Fig. 7 - 2 Location of Water Quality Stations (No. 643)

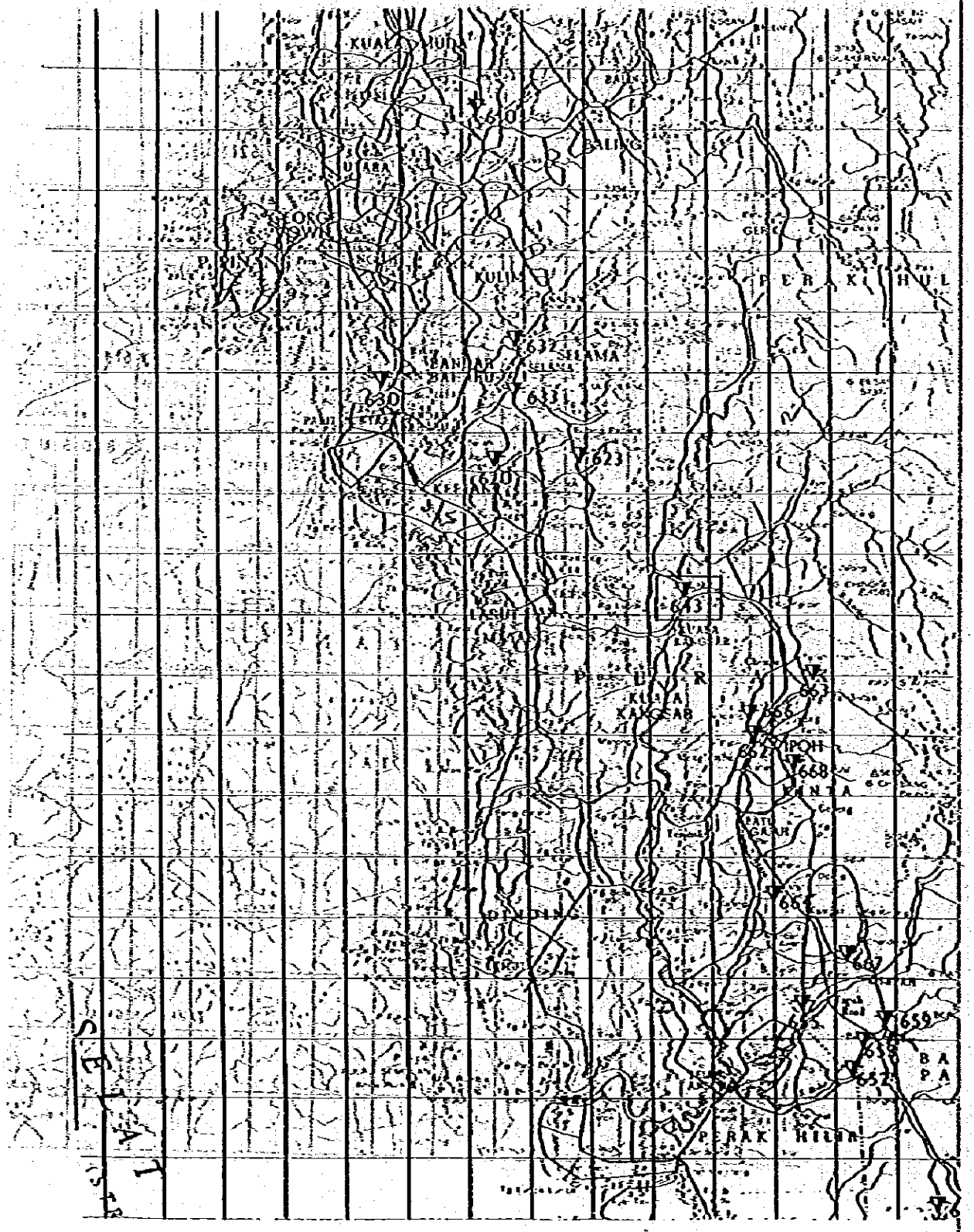
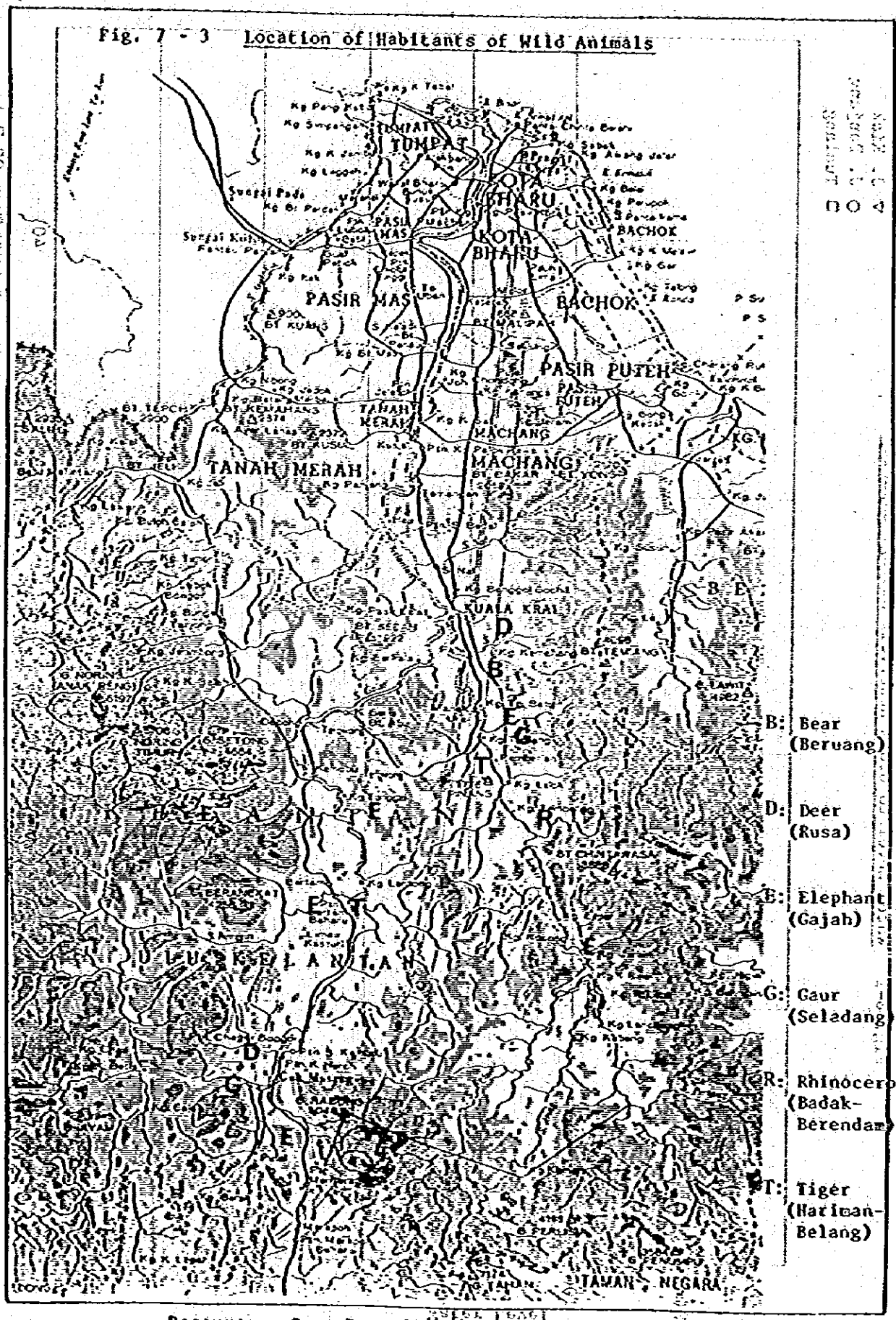
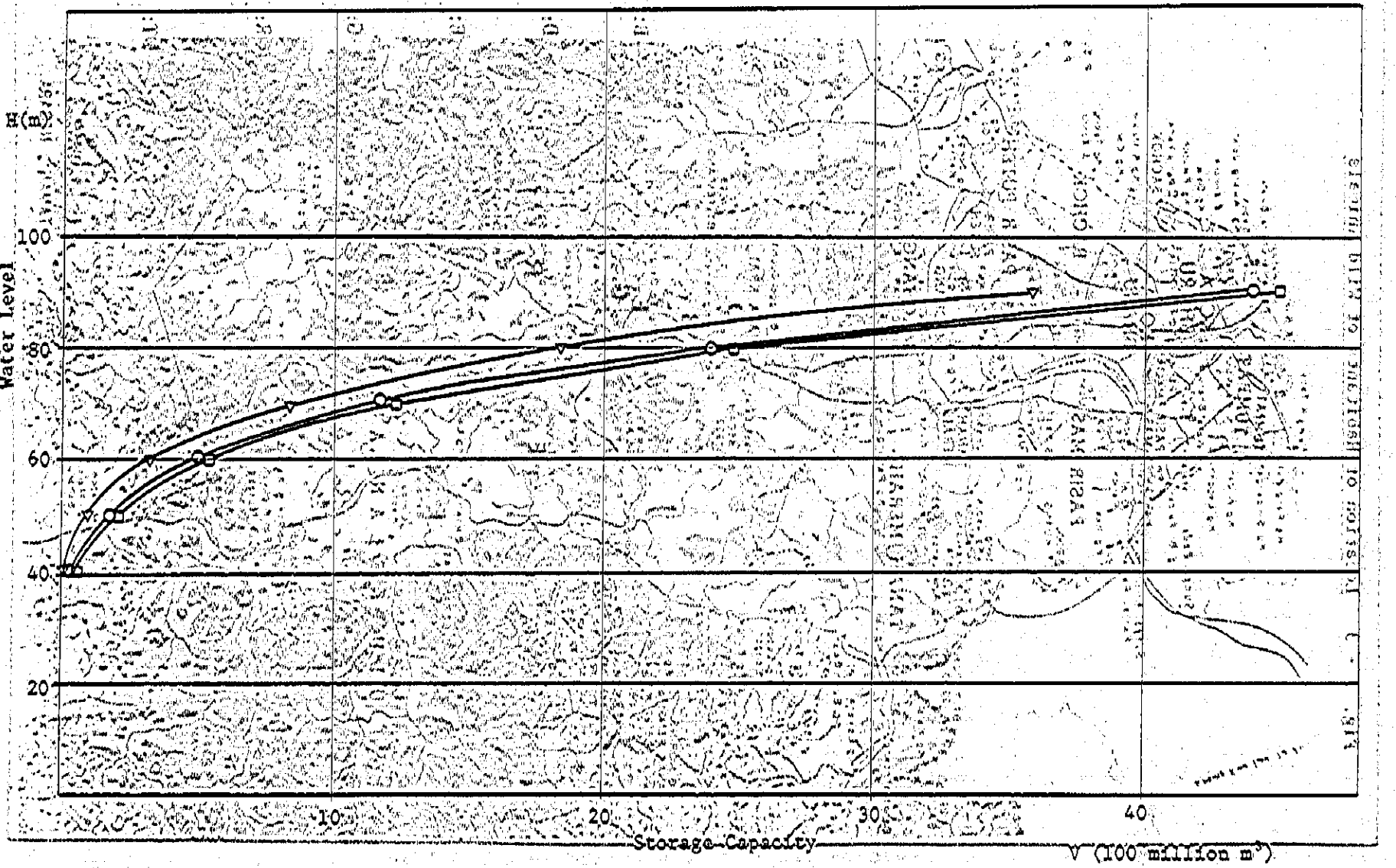


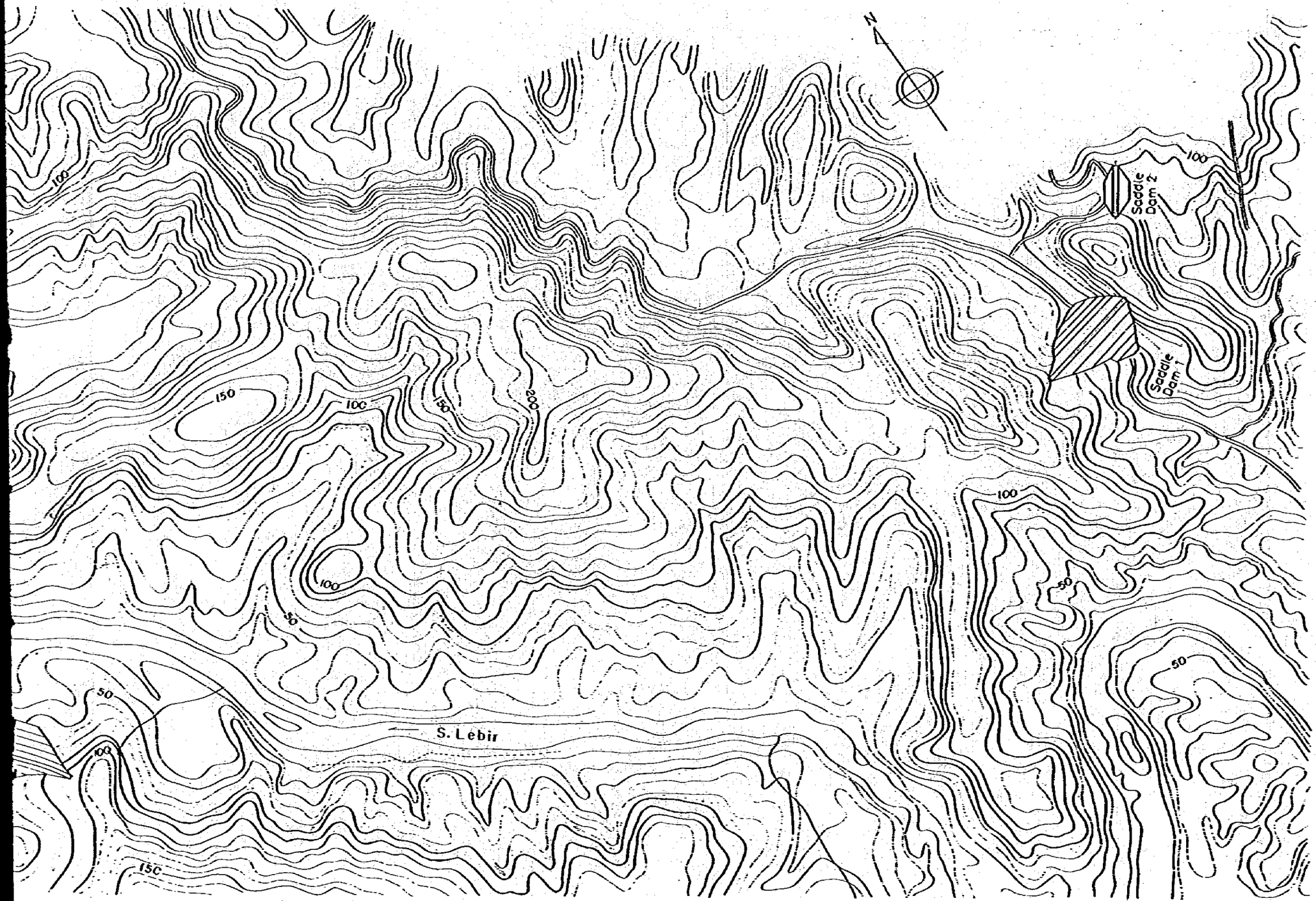
Fig. 7 - 3 Location of Habitants of Wild Animals



Resource: Game Dep. in Kelantan

Fig. 8-1 Water Level to Gross Reservoir Storage Capacity

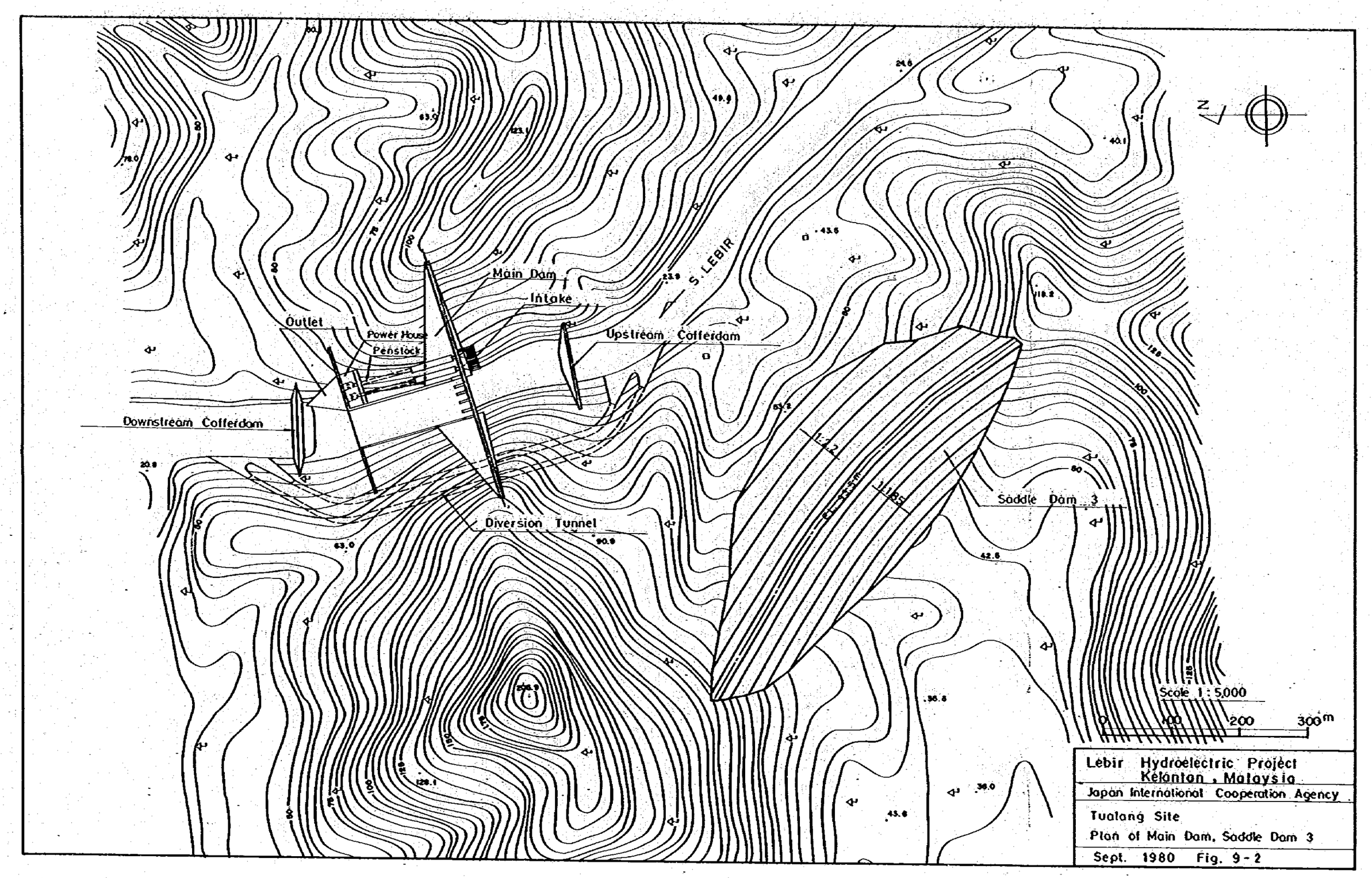




Scale 1:10,000

0 100 200 300 400 500 (m)

Lebir Hydroelectric Project Kelantan, Malaysia
Japan International Cooperation Agency
Tualang Site General Plan
Sept. 1980 Fig. 9-1



Lebir Hydroelectric Project
Kelanton , Malaysia

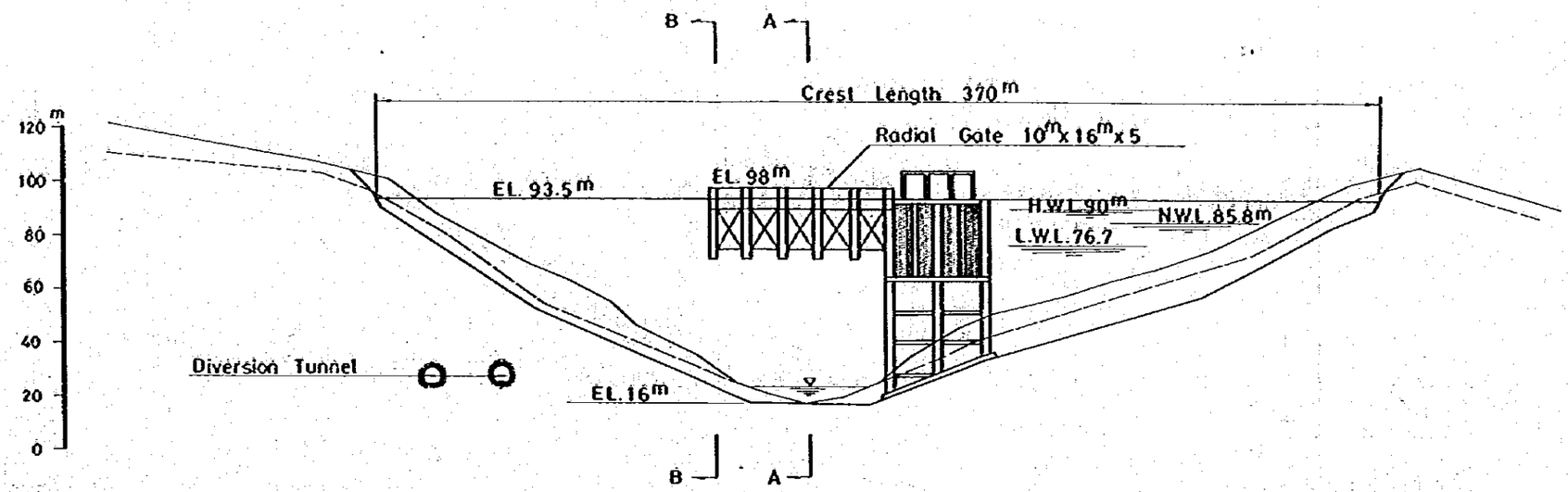
Japan International Cooperation Agency

Tualang Site

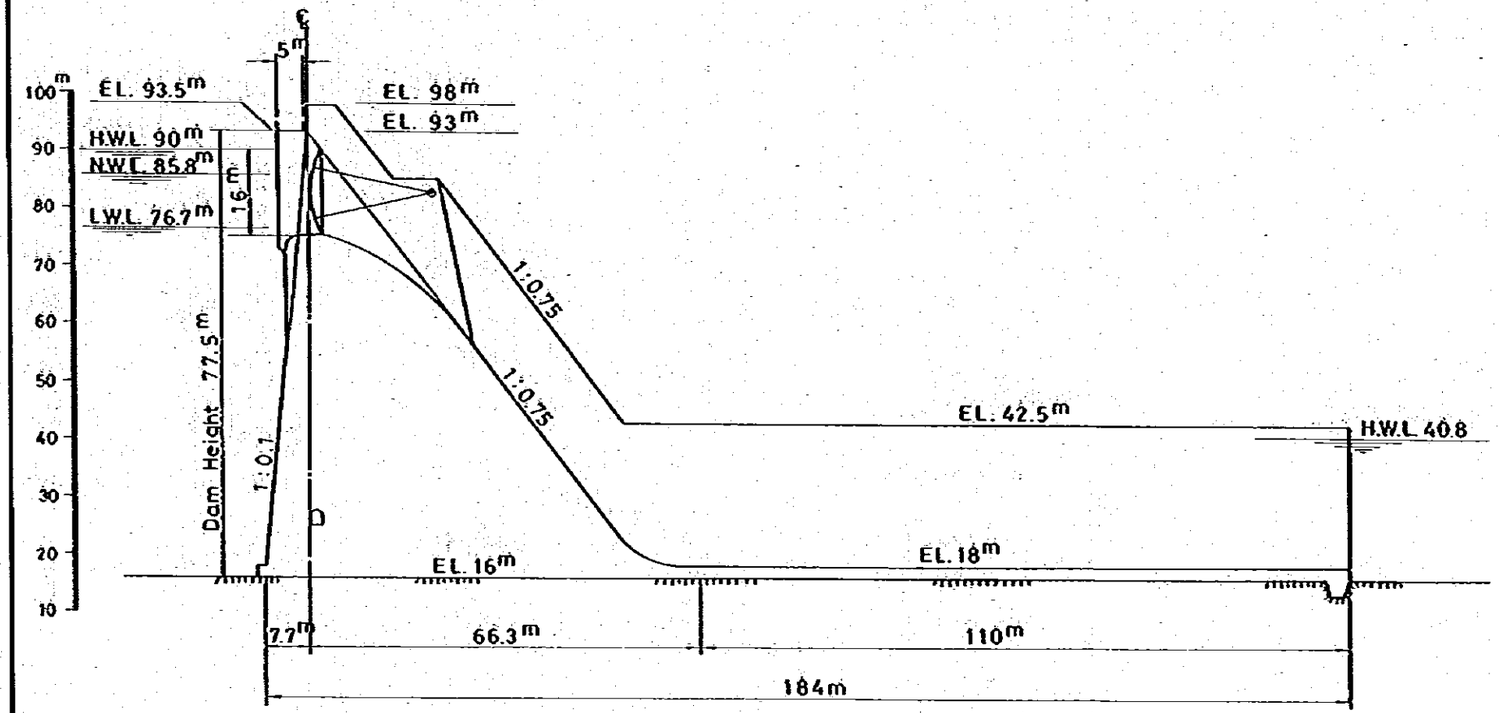
Plan of Main Dam, Saddle Dam 3

Sept. 1980 Fig. 9 - 2

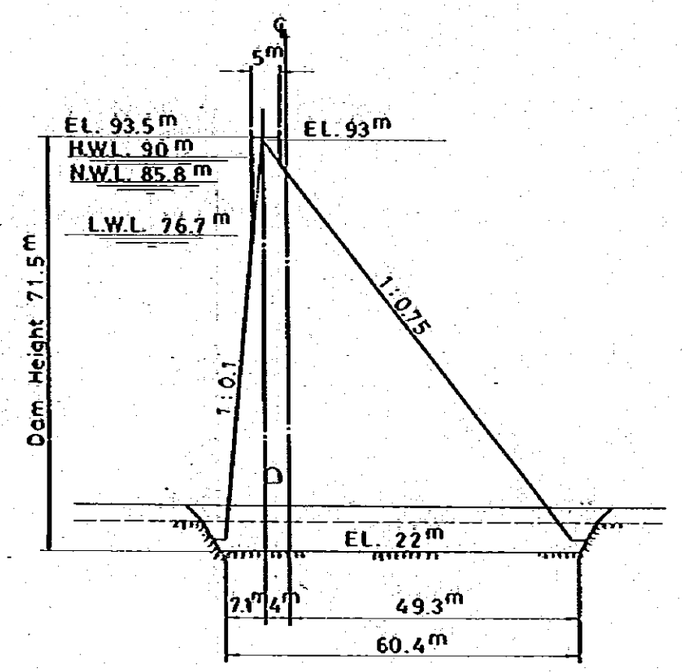
Main Dam Section S = 1/2,000



A - A S = 1/1,000



B - B S = 1/1,000



S = 1/2,000 0 20 40 60 80 100 (m)

S = 1/1,000 0 10 20 30 40 50 (m)

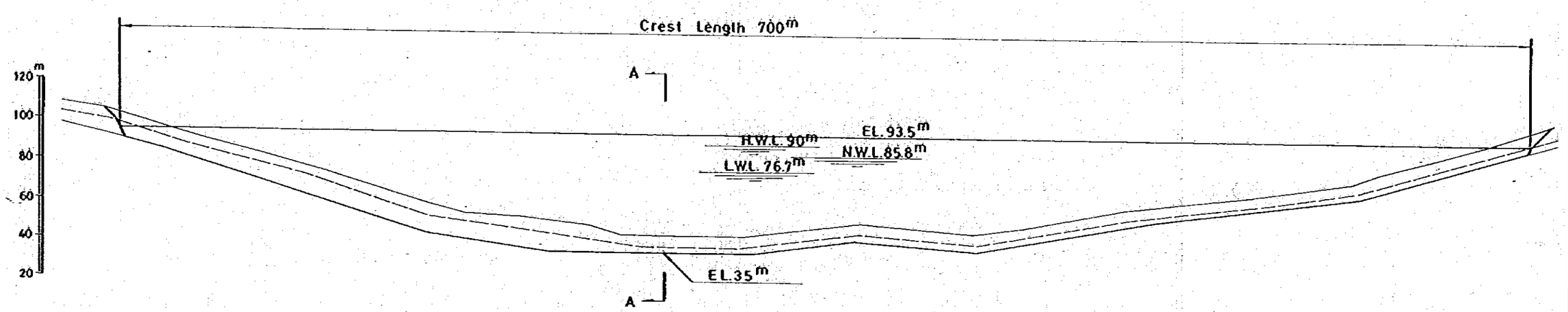
Lebir Hydroelectric Project
Kelantan, Malaysia

Japan International Cooperation Agency

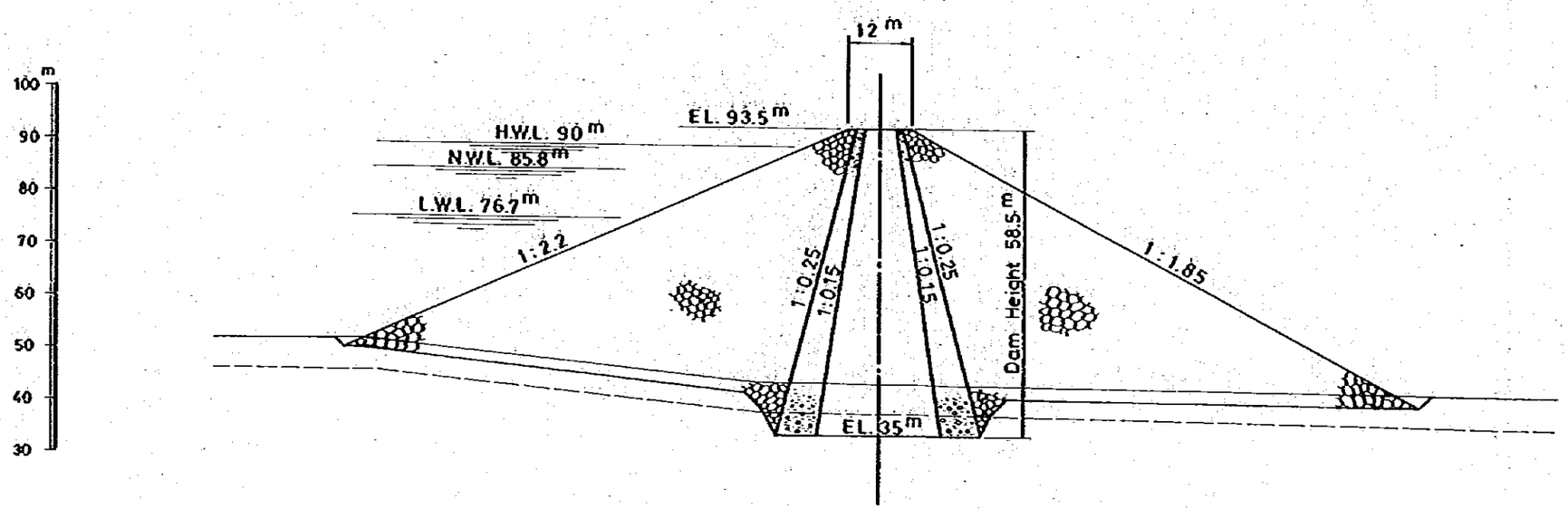
Tualang Site.
Main Dam Section

Sept. 1980 Fig. 9-3

Saddle Dam 3 Section S = 1/2,000



A - A S = 1/1,000

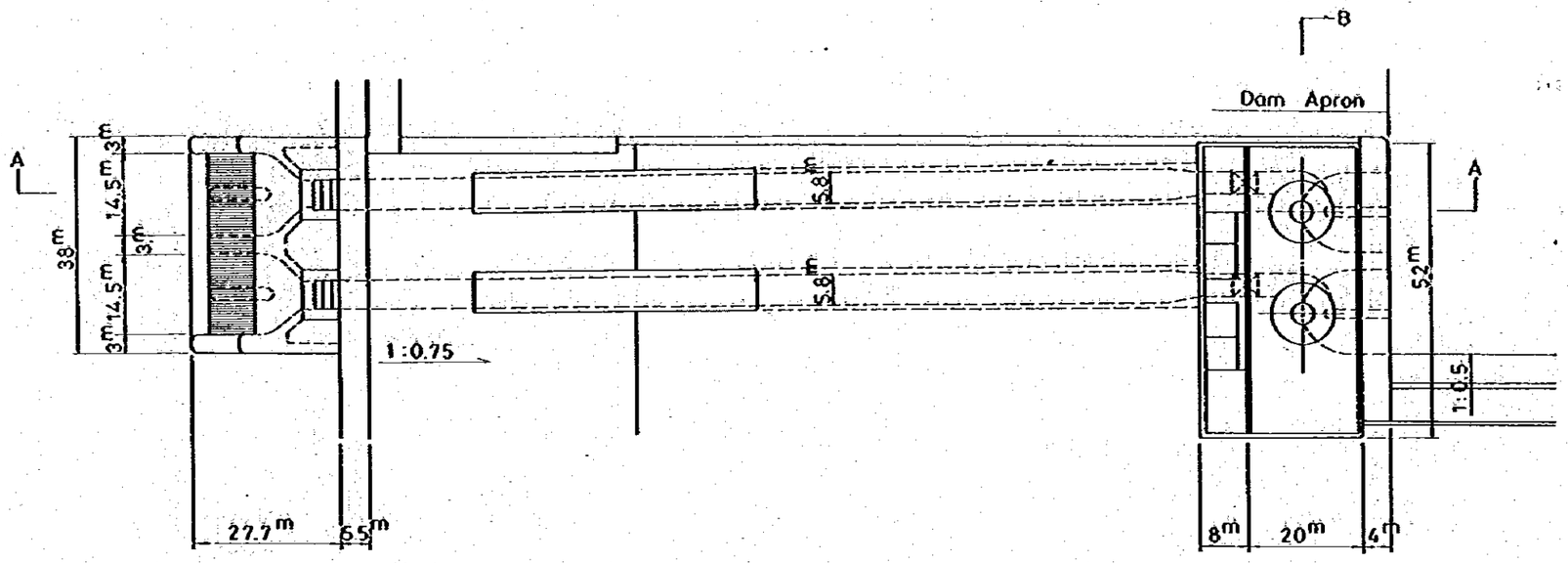


S=1/2,000 0 20 40 60 80 100 (m)

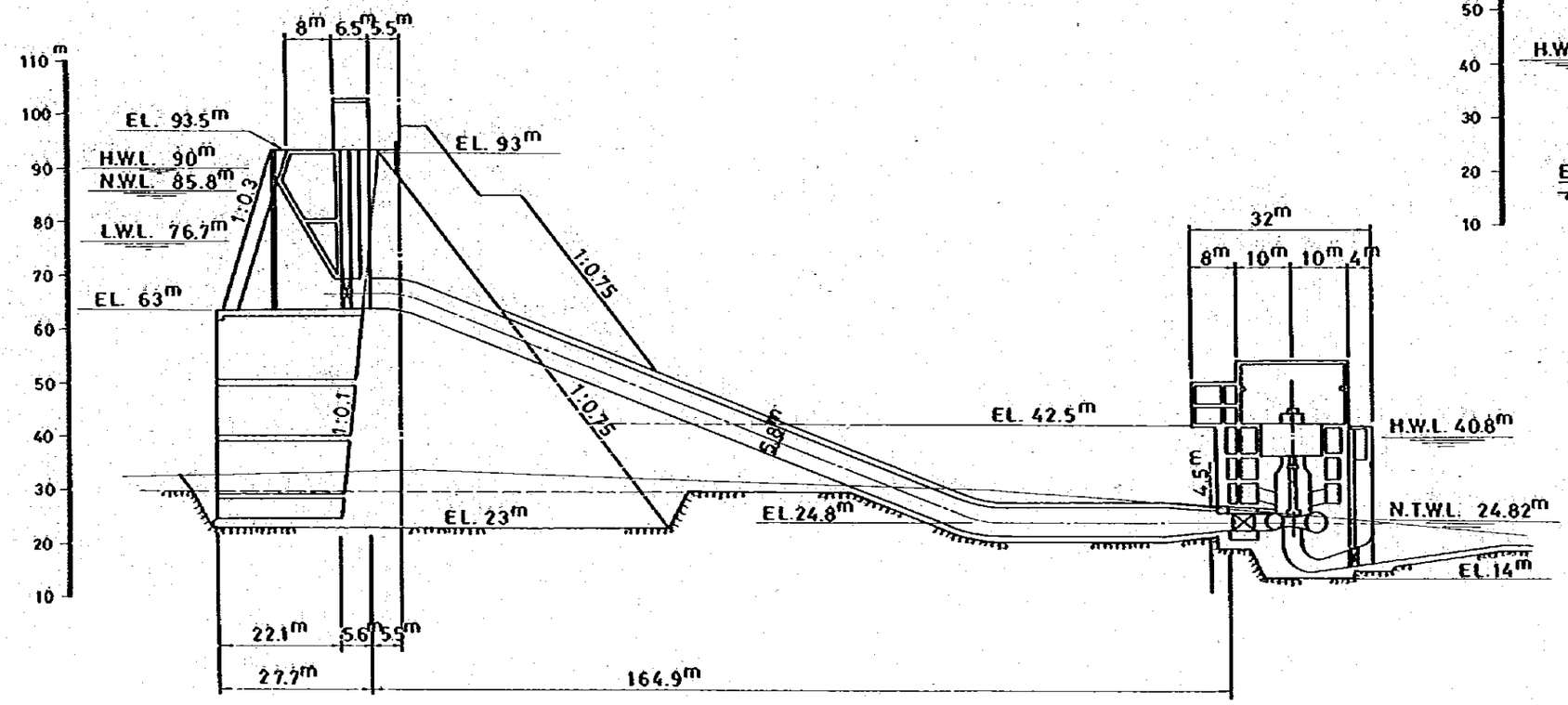
S=1/1,000 0 10 20 30 40 50 (m)

Lebir Hydroelectric Project Kelantan, Malaysia
Japan International Cooperation Agency
Tualang Site Saddle Dam 3 Section
Sept. 1980 Fig. 9-4

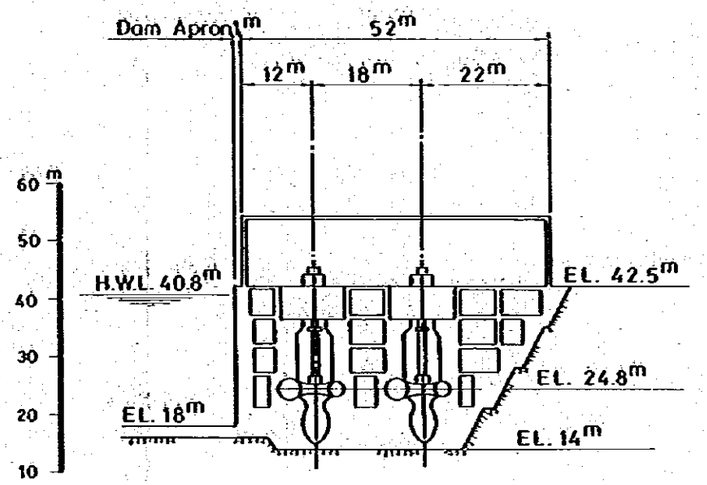
Plan of Power Plant



A - A

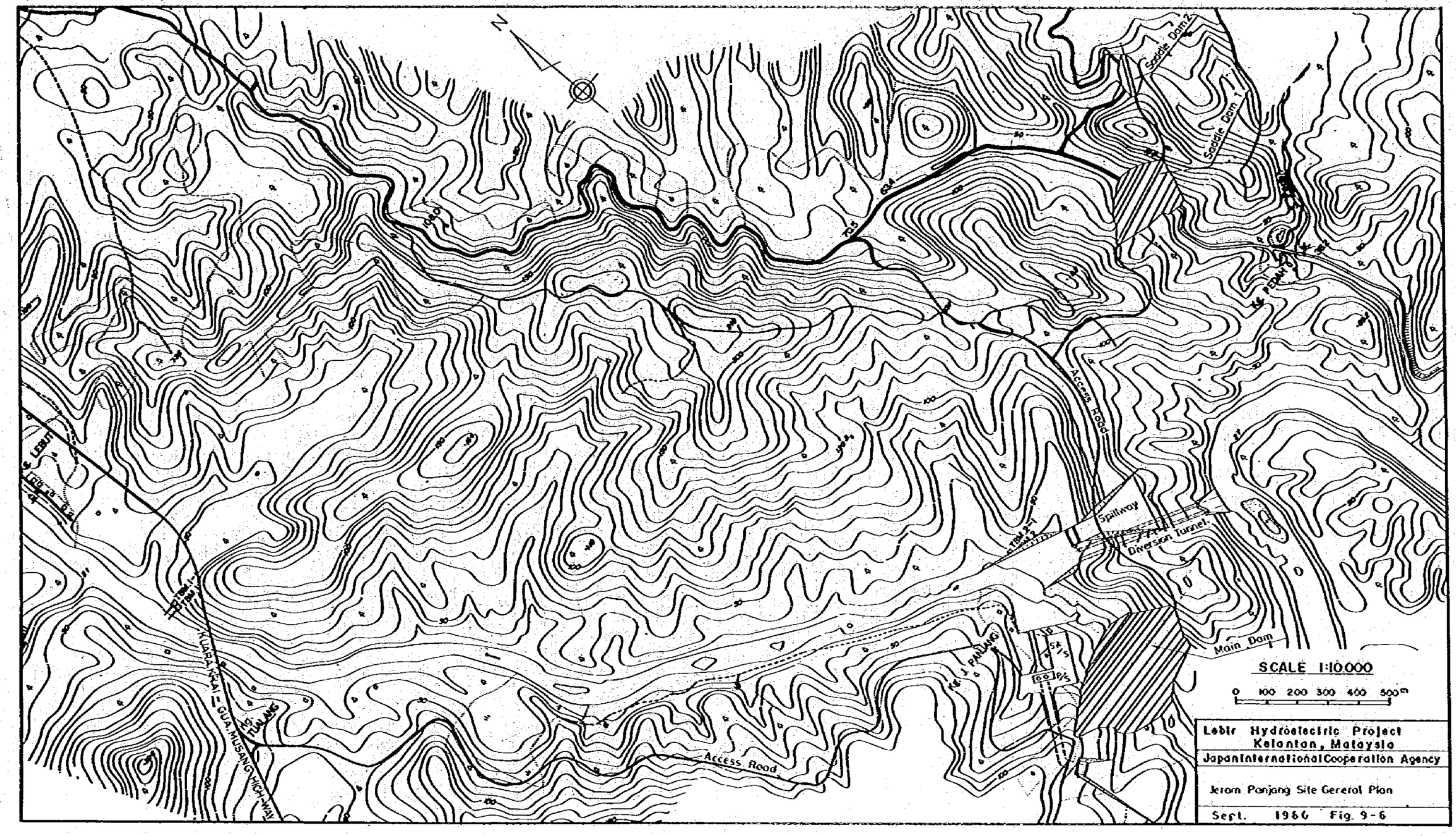


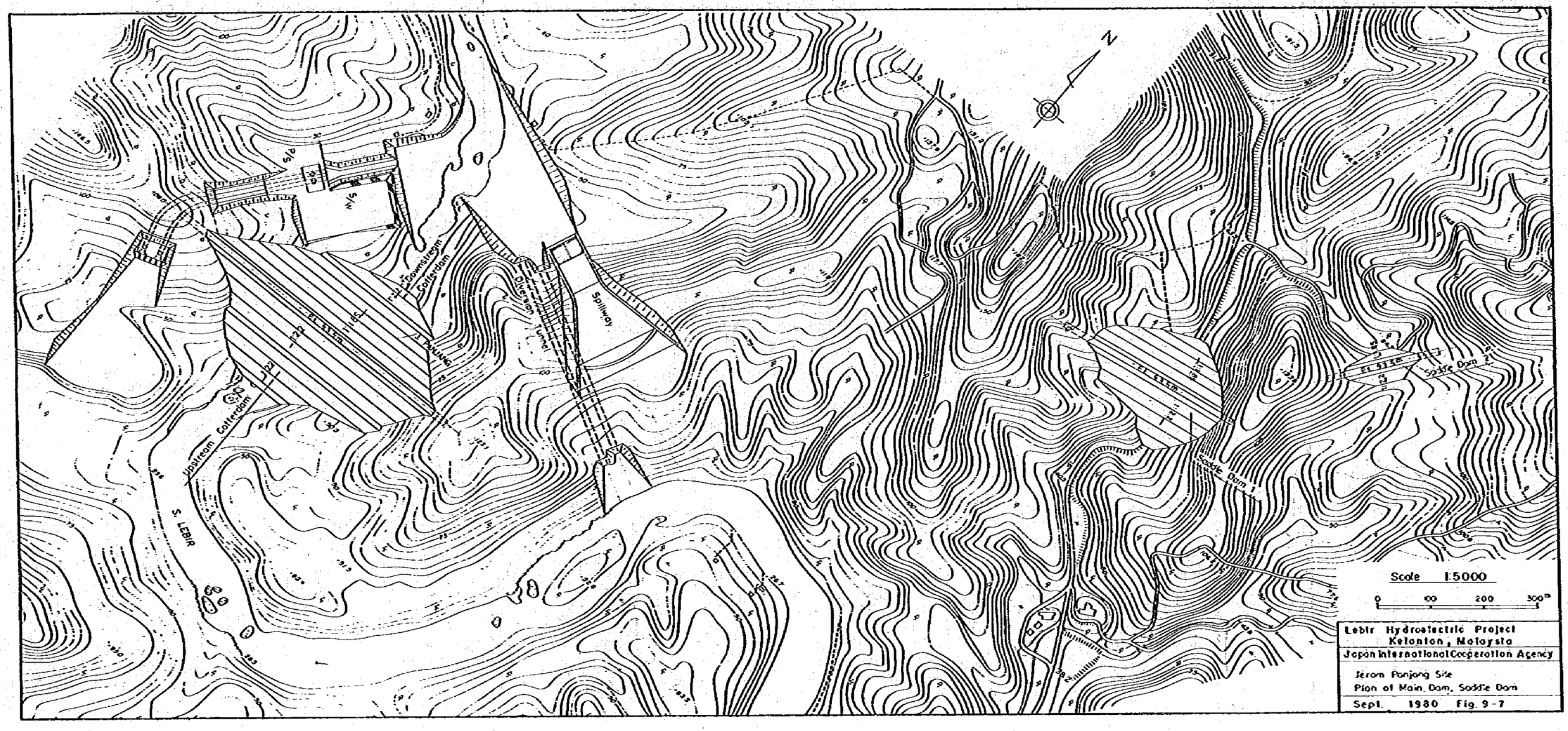
B - B



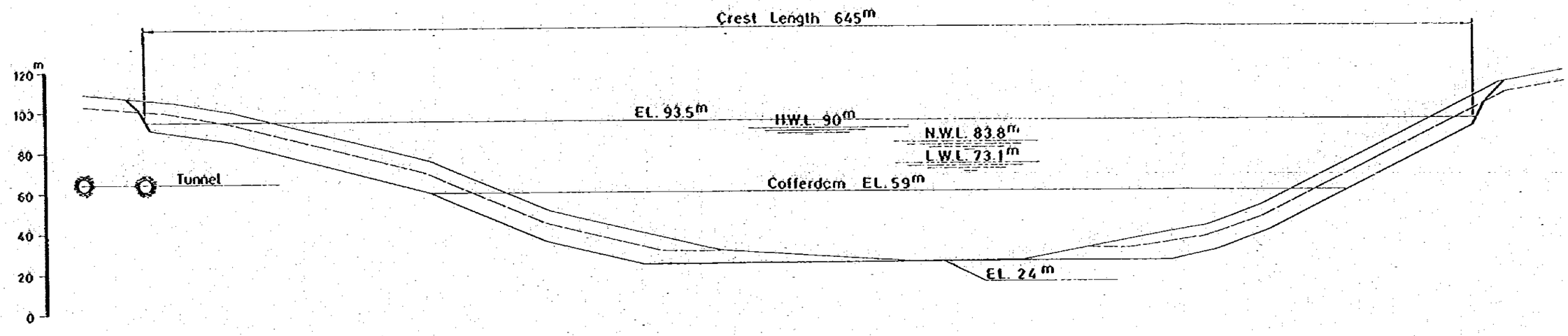
S = 1/1,000 0 10 20 30 40 50 (m)

Lebir Hydroelectric Project Kelantan, Malaysia
Japan International Cooperation Agency
Tualang Site Plan and Section of Power Plant
Sept. 1980 Fig. 9-5

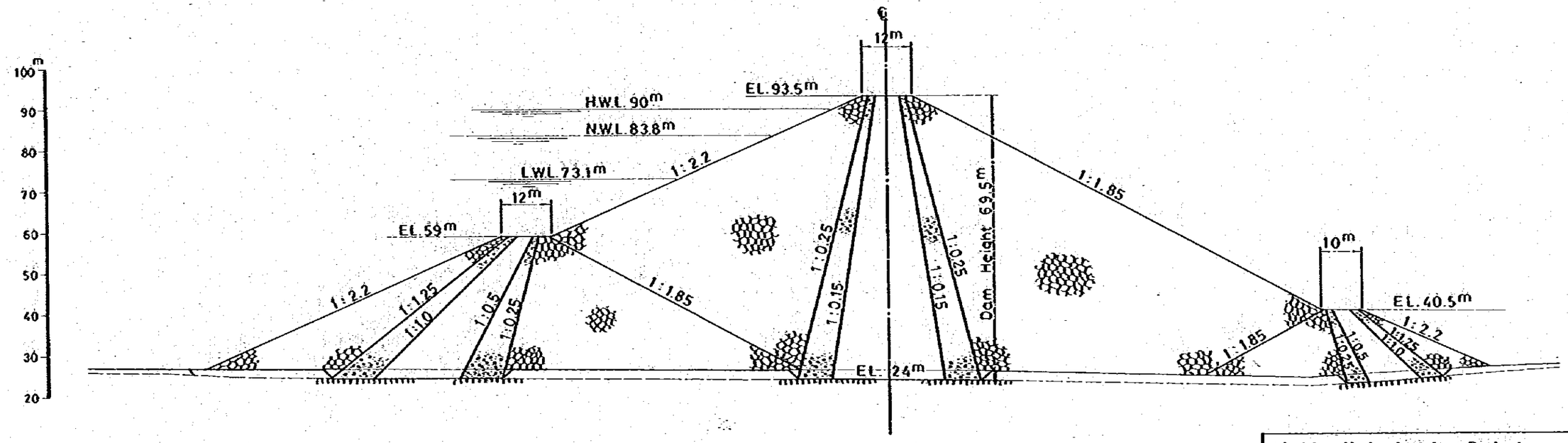

N
Saddle Dam 2
Saddle Dam 1
Access Road
Spillway
Diversion Tunnel
Main Dam
KUALA KAI - GUA MUSANG HIGHWAY
Access Road
SCALE 1:10.000
0 100 200 300 400 500m
Lebir Hydroelectric Project
Kelantan, Malaysia
Japan International Cooperation Agency
Jeram Panjang Site General Plan
Sept. 1986 Fig. 9-6


N
Downstream Cofferdam
Upstream Cofferdam
Diversion Tunnel
Spillway
Saddle Dam 1
Saddle Dam 2
S. LEBIR
Scale 1:5000
0 100 200 300m
Lebir Hydroelectric Project
Kelantan, Malaysia
Japan International Cooperation Agency
Jeram Panjang Site
Plan of Main Dam, Saddle Dam
Sept. 1980 Fig. 9-7

Longitudinal Section S = 1/2000



Typical Section S = 1/1000

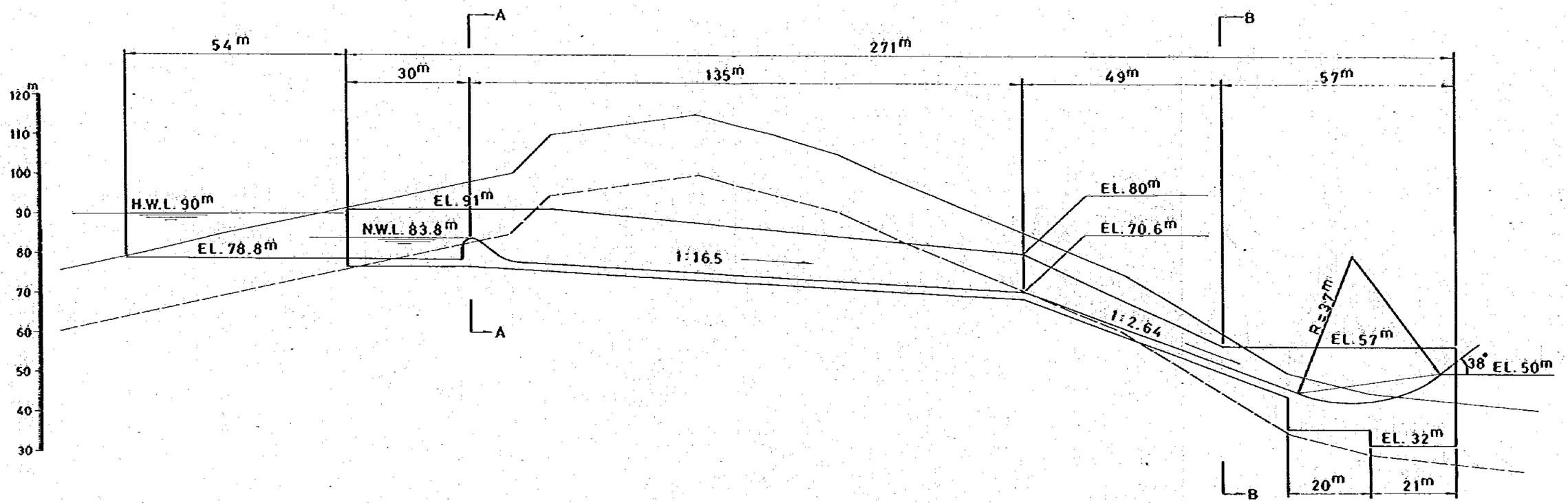


S = 1/2,000 0 20 40 60 80 100 (m)

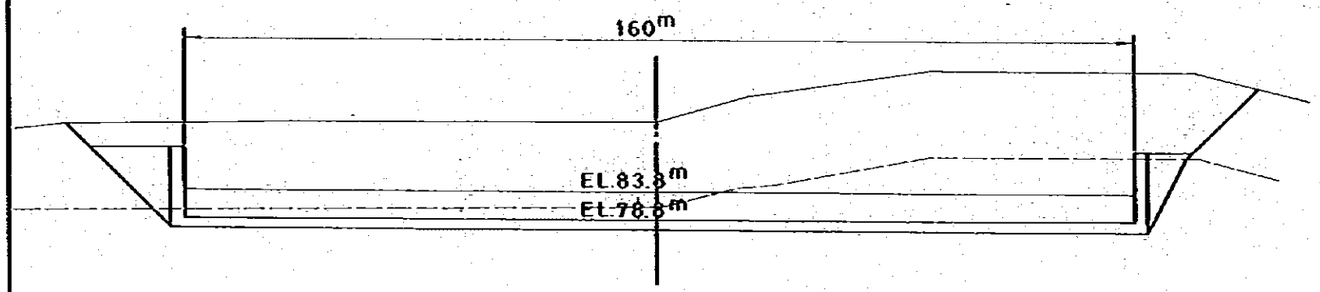
S = 1/1,000 0 10 20 30 40 50 (m)

Lebir Hydroelectric Project Kelantan, Malaysia
Japan International Cooperation Agency
Jerom Panjang Site Main Dam Section
Sept. 1980 Fig. 9-8

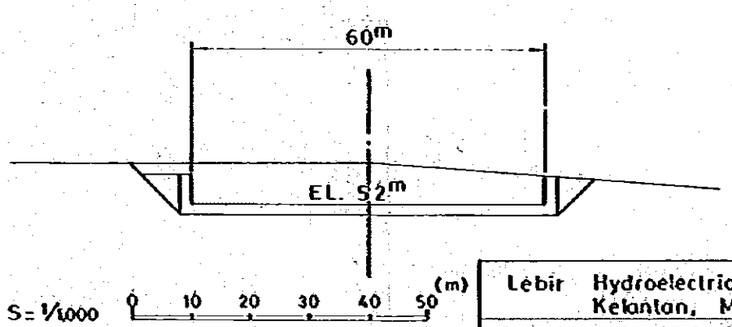
Longitudinal Section



A - A



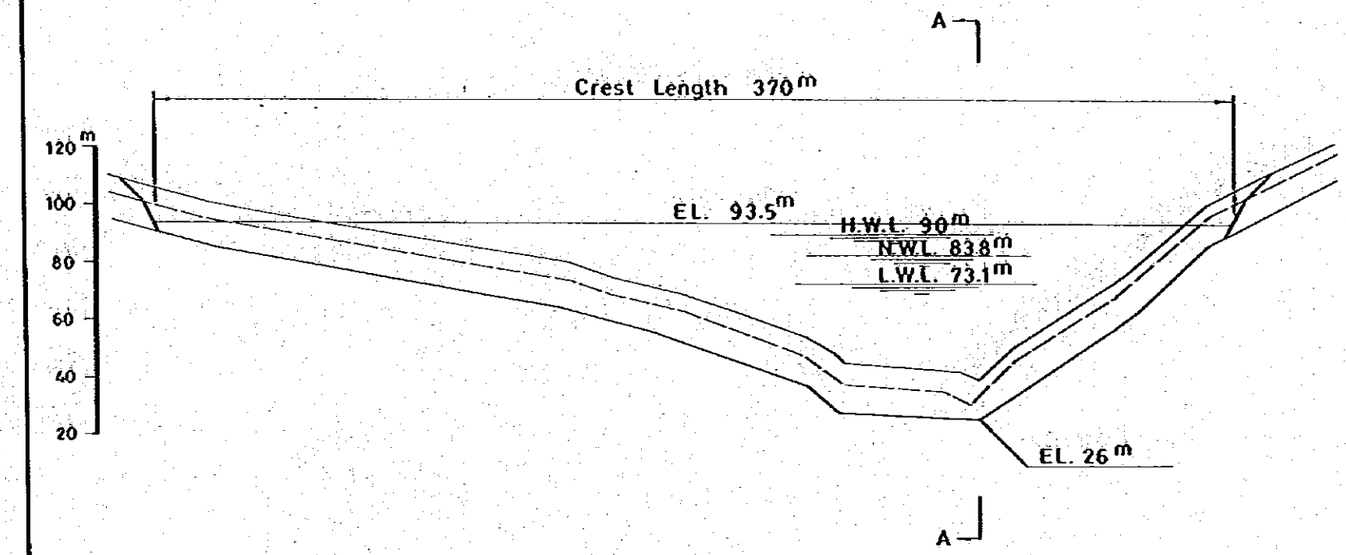
B - B



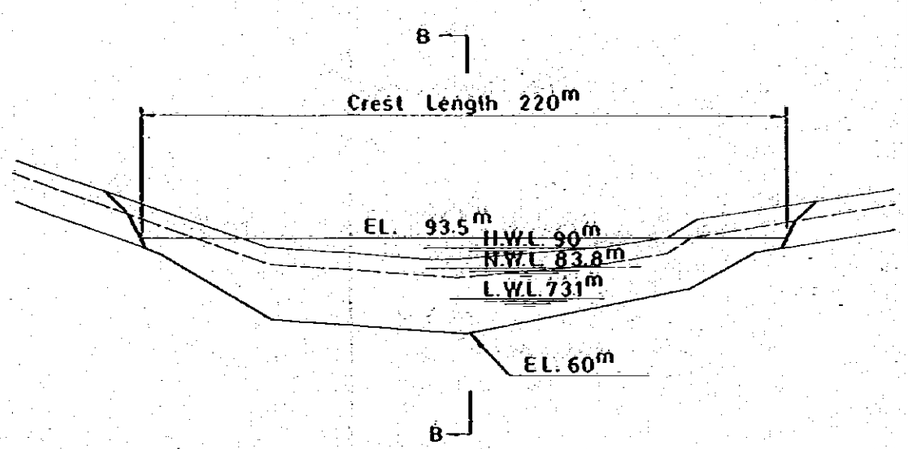
S= 1/1000 0 10 20 30 40 50 (m)

Lebir Hydroelectric Project Kelantan, Malaysia
Japan International Cooperation Agency
Jeram Panjang Site Spillway Section
Sept. 1980 Fig. 9-9

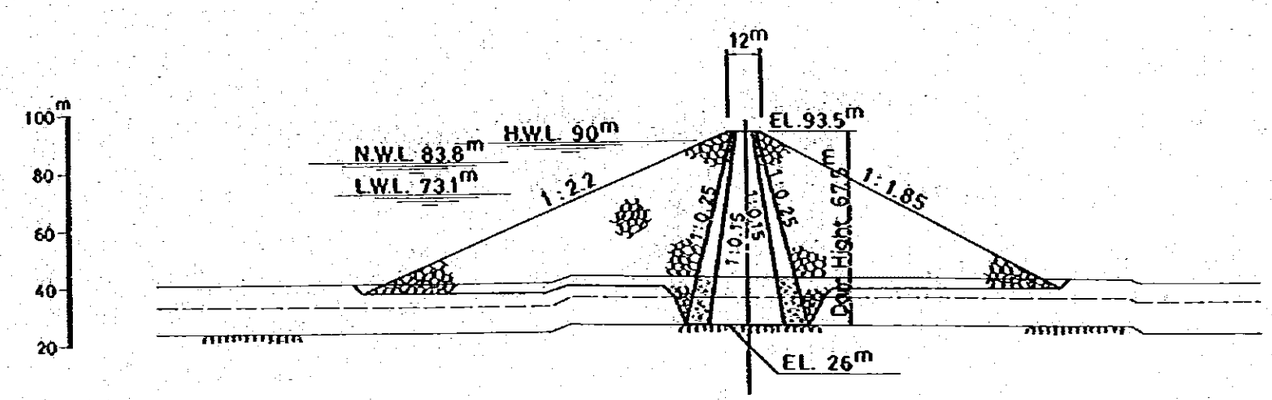
Saddle Dam 1 Section



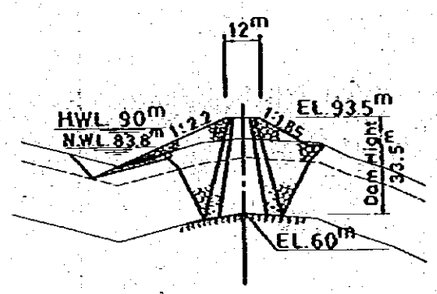
Saddle Dam 2 Section



A - A

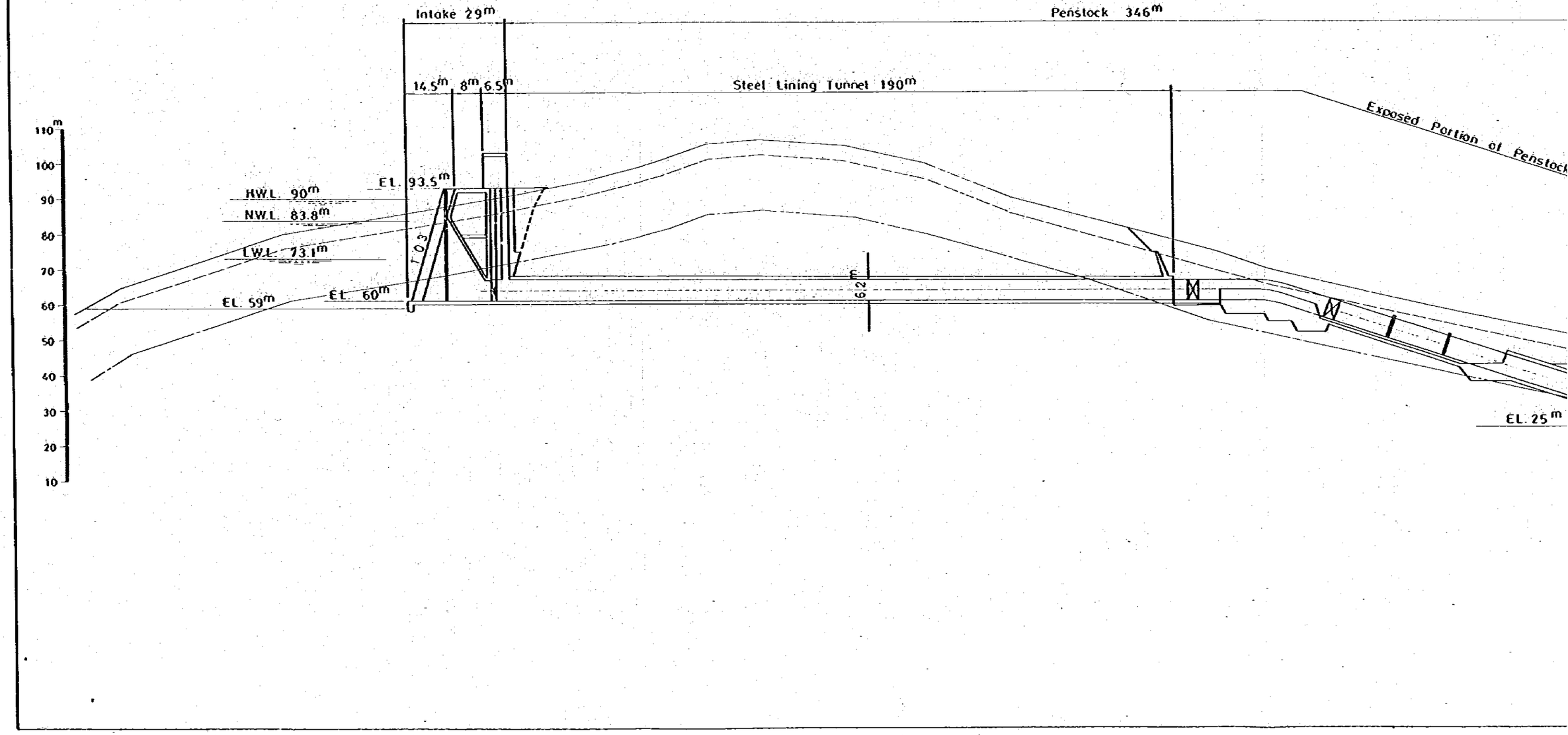


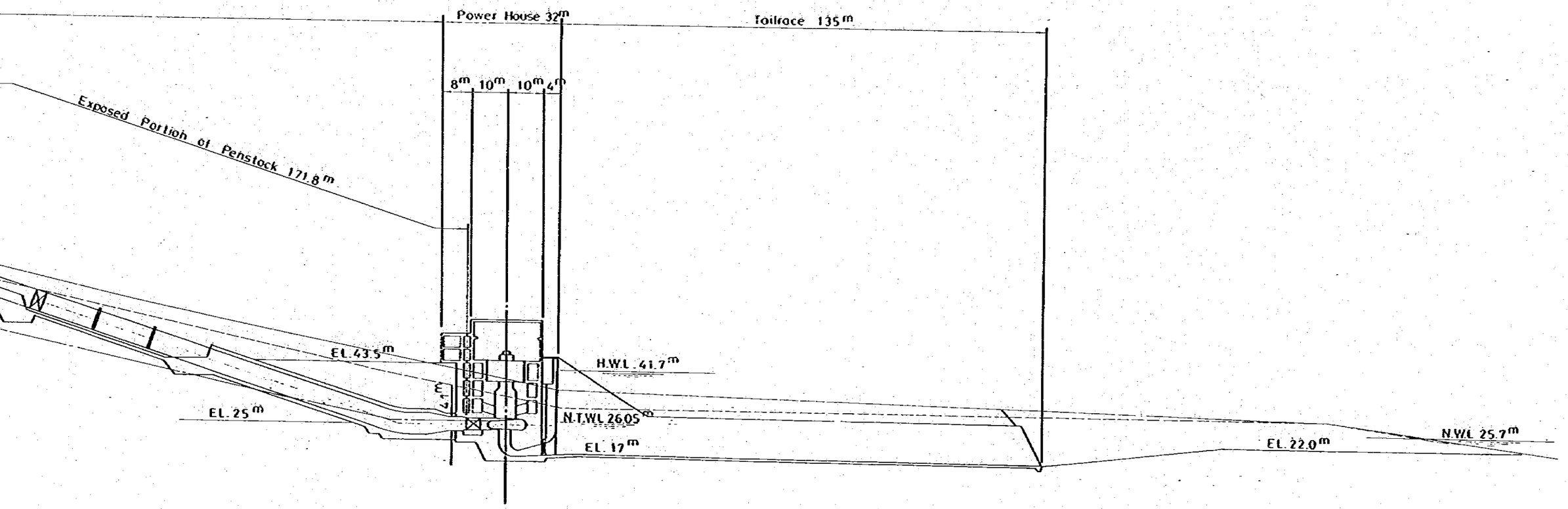
B - B



S = 1/2,000 0 20 40 60 80 100 (m)

Lebir Hydroelectric Project Kelantan, Malaysia	
Japan International Cooperation Agency	
Jeram Ponjang Site Saddle Dam 1, 2, Section	
Sept. 1980	Fig. 9-10


Intake 29m
Penstock 346m
14.5m 8m 6.5m
Steel Lining Tunnel 190m
Exposed Portion of Penstock
110m
100
90
80
70
60
50
40
30
20
10
HWL 90m
NWL 83.8m
LWL 73.1m
El. 93.5m
10.3
El. 59m
El. 60m
6.2m
EL. 25m



Lebir Hydroelectric Project Kelantan, Malaysia
Japan International Cooperation Agency
Jeram Panjang Site Power Plant Section
Sept. 1980 Fig. 9-11

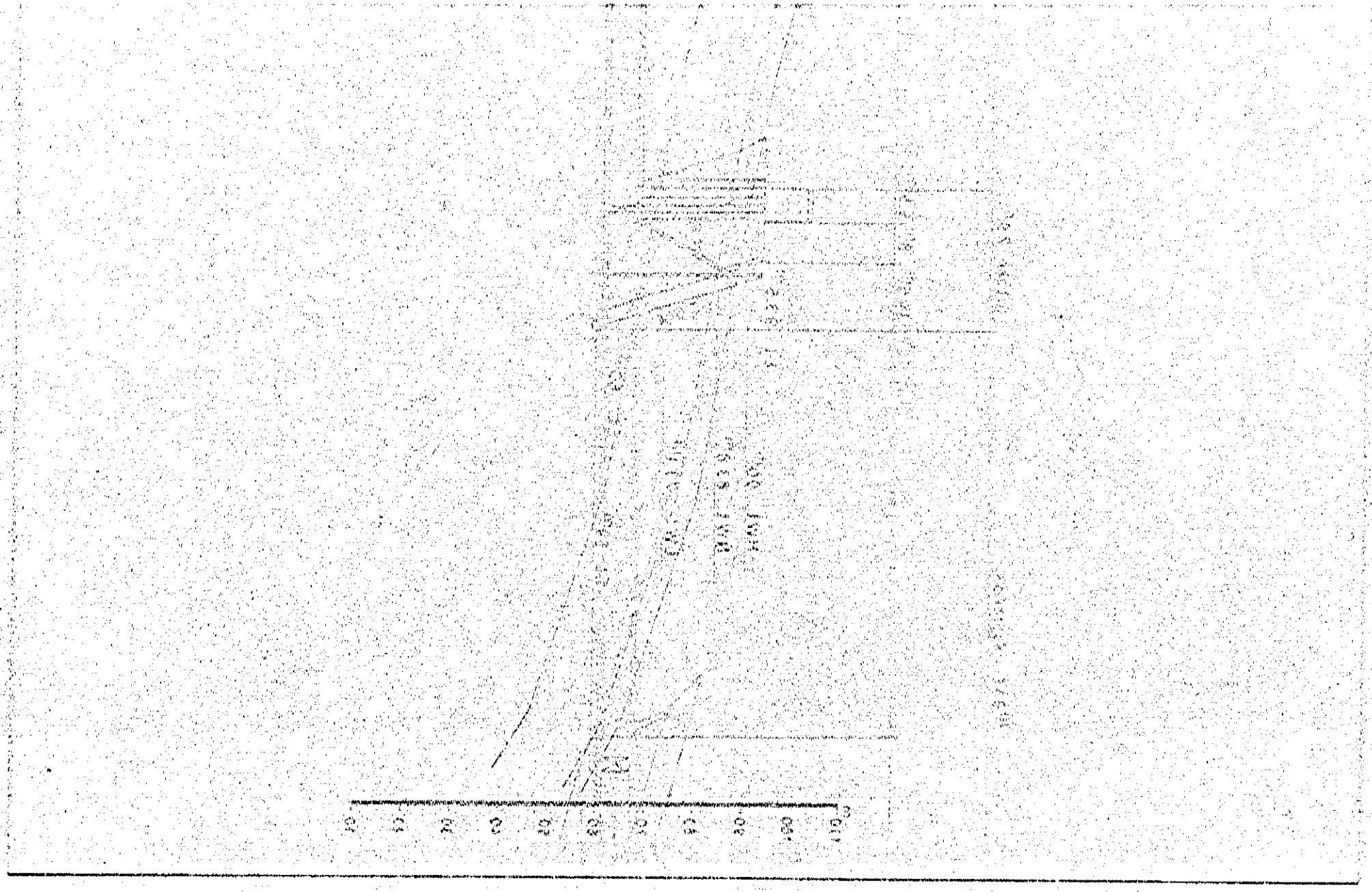


Fig. 11-1 Annual Cost of Thermal Plant

(Interest rate at 8%)

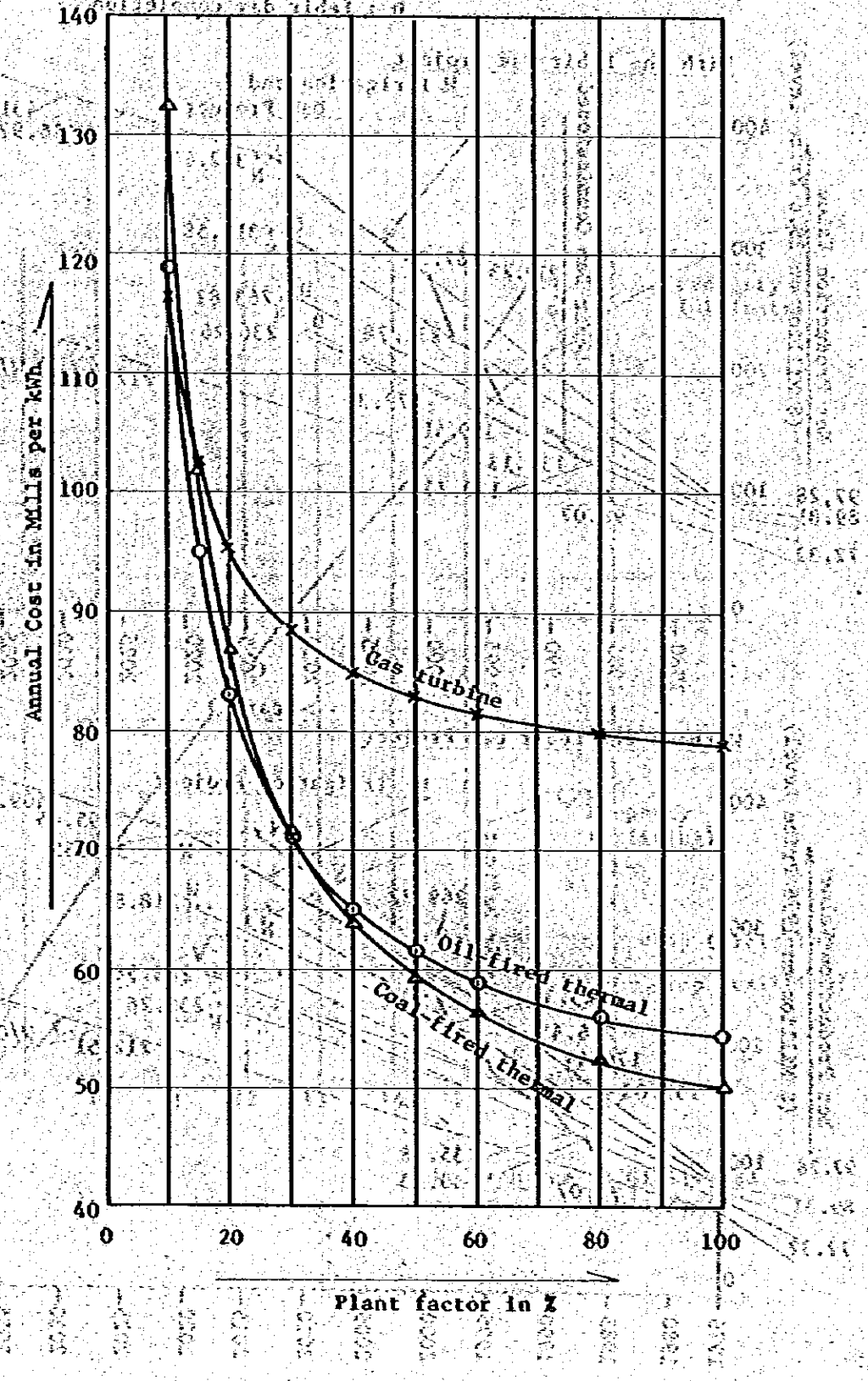


Fig. 11-2 Agricultural Net Production Value

N : Normal time horizon
W : With water deficit
D : Lebir dam completion

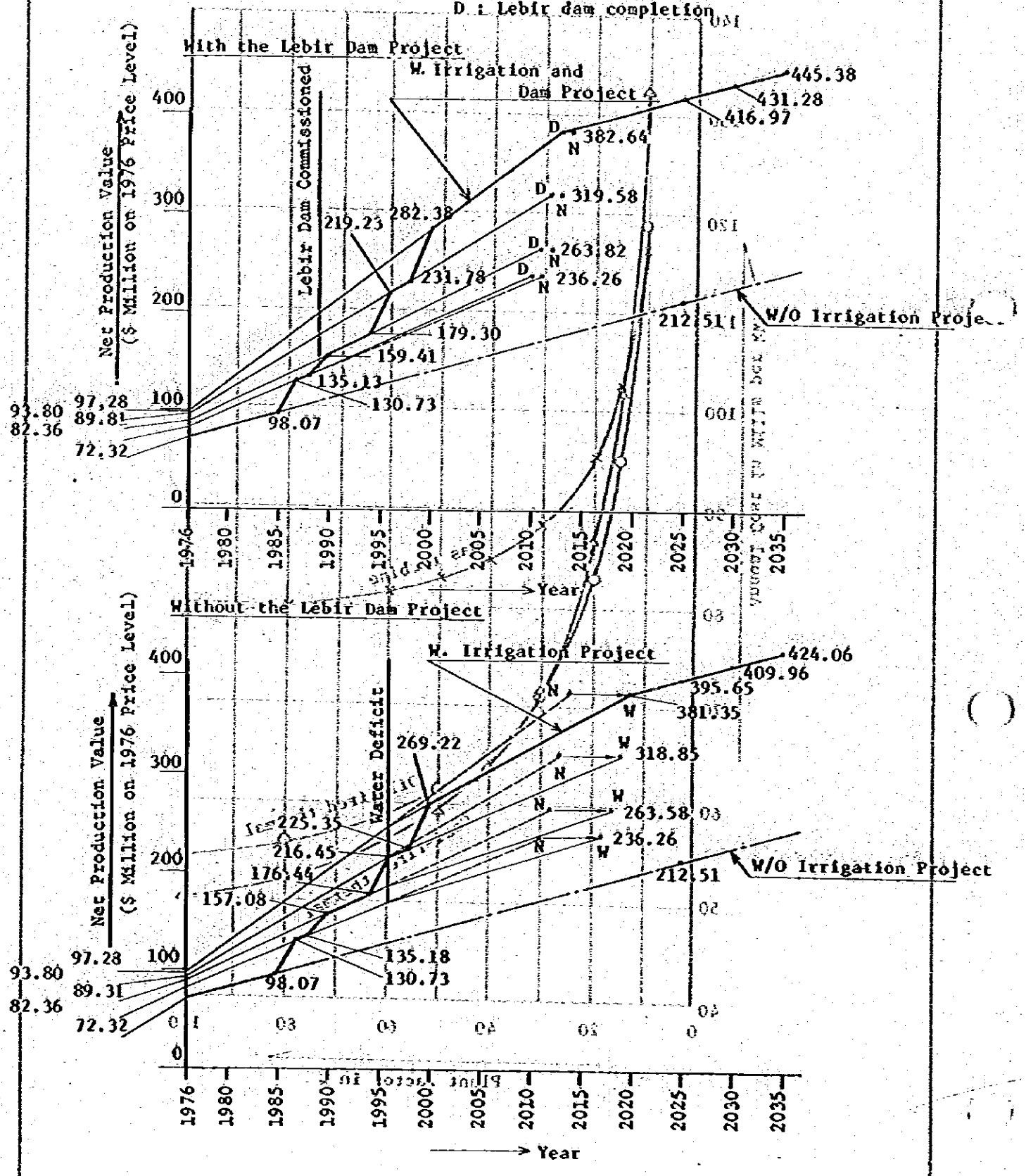


Fig. II-3 Relation between Peak Discharge and Damage

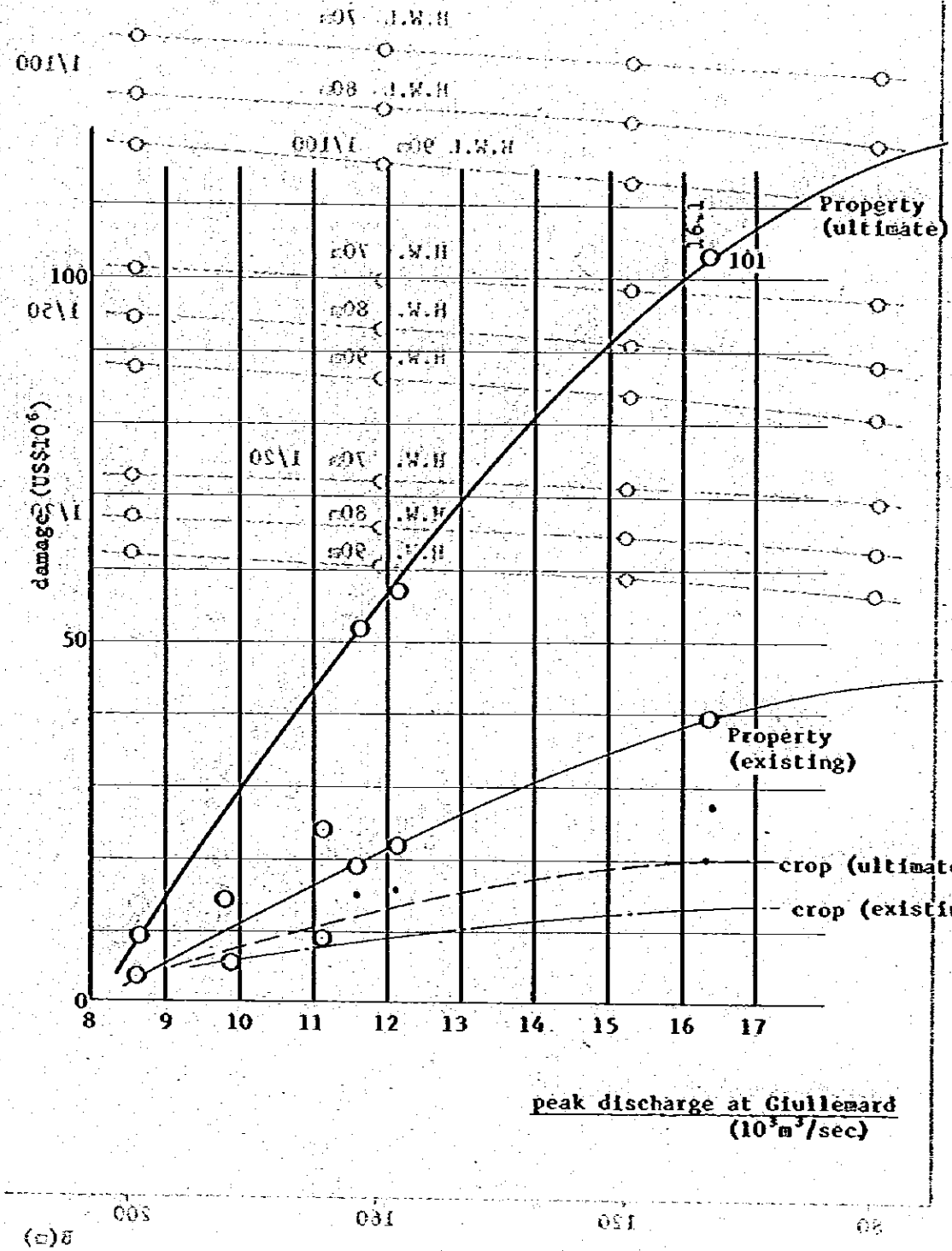


Fig. 11-4 Discharge at Guillemard Bridge

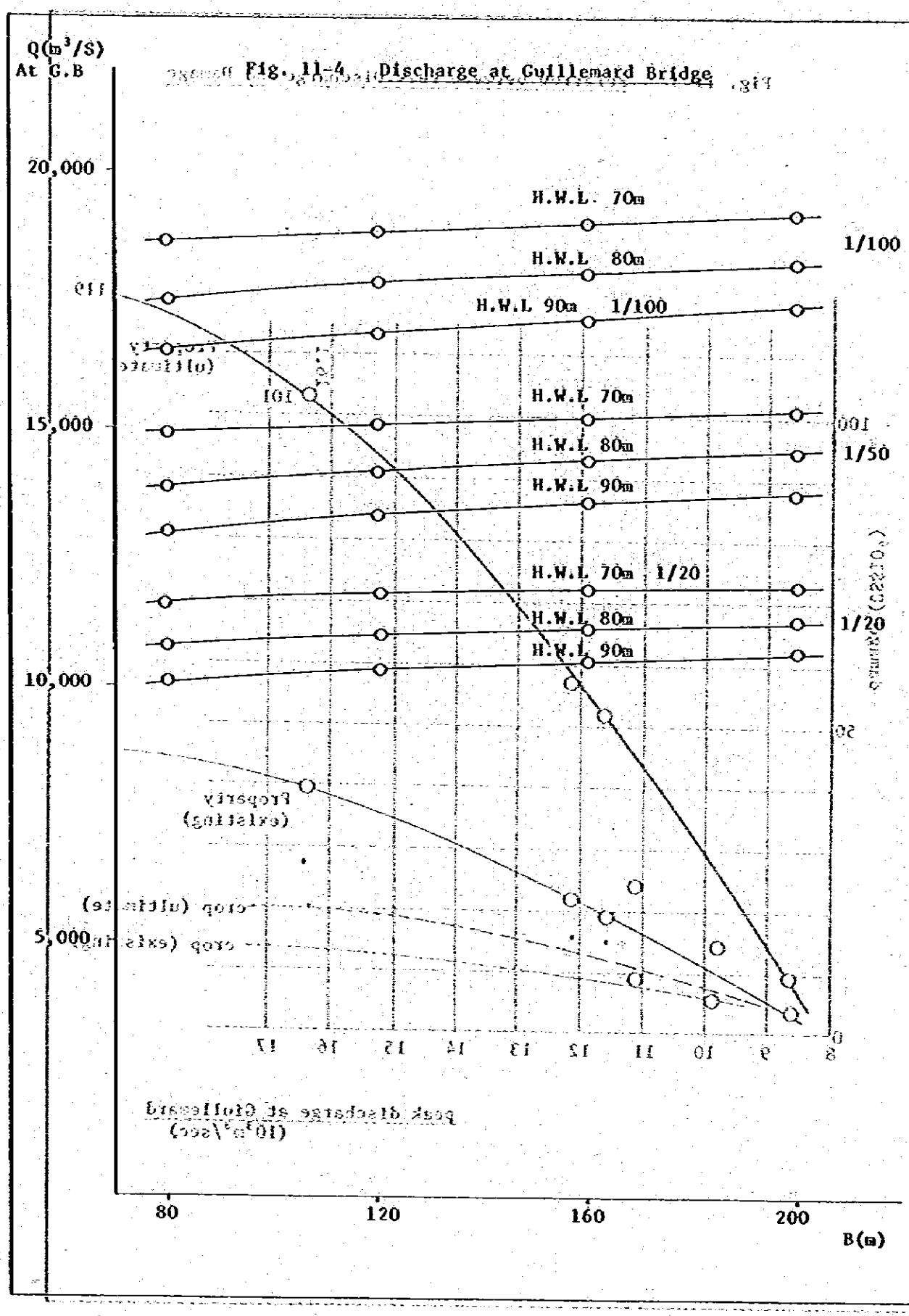


Fig. 11-5 Design Flood and the Water Stage of Lebir Reservoir

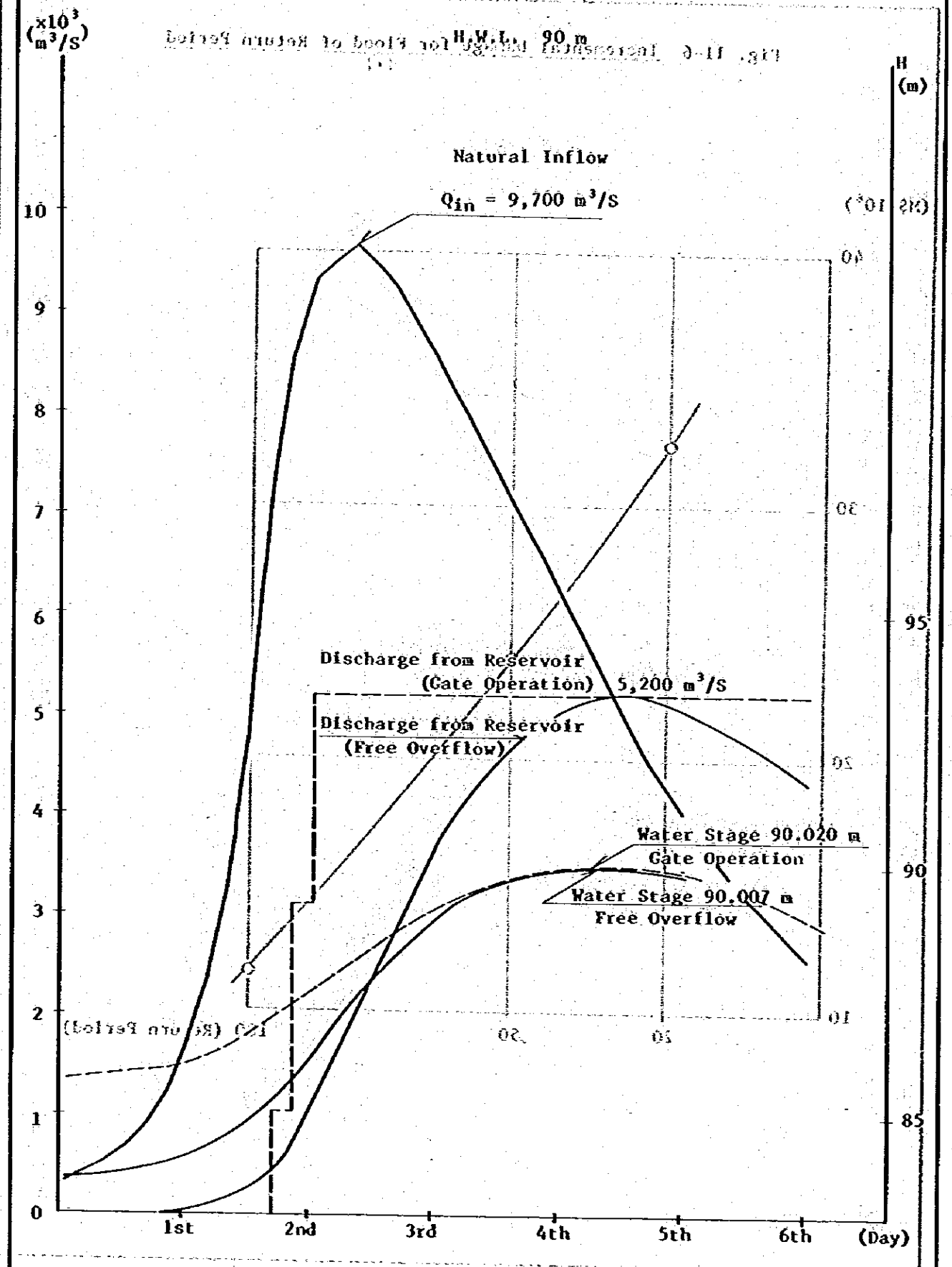


Fig. 11-6 Incremental Damage for Flood of Return Period

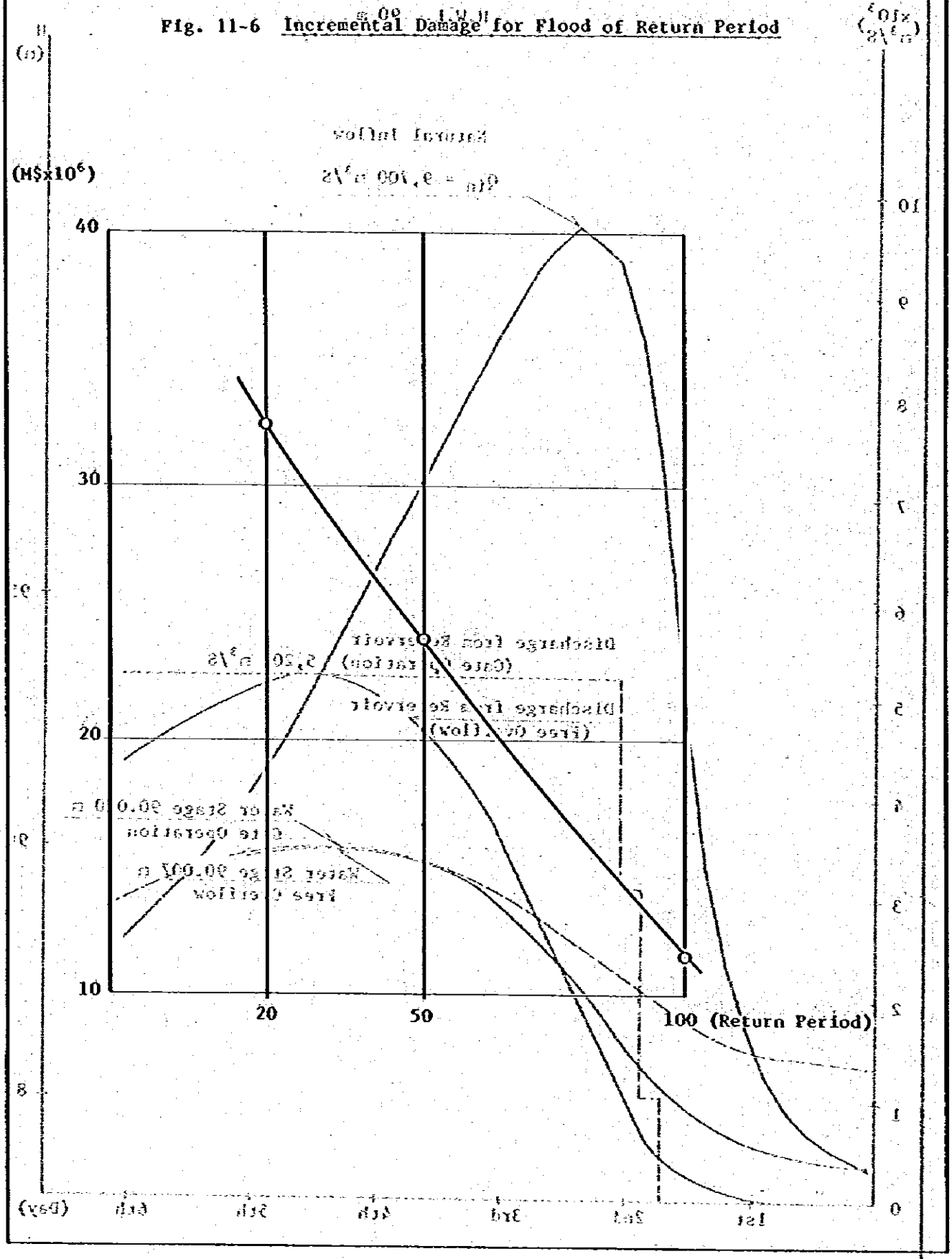


Fig. 12-1 Comparison of Dam Construction Costs

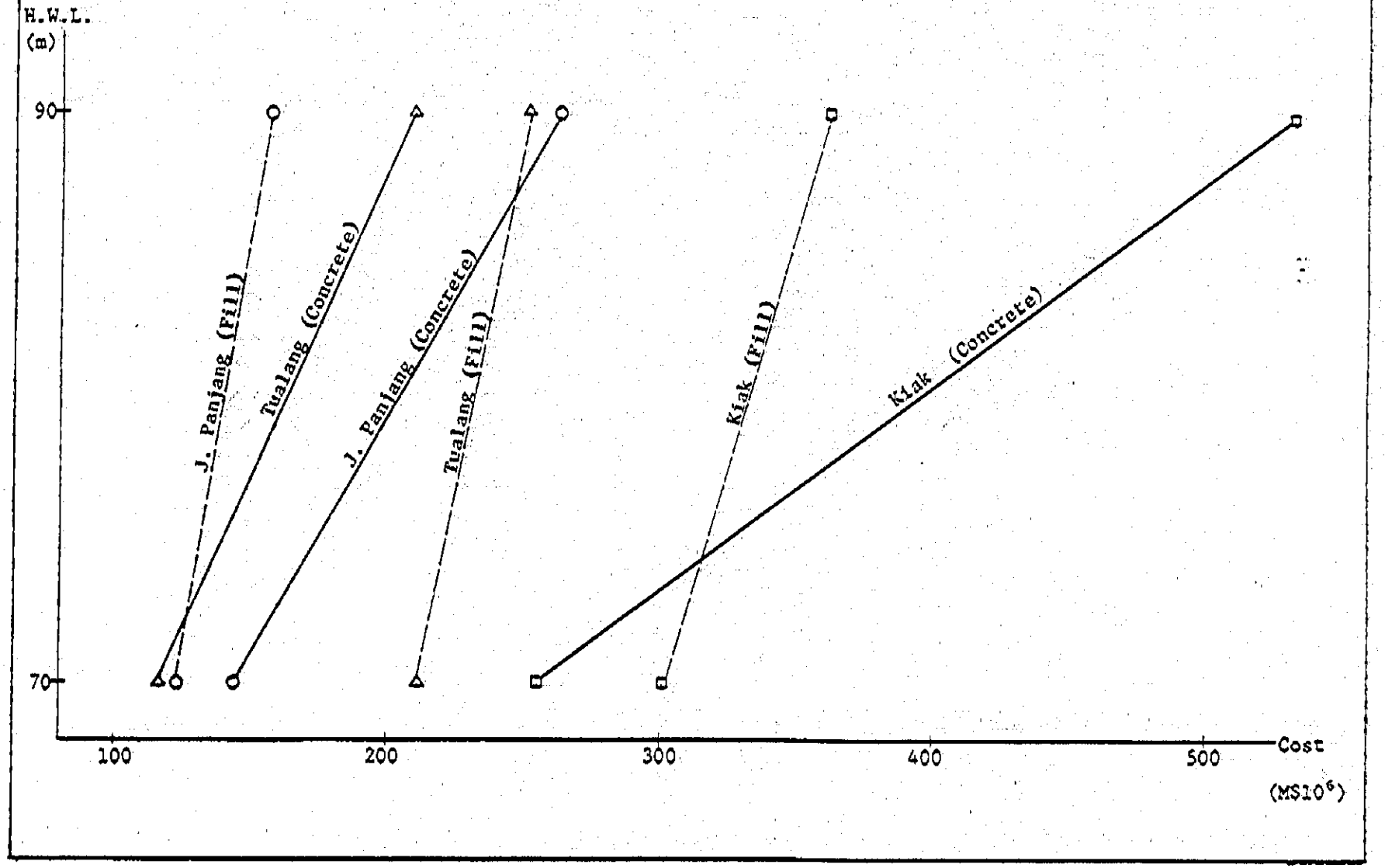


Fig. 12-1 Comparison of Dam Construction Costs

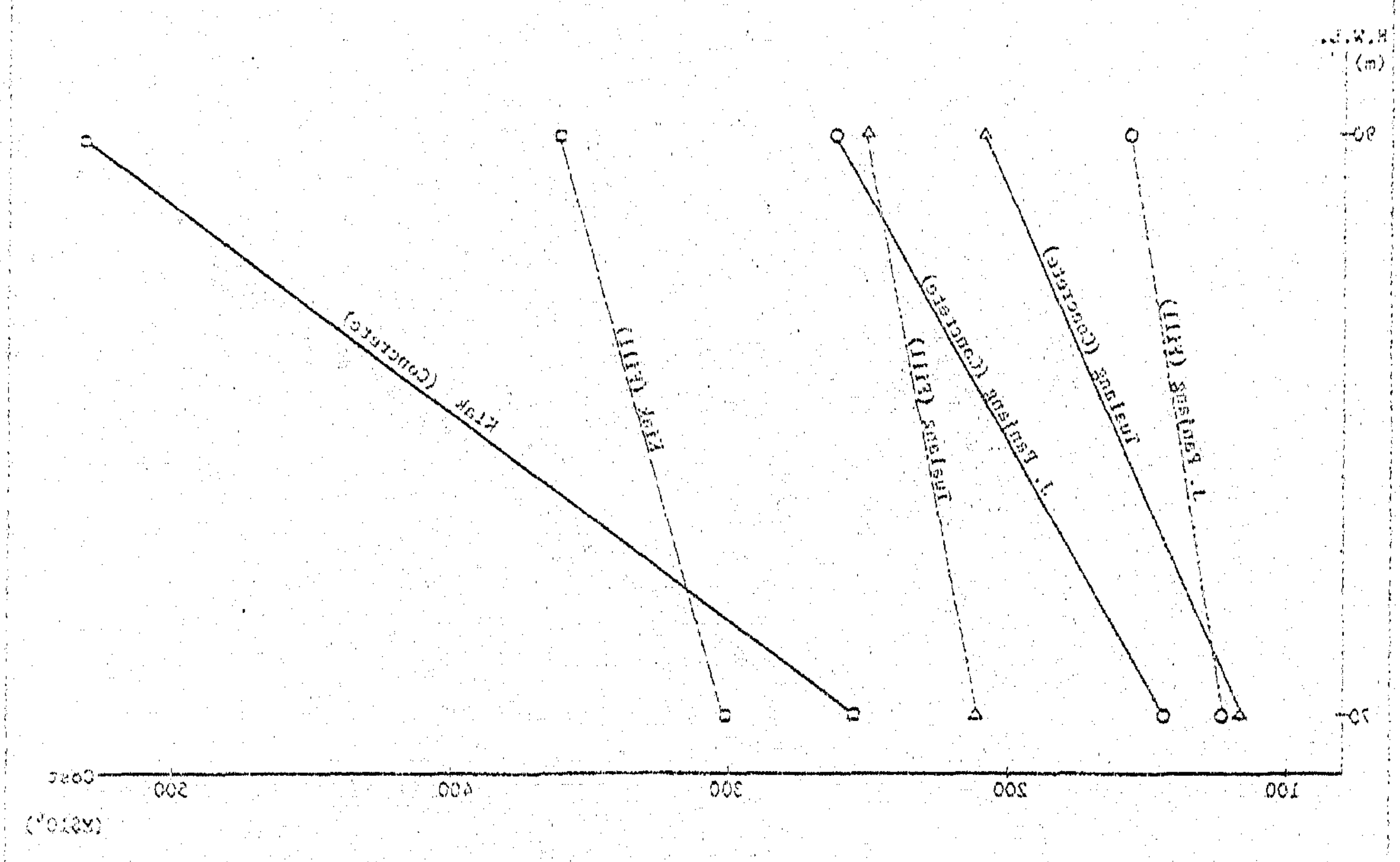


Fig. 13-1 Construction Schedule of Lebir Hydroelectric Power Development Project

	Description of Works	Unit	Quantity	1st Year 1986	2nd Year 1987	3rd Year 1988	4th Year 1989	5th Year 1990	Remarks
1.	Preparatory Works			Start			Reservoir Filling	Commissioning	Tualang Site H.W.L. 90m (Concrete Gravity)
1.1	Access Road	km	3.					Completion	
1.2	Camp and Housing	Lump Sum	1.						
1.3	Power and Communication	〃	1.						
1.4	Plant and Equipment	〃	1.						
2.	Diversion Tunnel								
2.1	Open Excavation	m^3	57,000.		Diversion of the River		Tunnel Blocking		Tunnel Length 635m×2 Diameter 8m
2.2	Tunnel Excavation	〃	97,000.						
2.3	Concrete	〃	34,500.						
2.4	Gate	ton	80.						
3.	Main Dam								
3.1	Excavation	m^3	293,000.						
3.2	Cofferdam Concrete	〃	21,400.						
3.3	Concrete	〃	495,000.						
3.4	Grouting	Lump Sum	1.						
3.5	Gate	ton	850.						
4.	Saddle Dam 1								
4.1	Stripping	m^3	393,000.						
4.2	Placing Fill	〃	990,000.						
4.3	Grauting	Lump Sum	1.						
5.	Saddle Dam 2								
5.1	Stripping	m^3	147,000.						
5.2	Placing	〃	119,000.						
5.3	Grouting	Lump Sum	1.						
6.	Saddle Dam 3								
6.1	Stripping	m^3	872,000.						
6.2	Placing	〃	2524,000.						
6.3	Grauting	Lump Sum	1.						
7.	Intake								
7.1	Excavation	m^3	13,900.						
7.2	Concrete	〃	19,200.						
7.3	Gate Screem	ton	410.						
8.	Penstock								
8.1	Excavation	m^3	128,600.						
8.2	Concrete	〃	14,600.						
8.3	Steel Pipe	ton	940.						
9.	Powerhouse Including Outlet								
9.1	Excavation	m^3	180,700.						
9.2	Concrete	〃	56,900.					Test Operation	
9.3	Architectural Finish	Lump Sum	1.						
9.4	Electrical and Mechanicalworks	〃	1.						
10.	Switchyard and Transformers								
10.1	Faundation	Lump Sum	1.						
10.2	Electrical Equipment	〃	1.						

Fig. 13-2 Construction Schedule of Lebir Hydroelectric Power Development Project

	Description of Works	Unit	Quantity	1st Year 1986	2nd Year 1987	3rd Year 1988	4th Year 1989	5th Year 1990	Remarks
1	Preparatory Works			Start			Reservoir Filling	Commissioning	
1.1	Access Road	km	63					Completion	Jeram Panjang Site H.W.L. 90m
1.2	Camp and Housing	Lump Sum	1						(Rock Fill, Free Overflow)
1.3	Power and Communication	〃	1						
1.4	Plant and Equipment	〃	1						
2	Diversion Tunnel								
2.1	Open Excavation	m³	283,000.		Diversion of the River		Tunnel Blocking		
2.2	Tunnel Excavation	〃	150,000.						Tunnel Length 460m×2
2.3	Concrete	〃	53,900.						Diameter 12m
2.4	Gate	ton	160.						
3	Spillway								
3.1	Excavation	m³	872,000.						
3.2	Concrete	〃	100,000.						
4	Main Dam								
4.1	Stripping	m³	929,000.		Cofferdam				
4.2	Placing Fill	〃	5203,000.						
4.3	Grouting	Lump Sum	1.						
5	Saddle Dam 1								
5.1	Stripping	m³	393,000.						
5.2	Placing Fill	〃	990,000.						
5.3	Grouting	Lump Sum	1.						
6	Saddle Dam 2								
6.1	Stripping	m³	147,000.						
6.2	Placing Fill	〃	119,000.						
6.3	Grouting	Lump Sum	1.						
7	Intake								
7.1	Excavation	m³	75,300.						
7.2	Concrete	〃	10,200.						
7.3	Gate Screen	ton	440.						
8	Penstock								
8.1	Open Excavation	m³	101,400.						
8.2	Concrete	〃	16,400.						
8.3	Tunnel Excavation	〃	16,400.						Tunnel Length 151m×2
8.4	Tunnel Concrete	〃	7,200.						
8.5	Steel Pipe	ton	1,150.						
9	Powerhouse Including Outlet								
9.1	Excavation	m³	135,000.						
9.2	Concrete	〃	56,200.					Test Operation	
9.3	Architectural Finish	Lump Sum	1.						
9.4	Electrical and Mechanicalworks	〃	1						
10	Switchyard and Transformers								
10.1	Faundation	Lump Sum	1.						
10.2	Electrical Equipment	〃	1.						

Table 2-1-1

Estimated Construction Costs of Alternative Dams (H.W.L. 70m)

(H10^6)

Item	Kiak		J. Panjang		Tualang	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
1. Main Dam	98.3	236.1	24.0	117.6	8.6	73.0
2. Spillway	107.6		56.7		127.1	
3. Diversion	85.9	11.5	33.2	16.7	50.2	21.4
Sub-total (1 ~ 3)	291.8	247.6	113.9	134.3	185.9	94.4
4. Saddle Dam 1			5.3	5.3	5.3	5.3
5. Saddle Dam 2						
6. Saddle Dam 3					13.6	13.6
7. Miscellaneous	8.7	7.4	3.6	4.2	6.2	3.4
Grand Total (1 ~ 7)	300.5	255.0	122.8	143.8	211.0	116.7

Note : Case 1 ----- All rockfill dams
Case 2 ----- Main dam : Concrete-gravity dam
Saddle dam : Rock-fill dam

Table 2-1-2

Estimated Construction Costs of Alternative Dams (H.W.L. 90m)

(H10^6)

Item	Ktak		J. Panjang		Tualang	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
1. Main Dam	157.4	506.8	65.8	221.3	13.2	128.8
2. Spillway	107.6		36.8		127.1	
3. Diversion	85.9	11.5	33.2	16.7	50.2	21.4
Sub-total (1 ~ 3)	350.9	518.3	135.8	238.0	190.5	150.2
4. Saddle Dam 1			14.9	14.9	14.9	14.9
5. Saddle Dam 2			2.6	2.6	2.6	2.6
6. Saddle Dam 3					35.9	35.9
7. Miscellaneous	10.5	15.6	4.5	7.7	7.3	6.1
Grand Total (1 ~ 7)	361.4	533.9	157.8	263.2	251.3	209.7

Note : Case 1 ----- All rockfill dams

Case 2 ----- Main dam : Concrete-gravity dam

Saddle dam : Rock-fill dam

Table 2-2-1 Benefit/Cost Analysis

At the J. Panjang Site - H.W.L. 90 m Rockfill

Item	Unit	Crest Length			
		80 m	120 m	160 m	200 m
N.W.L.	m	81.9	83.0	83.8	84.3
Peak Flood Discharge	m^3/S	3,900	4,700	5,200	5,600
Maximum Output	MW	145	149	151	153
Annual Generated Energy	GWH	412	420	426	429
Capacity Factor	%	32.44	32.18	32.21	32.01
Construction Cost	$M\$10^6$	432.948	437.417	441.875	446.249
Capital Value with IDC (IDC = 16%)	M$/kW	3463.6	3405.4	3394.5	3383.3
Capital Costs (1) (CRF = 0.0817)	M$/kWH	0.0996	0.0987	0.0983	0.0986
Fixed Cost with Overhead	M$/kW	9.37	9.37	9.37	9.37
Insurance (0.1%)	M$/kW	3.46	3.41	3.39	3.38
Inclusive Fixed Cost	M$/kW	12.83	12.78	12.76	12.75
O&M Costs (2)	M$/kWH	0.0045	0.0045	0.0045	0.0045
Total Operating Cost (1 + 2)	M$/kWH	0.1041	0.1032	0.1028	0.1031
Cost for Power Generation	$M\$10^6$	42.89	43.34	43.79	44.23
Reservoir Clearing Cost	$M\$10^6$	2.25	2.25	2.25	2.25
Annual Cost (C)	$M\$10^6$	45.14	45.59	46.04	46.48
Power Benefit	$M\$10^6$	56.85	58.08	58.90	59.41
Flood Mitigation Benefit	$M\$10^6$	2.72	2.30	2.07	1.89
Annual Benefit (B)	$M\$10^6$	59.57	60.38	60.97	61.30
B/C	-	1.320	1.324	1.324	1.319
B-C	$M\$10^6$	14.43	14.79	14.93	14.82

(Interest rate 8%)

Table 2-2-2 Benefit/Cost Analysis

At the J. Panjang Site - Spillway Crest Length 160 m

Item	Unit	Free Overflow			Gate Operation		
		H.W.L. 70 m	H.W.L. 80 m	H.W.L. 90 m	H.W.L. 70 m	H.W.L. 80 m	H.W.L. 90 m
N.W.L.	m	61.7	72.7	83.8	66.4	75.6	85.8
Peak Flood Discharge	m^3/S	8,300	6,800	5,200	8,300	6,800	5,200
Maximum Output	MW	69	109	151	84	122	158
Annual Generated Energy	GWH	268	350	426	303	372	440
Capacity Factor	%	44.34	36.66	32.21	41.18	34.81	31.79
Construction Cost	$M\$10^6$	334,378	393,891	441,875	357,631	406,874	442,938
Capital Value with IDC (IDC=16%)	M$/kW	5,621.4	4,191.9	3,394.5	4,938.7	3,868.6	3,251.9
Capital Costs (1) (CRF = 0.0817)	M$/kW	0.1182	0.1066	0.0983	0.1119 (1)	0.1036	0.0954
Fixed Cost with Overhead	M$/kW	9.37	9.37	9.37	9.37	9.37	9.37
Insurance (0.1%)	M$/kW	5.62	4.19	3.39	4.94	3.87	3.25
Inclusive Fixed Cost	M$/kW	14.99	13.59	12.76	14.31	13.24	12.62
O&M Costs (2)	M$/kWH	0.0039	0.0042	0.0045	0.0040	0.0043	0.0045
Total Operating Cost (1 + 2)	M$/kWH	0.1221	0.1108	0.1028	0.1159	0.1079	0.0999
Cost for Power Generation	$M\$10^6$	32.72	38.78	43.79	35.12	40.14	43.96
Reservoir Clearing Cost	$M\$10^6$	0.81	1.41	2.25	0.81	1.41	2.25
Annual Cost (C)	$M\$10^6$	33.53	40.19	46.04	35.93	41.55	46.21
Power Benefit	$M\$10^6$	34.32	46.81	58.90	39.43	50.39	61.05
Flood Mitigation Benefit	$M\$10^6$	0.51	1.29	2.07	0.85	1.45	2.38
Annual Benefit (B)	$M\$10^6$	34.83	48.10	60.97	40.28	51.84	63.43
B/C	-	1.039	1.197	1.324	1.121	1.248	1.373
B-C	$M\$10^6$	1.30	7.91	14.93	4.35	10.29	17.22
Agricultural Benefit	$M\$10^6$	14.26	14.26	14.26	14.26	14.26	14.26
Annual Benefit (B')	$M\$10^6$	49.09	62.36	75.23	54.54	66.10	77.69
B'/C	-	1.464	1.552	1.634	1.518	1.591	1.681
B'-C	$M\$10^6$	15.56	22.17	29.19	18.61	24.55	31.48

(Interest rate 8%)

Table 2-2-3 Benefit/Cost Analysis

At the Tualang Site - Concrete Gravity

Item	Unit	H.W.L. 70 m	H.W.L. 80 m	H.W.L. 90 m
N.W.L.	m	66.6	76.0	85.8
Peak Flood Discharge	m^3/S	8,300	6,800	5,200
Maximum Output	MW	88	128	162
Annual Generated Energy	GWH	321	392	455
Capacity Factor	%	41.64	34.96	32.06
Construction Cost	M10^6	342,271	428,383	509,788
Capital Value with IDC (IDC = 14%)	M$/kW	4,434.0	3,815.3	3,587.4
Capital Costs (1) (CRF = 0.0817)	M$/kWH	0.0993	0.1018	0.1044
Fixed Cost with Overhead	M$/kW	9.37	9.37	9.37
Insurance (0.1%)	M$/kW	4.43	3.82	3.59
Inclusive Fixed Cost	M$/kW	13.80	13.19	12.96
O&M Costs (2)	M$/kWH	0.0038	0.0043	0.0046
Total Operating Cost (1 + 2)	M$/kWH	0.1031	0.1061	0.1090
Cost for Power Generation	M10^6	33.10	41.59	49.60
Reservoir Clearing Cost	M10^6	0.83	1.42	2.28
Reconstruction Cost for Highway	M10^6	3.39	3.39	3.39
Annual Cost (C)	M10^6	37.32	46.40	55.27
Power Benefit	M10^6	41.67	53.04	62.98
Flood Mitigation Benefit	M10^6	0.85	1.45	2.38
Annual Benefit (B)	M10^6	42.52	54.49	65.36
B/C		1.139	1.174	1.183
B-C	M10^6	5.20	8.09	10.09

(Interest rate 8%)

Table 4.1 Agricultural Production: Existing and Proposed

No.	Crop	In 1976			In 2010 (Ultimate Status)		
		Cropped Area (Ha)	Production (Ton)	Gross Value ($'000)	Cropped Area (Ha)	Production (Ton)	Gross Value ($'000)
1.	Short-term Padi	35,369	99,399	39,759	88,793	353,049	141,220
2.	Long-term Padi	41,803	76,232	30,493	259	656	262
3.	Tobacco	7,268	5,088	38,157	13,863	16,430	123,242
4.	Groundnut	2,104	844	1,704	27,089	107,004	48,162
5.	Maize	625	0	278	4,360	10,874	3,588
6.	Soyabean	0	0	0	39,915	87,954	17,170
7.	Sorghum	0	19,299	0	11,683	36,847	11,054
8.	Vegetables	1,184	0	2,316	4,713	46,218	25,313
9.	Pasture	0	0	0	16,117	398,543	44,637
10.	Sugarcane	0		0	11,663	128,289	63,503
11.	Fruits	4,232		2,714	17,496		31,074
12.	Rubber	50,028	20,487	30,730	49,331	42,848	64,272
13.	Coconut	9,846	5,907	3,544	7,168	12,900	7,740
14.	Oil Palm	2,021	21,225	2,123	2,021	47,302	4,730
	Total	154,480		151,818	294,469		625,968
		(100.0%)			(190.6%)		
				(100.0%)			(412.3%)

* ..... on 1976 price level

(Source: KBRS, 1977)

Table 4-2-1 Flood Mitigations (without and with Development)

($ Million on Constant 1976 Price Level)

	Crop Production		Properties 1)		Disruption 2)		Total	
	Value	%	Value	%	Value	%	Value	%
Direct Damage without Development								
Existing = 1976 level	8.76	42.9	11.68	57.1			20.44	100.0
Future = 2005 level	18.60	45.1	22.60	54.9			41.20	100.0
(A) Benefits with Irrigation Project 3)								
	2.44	19.7	5.72	46.2	4.23	34.1	12.39	100.0
(B) Benefits with Irrigation and Dabong Dam Projects								
	3.64	21.4	8.45	49.8	4.87	28.7	16.97	100.0
(C) Benefits with Irrigation, Dabong Dam, Lebir Dam, and River Band Projects								
	4.54	22.6	10.28	51.1	5.28	26.3	20.10	100.0

1)..... Reduction in damages to road, railway, house, public utility, irrigation structure and livestock

2)..... Reduction in damages due to disruption of commercial activity, evacuation cost and loss of human life

3)..... Includes the installation of bulk drainage systems in association with the irrigation project