projects under the jurisdiction of the Northern Luzon Regional Center, including Binga. (Refer to Fig.13.3)

13.4. Binga Powerstation

With regard to the Binga Project, it is recommended that the existing conditions of all civil structures of the project be clearly established and understood. This can be done by collecting all available data from the project completion and making a survey of the existing conditions of the structures.

Since many important design and construction data on the project have been lost with the passage of time, understanding of the current conditions of the structures would be more difficult to accomplish. Therefore, to properly understand the conditions of the structures, a serious study of all the existing data should be made. It is understood that many important data on the design and construction of the project are not available any more. Some of these data could be obtained by surveying the structures in the field with a purpose of obtaining the information required for evaluation of the existing conditions.

13.5. General Remarks

Implementation of the Safety Control System for each project should be carried out in accordance with the importance of the project or year of construction. Once the program has been implemented, the work should be performed systematically and at a minimum cost.

Inspection, surveillance and maintenance of civil structures must be conducted regularly. The Northern Luzon Regional Center which has maintained the projects with large and important civil structures under its jurisdiction, should assign to each project at least one civil engineer with the responsibility for maintenance and inspection. In addition to the above duties, this engineer should also supervise the operation of the spillway gates, observe reservoir water levels, etc. (Refer to Fig. 13.4)

Fig.13.1 ORGANIZATION CHART FOR NAPOCOR

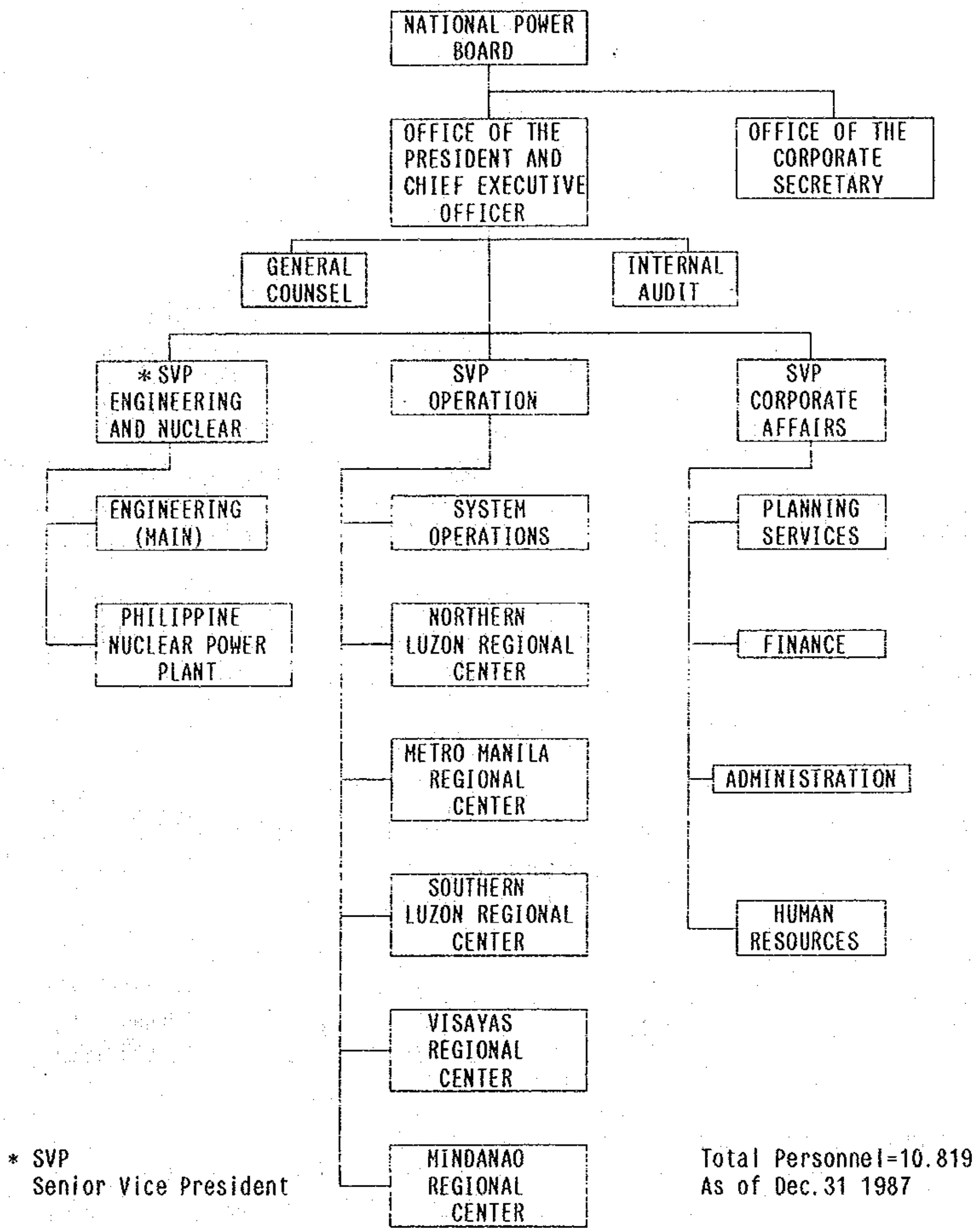
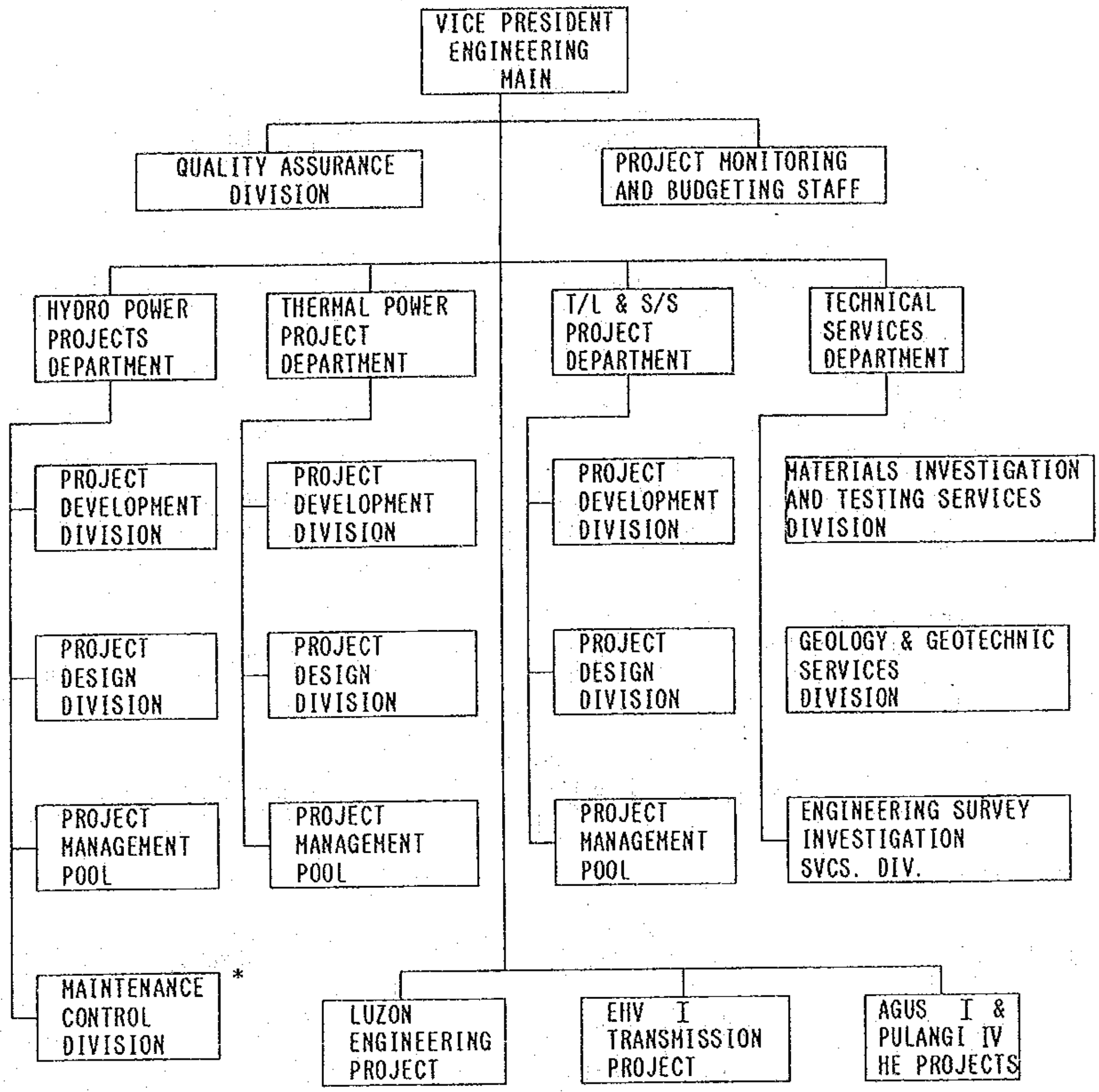
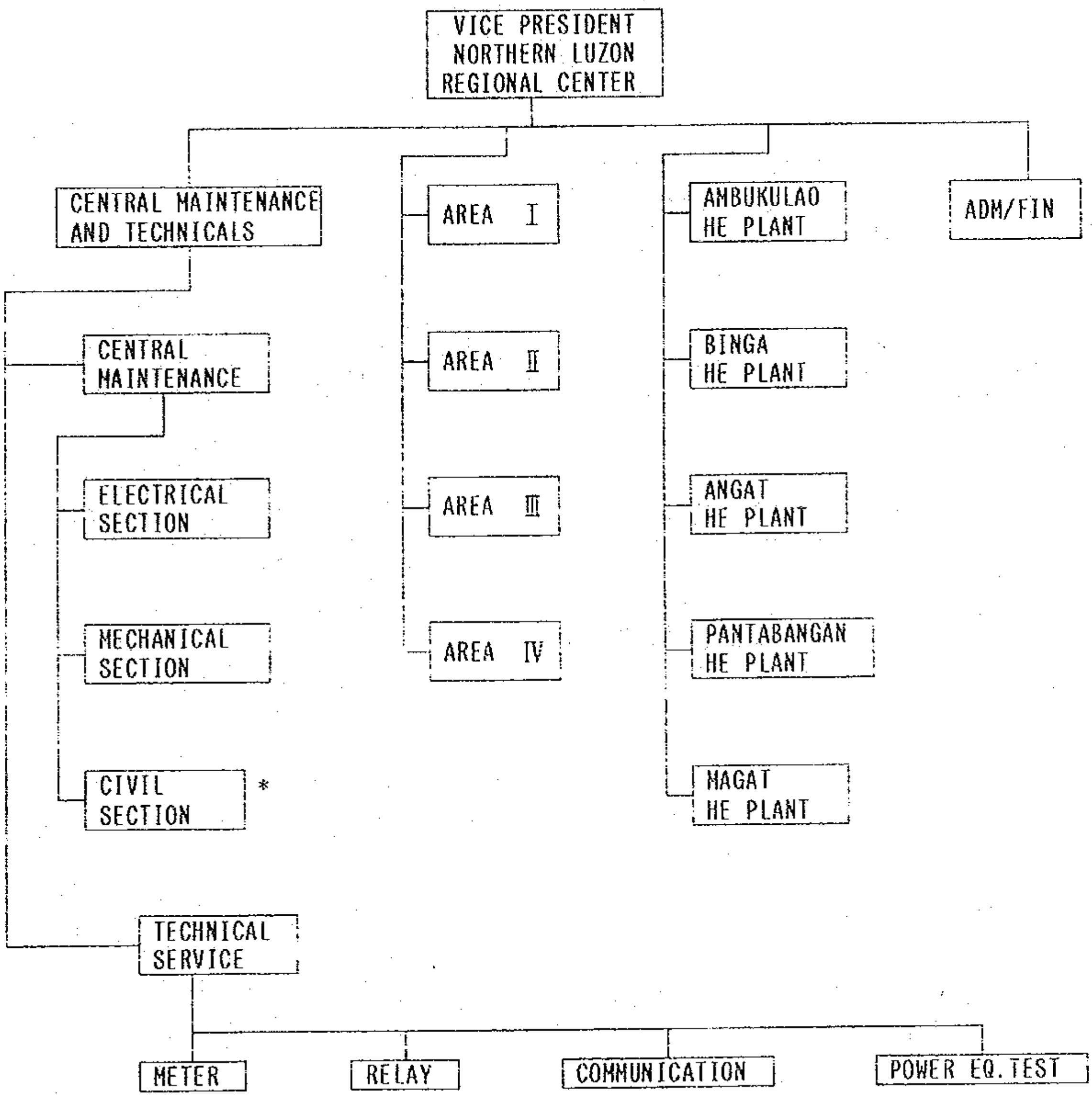


Fig. 13.2 ORGANIZATION CHART FOR NAPOCOR (ENGINEERING MAIN – HEAD OFFICE)



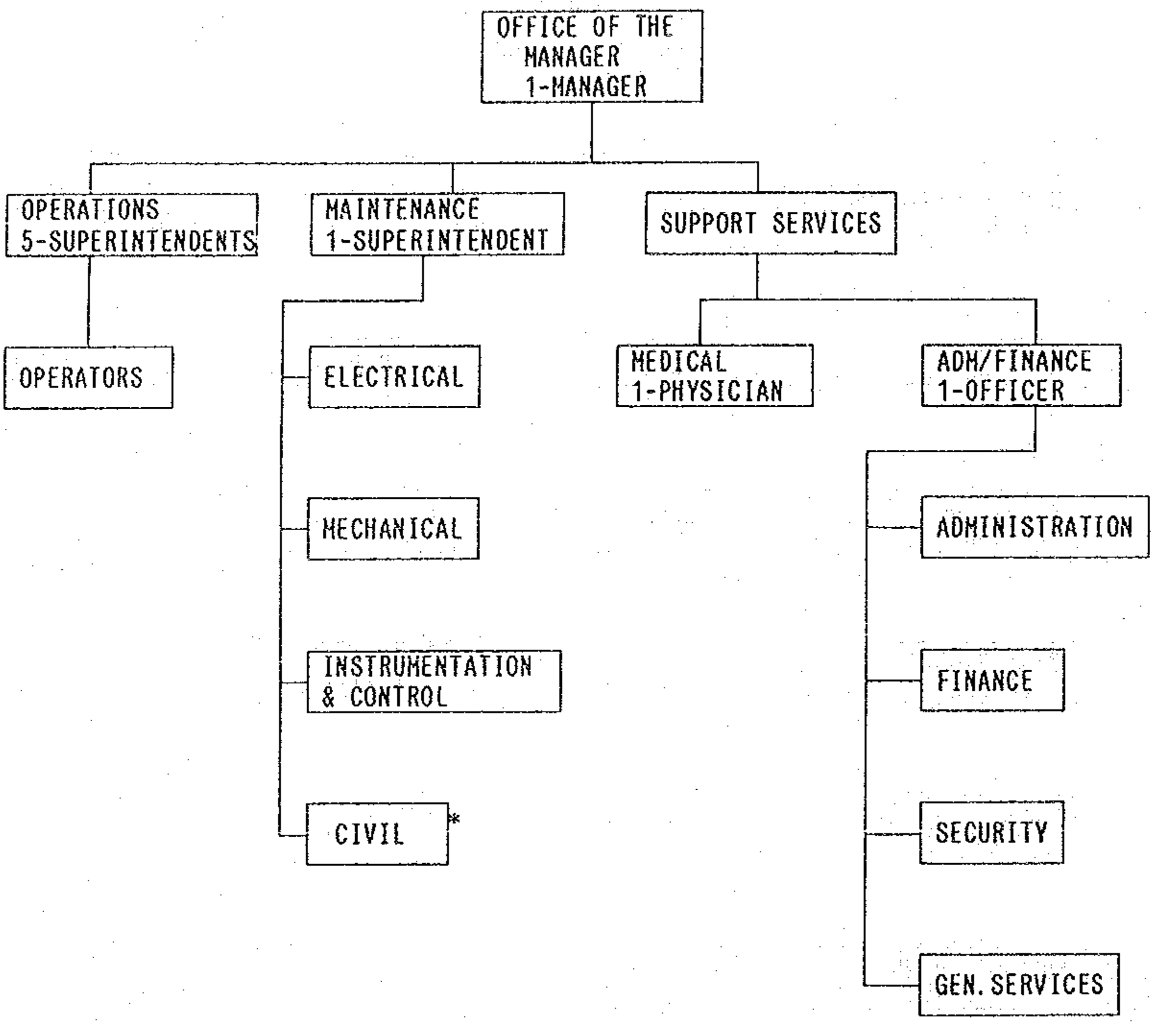
* newly proposed section

Fig. 13. 3 ORGANIZATION CHART FOR NORTHERN LUZON REGIONAL CENTER



* newly proposed section

Fig. 13.4 ORGANIZATION CHART FOR BINGA HYDROELECTRIC PLANT



* newly proposed section / group

14. STANDARDS FOR DAM SAFETY CONTROL

14. Standards for Dam Safety Control

14.1. General

The safety control of hydropower facilities covers wide area, such as safety against landslides at or near the project structures and around the reservoir, safety against floods and sedimentation, safety of the dam and its foundations, underground structures, generating equipment and facilities, and environmental conservation.

In this Section, safety control for the rockfill dam is discussed in greater detail.

For safety of rockfill dams, the following incidents should be prevented under any circumstances:

(1) Flow over the top of the dam
(2) Seepage through the dam or its foundations
(3) Collapse of face of the dam caused by large earthquakes

Therefore, inspection, surveillance and maintenance of the dam and its auxiliary structures are very important, for the safety of the project.

For this, the following measures are required:

(1) Monitoring
(2) Inspection and surveillance
(3) Detail inspection and further investigations

14.2. Monitoring

Once abnormal behaviour or conditions have been detected in the dam, it is required to monitor regularly, for the purpose of safety control, and determine how those behaviour and conditions would develop or progress. The frequency of monitoring should be determined properly taking into consideration the type and structural scale of the dam and the time elapsed after completion.

Dams are generally classified into the three stages according to the time elapsed after the completion in order-to judge the safety of the structure.

(1) First Stage

This is the stage which covers the initial reservoir filling period. The water pressure load acts on the dam for the first time. The dam shows variable reactions until the water reaches the maximum reservoir level. This first stage of observations is, no doubt, the most important for the safety of the dam. Monitoring, therefore, must be carried out carefully and frequently. The monitoring results must be analyzed quickly in order to evaluate the behaviour of the dam and its safety and to decide the mode and sequence of further water level rises.

(2) Second Stage

At this stage, monitoring is needed in order to determine whether the operating conditions of the dam could be judged to be normal, including seepages through the foundation rock. This period could cover 3 to 5 years.

(3) Third Stage

This stage covers the period during which monitoring of the dam is done with a purpose of maintaining the proper function of the structure through its lifetime. The period of this stage is the longest of the three stages.

The following table describes the frequency and type of monitoring normally used for rockfill dams:

Table 14.1.

Type of Monitoring and Frequency

	Appearance Check	Seepage	Deformation	Porewater Pressure
1st Stage	7 days	1 day	1 day	7 days
2nd Stage	1 month	7 days	1 month	1 month
3rd Stage	1 month	1 month	3 months	3 months

N.B.: Frequency is designated by an interval

As more than 30 years have passed since the completion of the Binga dam, and the structure itself and the foundation rock are supposed to be stable enough, it can be said that the dam should be classified in the third stage, and thus the type of monitoring and frequency may be effected accordingly as mentioned in the above table. The Binga dam had the first experience in executing the above monitoring on this occasion. In the framework of the scope of the Study, the seepage and dam deformation measurement devices were newly provided and installed by JICA. With this instrument, the monitoring was initiated and has been continued with more frequency than specified in Table 14.1 for the first year wherein the hydrological trend including the reservoir water level condition and rainfall intensity could be fully determined.

14.3. Inspection

Inspection of the dam on a regular basis and in accordance with some predetermined pattern can be very effective in preventing major problems or even failures from developing. Aside from this, inspections should also be performed after occurrence of a major event, such as large floods or earthquakes.

The regular inspection should be done once a month and the further inspection should also be done, in principle, when the following events take place:

- Flood discharge bigger than 3-year return period

- Daily inflow at the dam site equivalent to 3-year return period

- Earthquake stronger than one third of the design seismic coefficient

14.4. Detail Inspection and Repair Works

If abnormal behaviour or conditions are detected during the periodic inspection or from the collected monitoring data, a detail investigation must be undertaken to determine the causes.

The extent of the investigation will depend on the behaviour or condition of the structure. If the detail inspection reveals that the structure is not secured and the damage is serious, the repair works should be carried out immediately.

APPENDICES

(Tables and Figures for Sections 9 and 10)

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Table 9.1 Hydrologic Observation Period by Station

Station Name	1900	1910	1920	1930	1940	1950	1960	1970	1980 (year)
(Monthly rainfall)									
BUGUIAS							66/1	78/11	
ADAOAY							66/1	76/9	
KARAO							68/3	79/9	
BOBOK							66/1		83/6
BAGUIO CITY	02/1								84/12
BINGA						57			85
ROSALES								76/9	83/3
BALNGAO								71/6	84/4
BINALONAN								72/4	84/9
AMBUKLAO DAM							57		86
(Daily rainfall)									
BINGA DAM								70	87/11
AMBUKLAO DAM							64		87/2
(Hourly rainfall)									
BINGA DAM									80 86
(Wind Velocity)									
BINGA DAM									80 86

Table 9.2 Correlation Coefficient of Monthly Rainfall for Observation Stations, Observed during Rainy Season, May ~ November

(Upper Value : Correlation coefficient
Lower Value : Number of Data)

Station Name	Binal-onan	Rosal-es	Balun-gao	Bugui-as	Adaoay	Karao	Ambuk-lao	Bobok	Baguio	Binga	Balat-ok Mines
Binalon-an		0.799 (41)	0.911 (85)	0.388 (42)	0.493 (31)	0.364 (50)	0.801 (40)	0.902 (76)	0.893 (87)	0.821 (77)	0.690 (81)
Rosales			0.767 (43)	0.985 (10)	— (1)	0.656 (20)	0.770 (14)	0.688 (43)	0.671 (43)	0.702 (35)	0.674 (42)
Balungao				0.379 (49)	0.431 (38)	0.392 (58)	0.777 (48)	0.895 (84)	0.844 (94)	0.739 (84)	0.651 (89)
Buguias					0.252 (61)	0.372 (63)	0.363 (50)	0.545 (71)	0.413 (73)	0.360 (68)	0.464 (66)
Adaoay						0.478 (56)	0.223 (45)	0.560 (65)	0.586 (67)	0.657 (59)	0.463 (60)
Karao							0.362 (57)	0.508 (75)	0.491 (77)	0.319 (64)	0.349 (77)
Ambuklao								0.951 (59)	0.946 (61)	0.839 (51)	0.703 (61)
Bobok									0.814 (118)	0.734 (102)	0.707 (110)
Baguio City										0.828 (173)	0.787 (189)
Binga											0.778 (159)
Balatok Mines											

Table 9.3 (1) Maximum Monthly and Daily Rainfall at Binga Dam

Year	Max. monthly rainfall in the year applied for estimation (mm/month)		Max. monthly rainfall in the year at Binga (mm/month)	Max. daily rainfall in the year (mm/day)
	Baguio	Ambuklao		
1902	1238.0		705.0 *B	178.0
1903	883.0		536.0 *B	135.0
1904	984.0		584.0 *B	148.0
1905	1029.0		605.0 *B	153.0
1906	1398.0		781.0 *B	198.0
1907	1083.0		631.0 *B	160.0
1908	1509.0		834.0 *B	211.0
1909	1204.0		689.0 *B	174.0
1910	1025.0		604.0 *B	153.0
1911	3382.0		1726.0 *B	438.0
1912	1297.0		733.0 *B	185.0
1913	2108.0		1119.0 *B	284.0
1914	2511.0		1311.0 *B	332.0
1915	1120.0		649.0 *B	164.0
1916	1335.0		751.0 *B	190.0
1917	1180.0		677.0 *B	171.0

Note: *A Estimated from data taken at Ambuklao.
*B Estimated from data taken at Baguio City.

Table 9.3. (2) Maximum Monthly and Daily Rainfall at Binga Dam

Year	Max. monthly rainfall in the year applied for estimation (mm/month)		Max. monthly rainfall in the year at Binga (mm/month)	Max. daily rainfall in the year (mm/day)
	Baguio	Ambuklao		
1918	2202.0		1164.0 *B	295.0
1919	3462.0		1764.0 *B	448.0
1920	2951.0		1521.0 *B	386.0
1921	1849.0		996.0 *B	252.0
1922	1175.0		675.0 *B	171.0
1923	2367.0		1243.0 *B	315.0
1924	1546.0		852.0 *B	216.0
1925	2957.0		1524.0 *B	384.0
1926	909.0		548.0 *B	138.0
1927	840.0		515.0 *B	130.0
1928	933.0		560.0 *B	141.0
1929	1646.0		901.0 *B	228.0
1930	2113.0		1122.0 *B	284.0
1931	1507.0		833.0 *B	211.0
1932	1255.0		713.0 *B	180.0
1933	2288.0		1205.0 *B	305.0

Note : *A Estimated from data taken at Ambuklao.
*B Estimated from data taken at Baguio City.

Table 9.3 (3) Maximum Monthly and Daily Rainfall at Binga Dam

Year	Max. monthly rainfall in the year applied for estimation (mm/month)		Max. monthly rainfall in the year at Binga (mm/month)	Max. daily rainfall in the year (mm/day)
	Baguio	Ambuklao		
1934	1579.0		867.0 *B	220.0
1935	2347.0		1233.0 *B	313.0
1936	1096.0		637.0 *B	161.0
1937	1684.0		917.0 *B	232.0
1938	483.0		393.0 *B	99.0
1939	1398.0		781.0 *B	198.0
1940				
1941				
1942				
1943				
1944				
1945				
1946				
1947	1454.0		808.0 *B	204.0
1948	1095.0		637.0 *B	161.0
1949	700.0		449.0 *B	113.0

Note : *A Estimated from data taken at Ambuklao.
*B Estimated from data taken at Baguio City.

Table 9.3 (4) Maximum Monthly and Daily Rainfall at Binga Dam

Year	Max. monthly rainfall in the year applied for estimation (mm/month)		Max. monthly rainfall in the year at Binga (mm/month)	Max. daily rainfall in the year (mm/day)
	Baguio	Ambuklao		
1950	1505.0		832.0 *B	211.0
1951	958.0		572.0 *B	144.0
1952	669.0		434.0 *B	109.0
1953	1190.0		682.0 *B	172.0
1954	411.0		311.0 *B	78.0
1955	556.0		380.0 *B	96.0
1956	1199.0		686.0 *B	173.0
1957		1103.0	1148.0 *A	291.0
1958		738.0	820.0 *A	208.0
1959		414.0	529.0 *A	134.0
1960		276.0	405.0 *A	102.0
1961	1026.0		604.0 *B	153.0
1962	1249.0		710.0 *B	180.0
1963	1458.0		810.0 *B	205.0
1964	1871.0		1006.0 *B	255.0
1965	713.0		455.0 *B	115.0

Note: *A Estimated from data taken at Ambuklao.
*B Estimated from data taken at Baguio City.

Table 9.3 (5) Maximum Monthly and Daily Rainfall at Binga Dam

Year	Max. monthly rainfall in the year applied for estimation (mm/month)		Max. monthly rainfall in the year at Binga (mm/month)		Max. daily rainfall in the year (mm/day)
	Baguio	Ambuklao			
1966	1026.0		604.0	*B	153.0
1967	1560.0		858.0	*B	217.0
1968	1672.0		912.0	*B	231.0
1969		862.0	931.0	*A	236.0
1970		411.0	526.0	*A	133.0
1971			702.6		135.9
1972			2529.4		288.8
1973			424.2		122.2
1974			1040.1		220.2
1975			479.3		142.2
1976			940.6		367.0
1977		593.0	690.0	*A	175.0
1978		1047.0	1098.0	*A	278.0
1979	1078.0		629.0	*B	159.0
1980			848.2		312.4
1981			560.4		94.2

Note: *A Estimated from data taken at Ambuklao.
*B Estimated from data taken at Baguio City.

Table 9.3 (6) Maximum Monthly and Daily Rainfall at Binga Dam

Year	Max. monthly rainfall in the year applied for estimation (mm/month)		Max. monthly rainfall in the year at Binga (mm/month)	Max. daily rainfall in the year (mm/day)
	Baguio	Ambuklao		
1982			667.9	101.3
1983			632.9	152.9
1984			896.0	198.6
1985			885.4	191.4
1986			754.4	326.0

Note: *A Estimated from data taken at Ambuklao.
*B Estimated from data taken at Baguio City.

Table 9.4 The Periods during Which the Hourly Rainfall Data at the Binga Dam Site are Available

1980	6/5, 9/13~9/22, 9/25~9/29, 10/1~10/2, 10/4~10/6
1982	3/25, 3/31 ~4/1, 4/4~4/5, 4/9, 4/13~4/18, 4/21, 5/1, 5/9 ~5/10, 5/14, 5/17~5/20, 5/22~5/23, 5/25 ~5/26, 5/28, 6/3, 6/8, 6/12, 6/14, 6/20~6/24, 6/26 ~7/3
1985	5/23, 5/25, 5/28 ~5/31, 6/3, 6/5, 6/7 ~6/11, 6/13 ~6/18, 6/20~7/2, 7/5~7/8, 7/11, 7/18 ~7/20 7/22 ~7/23, 7/27, 8/1 ~8/2, 8/3~8/6, 8/8~8/14, 8/18 ~8/23, 8/26~8/29, 9/2 ~9/10, 9/11~9/12, 9/19 9/21, 9/26 ~10/1, 10/5, 11/19, 11/24~11/26
1986	3/24, 7/6, 7/8 ~7/11, 7/17~7/21, 7/24~7/25, 7/28 ~8/6, 8/8~8/9, 8/11 ~8/14, 8/16~8/18, 8/22 ~9/5, 9/15, 9/18, 9/20, 9/23 ~9/24, 9/26, 9/28 ~9/29, 10/3, 10/6~10/10, 10/23~10/24, 10/26, 11/1, 11/7, 11/8, 11/12, 11/16 ~11/19, 11/22

Table 9.5 Maximum Rainfall (RT) of Consecutive Hours (T)

	T(hr)	1	2	3	4	5	6	7	8	9	10	11	12	24
1980.10.5	R_T	56	95	112.5	129	145	161.5	176.5	184	214.5	235.5	255	273	371
	R_T/R_{24}	0.151	0.256	0.303	0.348	0.391	0.435	0.476	0.496	0.578	0.635	0.687	0.736	
	$T/24$	0.042	0.083	0.125	0.167	0.208	0.25	0.292	0.333	0.375	0.417	0.458	0.5	
1982.7.3	R_T	15.5	29.5	31	37	40	42.5	58	58	61.5	64	67	73	109.5
	R_T/R_{24}	0.142	0.269	0.283	0.338	0.365	0.388	0.530	0.530	0.562	0.584	0.612	0.667	
	$T/24$	0.042	0.083	0.125	0.167	0.208	0.25	0.292	0.333	0.375	0.417	0.458	0.5	
1985.6.22	R_T	25.0	41.5	55.5	62.5	67.5	81.5	90.5	107	118	132.5	153.5	157.7	231.0
	R_T/R_{24}	0.108	0.180	0.240	0.271	0.292	0.353	0.392	0.463	0.511	0.574	0.665	0.682	
	$T/24$	0.042	0.083	0.125	0.167	0.208	0.25	0.292	0.333	0.375	0.417	0.458	0.5	
1986.7.9	R_T	20.0	36.3	47.3	63.7	76.2	93.2	110.7	130	147.4	157.9	170.2	181.2	273.9
	R_T/R_{24}	0.073	0.133	0.173	0.233	0.278	0.340	0.404	0.475	0.538	0.576	0.621	0.662	
	$T/24$	0.042	0.083	0.125	0.167	0.208	0.25	0.292	0.333	0.375	0.417	0.458	0.5	

Table 9.6 Period for Which the Reservoir Operation Records are Available

Station Name	1900	1910	1920	1930	1940	1950	1960	1970	1980 (year)
BIMGA DAM									
Daily inflow discharge								76	87/3
Daily water level							64/1		87/9
Daily spilled discharge							64/1		87/9
Hourly water-level & generator output							65		86
Spilling record(hourly)							64		86
Monthly inflow dischage							62/1		87/2
Annual inflow dischage							62		86
AMBUKLAO DAM									
Hourly spillway discharge						58			86

Table 9.7 Period in Which Typical Magnitude Floods Occurred

No.	Period	Maximum Inflow	
1.	May 22 to 30, 1976	1,181.0 m^3/sec	(May 26)
2.	June 25 to July 3, 1976	2,497.0	(June 30)
3.	November 1 to 7, 1980	2,617.0	(Nov. 5)
4.	August 28 to 31, 1984	2,498.8	(Aug. 27)
5.	June 22 to 25, 1985	902.5	(June 22)
6.	June 28 to July 1, 1985	1,258.8	(June 29)
7.	July 9 to 11, 1986	939.1	(July 11)

Table 9 .8 Hourly Inflow to the Binga Reservoir During Typical Flood Periods

WL : Water Level
QS1 : Discharge through the Binga spillway
DV : Increment of the storage capacity
QE1 : Releases through the Binga power plant
QIN1 : Inflow to the Binga reservoir
QIN2 : Run-off inflow from the Binga dam basin excluding Ambuklao dam basin
QS2 : Discharge through the Ambuklao Spillway
QE2 : Releases through the Ambuklao power plant

DATE	TIME (HR)	BINGA DAM W.L (E.L.M)	DV (M**3/S)	QS1 (M**3/S)	QE1 (M**3/S)	QIN1 (M**3/S)	AMBUKLAO DAM QS2 (M**3/S)	QE2 (M**3/S)	QIN2 (M**3/S)
1976. 5.22	0.0	567.30	0.0	0.0	18.0560	0.0	0.0	17.0950	0.0
	1.0	567.30	0.0	0.0	18.0560	18.0560	0.0	17.0950	0.9610
	2.0	567.30	0.0	0.0	18.0560	18.0560	0.0	17.0950	0.9610
	3.0	567.30	0.0	0.0	18.0560	18.0560	0.0	17.0950	0.9610
	4.0	567.35	23.8715	0.0	18.0560	41.9275	0.0	17.0950	24.8325
	5.0	567.40	23.8715	0.0	18.0560	41.9275	0.0	17.0950	24.8325
	6.0	567.40	0.0	0.0	18.0560	18.0560	0.0	17.0950	0.9610
	7.0	567.45	23.8715	0.0	18.0560	41.9275	0.0	17.0950	24.8325
	8.0	567.45	0.0	0.0	18.0560	18.0560	0.0	17.0950	0.9610
	9.0	567.50	24.9566	0.0	18.0560	43.0126	0.0	17.0950	25.9176
	10.0	567.50	0.0	0.0	18.0560	18.0560	0.0	17.0950	0.9610
	11.0	567.55	23.8715	0.0	18.0560	41.9275	0.0	17.0950	24.8325
	12.0	567.55	0.0	0.0	18.0560	18.0560	0.0	17.0950	0.9610
	13.0	567.50	-23.8715	0.0	18.0560	-5.8155	0.0	17.0950	-22.9105
	14.0	567.50	0.0	0.0	18.0560	18.0560	0.0	17.0950	0.9610
	15.0	567.50	0.0	0.0	18.0560	18.0560	0.0	17.0950	0.9610
	16.0	567.50	0.0	0.0	18.0560	18.0560	0.0	17.0950	0.9610
	17.0	567.45	-24.9566	0.0	18.0560	-6.9006	0.0	17.0950	-23.9956
	18.0	567.45	0.0	0.0	18.0560	18.0560	0.0	17.0950	0.9610
	19.0	567.45	0.0	0.0	18.0560	18.0560	0.0	17.0950	0.9610
	20.0	567.45	0.0	0.0	18.0560	18.0560	0.0	17.0950	0.9610
	21.0	567.45	0.0	0.0	18.0560	18.0560	0.0	17.0950	0.9610
	22.0	567.45	0.0	0.0	18.0560	18.0560	0.0	17.0950	0.9610
	23.0	567.50	24.9566	0.0	18.0560	43.0126	0.0	17.0950	25.9176
	24.0	567.50	0.0	0.0	18.0560	18.0560	0.0	17.0950	0.9610

Table 9.8 Hourly Inflow to the Binga Reservoir During Typical Flood Periods

		BINGA DAM						AMBUKLAO DAM	
DATE	TIME (HR)	W.L (E.L.M)	DV (M**3/S)	QS1 (M**3/S)	QE1 (M**3/S)	QIN1 (M**3/S)	QS2 (M**3/S)	QE2 (M**3/S)	QIN2 (M**3/S)
1976. 5.23	0.0	567.50	0.0	0.0	15.5590	0.0	0.0	16.4470	0.0
	1.0	567.50	0.0	0.0	15.5590	15.5590	0.0	16.4470	-0.8880
	2.0	567.50	0.0	0.0	15.5590	15.5590	0.0	16.4470	-0.8880
	3.0	567.50	0.0	0.0	15.5590	15.5590	0.0	16.4470	-0.8880
	4.0	567.55	23.8715	0.0	15.5590	39.4305	0.0	16.4470	22.9835
	5.0	567.55	0.0	0.0	15.5590	15.5590	0.0	16.4470	-0.8880
	6.0	567.60	23.8715	0.0	15.5590	39.4305	0.0	16.4470	22.9835
	7.0	567.60	0.0	0.0	15.5590	15.5590	0.0	16.4470	-0.8880
	8.0	567.65	24.9566	0.0	15.5590	40.5156	0.0	16.4470	24.0686
	9.0	567.65	0.0	0.0	15.5590	15.5590	0.0	16.4470	-0.8880
	10.0	567.70	22.7865	0.0	15.5590	38.3454	0.0	16.4470	21.8984
	11.0	567.70	0.0	0.0	15.5590	15.5590	0.0	16.4470	-0.8880
	12.0	567.70	0.0	0.0	15.5590	15.5590	0.0	16.4470	-0.8880
	13.0	567.75	24.9566	0.0	15.5590	40.5156	0.0	16.4470	24.0686
	14.0	567.75	0.0	0.0	15.5590	15.5590	0.0	16.4470	-0.8880
	15.0	567.80	23.8715	0.0	15.5590	39.4305	0.0	16.4470	22.9835
	16.0	567.80	0.0	0.0	15.5590	15.5590	0.0	16.4470	-0.8880
	17.0	567.85	24.9566	0.0	15.5590	40.5156	0.0	16.4470	24.0686
	18.0	567.85	0.0	0.0	15.5590	15.5590	0.0	16.4470	-0.8880
	19.0	567.90	22.7865	0.0	15.5590	38.3454	0.0	16.4470	21.8984
	20.0	567.90	0.0	0.0	15.5590	15.5590	0.0	16.4470	-0.8880
	21.0	568.95	515.4077	0.0	15.5590	530.9666	0.0	16.4470	514.5195
	22.0	568.00	-465.4946	0.0	15.5590	-449.9355	0.0	16.4470	-466.3823
	23.0	568.05	23.8715	0.0	15.5590	39.4305	0.0	16.4470	22.9835
	24.0	568.10	24.9566	0.0	15.5590	40.5156	0.0	16.4470	24.0686

Table 9.8 Hourly Inflow to the Binga Reservoir During Typical Flood Periods

DATE	TIME (HR)	W.L (E.L.M)	BINGA DAM DV (M**3/S)	QS1 (M**3/S)	QE1 (M**3/S)	QIN1 (M**3/S)	QS2 (M**3/S)	AMBUKLAO DAM QE2 (M**3/S)	QIN2 (M**3/S)
1976. 5.24	0.0	568.10	0.0	0.0	46.0700	0.0	0.0	24.6410	0.0
	1.0	568.10	0.0	0.0	46.0700	46.0700	0.0	24.6410	21.4290
	2.0	568.15	23.8715	0.0	46.0700	69.9415	0.0	24.6410	45.3005
	3.0	568.20	24.9566	0.0	46.0700	71.0266	0.0	24.6410	46.3856
	4.0	568.25	23.8715	0.0	46.0700	69.9415	0.0	24.6410	45.3005
	5.0	568.30	24.9566	0.0	46.0700	71.0266	0.0	24.6410	46.3856
	6.0	568.30	0.0	0.0	46.0700	46.0700	0.0	24.6410	21.4290
	7.0	568.40	48.8281	0.0	46.0700	94.8981	0.0	24.6410	70.2571
	8.0	568.50	48.8281	0.0	46.0700	94.8981	0.0	24.6410	70.2571
	9.0	568.70	97.6563	0.0	46.0700	143.7263	0.0	24.6410	119.0853
	10.0	568.90	98.7413	0.0	46.0700	144.8113	0.0	24.6410	120.1703
	11.0	569.05	74.8698	0.0	46.0700	120.9398	0.0	24.6410	96.2988
	12.0	569.15	48.8281	0.0	46.0700	94.8981	0.0	24.6410	70.2571
	13.0	569.25	49.9132	0.0	46.0700	95.9832	0.0	24.6410	71.3422
	14.0	569.40	74.8698	0.0	46.0700	120.9398	0.0	24.6410	96.2988
	15.0	569.60	99.8264	0.0	46.0700	145.8964	0.0	24.6410	121.2554
	16.0	569.80	100.9115	0.0	46.0700	146.9815	0.0	24.6410	122.3405
	17.0	570.00	99.8264	0.0	46.0700	145.8964	0.0	24.6410	121.2554
	18.0	570.20	100.9115	0.0	46.0700	146.9815	0.0	24.6410	122.3405
	19.0	570.45	126.9531	0.0	46.0700	173.0231	0.0	24.6410	148.3821
	20.0	570.70	125.8680	0.0	46.0700	171.9380	0.0	24.6410	147.2970
	21.0	570.95	126.9531	0.0	46.0700	173.0231	0.0	24.6410	148.3821
	22.0	571.20	129.1233	0.0	46.0700	175.1933	0.0	24.6410	150.5523
	23.0	571.45	128.0382	0.0	46.0700	174.1082	0.0	24.6410	149.4672
	24.0	571.70	129.1233	0.0	46.0700	175.1933	0.0	24.6410	150.5523

Table 9.8 Hourly Inflow to the Binga Reservoir During Typical Flood Periods

		BINGA DAM						AMBUKLAO DAM	
DATE	TIME (HR)	W.L (E.L.M)	DV (M**3/S)	QS1 (M**3/S)	QE1 (M**3/S)	QIN1 (M**3/S)	QS2 (M**3/S)	QE2 (M**3/S)	QIN2 (M**3/S)
1976. 5.25	0.0	571.70	0.0	382.6389	63.8600	0.0	0.0	41.9440	0.0
	1.0	572.00	155.1649	382.6389	63.8600	601.6636	0.0	41.9440	559.7195
	2.0	572.30	156.2500	382.6389	63.8600	602.7488	0.0	41.9440	560.8047
	3.0	572.50	104.1667	382.6389	63.8600	550.6653	0.0	41.9440	508.7212
	4.0	572.80	157.3351	382.6389	63.8600	603.8337	0.0	41.9440	561.8896
	5.0	573.15	184.4618	382.6389	63.8600	630.9604	0.0	41.9440	589.0164
	6.0	573.45	159.5052	382.6389	63.8600	606.0039	0.0	41.9440	564.0598
	7.0	573.45	0.0	382.6389	63.8600	446.4988	0.0	41.9440	404.5547
	8.0	573.85	212.6736	382.6389	63.8600	659.1724	0.0	41.9440	617.2283
	9.0	574.00	80.2951	382.6389	63.8600	526.7937	0.0	41.9440	484.8496
	10.0	574.20	107.4219	382.6389	63.8600	553.9207	0.0	41.9440	511.9766
	11.0	574.40	106.3368	382.6389	63.8600	552.8354	0.0	41.9440	510.8914
	12.0	574.70	162.7604	382.6389	63.8600	609.2590	0.0	41.9440	567.3149
	13.0	574.70	0.0	382.6389	63.8600	446.4988	0.0	41.9440	404.5547
	14.0	574.40	-162.7604	382.6389	63.8600	283.7383	0.0	41.9440	241.7943
	15.0	574.10	-160.5903	382.6389	63.8600	285.9084	0.0	41.9440	243.9644
	16.0	574.90	431.8574	382.6389	63.8600	878.3562	0.0	41.9440	836.4121
	17.0	573.95	-511.0674	382.6389	63.8600	-64.5686	0.0	41.9440	-106.5126
	18.0	573.85	-54.2535	382.6389	63.8600	392.2451	0.0	41.9440	350.3010
	19.0	573.75	-53.1684	382.6389	63.8600	393.3303	0.0	41.9440	351.3862
	20.0	573.65	-53.1684	382.6389	63.8600	393.3303	0.0	41.9440	351.3862
	21.0	573.55	-53.1684	382.6389	63.8600	393.3303	0.0	41.9440	351.3862
	22.0	573.50	-26.0417	382.6389	63.8600	420.4570	0.0	41.9440	378.5129
	23.0	573.45	-27.1267	382.6389	63.8600	419.3718	0.0	41.9440	377.4277
	24.0	573.35	-53.1684	382.6389	63.8600	393.3303	0.0	41.9440	351.3862

Table 9.8 Hourly Inflow to the Binga Reservoir During Typical Flood Periods

		BINGA DAM						AMBUKLAO DAM	
DATE	TIME (HR)	W.L (E.L.M)	DV (M**3/S)	QS1 (M**3/S)	QE1 (M**3/S)	QIN1 (M**3/S)	QS2 (M**3/S)	QE2 (M**3/S)	QIN2 (M**3/S)
1976. 5.26	0.0	573.35	0.0	885.4170	61.1690	0.0	0.0	46.2500	0.0
	1.0	573.15	-106.3368	885.4170	61.1690	840.2490	0.0	46.2500	793.9990
	2.0	572.95	-105.2517	885.4170	61.1690	841.3340	0.0	46.2500	795.0840
	3.0	572.65	-158.4201	885.4170	61.1690	788.1658	0.0	46.2500	741.9158
	4.0	572.70	27.1267	885.4170	61.1690	973.7126	0.0	46.2500	927.4626
	5.0	571.75	-494.7915	885.4170	61.1690	451.7944	6.0910	46.2500	399.4534
	6.0	571.60	-78.1250	885.4170	61.1690	868.4609	5.8480	46.2500	816.3628
	7.0	571.40	-103.0816	885.4170	61.1690	843.5042	123.3270	46.2500	673.9270
	8.0	571.45	26.0417	885.4170	61.1690	972.6274	202.0700	46.2500	724.3074
	9.0	571.70	129.1233	885.4170	61.1690	1075.7090	264.5911	46.2500	764.8679
	10.0	571.70	0.0	885.4170	61.1690	946.5859	668.7000	46.2500	231.6360
	11.0	571.20	-257.1614	885.4170	61.1690	689.4246	690.0000	46.2500	-46.8254
	12.0	571.05	-78.1250	885.4170	61.1690	868.4609	720.0000	46.2500	102.2109
	13.0	571.15	50.9983	885.4170	61.1690	997.5840	721.0000	46.2500	230.3340
	14.0	571.20	27.1267	885.4170	61.1690	973.7126	721.8000	46.2500	205.6626
	15.0	571.20	0.0	885.4170	61.1690	946.5859	733.6130	46.2500	166.7229
	16.0	571.20	0.0	885.4170	61.1690	946.5859	710.8000	46.2500	189.5359
	17.0	571.40	101.9965	885.4170	61.1690	1048.5823	731.8000	46.2500	270.5322
	18.0	571.65	129.1233	885.4170	61.1690	1075.7090	751.7000	46.2500	277.7590
	19.0	571.90	129.1233	885.4170	61.1690	1075.7090	756.8379	46.2500	272.6211
	20.0	572.35	234.3750	885.4170	61.1690	1180.9609	652.2400	46.2500	482.4709
	21.0	572.60	131.2934	885.4170	61.1690	1077.8792	386.6670	46.2500	644.9622
	22.0	572.90	157.3351	885.4170	61.1690	1103.9209	346.1111	46.2500	711.5598
	23.0	573.20	157.3351	885.4170	61.1690	1103.9209	346.1111	46.2500	711.5598
	24.0	573.45	133.4635	885.4170	61.1690	1080.0493	405.0000	46.2500	628.7993

Table 9.8 Hourly Inflow to the Binga Reservoir During Typical Flood Periods

DATE	TIME (HR)	W.L (E.L.M)	BINGA DAM DV (M**3/S)	QS1 (M**3/S)	QE1 (M**3/S)	QIN1 (M**3/S)	QS2 (M**3/S)	AMBUKLAO DAM QE2 (M**3/S)	QIN2 (M**3/S)
1976. 5.27	0.0	573.45	0.0	212.7890	64.2750	0.0	405.0000	52.9280	0.0
	1.0	573.60	80.2951	212.7890	64.2750	357.3589	410.0000	52.9280	-105.5691
	2.0	573.70	53.1684	212.7890	64.2750	330.2322	410.0000	52.9280	-132.6958
	3.0	573.75	26.0417	212.7890	64.2750	303.1055	351.6670	52.9280	-101.4895
	4.0	573.70	-26.0417	212.7890	64.2750	251.0223	53.3330	52.9280	144.7613
	5.0	573.80	52.0833	212.7890	64.2750	329.1472	53.3330	52.9280	222.8862
	6.0	574.00	107.4219	212.7890	64.2750	384.4858	53.3330	52.9280	278.2249
	7.0	574.30	160.5903	212.7890	64.2750	437.6541	53.3330	52.9280	331.3931
	8.0	574.35	27.1267	212.7890	64.2750	304.1907	53.3330	52.9280	197.9297
	9.0	574.50	81.3802	212.7890	64.2750	358.4441	53.3330	52.9280	252.1831
	10.0	574.50	0.0	212.7890	64.2750	277.0640	53.3330	52.9280	170.8030
	11.0	574.45	-27.1267	212.7890	64.2750	249.9372	53.3330	52.9280	143.6763
	12.0	574.40	-28.2118	212.7890	64.2750	248.8522	53.3330	52.9280	142.5912
	13.0	574.40	0.0	212.7890	64.2750	277.0640	53.3330	52.9280	170.8030
	14.0	574.35	-26.0417	212.7890	64.2750	251.0223	52.5000	52.9280	145.5943
	15.0	574.35	0.0	212.7890	64.2750	277.0640	0.0	52.9280	224.1360
	16.0	574.40	26.0417	212.7890	64.2750	303.1055	0.0	52.9280	250.1775
	17.0	574.50	55.3385	212.7890	64.2750	332.4023	0.0	52.9280	279.4741
	18.0	574.55	26.0417	212.7890	64.2750	303.1055	0.0	52.9280	250.1775
	19.0	574.60	28.2118	212.7890	64.2750	305.2756	0.0	52.9280	252.3476
	20.0	574.50	-54.2535	212.7890	64.2750	222.8105	0.0	52.9280	169.8825
	21.0	574.40	-55.3385	212.7890	64.2750	221.7254	0.0	52.9280	168.7974
	22.0	574.30	-53.1684	212.7890	64.2750	223.8956	0.0	52.9280	170.9676
	23.0	574.25	-26.0417	212.7890	64.2750	251.0223	0.0	52.9280	198.0943
	24.0	574.25	0.0	212.7890	64.2750	277.0640	0.0	52.9280	224.1360

Table 9.8 Hourly Inflow to the Binga Reservoir During Typical Flood Periods

DATE	TIME (HR)	BINGA DAM W.L (E.L.M)	DV (M**3/S)	QS1 (M**3/S)	QE1 (M**3/S)	QIN1 (M**3/S)	AMBUKLAO DAM QS2 (M**3/S)	QE2 (M**3/S)	QIN2 (M**3/S)
1976. 5.28	0.0	574.25	0.0	212.7890	79.0630	0.0	52.5000	54.3400	0.0
	1.0	574.25	0.0	109.8340	79.0630	188.8970	0.0	54.3400	134.5570
	2.0	574.25	0.0	109.8340	79.0630	188.8970	0.0	54.3400	134.5570
	3.0	574.25	0.0	109.8340	79.0630	188.8970	0.0	54.3400	134.5570
	4.0	574.25	0.0	109.8340	79.0630	188.8970	4.7000	54.3400	129.8570
	5.0	574.30	26.0417	109.8340	79.0630	214.9387	15.7500	54.3400	144.8487
	6.0	574.40	53.1684	323.1660	79.0630	455.3972	131.1810	54.3400	269.8762
	7.0	574.40	0.0	336.8469	79.0630	415.9099	228.2460	54.3400	133.3240
	8.0	574.35	-26.0417	425.0000	79.0630	478.0212	357.3560	54.3400	66.3254
	9.0	574.35	0.0	425.0000	79.0630	504.0630	368.1941	54.3400	81.5291
	10.0	574.30	-27.1267	424.7500	79.0630	476.6860	351.9651	54.3400	70.3811
	11.0	574.30	0.0	424.7500	79.0630	503.8130	352.9580	54.3400	96.5151
	12.0	574.25	-26.0417	438.1670	79.0630	491.1882	348.7561	54.3400	88.0923
	13.0	574.20	-27.1267	438.1670	79.0630	490.1030	346.6079	54.3400	89.1553
	14.0	574.15	-27.1267	421.3330	79.0630	473.2690	345.0339	54.3400	73.8953
	15.0	574.10	-27.1267	387.6111	79.0630	439.5471	342.9800	54.3400	42.2273
	16.0	574.05	-26.0417	265.7810	79.0630	318.8022	254.5880	54.3400	9.8743
	17.0	573.90	-80.2951	209.0000	79.0630	207.7679	144.6580	54.3400	8.7699
	18.0	573.80	-54.2535	207.5000	79.0630	232.3095	125.7690	54.3400	52.2005
	19.0	574.05	134.5486	0.0	79.0630	213.6116	131.1810	54.3400	28.0906
	20.0	574.40	186.6319	0.0	79.0630	265.6948	236.9930	54.3400	-25.6379
	21.0	574.75	189.8871	9.3950	79.0630	278.3450	245.5100	54.3400	-21.5049
	22.0	574.90	81.3802	112.7420	79.0630	273.1851	245.5100	54.3400	-26.6648
	23.0	575.05	81.3802	130.1170	79.0630	290.5601	244.3690	54.3400	-8.1489
	24.0	575.10	27.1267	219.7500	79.0630	325.9397	243.2300	54.3400	28.3699

Table 9.8 Hourly Inflow to the Binga Reservoir During Typical Flood Periods

DATE	TIME (HR)	BINGA DAM W.L (E.L.M)	DV (M**3/S)	QS1 (M**3/S)	QE1 (M**3/S)	QIN1 (M**3/S)	AMBUKLAO DAM QS2 (M**3/S)	QE2 (M**3/S)	QIN2 (M**3/S)
1976. 5.29	0.0	575.10	0.0	202.0830	81.7860	0.0	243.2300	55.9840	0.0
	1.0	575.10	0.0	202.0830	81.7860	283.8689	242.0730	55.9840	-14.1880
	2.0	575.05	-27.1267	202.0830	81.7860	256.7419	240.9330	55.9840	-40.1750
	3.0	574.95	-53.1684	202.0830	81.7860	230.7005	239.7940	55.9840	-65.0773
	4.0	574.90	-28.2118	202.0830	81.7860	255.6571	238.6540	55.9840	-38.9808
	5.0	574.80	-54.2535	202.0830	81.7860	229.6154	237.5150	55.9840	-63.8833
	6.0	574.70	-54.2535	202.0830	81.7860	229.6154	235.1890	55.9840	-61.5574
	7.0	574.60	-53.1684	202.0830	81.7860	230.7005	232.9470	55.9840	-58.2304
	8.0	574.60	0.0	202.0830	81.7860	283.8689	230.6580	55.9840	-2.7729
	9.0	574.60	0.0	202.0830	81.7860	283.8689	230.4800	55.9840	-2.5950
	10.0	574.70	53.1684	202.0830	81.7860	337.0371	230.3530	55.9840	50.7002
	11.0	574.75	27.1267	202.0830	81.7860	310.9956	230.0000	55.9840	25.0117
	12.0	574.80	27.1267	202.0830	81.7860	310.9956	229.8400	55.9840	25.1716
	13.0	574.80	0.0	202.0830	81.7860	283.8689	191.6670	55.9840	36.2179
	14.0	574.80	0.0	202.0830	81.7860	283.8689	86.8030	55.9840	141.0819
	15.0	574.80	0.0	202.0830	81.7860	283.8689	3.9500	55.9840	223.9349
	16.0	574.85	28.2118	202.0830	81.7860	312.0806	10.2500	55.9840	245.8466
	17.0	574.90	26.0417	202.0830	81.7860	309.9104	19.2220	55.9840	234.7044
	18.0	574.85	-26.0417	202.0830	81.7860	257.8271	132.7040	55.9840	69.1392
	19.0	574.95	54.2535	202.0830	81.7860	338.1223	132.7040	55.9840	149.4343
	20.0	575.00	26.0417	202.0830	81.7860	309.9104	132.7040	55.9840	121.2224
	21.0	574.90	-54.2535	202.0830	81.7860	229.6154	135.8400	55.9840	37.7914
	22.0	574.85	-26.0417	202.0830	81.7860	257.8271	138.9760	55.9840	62.8672
	23.0	574.85	0.0	202.0830	81.7860	283.8689	198.0880	55.9840	29.7969
	24.0	575.00	80.2951	202.0830	81.7860	364.1638	245.5100	55.9840	62.6699

Table 9.8 Hourly Inflow to the Binga Reservoir During Typical Flood Periods

DATE	TIME (HR)	BINGA DAM W.L (E.L.M)	DV (M**3/S)	QS1 (M**3/S)	QE1 (M**3/S)	QIN1 (M**3/S)	AMBUKLAO DAM QS2 (M**3/S)	QE2 (M**3/S)	QIN2 (M**3/S)
1976. 5.30	0.0	575.00	0.0	131.0190	81.7260	0.0	245.5100	56.3660	0.0
	1.0	575.05	27.1267	131.0190	81.7260	239.8717	240.3350	56.3660	-56.8292
	2.0	575.10	27.1267	131.0190	81.7260	239.8717	236.5630	56.3660	-53.0572
	3.0	575.10	0.0	131.0190	81.7260	212.7450	233.3530	56.3660	-76.9740
	4.0	575.15	28.2118	131.0900	81.7260	241.0278	230.8550	56.3660	-46.1932
	5.0	575.15	0.0	131.0900	81.7260	212.8160	229.8400	56.3660	-73.3898
	6.0	575.15	0.0	131.0190	81.7260	212.7450	191.4800	56.3660	-35.1010
	7.0	575.05	-55.3385	131.0190	81.7260	157.4065	114.8400	56.3660	-13.7995
	8.0	575.05	0.0	131.0190	81.7260	212.7450	28.7100	56.3660	127.6690
	9.0	575.05	0.0	131.0190	81.7260	212.7450	3.2500	56.3660	153.1290
	10.0	574.95	-53.1684	131.0900	81.7260	159.6476	6.4500	56.3660	96.8316
	11.0	574.90	-28.2118	131.0900	81.7260	184.6042	6.8000	56.3660	121.4382
	12.0	574.80	-54.2535	131.0190	81.7260	158.4915	7.3500	56.3660	94.7755
	13.0	574.75	-27.1267	131.0190	81.7260	185.6183	49.6330	56.3660	79.6193
	14.0	574.75	0.0	131.0190	81.7260	212.7450	131.1810	56.3660	25.1980
	15.0	574.75	0.0	131.0190	81.7260	212.7450	181.1810	56.3660	-24.8020
	16.0	574.85	55.3385	131.0900	81.7260	268.1543	130.0550	56.3660	81.7333
	17.0	575.10	134.5486	131.0900	81.7260	347.3645	128.8850	56.3660	162.1135
	18.0	575.15	28.2118	131.0190	81.7260	240.9568	126.7200	56.3660	57.8708
	19.0	575.20	26.0417	131.0190	81.7260	238.7867	124.8180	56.3660	57.6027
	20.0	575.05	-81.3802	131.0190	81.7260	131.3648	122.8200	56.3660	-47.8212
	21.0	575.00	-27.1267	131.0190	81.7260	185.6183	121.0560	56.3660	8.1963
	22.0	575.05	27.1267	131.0900	81.7260	239.9427	119.4160	56.3660	64.1607
	23.0	575.10	27.1267	131.0900	81.7260	239.9427	118.6840	56.3660	64.8927
	24.0	575.10	0.0	131.0190	81.7260	212.7450	117.9510	56.3660	38.4280

Table 9.8 Hourly Inflow to the Binga Reservoir During Typical Flood Periods

DATE	TIME (HR)	W.L (E.L.M)	BINGA DAM DV (M**3/S)	QS1 (M**3/S)	QE1 (M**3/S)	QIN1 (M**3/S)	QS2 (M**3/S)	AMBUKLAO DAM QE2 (M**37S)	QIN2 (M**3/S)
1976. 6.25	0.0	569.20	0.0	0.0	83.7000	0.0	0.0	53.8000	0.0
	1.0	569.15	-26.0417	0.0	83.7000	57.6583	0.0	53.8000	3.8583
	2.0	569.15	0.0	0.0	83.7000	83.7000	0.0	53.8000	29.9000
	3.0	569.15	0.0	0.0	83.7000	83.7000	0.0	53.8000	29.9000
	4.0	569.15	0.0	0.0	83.7000	83.7000	0.0	53.8000	29.9000
	5.0	569.15	0.0	0.0	83.7000	83.7000	0.0	53.8000	29.9000
	6.0	569.15	0.0	0.0	83.7000	83.7000	0.0	53.8000	29.9000
	7.0	569.10	-23.8715	0.0	83.7000	59.8285	0.0	53.8000	6.0285
	8.0	569.10	0.0	0.0	83.7000	83.7000	0.0	53.8000	29.9000
	9.0	569.05	-24.9566	0.0	83.7000	58.7434	0.0	53.8000	4.9434
	10.0	569.00	-23.8715	0.0	83.7000	59.8285	0.0	53.8000	6.0285
	11.0	568.95	-26.0417	0.0	83.7000	57.6583	0.0	53.8000	3.8583
	12.0	568.95	0.0	0.0	83.7000	83.7000	0.0	53.8000	29.9000
	13.0	568.95	0.0	0.0	83.7000	83.7000	0.0	53.8000	29.9000
	14.0	568.95	0.0	0.0	83.7000	83.7000	0.0	53.8000	29.9000
	15.0	568.90	-24.9566	0.0	83.7000	58.7434	0.0	53.8000	4.9434
	16.0	568.90	0.0	0.0	83.7000	83.7000	0.0	53.8000	29.9000
	17.0	568.90	0.0	0.0	83.7000	83.7000	0.0	53.8000	29.9000
	18.0	568.90	0.0	0.0	83.7000	83.7000	0.0	53.8000	29.9000
	19.0	568.90	0.0	0.0	83.7000	83.7000	0.0	53.8000	29.9000
	20.0	568.90	0.0	0.0	83.7000	83.7000	0.0	53.8000	29.9000
	21.0	568.90	0.0	0.0	83.7000	83.7000	5.5000	53.8000	24.4000
	22.0	569.10	99.8264	0.0	83.7000	183.5264	454.1001	53.8000	-324.3733
	23.0	569.95	424.2617	0.0	83.7000	507.9617	480.3999	53.8000	-26.2380
	24.0	570.50	276.6926	0.0	83.7000	360.3926	422.3999	53.8000	-115.8071

Table 9.8 Hourly Inflow to the Binga Reservoir During Typical Flood Periods

DATE	TIME (HR)	BINGA DAM W.L (E.L.M)	DV (M**3/S)	QS1 (M**3/S)	QE1 (M**3/S)	QIN1 (M**3/S)	AMBUKLAO DAM QS2 (M**3/S)	QE2 (M**3/S)	QIN2 (M**3/S)
1976. 6.26	0.0	570.50	0.0	0.0	85.1000	0.0	422.3999	54.8000	0.0
	1.0	571.30	409.0710	0.0	85.1000	494.1709	422.3999	54.8000	16.9712
	2.0	572.05	387.3696	0.0	85.1000	472.4695	422.6001	54.8000	-4.9304
	3.0	572.75	365.6682	0.0	85.1000	450.7681	363.8999	54.8000	32.0684
	4.0	573.30	289.7134	0.0	85.1000	374.8132	0.0	54.8000	320.0132
	5.0	573.50	107.4219	0.0	85.1000	192.5219	0.0	54.8000	137.7219
	6.0	573.70	106.3368	0.0	85.1000	191.4368	0.0	54.8000	136.6368
	7.0	574.00	159.5052	0.0	85.1000	244.6052	168.2000	54.8000	21.6052
	8.0	574.20	107.4219	0.0	85.1000	192.5219	168.9000	54.8000	-31.1781
	9.0	574.30	53.1684	0.0	85.1000	138.2684	185.6000	54.8000	-102.1316
	10.0	574.40	53.1684	0.0	85.1000	138.2684	226.8000	54.8000	-143.3315
	11.0	574.60	109.5920	0.0	85.1000	194.6920	227.0000	54.8000	-87.1078
	12.0	574.70	53.1684	0.0	85.1000	138.2684	227.0000	54.8000	-143.5314
	13.0	574.70	0.0	0.0	85.1000	85.1000	227.0000	54.8000	-196.6998
	14.0	574.75	27.1267	0.0	85.1000	112.2267	227.0000	54.8000	-169.5731
	15.0	574.80	27.1267	0.0	85.1000	112.2267	227.0000	54.8000	-169.5731
	16.0	574.80	0.0	0.0	85.1000	85.1000	228.1000	54.8000	-197.7999
	17.0	574.80	0.0	0.0	85.1000	85.1000	121.1000	54.8000	-90.8000
	18.0	574.80	0.0	0.0	85.1000	85.1000	125.8000	54.8000	-95.5000
	19.0	574.80	0.0	0.0	85.1000	85.1000	130.1000	54.8000	-99.8000
	20.0	574.80	0.0	0.0	85.1000	85.1000	130.0000	54.8000	-99.7000
	21.0	574.90	54.2535	0.0	85.1000	139.3535	237.3000	54.8000	-152.7464
	22.0	574.90	0.0	0.0	85.1000	85.1000	234.0000	54.8000	-203.6998
	23.0	574.90	0.0	0.0	85.1000	85.1000	231.6000	54.8000	-201.2999
	24.0	574.90	0.0	0.0	85.1000	85.1000	131.6000	54.8000	-101.3000

Table 9.8 Hourly Inflow to the Binga Reservoir During Typical Flood Periods

DATE	TIME (HR)	BINGA DAM W.L (E.L.M)	DV (M**3/S)	QS1 (M**3/S)	QE1 (M**3/S)	QIN1 (M**3/S)	AMBUKLAO DAM QS2 (M**3/S)	QE2 (M**3/S)	QIN2 (M**3/S)
1976. 6.27	0.0	574.90	0.0	0.0	85.2000	0.0	131.6000	54.2000	0.0
	1.0	574.90	0.0	0.0	85.2000	85.2000	231.6000	54.2000	-200.5998
	2.0	574.90	0.0	0.0	85.2000	85.2000	230.9000	54.2000	-199.8999
	3.0	574.85	-26.0417	0.0	85.2000	59.1583	229.6000	54.2000	-224.6415
	4.0	574.80	-28.2118	0.0	85.2000	56.9882	228.5000	54.2000	-225.7117
	5.0	574.80	0.0	0.0	85.2000	85.2000	227.6000	54.2000	-196.5998
	6.0	574.80	0.0	0.0	85.2000	85.2000	189.7000	54.2000	-158.7000
	7.0	574.75	-27.1267	0.0	85.2000	58.0733	86.8000	54.2000	-82.9267
	8.0	574.60	-80.2951	0.0	85.2000	4.9049	4.2000	54.2000	-53.4951
	9.0	574.40	-109.5920	0.0	85.2000	-24.3920	12.0000	54.2000	-90.5920
	10.0	574.20	-106.3368	0.0	85.2000	-21.1368	167.0000	54.2000	-242.3368
	11.0	574.45	134.5486	0.0	85.2000	219.7486	232.4000	54.2000	-66.8513
	12.0	574.55	53.1684	0.0	85.2000	138.3684	232.4000	54.2000	-148.2315
	13.0	574.70	81.3802	0.0	85.2000	166.5802	229.6000	54.2000	-117.2196
	14.0	574.70	0.0	0.0	85.2000	85.2000	146.4000	54.2000	-115.4000
	15.0	574.60	-53.1684	0.0	85.2000	32.0316	119.4000	54.2000	-141.5684
	16.0	574.60	0.0	0.0	85.2000	85.2000	121.1000	54.2000	-90.1000
	17.0	574.65	26.0417	0.0	85.2000	111.2417	121.1000	54.2000	-64.0583
	18.0	574.70	27.1267	0.0	85.2000	112.3267	122.0000	54.2000	-63.8733
	19.0	574.80	54.2535	0.0	85.2000	139.4535	122.8000	54.2000	-37.5465
	20.0	574.85	28.2118	0.0	85.2000	113.4118	123.8000	54.2000	-64.5882
	21.0	574.90	26.0417	0.0	85.2000	111.2417	124.8000	54.2000	-67.7583
	22.0	575.00	54.2535	0.0	85.2000	139.4535	158.8000	54.2000	-73.5465
	23.0	574.95	-26.0417	0.0	85.2000	59.1583	126.7000	54.2000	-121.7417
	24.0	574.90	-28.2118	0.0	85.2000	56.9882	126.7000	54.2000	-123.9118

Table 9.8 Hourly Inflow to the Binga Reservoir During Typical Flood Periods

DATE	TIME (HR)	BINGA DAM W.L (E.L.M)	DV (M**3/S)	QS1 (M**3/S)	QE1 (M**3/S)	QIN1 (M**3/S)	AMBUKLAO DAM QS2 (M**3/S)	QE2 (M**3/S)	QIN2 (M**3/S)
1976. 6.28	0.0	574.90	0.0	0.0	83.6000	0.0	126.7000	53.0300	0.0
	1.0	574.80	-54.2535	329.8999	83.6000	359.2461	127.7000	53.0300	178.5161
	2.0	574.75	-27.1267	216.7000	83.6000	273.1729	127.7000	53.0300	92.4429
	3.0	574.65	-54.2535	216.0000	83.6000	245.3464	128.9000	53.0300	63.4164
	4.0	574.70	27.1267	216.0000	83.6000	326.7266	128.9000	53.0300	144.7966
	5.0	574.80	54.2535	111.5000	83.6000	249.3535	128.9000	53.0300	67.4235
	6.0	574.85	28.2118	111.7000	83.6000	223.5118	128.9000	53.0300	41.5818
	7.0	574.90	26.0417	111.9000	83.6000	221.5417	131.1000	53.0300	37.4117
	8.0	574.95	28.2118	112.1000	83.6000	223.9118	240.0000	53.0300	-69.1180
	9.0	575.05	53.1684	320.7500	83.6000	457.5181	336.5000	53.0300	67.9883
	10.0	574.90	-81.3802	395.2000	83.6000	397.4194	248.9000	53.0300	95.4895
	11.0	574.75	-81.3802	355.3999	83.6000	357.6194	144.2000	53.0300	160.3894
	12.0	574.50	-134.5486	318.0000	83.6000	267.0510	131.2000	53.0300	82.8210
	13.0	574.50	0.0	214.0000	83.6000	297.5999	227.4000	53.0300	17.1699
	14.0	574.60	54.2535	214.5000	83.6000	352.3533	244.2000	53.0300	55.1233
	15.0	574.55	-28.2118	384.7000	83.6000	440.0879	340.7000	53.0300	46.3582
	16.0	574.60	28.2118	384.7000	83.6000	496.5115	336.5000	53.0300	106.9817
	17.0	574.60	0.0	384.7000	83.6000	468.2998	336.6001	53.0300	78.6699
	18.0	574.50	-54.2535	633.0000	83.6000	662.3462	474.5000	53.0300	134.8164
	19.0	574.50	0.0	632.0000	83.6000	715.5999	533.8000	53.0300	128.7700
	20.0	574.50	0.0	632.0000	83.6000	715.5999	532.6001	53.0300	129.9700
	21.0	574.55	26.0417	632.5000	83.6000	742.1414	531.6001	53.0300	157.5115
	22.0	574.60	28.2118	632.5000	83.6000	744.3115	530.6001	53.0300	160.6816
	23.0	574.60	0.0	634.0000	83.6000	717.5999	529.2000	53.0300	135.3701
	24.0	574.60	0.0	634.0000	83.6000	717.5999	454.1001	53.0300	210.4700

Table 9.8 Hourly Inflow to the Binga Reservoir During Typical Flood Periods

DATE	TIME (HR)	BINGA DAM W.L (E.L.M)	DV (M**3/S)	QS1 (M**3/S)	QE1 (M**3/S)	QIN1 (M**3/S)	AMBUKLAO DAM QS2 (M**3/S)	QE2 (M**3/S)	QIN2 (M**3/S)
1976. 6.29	0.0	574.60	0.0	634.0000	82.8000	0.0	454.1001	55.0000	0.0
	1.0	574.40	-109.5920	0.0	82.8000	-26.7920	357.0500	55.0000	-438.8420
	2.0	574.40	0.0	0.0	82.8000	82.8000	332.6001	55.0000	-304.8000
	3.0	574.35	-26.0417	0.0	82.8000	56.7583	332.2000	55.0000	-330.4414
	4.0	574.40	26.0417	0.0	82.8000	108.8417	331.8000	55.0000	-277.9583
	5.0	574.50	55.3385	0.0	82.8000	138.1385	331.3999	55.0000	-248.2614
	6.0	574.60	54.2535	0.0	82.8000	137.0535	331.0000	55.0000	-248.9465
	7.0	574.70	53.1684	0.0	82.8000	135.9684	331.0000	55.0000	-250.0316
	8.0	574.80	54.2535	0.0	82.8000	137.0535	331.2000	55.0000	-249.1465
	9.0	574.90	54.2535	0.0	82.8000	137.0535	308.7000	55.0000	-226.6465
	10.0	574.85	-26.0417	0.0	82.8000	56.7583	226.8000	55.0000	-225.0415
	11.0	574.80	-28.2118	0.0	82.8000	54.5882	227.6000	55.0000	-228.0116
	12.0	574.85	28.2118	0.0	82.8000	111.0118	239.4000	55.0000	-183.3881
	13.0	574.85	0.0	0.0	82.8000	82.8000	295.1001	55.0000	-267.3000
	14.0	574.85	0.0	161.7000	82.8000	244.5000	589.2000	55.0000	-399.7000
	15.0	574.65	-109.5920	346.5000	82.8000	319.7078	705.5000	55.0000	-440.7922
	16.0	574.55	-54.2535	408.0000	82.8000	436.5461	709.8000	55.0000	-328.2539
	17.0	574.40	-81.3802	405.5000	82.8000	406.9194	704.3999	55.0000	-352.4805
	18.0	574.20	-106.3368	402.0000	82.8000	378.4629	699.7000	55.0000	-376.2371
	19.0	574.20	0.0	398.5000	82.8000	481.2998	969.1001	55.0000	-542.8003
	20.0	574.10	-54.2535	333.6001	82.8000	362.1462	969.2000	55.0000	-662.0537
	21.0	574.15	27.1267	312.0000	82.8000	421.9265	716.0000	55.0000	-349.0735
	22.0	574.40	133.4635	401.5000	82.8000	617.7632	873.6001	55.0000	-310.8369
	23.0	574.40	0.0	580.3000	82.8000	663.0999	1779.2000	55.0000	-1171.1001
	24.0	574.50	55.3385	906.2000	82.8000	1044.3381	1744.8999	55.0000	-755.5618

Table 9.8 Hourly Inflow to the Binga Reservoir During Typical Flood Periods

DATE	TIME (HR)	BINGA DAM W.L (E.L.M)	BINGA DAM DV (M**3/S)	BINGA DAM QS1 (M**3/S)	BINGA DAM QE1 (M**3/S)	BINGA DAM QIN1 (M**3/S)	AMBUKLAO DAM QS2 (M**3/S)	AMBUKLAO DAM QE2 (M**3/S)	AMBUKLAO DAM QIN2 (M**3/S)
1976. 6.30	0.0	574.50	0.0	906.2000	82.6000	0.0	1744.8999	52.9000	0.0
	1.0	573.95	-295.1387	2196.3999	82.6000	1983.8611	1604.0000	52.9000	326.9612
	2.0	573.55	-213.7587	1809.5000	82.6000	1678.3411	1502.0000	52.9000	123.4412
	3.0	573.70	80.2951	1393.2000	82.6000	1556.0947	1339.0000	52.9000	164.1948
	4.0	574.00	159.5052	1248.6001	82.6000	1490.7051	1177.6001	52.9000	260.2051
	5.0	574.35	187.7170	1268.7000	82.6000	1539.0166	1008.8999	52.9000	477.2168
	6.0	575.20	460.0693	1341.0000	82.6000	1883.6692	1616.0000	52.9000	214.7693
	7.0	575.50	164.9305	1912.5000	82.6000	2160.0303	1272.7000	52.9000	834.4304
	8.0	575.20	-164.9305	2578.8999	82.6000	2496.5691	1907.7000	52.9000	535.9692
	9.0	574.75	-244.1406	2602.2000	82.6000	2440.6592	1898.3000	52.9000	489.4592
	10.0	574.35	-215.9288	2551.8999	82.6000	2418.5708	1792.6001	52.9000	573.0708
	11.0	573.75	-321.1804	2493.3000	82.6000	2254.7195	1587.3999	52.9000	614.4197
	12.0	573.00	-398.2202	2331.7000	82.6000	2016.0796	1270.2000	52.9000	692.9797
	13.0	572.65	-184.4618	1960.0000	82.6000	1858.1379	1277.5000	52.9000	527.7380
	14.0	572.65	0.0	1870.1001	82.6000	1952.7000	1306.3999	52.9000	593.4001
	15.0	572.65	0.0	1499.2000	82.6000	1581.7998	1474.8999	52.9000	54.0000
	16.0	572.75	53.1684	1945.6001	82.6000	2081.3682	1525.0000	52.9000	503.4683
	17.0	573.20	236.5451	1973.3999	82.6000	2292.5447	1630.0000	52.9000	609.6448
	18.0	573.55	186.6319	2173.8000	82.6000	2443.0317	1675.0000	52.9000	715.1318
	19.0	573.45	-53.1684	2367.3000	82.6000	2396.7314	1757.6001	52.9000	586.2314
	20.0	573.35	-53.1684	2392.0000	82.6000	2421.4314	1672.8999	52.9000	695.6316
	21.0	573.40	26.0417	2309.8000	82.6000	2418.4414	1670.7000	52.9000	694.8416
	22.0	573.45	27.1267	2278.6001	82.6000	2388.3267	1675.0000	52.9000	660.4268
	23.0	573.45	0.0	2290.0000	82.6000	2372.5999	1761.1001	52.9000	558.5999
	24.0	573.45	0.0	2290.0000	82.6000	2372.5999	1807.5000	52.9000	512.2000

Table 9.8 Hourly Inflow to the Binga Reservoir During Typical Flood Periods

		BINGA DAM						AMBUKLAO DAM	
DATE	TIME (HR)	W.L (E.L.M)	DV (M**3/S)	QS1 (M**3/S)	QE1 (M**3/S)	QIN1 (M**3/S)	QS2 (M**3/S)	QE2 (M**3/S)	QIN2 (M**3/S)
1976. 7. 1	0.0	573.45	0.0	1807.5000	79.7000	0.0	2290.0000	47.5000	0.0
	1.0	573.70	133.4635	904.6001	79.7000	1117.7634	1885.3000	47.5000	-815.0366
	2.0	573.80	52.0833	1014.8000	79.7000	1146.5833	1853.6001	47.5000	-754.5168
	3.0	573.85	27.1267	1092.3000	79.7000	1199.1267	1775.8000	47.5000	-624.1733
	4.0	573.85	0.0	1160.8000	79.7000	1240.5000	1779.2000	47.5000	-586.2000
	5.0	573.80	-27.1267	1170.5000	79.7000	1223.0730	1784.0000	47.5000	-608.4270
	6.0	573.45	-185.5469	1164.0000	79.7000	1058.1531	1784.0000	47.5000	-773.3469
	7.0	573.30	-80.2951	1153.0000	79.7000	1152.4048	1790.3999	47.5000	-685.4951
	8.0	573.20	-53.1684	1151.5000	79.7000	1178.0315	1876.3999	47.5000	-745.8684
	9.0	573.40	106.3368	1030.1001	79.7000	1216.1367	1893.3999	47.5000	-724.7632
	10.0	573.45	27.1267	977.6001	79.7000	1084.4268	1893.3999	47.5000	-856.4731
	11.0	573.30	-80.2951	1063.5000	79.7000	1062.9048	1835.8000	47.5000	-820.3953
	12.0	572.90	-210.5035	1059.5000	79.7000	928.6963	1593.7000	47.5000	-712.5037
	13.0	572.60	-157.3351	970.0000	79.7000	892.3647	1576.3000	47.5000	-731.4353
	14.0	572.60	0.0	890.7000	79.7000	970.3999	1340.0000	47.5000	-417.1001
	15.0	572.60	0.0	890.7000	79.7000	970.3999	1104.2000	47.5000	-181.3000
	16.0	572.90	157.3351	901.3999	79.7000	1138.4348	909.6001	47.5000	181.3347
	17.0	573.15	131.2934	942.2000	79.7000	1153.1931	1114.3000	47.5000	-8.6069
	18.0	573.20	26.0417	986.5000	79.7000	1092.2415	1120.0000	47.5000	-75.2585
	19.0	573.25	27.1267	986.1001	79.7000	1092.9268	1124.0000	47.5000	-78.5732
	20.0	573.30	26.0417	992.7000	79.7000	1098.4414	1128.0000	47.5000	-77.0586
	21.0	573.35	27.1267	794.7000	79.7000	901.5266	1167.8000	47.5000	-313.7734
	22.0	573.35	0.0	796.8000	79.7000	876.5000	1180.2000	47.5000	-351.2000
	23.0	573.35	0.0	798.3000	79.7000	878.0000	1170.6001	47.5000	-340.1001
	24.0	573.35	0.0	1008.2000	79.7000	1087.8999	1117.8000	47.5000	-77.4001

Table 9.8 Hourly Inflow to the Binga Reservoir During Typical Flood Periods

DATE	TIME (HR)	BINGA DAM W.L (E.L.M)	BINGA DAM DV (M**3/S)	BINGA DAM QS1 (M**3/S)	BINGA DAM QE1 (M**3/S)	BINGA DAM QIN1 (M**3/S)	AMBUKLAO DAM QS2 (M**3/S)	AMBUKLAO DAM QE2 (M**3/S)	AMBUKLAO DAM QIN2 (M**3/S)
1976. 7. 2	0.0	573.35	0.0	1008.2000	82.5000	0.0	1117.8000	55.7000	0.0
	1.0	572.25	-578.3418	304.0000	82.5000	-191.8418	1003.7000	55.7000	-1251.2417
	2.0	572.95	366.7532	301.5000	82.5000	750.7532	940.3999	55.7000	-245.3467
	3.0	572.85	-53.1684	301.5000	82.5000	330.8315	1089.8000	55.7000	-814.6685
	4.0	572.55	-157.3351	296.5000	82.5000	221.6649	1016.8000	55.7000	-850.8350
	5.0	572.25	-156.2500	296.5000	82.5000	222.7500	892.8000	55.7000	-725.7500
	6.0	572.10	-78.1250	292.8000	82.5000	297.1750	890.6001	55.7000	-649.1250
	7.0	572.15	26.0417	224.4000	82.5000	332.9414	888.6001	55.7000	-611.3586
	8.0	572.25	52.0833	191.0000	82.5000	325.5833	885.3999	55.7000	-615.5166
	9.0	572.35	52.0833	192.0000	82.5000	326.5833	882.2000	55.7000	-611.3167
	10.0	572.40	26.0417	193.0000	82.5000	301.5415	877.7000	55.7000	-631.8584
	11.0	572.45	26.0417	193.0000	82.5000	301.5415	872.8000	55.7000	-626.9585
	12.0	572.50	26.0417	193.8000	82.5000	302.3413	866.7000	55.7000	-620.0586
	13.0	572.45	-26.0417	193.8000	82.5000	250.2581	863.2000	55.7000	-668.6416
	14.0	572.65	104.1667	194.5000	82.5000	381.1665	857.8000	55.7000	-532.3335
	15.0	572.80	79.2101	247.6000	82.5000	409.3098	854.2000	55.7000	-500.5901
	16.0	572.90	53.1684	299.5000	82.5000	435.1682	845.8000	55.7000	-466.3318
	17.0	573.00	52.0833	300.5000	82.5000	435.0833	840.5000	55.7000	-461.1167
	18.0	573.30	158.4201	251.5000	82.5000	492.4199	760.0000	55.7000	-323.2800
	19.0	575.50	1185.9807	203.0000	82.5000	1471.4807	740.0000	55.7000	675.7808
	20.0	573.80	-920.1387	205.5000	82.5000	-632.1387	702.0000	55.7000	-1389.8386
	21.0	574.25	241.9705	209.5000	82.5000	533.9705	700.0000	55.7000	-221.7295
	22.0	574.70	241.9705	214.0000	82.5000	538.4705	698.0000	55.7000	-215.2295
	23.0	575.00	162.7604	217.5000	82.5000	462.7603	694.3999	55.7000	-287.3396
	24.0	575.10	54.2535	220.7000	82.5000	357.4534	693.3000	55.7000	-391.5466

Table 9.8 Hourly Inflow to the Binga Reservoir During Typical Flood Periods

			BINGA DAM				AMBUKLAO DAM		
DATE	TIME (HR)	W.L (E.L.M)	DV (M**3/S)	QS1 (M**3/S)	QE1 (M**3/S)	QIN1 (M**3/S)	QS2 (M**3/S)	QE2 (M**3/S)	QIN2 (M**3/S)
1976. 7. 3	0.0	575.10	0.0	220.7000	84.5000	0.0	693.3000	46.9000	0.0
	1.0	575.10	0.0	0.0	84.5000	84.5000	683.6001	46.9000	-646.0000
	2.0	575.20	54.2535	0.0	84.5000	138.7535	682.0000	46.9000	-590.1462
	3.0	575.30	55.3385	0.0	84.5000	139.8385	681.6001	46.9000	-588.6614
	4.0	575.40	55.3385	0.0	84.5000	139.8385	680.8000	46.9000	-587.8613
	5.0	575.40	0.0	0.0	84.5000	84.5000	680.0000	46.9000	-642.3999
	6.0	575.30	-55.3385	0.0	84.5000	29.1615	679.8999	46.9000	-697.6382
	7.0	575.20	-55.3385	0.0	84.5000	29.1615	679.0000	46.9000	-696.7383
	8.0	575.10	-54.2535	0.0	84.5000	30.2465	551.6001	46.9000	-568.2534
	9.0	575.50	219.1840	0.0	84.5000	303.6838	506.7000	46.9000	-249.9160
	10.0	574.35	-625.0000	0.0	84.5000	-540.5000	506.3999	46.9000	-1093.7998
	11.0	574.70	188.8021	0.0	84.5000	273.3020	506.3000	46.9000	-279.8979
	12.0	575.00	162.7604	0.0	84.5000	247.2604	495.0000	46.9000	-294.6394
	13.0	575.30	163.8455	11.2200	84.5000	259.5654	482.7000	46.9000	-270.0344
	14.0	575.30	0.0	0.0	84.5000	84.5000	533.1001	46.9000	-495.5000
	15.0	575.50	109.5920	24.1000	84.5000	218.1920	602.0000	46.9000	-430.7078
	16.0	575.70	109.5920	24.1000	84.5000	218.1920	601.0000	46.9000	-429.7078
	17.0	575.40	-163.8455	27.8700	84.5000	-51.4755	600.0000	46.9000	-698.3752
	18.0	575.00	-219.1840	8.0000	84.5000	-126.6840	599.6001	46.9000	-773.1838
	19.0	574.45	-297.3088	0.0	84.5000	-212.8088	596.0000	46.9000	-855.7087
	20.0	574.00	-241.9705	0.0	84.5000	-157.4705	590.0000	46.9000	-794.3704
	21.0	573.60	-212.6736	0.0	84.5000	-128.1736	589.0000	46.9000	-764.0735
	22.0	573.00	-319.0103	0.0	84.5000	-234.5103	560.0000	46.9000	-841.4102
	23.0	572.60	-209.4184	0.0	84.5000	-124.9184	559.6001	46.9000	-731.4182
	24.0	572.20	-209.4184	0.0	84.5000	-124.9184	556.0000	46.9000	-727.8181