

## TABLES

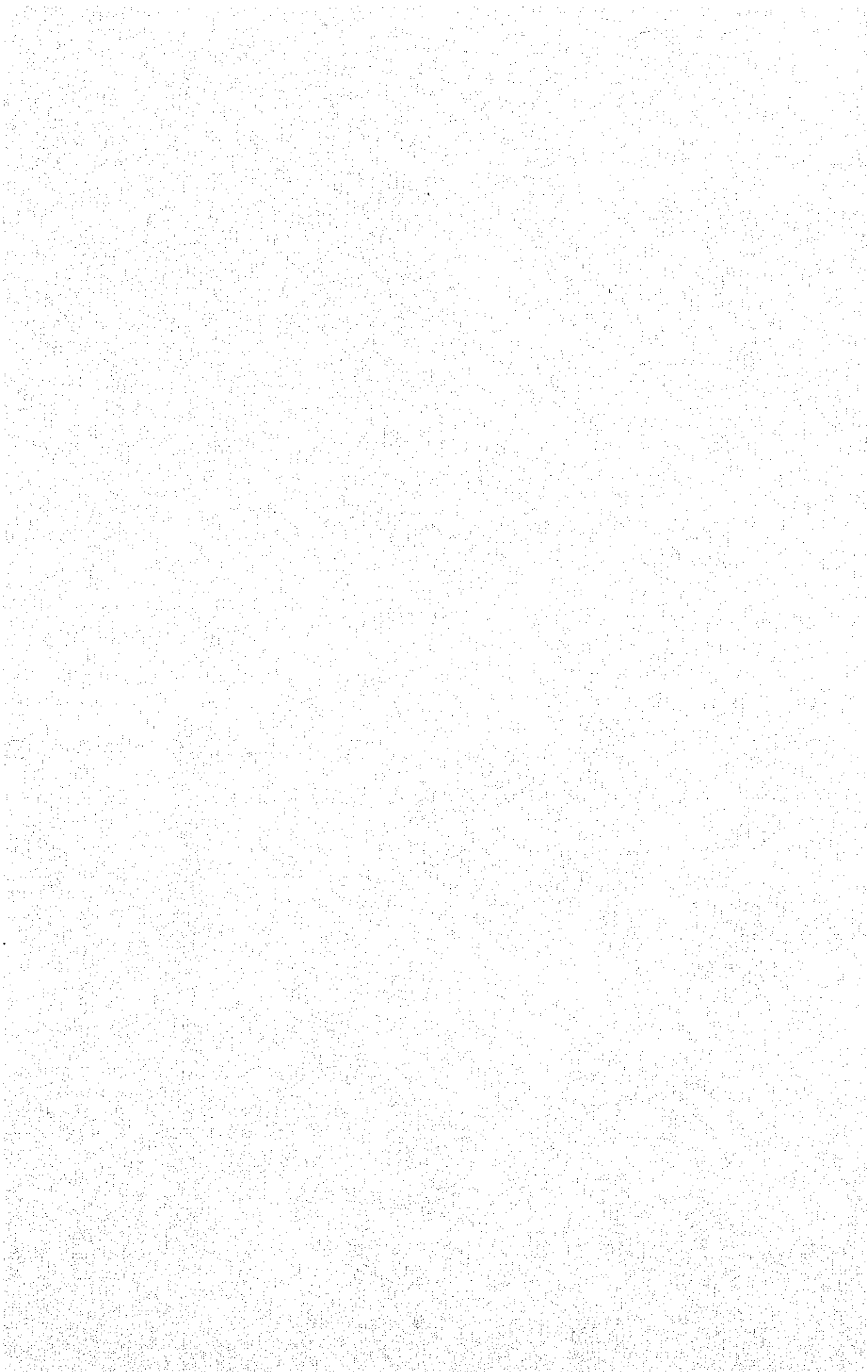


Table 1-1 List of JICA Experts and NAPOCOR Counterparts

Name	Speciality/Position
(JICA Experts)	
Mr. Makoto TSUDA	Team Leader
Mr. Shuhei NISHIOKA	Senior Geologist
Mr. Mitsuharu YAKO	Geologist
Mr. Toshiharu NISHINA	Geophysicist
Mr. Hiroyuki KITO	- do -
Mr. Michimasa MENJO	Soil Mechanic Engineer
Mr. Koichi MIKI	Photogrametrist
Mr. Satoshi NOGUCHI	Topo Survey Expert
Mr. Katsuhiko CHIKIRA	- do -
Mr. Akio KATAYAMA	Hydrologist
Mr. Saburo SUZUKI	Electrical Engineer
Mr. Yoshio MIZUHARA	Civil Engineer
Mr. Shonosuke EZOE	Environment Engineer
Mr. Toshikazu TAI	Project Economist
Mr. Masaru TATEISHI	Coordinator
(NAPOCOR Counterparts)	
Mr. Eduardo P. Abesamis	Manager, Project Development Department
Mr. Narciso V. Angeles	Manager, Materials Investigations and Tests Division
Mr. Bernardo E. Acuna	Manager, Materials Investigations and Tests Division
Mr. R. V. Geroso	Chief, Luzon Engineering Laboratories
Mr. Z. P. Santos, Jr.	Chief, Geodesy & Cartography Division
Mr. R. A. Almero	Chief, Geology & Geotechnics Division
Mr. Geminiano A. Wi	Hydrology Specialist
Mr. M. Arroyo	Geologist
Mr. M. D. Edjawan	Chief, Transmission Project Planning
Mr. Eduardo F. Cruz, Jr.	Specialist A
Mr. Mario Baile	Economist
Mr. H. B. Alba	Field Investigation Engineer
Mr. William R. Orola	Civil Engineer
Mr. Ernest C. Esmerio	Supervising Biologist
Mr. Cornelio Garde	Engineer II, MITD

Table 3-1 List of Existing Power Stations in Luzon

HYDRO ELECTRIC PLANT									
No. PLANT	No. & Cap. of GEN. No. x MW	CROSS HEAD m	EFFECTIVE STORAGE CAP. OF RESERVOIR 10 <sup>6</sup> m <sup>3</sup>	TOTAL INSTALLED CAPACITY MW	EFFECTIVE CAPABILITY MW	ANNUAL AVAILABLE ENERGY GWH	YEAR COMM.		
1. Caliraya	4 x 8	271	43.8	32	32	192	1945/50		
2. Ambuklao	3 x 25	180	258	75	75	459	1956		
3. Lak Buhí-Barit	1 x 1.8	19.2 Ef.	Run of River	1.8	1.8	12	1957		
4. Cavayan	1 x 0.4	77.2 Ef.	Run of River	0.4	0.4	3.1	1959		
5. Binga	4 x 25	155	48.2	100	100	610	1960		
6. Angat	4 x 50	-	630						
7. Patanbangan	3 x 6	119		218	218	505	1967		
8. Botocan	2 x 50	91	208.3	100	100	224	1977		
	2 x 8.0								
	1 x 0.96			16.96	15.0 $\frac{1}{2}$	60.0	1946		
Total capacity of Hydro Electric Plant				544.16	542.2	2,065.1			
THERMAL POWER PLANT INCLUDING DIESEL PLANT									
No. PLANT	No. & Cap. of Gen. No. x MW	No.	Capaci. Ton/H	Boiler Temp. °C	Pressure kg/cm <sup>2</sup>	TOTAL INSTALLED CAPACITY MW	Net Capacity MW	Annual Available Energy GWH	Year Comm.
1. Rock well	5 x 25	5	125	482	61.5	305	315	574	1950-1958
2. Tegen	3 x 60	3	204	538	129.4	200	220	985	1960-1963
3. Ligeo	2 x 100	2	343	538	129.4	3.0	3.0	1,248	1965-1966
4. Gardner	2 x 1.5	1	507	Diesel			165	17.0	1968
5. Snyder	1 x 150	1	726	540	130	350	220	920	1970
6. Bataan	1 x 200	1	726	540	196	500	220	1,182	1971
7. Malaya	1 x 300	1	1,032	540	196	330	330	1,248	1972
8. Tivi	1 x 75	1	295	538	127	225	75	1,905	1972
9. Tivi Geothermal	1 x 150	1	507	538	165	350	150	473	1972
10. Mak-Ban Geothermal	1 x 350	1	1,205	540	175	2.5	390	940	1977
	5 x 0.5	1	1,205	Diesel			2.5	1,905	1978
	2 x 55	1	110			110	110	2,491	1979
	2 x 55	1	110			110	110	794	1979
	2 x 55	1	110			110	110	794	1979
Total capacity of Thermal Power Plant				2,455.5	2,640.5	15,480.76			
Total of Plant				2,999.66 MW	3,182.7 MW	17,545.86 GWH			

Source. Statistics data of NAFOCOR operating plant NAFOCOR Jan. 1978, and MERALCO generating capability 1947-1976

1: The effective capability of Batocan with all three units operating as full load is reduced to 15,000 kW by age.

Table 3-2 Historical Growth of Electricity Sales in Luzon Mainland

Year	NAPOCOR Energy Sales <sup>1</sup>										MERALCO <sup>2</sup>				Total Energy Sales GWE	A.G.R. <sup>4</sup> %
	Utilities GWH	Industrial GWH	Miscellaneous GWH	Total GWH	Residential GWH	Commercial GWH	Industrial GWH	Street Light GWH	Resale GWE	Transmission GWH	Total GWE	Sold GWH	Sub-total GWH	Self Generation GWE/3		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(5) + (12)	(13)	(14)	(15)	(16)
1960	55	74	5	134	458	424	516	10	54	-	1,462	1,596	53	1,649		
1961	83	91	6	180	507	470	631	11	69	-	1,688	1,868	56	1,924		
1962	106	98	8	212	578	514	748	13	86	-	1,939	2,151	84	2,235		
1963	146	111	14	271	640	569	854	17	95	-	2,175	2,446	79	2,525		
1964	176	135	33	344	737	656	976	22	102	-	2,493	2,837	82	2,919	13.8	
1965	204	158	39	401	801	723	1,073	26	98	-	2,721	3,122	87	3,209		
1966	242	206	39	487	889	825	1,187	30	124	-	3,055	3,542	130	3,672		
1967	285	209	36	530	959	935	1,354	34	149	-	3,431	3,961	175	4,136		
1968	348	307	48	703	1,037	1,084	1,523	35	174	-	3,853	4,556	206	4,762		
1969	401	394	57	852	1,221	1,299	1,634	37	181	-	4,372	5,224	225	5,449		
1970	448	530	53	1,031	1,262	1,372	1,708	36	177	-	4,555	5,586	240	5,826		
1971	493	631	183	1,307	1,287	1,433	1,884	29	201	-	4,894	6,141	273	6,414	8.5	
1972	540	657	290	1,487	1,362	1,522	1,964	43	210	-	5,101	6,588	293	6,881		
1973	626	676	341	1,643	1,447	1,649	2,202	44	225	-	5,567	7,210	320	7,530	0.9	
1974	645	791	400	1,836	1,302	1,629	2,248	44	216	-	5,439	7,275	323	7,598		
1975	791	883	469	2,143	1,418	1,814	2,386	45	228	-	5,891	8,034	357	8,391		
1976	806	967	496	2,269	1,485	1,958	2,571	47	252	-	6,313	8,562	381	8,963	7.4	
1977	889	901	392	2,182	1,623	2,177	2,764	50	281	-	6,895	9,077	404	9,481		
1978	1,072	841	441	2,354	1,713	2,349	3,000	53	318	-	7,433	9,787	430	10,217		

Source: <sup>1</sup> Actual NAPOCOR Demand and Energy Sales Luzon (NAPOCOR System Planning Section)

<sup>2</sup> Utility Economic Forecast Date Nov. 1978 MERALCO

<sup>3</sup> Power System Luzon Generation Expansion Study (December 1977) until 1971, from the growth rate over previous year is assumed to be the same as that of the sum of NAPOCOR and MERALCO after 1972.

<sup>4</sup> AGR: Annual Average Growth Rate

Table 3-3 Sales Revenue of Electric Power, NAPOCOR

Year	LUZON			VISAYAS			MINDANAO			TOTAL		
	Revenue (10 <sup>6</sup> P)	Energy Sales (GWh)	Av. Value (P/kWh)	Revenue (10 <sup>6</sup> P)	Energy Sales (GWh)	Av. Value (P/kWh)	Revenue (10 <sup>6</sup> P)	Energy Sales (GWh)	Av. Value (P/kWh)	Revenue (10 <sup>6</sup> P)	Energy Sales (GWh)	Av. Value (P/kWh)
1969	-	-	-	-	-	-	-	-	-	37.9	1,288	0.029
1970	-	-	-	-	-	-	-	-	-	46.3	1,738	0.027
1971	-	-	-	-	-	-	-	-	-	60.9	2,110	0.029
1972	80.4	1,377	0.058	0.7	9	0.082	9.7	356	0.027	90.8	1,742	0.052
1973	101.8	1,608	0.063	0.6	7	0.085	10.8	396	0.027	113.2	2,011	0.056
1974	177.4	1,718	0.103	0.8	9	0.088	12.9	506	0.025	191.1	2,233	0.086
1975	221.1	1,988	0.111	1.5	8	0.180	14.8	495	0.029	237.4	2,491	0.095
1976/1	318.4	2,269	0.140	1.4	10	0.142	22.2	745	0.030	342.0	3,024	0.113
1977	395	2,182	0.181	15.0	51	0.292	37	868	0.043	447.0	3,101	0.144
1978	738.7	3,731	0.198	68.81	214.7	0.32	114.05	996.5	0.114	921.56	4,942.2	0.186

Source: Annual Report, NAPOCOR (1972-1977)  
Project Planning, NAPOCOR (1969-1971)

1 From 1976 Calendar Year is used.  
Before 1976, Fiscal Year is used starting in July and ending in June.

Table 3-4 Historical and Projected Energy Sales, Generation and Peak Demand Luzon Grid

Calendar Year	Consolidated Sales	Energy Req't	Peak Load	Load Factor
(1)	(GWh) (2)	(GWh) (3)	(MW) (4)	(%) (5)
<u>Actual</u>				
1968	4,996	5,387	903	68.1
1969	5,639	6,087	1,020	68.1
1970	6,046	6,386	1,111	65.6
1971	6,596	7,048	1,205	66.8
1972	7,131	7,555	1,331	64.8
1973	7,723	8,212	1,335	70.2
1974	7,804	8,240	1,379	68.2
1975	8,585	9,014	1,513	68.0
1976	9,453	9,626	1,659	66.2
1977	9,813	10,357	1,709	69.2
1978	10,414	11,223	1,780	71.9
1969-1978 <sup>/1</sup>	7.6%	7.6	7.0	
<u>Forecast</u>				
1979	11,140	12,010	1,960	70.0
1980	11,925	12,850	2,100	70.0
1981	12,760	13,750	2,240	70.0
1982	13,650	14,710	2,400	70.0
1983	14,605	15,740	2,565	70.0
1979-1983 <sup>/1</sup>	7.0%	7.0	7.6	70.0
1984	15,630	16,840	2,745	70.0
1985	16,725	18,020	2,940	70.0
1986	17,900	19,280	3,145	70.0
1987	19,145	20,630	3,365	70.0
1988	20,485	22,075	3,600	70.0
1989	21,920	23,620	3,850	70.0
1990	23,455	25,275	4,120	70.0
1984-1990 <sup>/1</sup>	7.0%	7.0	7.0	
1979-1990 <sup>/1</sup>	7.0	7.0	7.0	

<sup>/1</sup> Average annual compound growth  
Excludes pumping requirements

Source: NAPOCOR Expansion Program on June 1980

Table 3-5 Projected Power Consumption and Peak Demand  
in Luzon Mainland

Year (1)	Consolidated Sales (GWh) (2)	Loss (%) (3)	Net Energy Production (GWh) (4)	Load Factor (%) (5)	Peak Power Demand (MW) (6)
1979	10,963	7.5	11,850	69	1,960
1980	11,760	7.5	12,710	69	2,100
1981	12,600	7.5	13,620	69	2,250
1982	13,490	7.5	14,580	69	2,410
1983	14,610	7.0	15,710	70	2,560
1984	15,830	7.0	17,020	70	2,780
1985	17,140	7.0	18,430	70	3,000
1986	18,540	7.0	19,940	70	3,250
1987	20,070	7.0	21,580	70	3,520
1988	21,690	6.5	23,200	70	3,780
1989	23,450	6.5	25,080	70	4,090
1990	25,350	6.5	27,110	70	4,420
1991	27,320	6.5	29,220	70	4,760
1992	29,460	6.5	31,510	70	5,140
1993	31,750	6.5	33,960	70	5,540
1994	34,230	6.5	36,610	70	6,970
1995	36,900	6.5	39,460	70	6,430



Table 4-1 Mortar and Concrete Strength Test

Sample	(kg/cm <sup>2</sup> )			
	<u>Unwashed</u>		<u>Washed</u>	
	7 days	28 days	7 days	28 days
A sand	240	385	240	387
D "	241	437	252	443
STM	271	425	282	446
F "	252	461	274	465
F "	221	371	250	376
F "	240	347	250	410
F + STM (1:1)	341	526	347	536
Mean	258	472	271	438

A,D,F sand derived from river deposit, STM sand from Santa Monica beach, location of sources shall be referred to Fig. 4-7.

Concrete Strength

Water cement ratio (w/c)	<u>7 days strength</u>		<u>28 days strength</u>	
		Mean		Mean
47.0 %	(181, 193)	187	(291, 294, 267)	284
41.3 %	(213, 206, 233)	217	(291, 334, 301)	309
39.1 %	(255, 255, 257)	256	(318, 342, 354)	338

Table 5-1 Benefit Cost Analysis of Agos River Development Plans

(million US dollars)

HVL of Agos Kanan (m)	BENEFIT																		B-C	B/C
	Power & Energy						Water supply						CFSI							
	Agos Kanan (2)	Sub- total (5)	Water supply Sub- total (7)	Power & Energy Sub- total (8)	Agos Kanan (9)	Pantay I (10)	Pantay II (11)	Sub- total (12)	Water supply Sub- total (13)	Kaliwa Kanan (14)	Kaliwa pump P.S Energy cost (15)	Sub- total (16)	Water supply Sub- total (17)	Sub- total (18)	Total					
175 290	495.12	180.13	76.96	-	752.21	829.70	344.50	128.8	49.85	-	523.05	572.33	-	-	572.33	1,581.91	1,095.38*	486.53	1.44	
165 290	457.88	195.71	"	-	730.55	"	303.70	130.3	"	-	483.85	"	-	-	"	1,560.25	1,056.18	504.07	1.48	
A-1 155 300	420.66	223.13	"	-	720.75	"	275.00	154.0	"	-	478.85	"	-	-	"	1,550.45	1,051.18	499.27	1.47	
145 300	383.70	237.87	"	-	698.53	"	254.00	158.5	"	-	462.35	"	-	-	"	1,528.23	1,034.68	493.55	1.48	
175 295	382.14	-	76.96	52.86	511.96	829.70	320.31	-	49.85	29.37	399.53	572.33	522.19	-	1,094.52	1,881.18	1,494.05	387.13	1.26	
165 295	322.24	-	"	"	482.06	"	286.37	-	"	"	365.59	"	-	-	"	1,851.28	1,460.11	391.17	1.27	
A-2 155 295	322.41	-	"	"	452.23	"	258.23	-	"	"	337.45	"	-	-	"	1,821.45	1,431.97	389.48	1.27	
145 295	292.71	-	"	"	422.53	"	242.25	-	"	"	321.47	"	-	-	"	1,791.75	1,415.99	375.76	1.27	
175 290	381.25	180.13	76.96	52.86	691.20	829.70	320.31	128.8	49.85	29.37	528.33	572.33	314.63	84.06	67.43	1,038.45	2,060.42	1,566.78	493.64	1.32
A-3 165 290	351.49	195.71	"	"	677.02	"	286.37	130.3	"	"	495.89	"	84.00	74.54	1,045.50	2,046.24	1,541.39	504.85	1.33	
155 300	321.77	223.13	"	"	674.72	"	258.23	154.0	"	"	491.45	"	84.92	81.88	1,033.76	2,043.94	1,545.21	498.73	1.32	
145 300	292.14	237.87	"	"	659.83	"	242.25	158.5	"	"	479.97	"	90.10	89.77	1,066.83	2,029.05	1,546.80	482.25	1.31	
B - 260	-	635.27	76.96		712.23	829.70	829.70	-	428.45	49.85	478.30	572.33			572.33	1,541.93	1,050.63	491.30	1.47	

All the costs and benefits are discounted to Jan. 1989

Table 6-1 Main Feature of Alternative Scheme  
 Agos Hydropower Project

	<u>Alternative Scheme</u>			
	<u>AG-175</u>	<u>AG-165</u>	<u>AG-155</u>	<u>AG-145</u>
<u>Reservoir</u>				
HWL (m)	175.0	165.0	155.0	145.0
LWL (m)	135.0	128.0	120.8	113.8
Live storage (x10 <sup>6</sup> m <sup>3</sup> )	695.0	550.0	438.0	336.0
<u>Main dam</u>				
Crest Elevation (m)	182.0	172.0	162.0	152.0
Crest length (m)	810.0	780.0	735.0	695.0
Dam height above foundation (m)	182.0	172.0	162.0	152.0
Dam volume incl. cofferdams (x10 <sup>6</sup> m <sup>3</sup> )	20.21	17.03	14.31	11.91
<u>Spillway</u>				
Design discharge (m <sup>3</sup> /sec)	10,600			
Type	14.0 H x 14 W x 4 nos. gated spillway with 2 lanes of 210 m long side channel			
<u>Diversion tunnels</u>				
Design discharge (m <sup>3</sup> /sec)	5,210			
Number	2			
Diameter (m)	9.0			
Length (m)	816/817			
<u>Power tunnel</u>				
Maximum discharge (m <sup>3</sup> /sec)	163.86	163.45	162.97	161.36
Diameter (m)	6.2			
Length (m)	226			
<u>Penstock line</u>				
Type	Embedded in tunnel			
Number	1			
Diameter of penstock (m)	6.1			
Length (m)	370	350	330	310
<u>Power house</u>				
Installed capacity (MW)	152	140	128	116
Number of unit	2			
Rated head (m)	110.1	101.6	93.2	85.3
Tail water level (m)	41.5			

Table 6-2 Summary of Project Cost of Alternatives  
Agos Hydropower Project

(million US dollars)

	Alternative Scheme			
	AG-175	AG-165	AG-155	AG-145
1. Land acquisition	3.2	2.7	2.3	1.95
2. Preparatory work	13.48	11.57	10.33	9.61
3. Diversion tunnels	9.08	9.08	9.08	9.08
4. Main & cofferdams	148.42	125.54	105.86	88.28
5. Spillway	24.15	24.15	25.66	34.74
(1 - 5)	(198.33)	(173.04)	(153.23)	(143.66)
6. Intake & power tunnel	1.97	1.92	1.85	1.80
7. Penstock line	0.32	0.32	0.32	0.32
8. Powerhouse and switchyard	3.08	2.92	2.76	2.60
9. Tailrace	1.53	1.53	1.53	1.53
10. Architectural work	2.20	2.14	2.07	1.99
(7 - 10)	(9.10)	(8.83)	(8.53)	(8.24)
11. Electro-mechanical work	31.46	29.42	27.26	25.17
12. Transmission line	3.45	3.38	3.31	3.28
13. Hydro-mechanical work	10.05	10.00	9.95	9.90
(11 - 13)	(44.96)	(42.80)	(40.52)	(38.35)
14. Contingency (10 %)	25.24	22.47	20.23	19.03
15. Engineering and administration	16.66	14.83	13.35	12.56
Grand Total	294.29	261.97	235.86	221.83
Operation and Maintenance Cost	23.23	21.38	19.75	18.67
Replacement Cost	1.60	1.52	1.44	1.36

Table 6-3 Financial Construction Cost

(million US dollars)

Work Item	F.C.	L.C.	Total
1. Land acquisition	-	2.70	2.70
2. Preparatory works	11.44	2.01	13.45
3. Diversion tunnels	7.70	3.75	11.45
4. Cofferdams	9.23	1.05	10.28
5. Main dam	109.53	19.32	128.85
6. Spillway	29.84	2.48	32.32
(Sub total 1-6)	167.74	31.31	199.05
7. Power tunnel	2.37	0.57	2.94
8. Powerhouse and tailrace	5.02	0.54	5.56
9. Switchyard	0.40	0.05	0.45
10. Architectural works	1.94	0.77	2.71
(Sub total 7-10)	9.73	1.93	11.66
11. Generating equipment	22.02	2.93	24.95
12. Transmission line and substation	5.81	2.04	7.85
13. Hydro-mechanical equipment	7.83	2.15	9.98
(Sub total 11-13)	35.66	7.12	42.78
14. Physical contingency	21.31	4.04	25.35
15. Engineering and administration	14.07	2.66	16.73
16. Price contingency	125.60	35.40	161.00
Total	374.11	82.46	456.57

Table 6-4 Disbursement Schedule of Financial Construction Cost

Exchange rate: US\$1 = ¥250 = Zeso 7.5  
(thousand US dollars)

Item	1981		1982		1983		1984		1985		1986		1987		1988		
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	
1. Land acquisition		2,700		900		900		900									
2. Civil works																	
(1) Dam and appurtenant structures	167,800	28,600			13,600	3,200	20,800	4,200	24,900	4,100	42,000	6,700	36,300	5,700	30,200	4,700	
(2) Power facility works	9,700	1,900					500	100	1,100	200	2,800	500	4,300	900	1,000	200	
Sub total	177,500	30,500			13,600	3,200	21,300	4,300	26,000	4,300	44,800	7,200	40,600	6,600	31,200	4,900	
3. Generating equipment and metal works																	
(1) Generating equipment	27,800	5,000							5,200		8,000	1,500	6,800	3,000	7,800	500	
(2) Metal works	7,800	2,200							2,100		500	1,100	5,100	600	100	500	
Sub total	35,600	7,200							7,300		8,500	2,600	11,900	3,600	7,900	1,000	
4. Physical contingency	21,300	4,000			1,500	300	2,200	400	3,200	600	5,300	1,000	5,200	1,100	3,900	600	
5. Engineering service and government administration	14,100	2,700															
Total	248,500	47,100			600	100	800	200	1,300	300	2,100	500	2,100	500	1,600	300	
6. Price contingency	125,607	35,370			15,700	4,500	24,300	5,800	37,800	5,200	60,700	11,300	59,800	11,800	44,600	6,800	
Sub total			147	30	3,533	1,490	7,552	2,692	15,217	3,175	30,394	8,719	36,226	11,195	32,031	7,776	
Total Financial Cost	374,107	82,470	2,247	330	19,233	5,990	31,852	8,492	53,017	8,375	91,094	20,019	96,026	22,995	76,631	14,576	
	456,577																

Table 7-1 Economic Construction Cost

(million US dollars)

Work Item	F.C.	L.C.	Total
1. Land acquisition	-	2.70	2.70
2. Preparatory works	9.72	1.86	11.58
3. Diversion tunnels	5.67	3.42	9.09
4. Cofferdams	7.61	1.00	8.61
5. Main dam	98.31	18.62	116.93
6. Spillway	21.75	2.40	24.15
(Sub total 1-6)	143.06	30.00	173.06
7. Power tunnel	1.69	0.54	2.23
8. Powerhouse and tailrace	3.58	0.53	4.11
9. Switchyard	0.28	0.05	0.33
10. Architectual works	1.43	0.71	2.14
(Sub total 7-10)	6.98	1.83	8.81
11. Generating equipment	22.02	2.93	24.95
12. Transmission line and substation	5.81	2.04	7.85
13. Hydro-mechanical equipment	7.83	2.15	9.98
(Sub total 11-13)	35.66	7.12	42.78
14. Physical contingency	18.57	3.90	22.47
15. Engineering and administration	12.26	2.57	14.83
<b>Total</b>	<b>216.53</b>	<b>45.42</b>	<b>261.95</b>

Table 7-2 Yearly Disbursement of Economic Construction Cost

Exchange rate: US\$1 = ₱250 = Peso 7.5  
(thousand US dollars)

Item	Total		1981		1982		1983		1984		1985		1986		1987		1988		
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	
1. Land acquisition		2,700				900													
2. Civil works																			
(1) Dam and appurtenant structures	143,100	27,300					11,600	3,100	17,700	4,000	21,200	3,900	35,800	6,400	31,000	5,400	25,800	4,500	
(2) Power facility works	7,000	1,800							400	100	800	200	2,000	500	3,100	800	700	200	
Sub total	150,100	29,100					11,600	3,100	18,100	4,100	22,000	4,100	37,800	6,900	34,100	6,200	26,500	4,700	
3. Generating equipment and metal works																			
(1) Generating equipment	27,800	5,000									5,200		8,000	1,500	6,800	3,000	7,800	500	
(2) Metal works	7,800	2,200									2,100		500	1,100	5,100	600	100	500	
Sub total	35,600	7,200									7,300		8,500	2,600	11,900	3,600	7,900	1,000	
4. Physical contingency	18,600	3,900					1,300	300	1,900	400	2,800	600	4,600	1,000	4,600	1,000	3,400	600	
5. Engineering service and government administration	12,200	2,600					500	100	700	200	1,100	300	1,800	500	2,800	500	1,400	300	
<b>Total</b>	<b>216,500</b>	<b>45,500</b>	<b>1,800</b>	<b>300</b>	<b>3,100</b>	<b>1,300</b>	<b>13,400</b>	<b>4,400</b>	<b>20,700</b>	<b>5,600</b>	<b>33,200</b>	<b>5,000</b>	<b>52,700</b>	<b>11,000</b>	<b>52,400</b>	<b>11,300</b>	<b>39,200</b>	<b>6,600</b>	
	<b>262,000</b>		<b>2,100</b>	<b>4,400</b>	<b>4,400</b>	<b>17,800</b>	<b>26,300</b>	<b>38,200</b>	<b>63,700</b>				<b>63,700</b>		<b>63,700</b>		<b>45,800</b>		



Table 7-3 Power Benefit Estimate

(thousand US dollars)

Year	Available Power (MW)	Energy Output (GWh)	Power Benefit						
			kWh Benefit / Discount Rate		Total Benefit / Discount Rate				
			10 %	12 %	14 %	16 %			
1989	140.0	709.66	26.02	30.09	34.62	16.61	42.63	46.70	51.23
90	140.0	692.24	26.02	30.09	34.62	16.20	42.22	46.29	50.82
91	140.0	674.82	26.02	30.09	34.62	15.79	41.81	45.88	50.41
92	140.0	657.40	26.02	30.09	34.62	15.38	41.40	45.47	50.00
93	140.0	639.98	26.02	30.09	34.62	14.98	41.00	45.07	49.60
94	140.0	622.56	26.02	30.09	34.62	14.57	40.59	44.66	49.19
95	140.0	596.82	26.02	30.09	34.62	13.97	39.99	44.06	48.59
96	140.0	571.07	26.02	30.09	34.62	13.36	39.38	43.45	47.98
97	140.0	545.33	26.02	30.09	34.62	12.76	38.78	42.85	47.38
98	140.0	519.58	26.02	30.09	34.62	12.16	38.18	42.25	46.78
99	140.0	493.84	26.02	30.09	34.62	11.56	37.58	41.65	46.18
2000	140.0	468.10	26.02	30.09	34.62	10.95	36.97	41.04	45.57
01	139.6	457.37	25.95	30.00	34.52	10.70	36.65	40.70	45.22
02	139.3	446.65	25.89	29.94	34.44	10.45	36.34	40.39	44.89
03	138.9	435.92	25.82	29.85	34.34	10.20	36.02	40.05	44.54
04	138.5	425.20	25.74	29.77	34.25	9.95	35.69	39.72	44.20
05	138.2	414.48	25.69	29.70	34.17	9.70	35.39	39.40	43.87
06	138.4	409.73	25.72	29.75	34.22	9.59	35.35	39.38	43.81
07	138.6	404.98	25.76	29.79	34.27	9.48	35.24	39.27	43.72
08	138.8	400.24	25.80	29.83	34.32	9.37	35.17	39.20	43.69
09	139.3	395.49	25.89	29.94	34.44	9.25	35.14	39.19	43.69
10									
11									
12									
.									
.									
.									
2038									

Δ: Construction period of coal-fired thermal plant is assumed to be 4 years.

Table 7-4 Cash Flow of Project Cost and Benefit

Year	Project Cost		Project Benefit			B - C			Discounted (B - C)			
	Const. Cost	O & M	Total	Discount Rate			Case I	Case II	Case III	(Case I) 10%	(Case II) 12%	(Case III) 14%
				Case I	Case II	Case III						
1980	2.1		2.1			- 2.1	- 2.1	- 2.1	- 4.29	- 4.91	- 5.61	
81	4.4		4.4			- 4.4	- 4.4	- 4.4	- 8.18	- 9.19	- 10.31	
82	17.8		17.8			- 17.8	- 17.8	- 17.8	- 30.07	- 33.20	- 36.59	
83	26.3		26.3			- 26.3	- 26.3	- 26.3	- 40.39	- 43.80	- 47.43	
84	38.2		38.2			- 38.2	- 38.2	- 38.2	- 53.33	- 56.80	- 60.43	
85	63.7		63.7			- 63.7	- 63.7	- 63.7	- 80.84	- 84.56	- 88.39	
86	63.7		63.7			- 63.7	- 63.7	- 63.7	- 73.49	- 75.50	- 77.53	
87	45.8		45.8			- 45.8	- 45.8	- 45.8	- 48.04	- 48.47	- 48.90	
88	0	1.88	1.88			40.75	44.82	49.35	38.85	42.35	46.22	
89				51.23		40.37	44.41	48.94	34.99	37.47	40.21	
90				50.82		39.93	44.00	48.53	31.46	33.14	34.97	
91				50.41		39.52	43.59	48.12	28.31	29.32	30.42	
92				50.00		39.12	43.19	47.72	25.48	25.94	26.46	
93				49.60		38.71	42.78	47.31	22.92	22.94	23.01	
94				49.19		38.31	42.38	46.85	20.51	20.19	19.93	
95				48.79		37.90	41.97	46.40	18.35	17.77	17.25	
96				48.38		37.50	41.57	45.95	16.41	15.64	14.94	
97				47.98		37.10	41.17	45.50	14.68	13.76	12.93	
98				47.58		36.70	40.77	45.00	13.12	12.10	11.19	
99				47.18		36.30	40.37	44.50	11.73	10.64	9.68	
2000				46.78		35.90	39.96	43.99	10.36	9.42	8.43	
01				46.38		35.50	39.56	43.48	9.52	8.34	7.33	
02				45.98		35.10	39.16	42.97	8.57	7.38	6.38	
03				45.58		34.70	38.76	42.46	7.72	6.53	5.55	
04				45.18		34.30	38.36	41.95	6.95	5.78	4.83	
05				44.78		33.90	37.96	41.44	6.31	5.16	4.23	
06				44.38		33.50	37.56	40.93	5.72	4.59	3.71	
07				43.98		33.10	37.16	40.42	5.19	4.09	3.25	
08				43.58		32.70	36.76	39.91	4.71	3.65	2.85	
09				43.18		32.30	36.36	39.40	4.29	3.25	2.41	
10				42.78		31.90	35.96	38.89	3.92	2.81	2.06	
...				42.38		31.50	35.56	38.38	3.59	2.41	1.71	
23	42.8	1.88	44.68			- 9.54	- 5.49	- 0.99	1.37	0.84	0.52	
...	0		1.88			33.26	37.31	41.81	- 0.36	- 0.11	- 0.01	
...									1.13	0.67	0.40	
2038	0	1.88	1.88			31.26	37.31	41.81	0.30	0.14	0.06	
Total						46.03	8.24	- 21.97				

Table 7-5 Investment Cost and Financing Plan

Description	(million US dollars)							Total	
	1981	1982	1983	1984	1985	1986	1987		1988
I. Investment cost									
1.1 Detailed design cost	2.40	4.90							7.30
Foreign	2.10	3.50							5.60
Local	0.30	1.40							1.70
1.2 Price escalation for 1.1	0.18	0.80							0.98
Foreign	0.15	0.51							0.65
Local	0.03	0.29							0.32
1.3 Construction cost			20.20	30.10	43.00	72.00	71.60	51.40	288.30
Foreign			15.70	24.30	37.80	60.70	59.80	44.60	242.90
Local			4.50	5.80	5.20	11.30	11.80	6.80	45.40
1.4 Price escalation for 1.3			5.02	10.24	18.39	39.11	47.42	39.81	160.00
Foreign			3.53	7.55	15.22	30.39	36.23	32.03	124.95
Local			1.49	2.69	3.17	8.72	11.19	7.78	35.05
1.5 Interest during construction									
Foreign	0.10	0.36	1.35	3.52	7.13	13.25	21.20	28.54	75.45
1.6 Commitment charges									
Foreign	0.04	0.00	3.49	3.17	2.64	1.73	0.77	0.00	11.82
1.7 Total investment cost	2.71	6.06	30.06	47.03	71.16	126.09	140.99	119.75	543.85
Foreign	2.38	4.37	24.07	38.54	62.78	106.07	118.00	105.17	461.38
Local	0.33	1.69	5.99	8.49	8.37	20.02	22.99	14.58	82.47
II. Financing plan									
2.1 International loans	2.71	6.06	30.06	47.03	71.16	126.09	140.99	119.75	543.85
2.2 Government contribution	2.25	4.01	19.23	31.85	53.02	91.09	96.03	76.63	374.11
	0.47	2.06	10.82	15.18	18.14	35.00	44.97	43.12	169.75

Table 7-6 Income Statement

(million US dollars)									
Year	Revenue	Expenses		Operating Income	Interest	Net Income	Project Cost	Surplus	Cumulated Surplus
		O & M	Depreci- ation						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				(1)-(2) -(3)		(4)-(5)		(1)-(2) -(7)	
1981							2.58	-2.58	-2.58
1982							5.70	-5.70	-8.28
1983							25.22	-25.22	-33.50
1984							40.34	-40.34	-73.84
1985							61.39	-61.39	-135.23
1986							111.11	-111.11	-246.34
1987							119.02	-119.02	-365.36
1988							91.21	-91.21	-456.57
1989	86.73	4.17	10.88	71.69	31.80	39.89		82.57	-374.00
1990	84.61	4.17	10.88	69.56	31.14	38.42		80.44	-293.56
1991	82.48	4.17	10.88	67.43	30.43	37.00		78.31	-215.25
1992	80.35	4.17	10.88	65.30	29.65	35.65		76.18	-139.07
1993	78.22	4.17	10.88	63.17	28.82	34.36		74.05	-65.02
1994	76.09	4.17	10.88	61.05	27.90	33.14		71.92	6.90
1995	72.94	4.17	10.88	57.90	26.92	30.98		68.78	75.68
1996	69.80	4.17	10.88	54.75	25.84	28.91		65.63	141.31
1997	66.65	4.17	10.88	51.61	24.68	26.93		62.48	203.79
1998	63.50	4.17	10.88	48.46	23.42	25.04		59.34	263.13
1999	60.36	4.17	10.88	45.31	22.05	23.27		56.19	319.32
2000	57.21	4.17	10.88	42.17	20.56	21.61		53.04	372.36
2001	55.90	4.17	10.88	40.86	18.95	21.91		51.73	424.09
2002	54.59	4.17	10.88	39.55	17.20	22.35		50.42	474.51
2003	53.28	4.17	10.88	38.23	15.30	22.93		49.11	523.62
2004	51.97	4.17	10.88	36.92	13.24	23.68		47.80	571.42
2005	50.66	4.17	10.88	35.61	11.01	24.61		46.49	617.91
2006	50.08	4.17	10.88	35.03	8.58	26.45		45.91	663.82
2007	49.50	4.17	10.88	34.45	5.95	28.50		45.33	709.15
2008	48.92	4.17	10.88	33.87	3.10	30.78		44.75	753.90
2009	48.34	4.17	10.88	33.29		33.29		44.17	798.07
2022	48.34	4.17	10.88	33.29		33.29		44.17	1,372.28
2023	48.34	4.17	10.88	33.29		33.29	78.69/1	-34.52	1,337.76
2024	48.34	4.17	10.88	33.29		33.29		44.17	1,381.93
2038	48.34	4.17	10.88	33.29		33.29		44.17	2,000.31
<b>Total</b>	<b>2,743.92</b>	<b>208.35</b>	<b>543.85</b>	<b>1,991.72</b>	<b>416.54</b>	<b>1,575.18</b>	<b>535.26</b>	<b>2,000.31</b>	

/1: Replacement cost

Note: FIRR Calculation by Surplus (8)

Discounted at 10% 82.65 x 10<sup>6</sup> US\$

Discounted at 11% 23.24 x 10<sup>6</sup> US\$

Discounted at 12% -30.23 x 10<sup>6</sup> US\$

FIRR = 11.4%

Table 7-7 Cash Flow Statement

Year	Cash Inflow				Total	Cash Outflow			Surplus	Cumulated Surplus	
	External Sources		Internal Cash Generation			Investment Cost	Debt Service				Total
	Loan	Government	Operation	Depreciation			Interest	Principal			
	A & B	Contribution	Income								
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	
1981	2.25	0.47			2.71	2.71			2.71		
1982	4.01	2.06			6.06	6.06			6.06		
1983	19.23	10.82			30.06	30.06			30.06		
1984	31.85	15.18			47.03	47.03			47.03		
1985	53.02	18.14			71.16	71.16			71.16		
1986	91.09	35.00			126.09	126.09			126.09		
1987	96.03	44.97			140.99	140.99			140.99		
1988	76.63	43.12			119.75	119.75			119.75		
1989			71.69	10.88	82.57		31.80	7.73	39.53	43.05	43.05
1990			69.56	10.88	80.44		31.14	8.39	39.53	40.91	83.96
1991			67.43	10.88	78.31		30.43	9.10	39.53	38.78	122.74
1992			65.30	10.88	76.18		29.65	9.88	39.53	36.65	159.39
1993			63.17	10.88	74.05		28.82	10.72	39.53	34.53	193.92
1994			61.05	10.88	71.92		27.90	11.63	39.53	32.39	226.31
1995			57.90	10.88	68.78		26.92	12.62	39.53	29.25	255.56
1996			54.75	10.88	65.63		25.84	13.69	39.53	26.10	281.66
1997			51.61	10.88	62.48		24.68	14.85	39.53	22.95	304.61
1998			48.46	10.88	59.34		23.42	16.11	39.53	19.82	324.43
1999			45.31	10.88	56.19		22.05	17.48	39.53	16.66	341.09
2000			42.17	10.88	53.04		20.56	18.97	39.53	13.51	354.60
2001			40.86	10.88	51.73		18.95	20.58	39.53	12.20	366.80
2002			39.55	10.88	50.42		17.20	22.33	39.53	10.89	377.69
2003			38.23	10.88	49.11		15.30	24.23	39.53	9.59	387.28
2004			36.92	10.88	47.80		13.24	26.29	39.53	8.27	395.55
2005			35.61	10.88	46.49		11.01	28.53	39.53	6.96	402.51
2006			35.03	10.88	45.91		8.58	30.95	39.53	6.38	408.89
2007			34.45	10.88	45.33		5.95	33.58	39.53	5.80	414.69
2008			33.87	10.88	44.75		3.10	36.44	39.53	5.23	419.92
2009			33.29	10.88	44.17					44.17	464.09
2022			33.29	10.88	44.17					44.17	1,038.32
2023			33.29	10.88	44.17	78.69			78.69	-34.51	1,003.81
2024			33.29	10.88	44.17					44.17	1,047.98
2038			33.29	10.88	44.17					44.18	1,666.39
Total	374.11	169.75	1,991.72	543.85	3,079.42	622.39	416.54	374.11	1,413.03	1,666.39	

Note: (5) = (1) + (2) + (3) + (4)

(9) = (6) + (7) + (8)

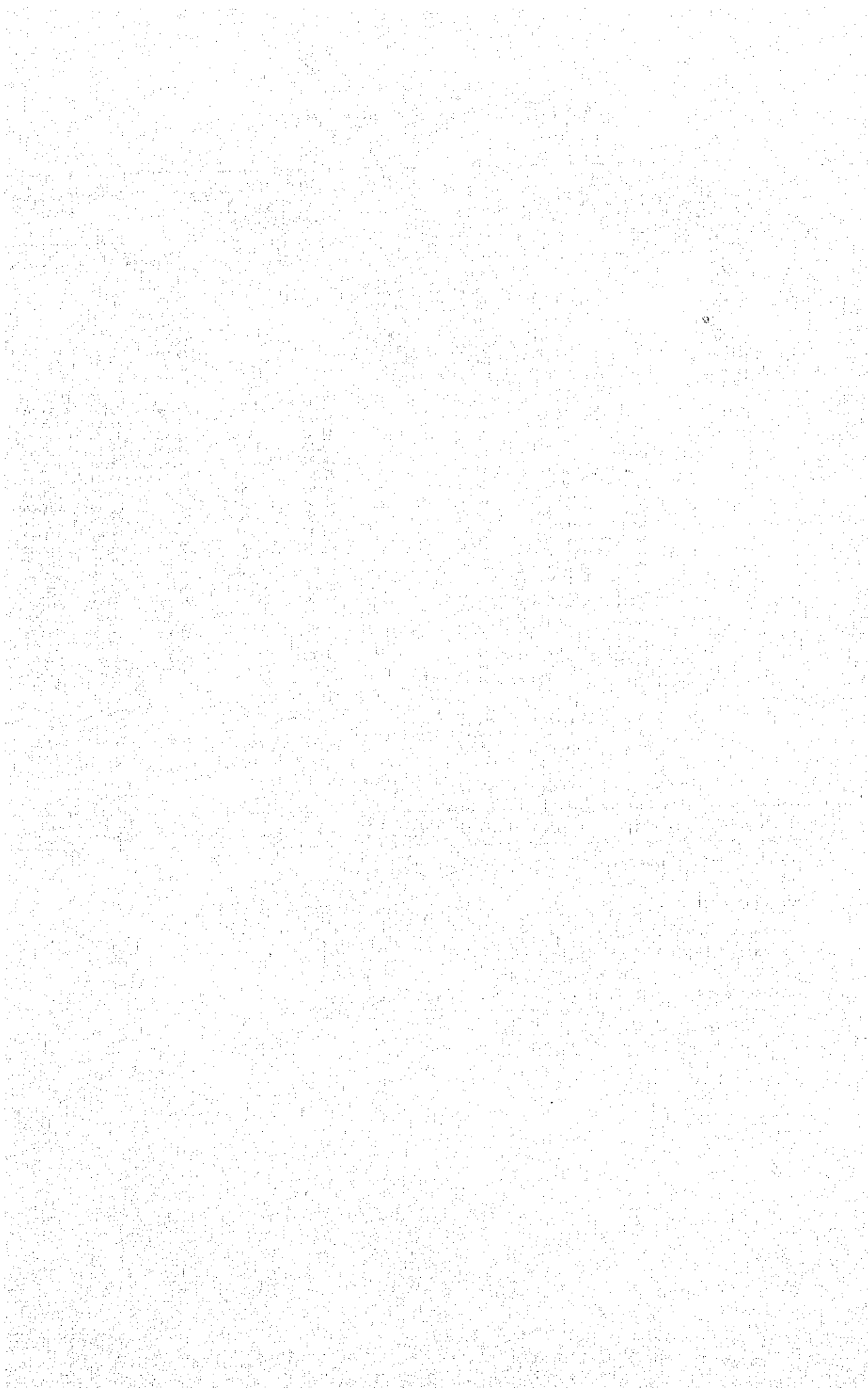
(10) = (5) - (9)

Debt service ratio (D.S.R.):

- D.S.R. = ((3) + (4)) / ((7) + (8))

- D.S.R. in 1989 is 2.09 while 1.13 in 2008.

- Average D.S.R. is 1.53 for the 20 years' debt service period.



**FIGURES**





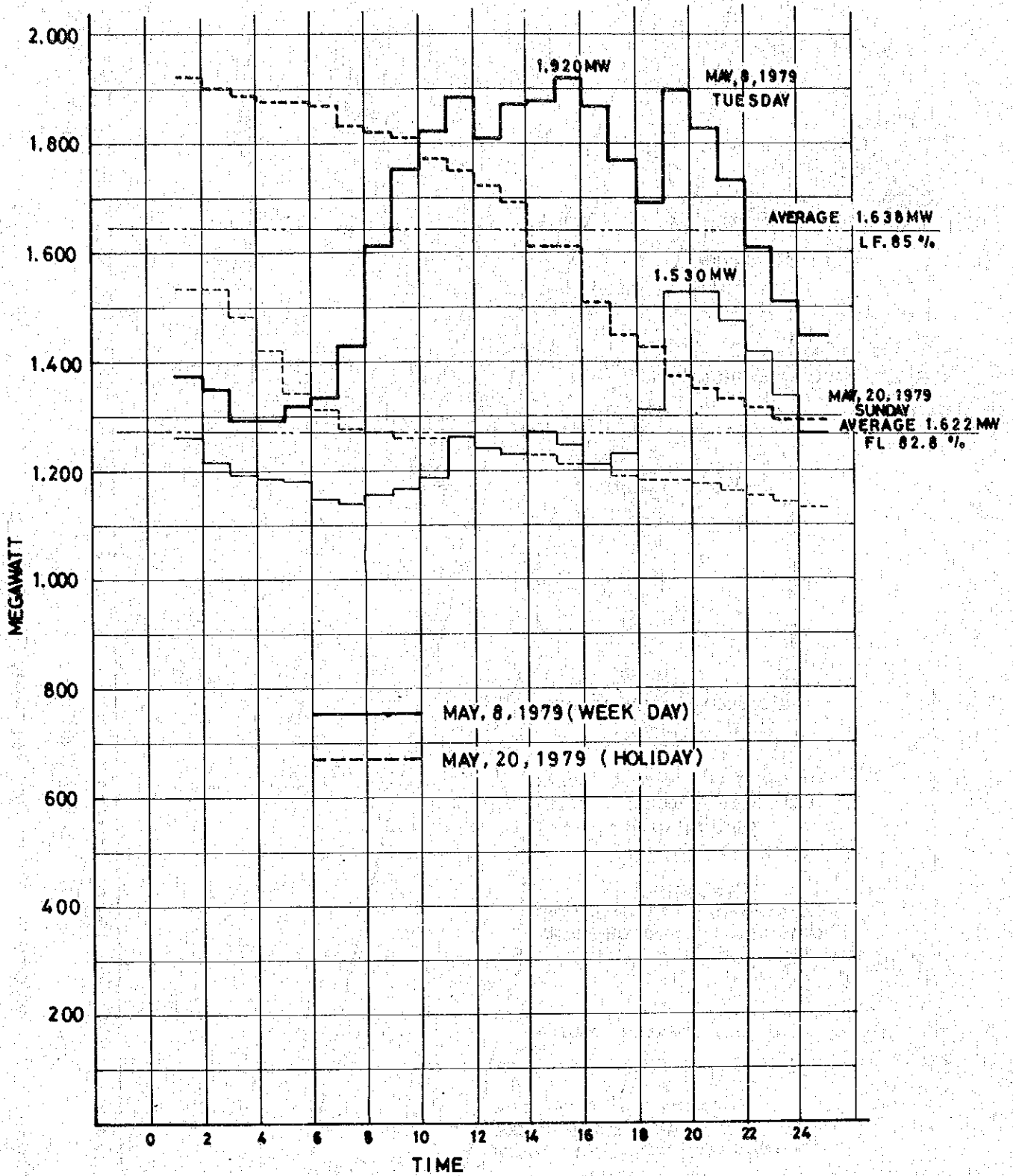


Fig. 3 - 1 Typical Load Duration Curves  
Luzon Grid

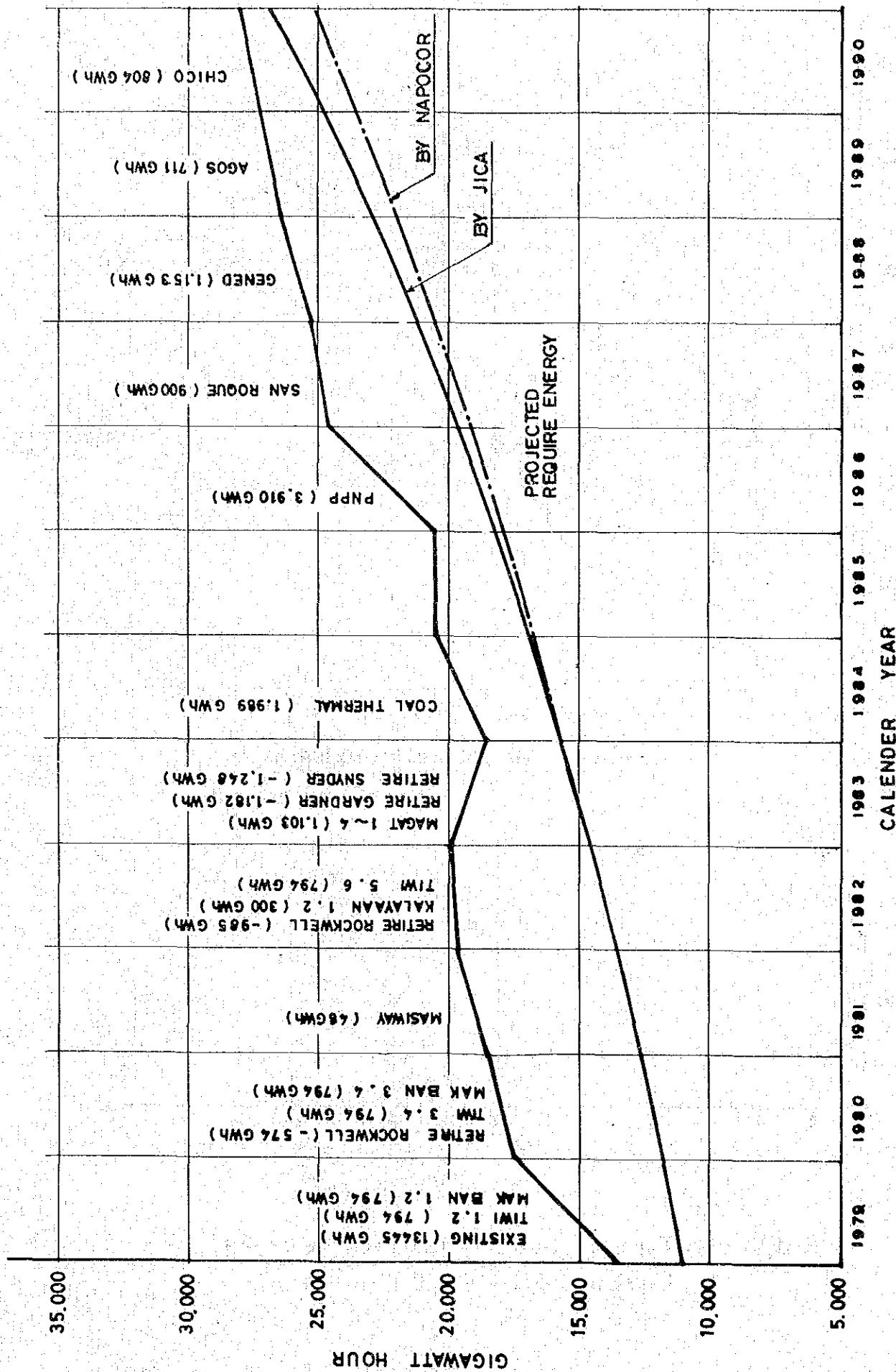


Fig. 3 - 2 System Energy Requirement & Supply Curve

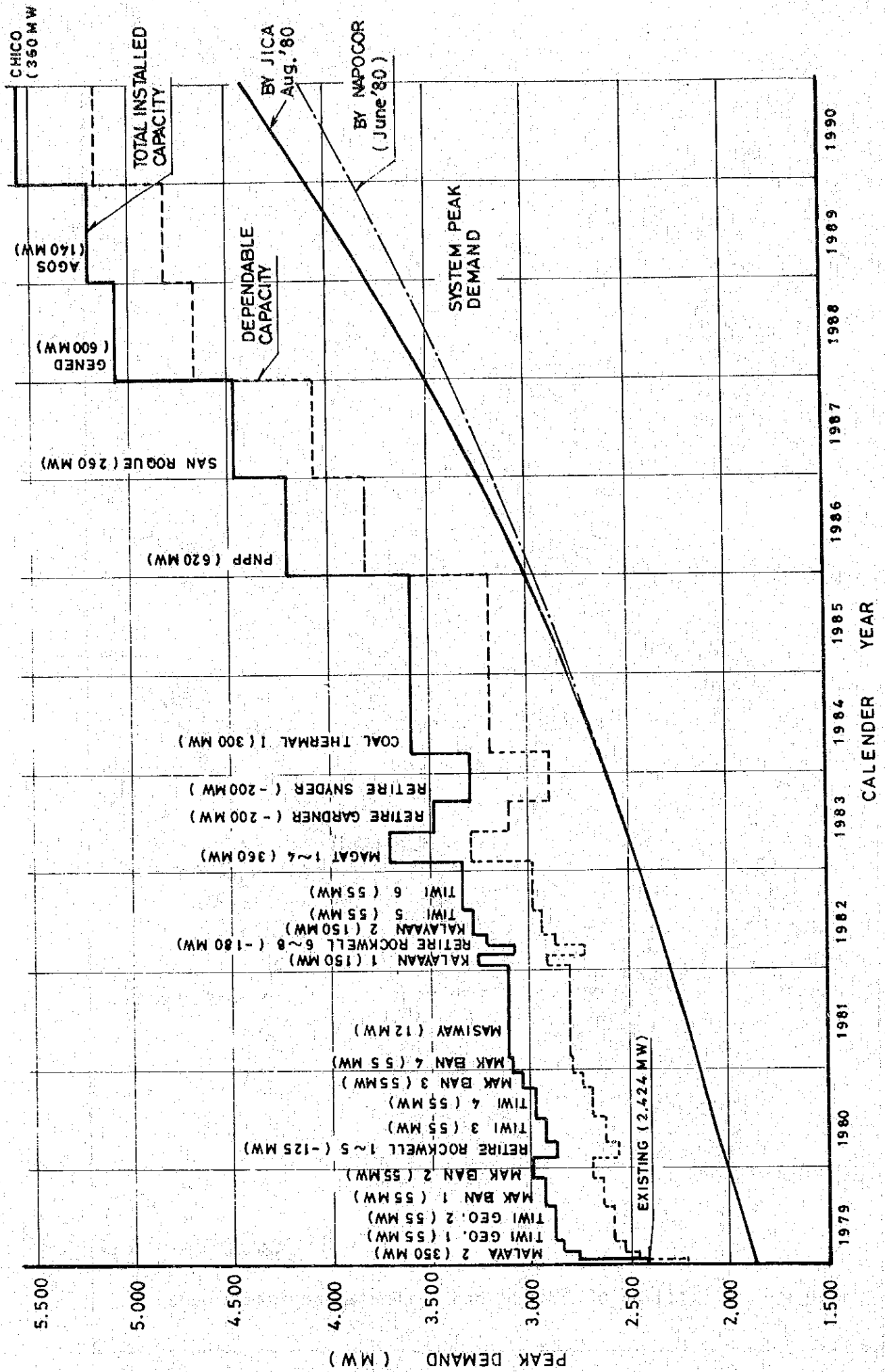


Fig. 3 - 3 System Peak Demand & Supply Capacity

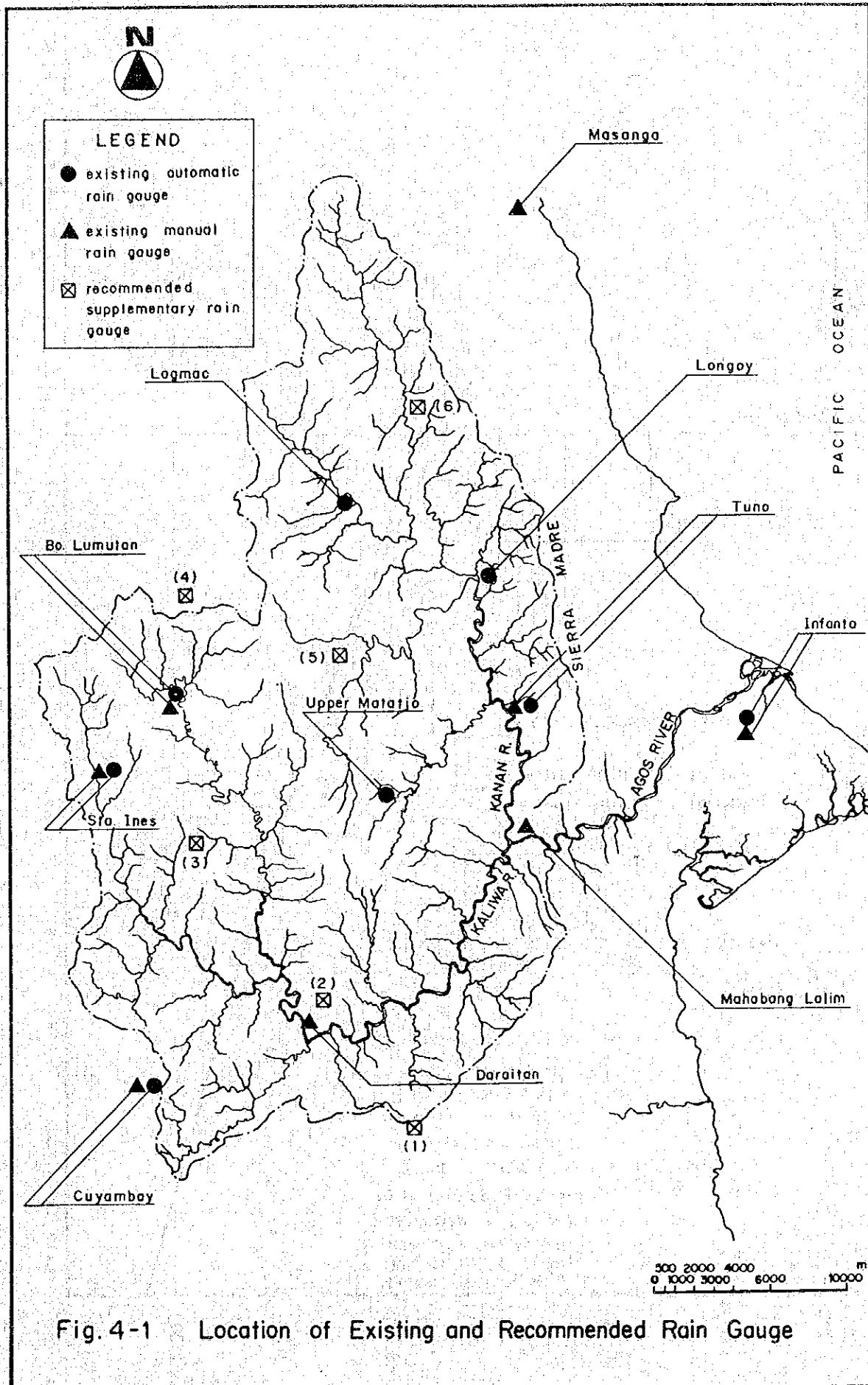


Fig. 4-1 Location of Existing and Recommended Rain Gauge

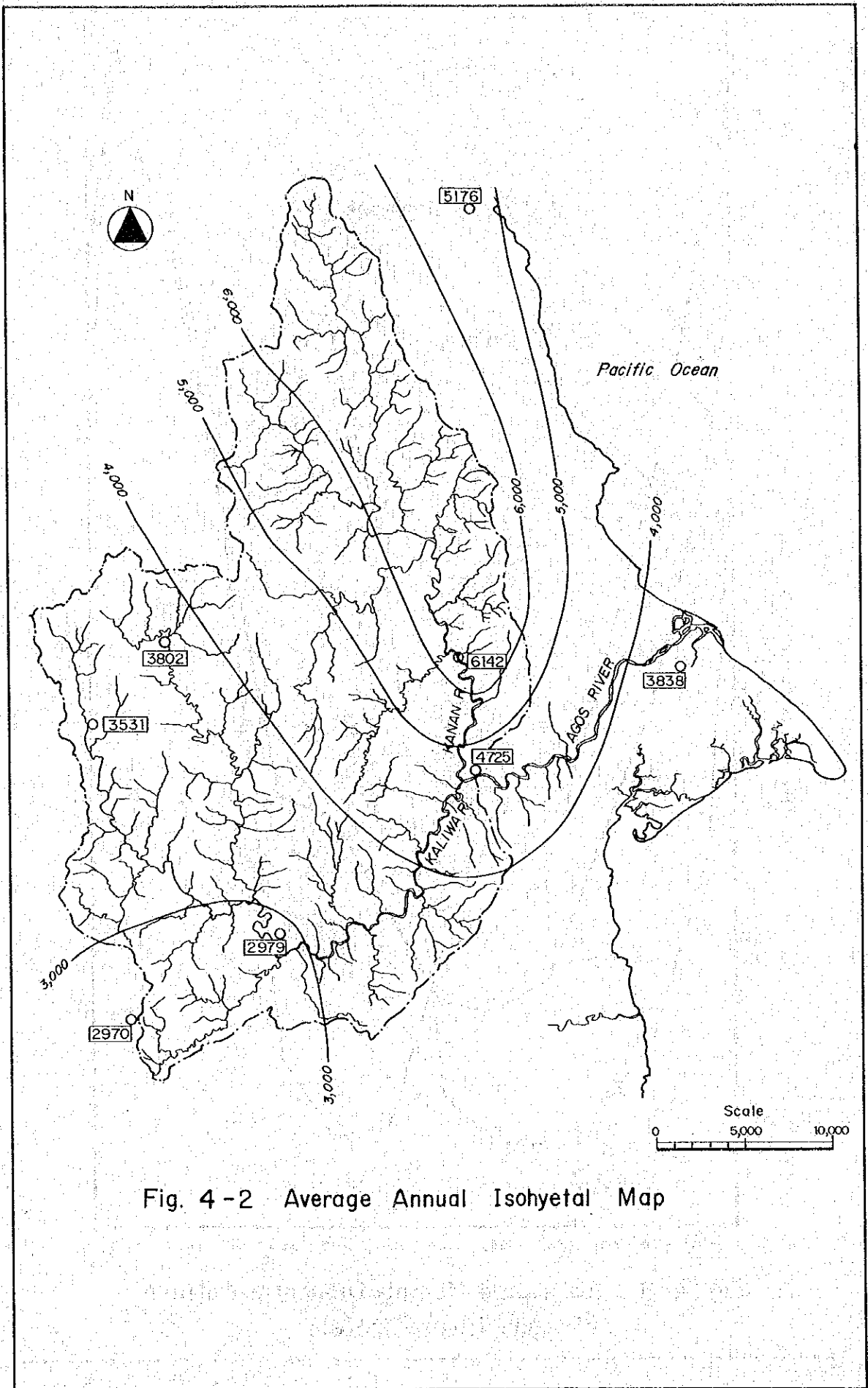


Fig. 4 -2 Average Annual Isohyetal Map

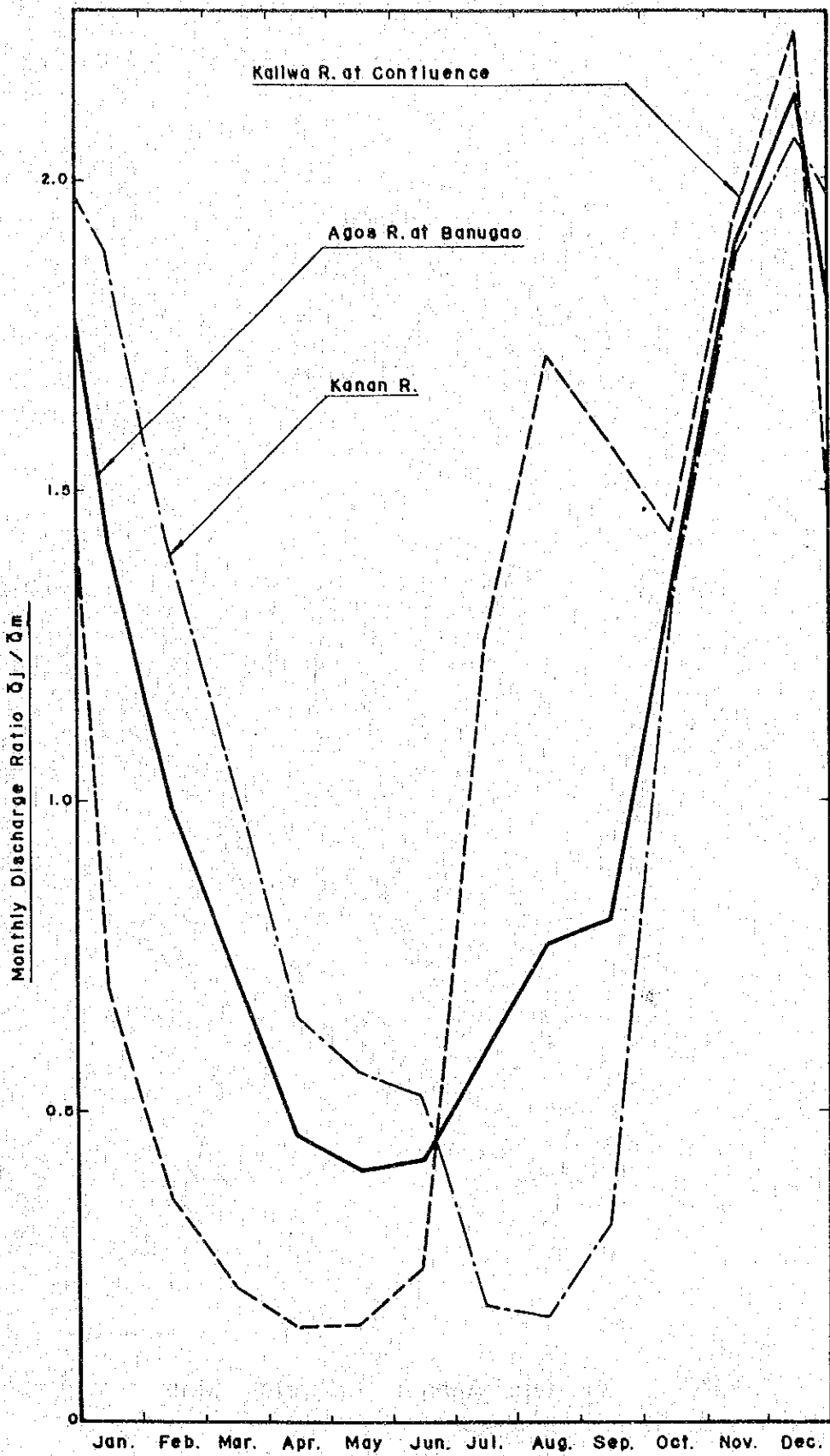


Fig. 4-3 Estimated Monthly Discharge Pattern of Agos River System.

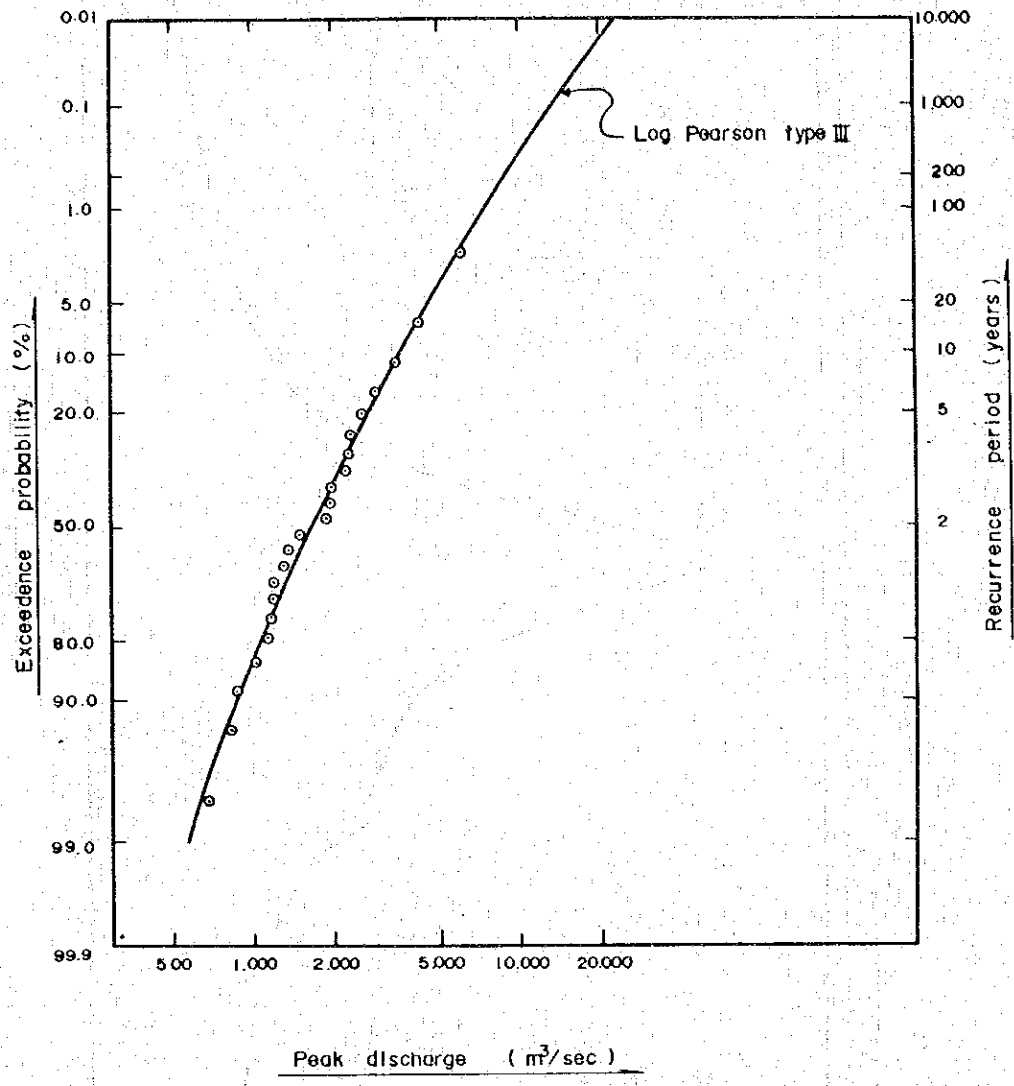


Fig. 4-4 Flood Frequency Curve, Agos River at Banugao G.S.

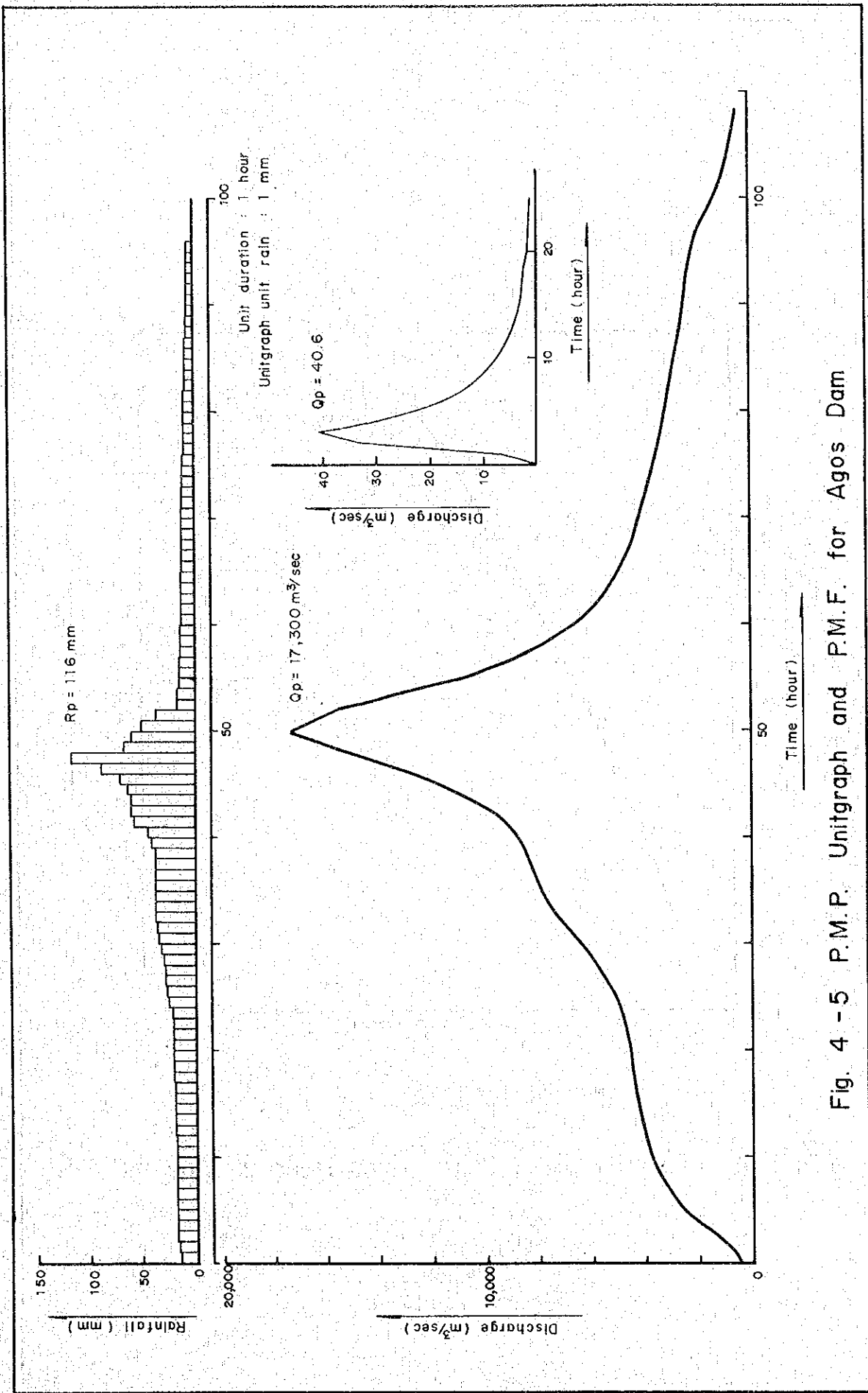


Fig. 4 - 5 P.M.P. Unitgraph and P.M.F. for Agos Dam



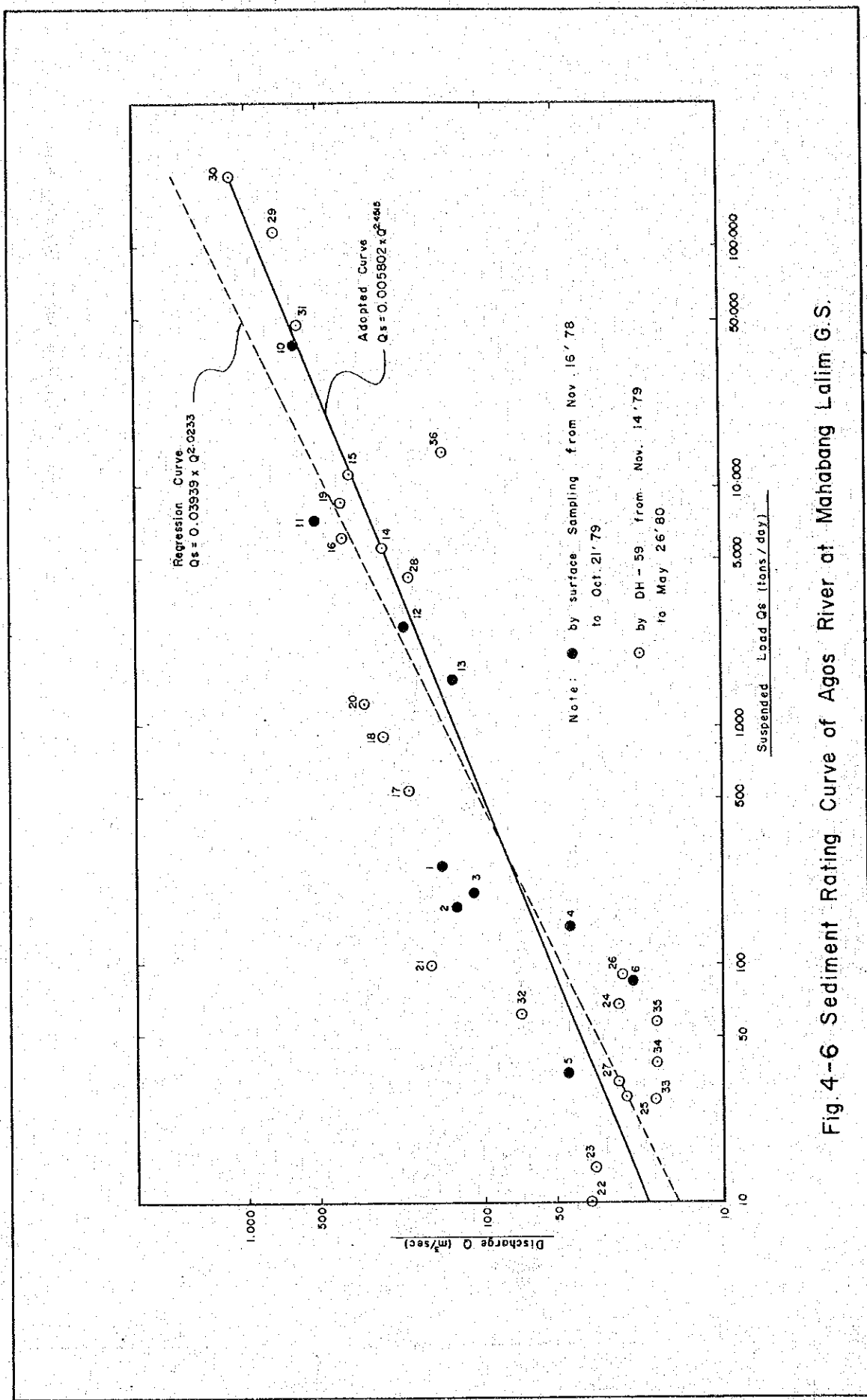


Fig. 4-6 Sediment Rating Curve of Agos River at Mahabang Lalim G.S.



Boundary curves are shown at the following conditions

1.  $F_{15} \geq 5 \times B_{15}$
2.  $F_{15} \leq 5 \times B_{65}$
3.  $F_{15} \leq 0.074 \text{ mm}$
4. Filter gradation curve to be similar to basement material (core material) gradation curve.

where;

F ; Filter grain size, suffix is percentage passing  
 B ; Basement material grain size  
 $B_{15} = 0.01\text{mm}$      $B_{65} = 0.7 \text{ mm}$

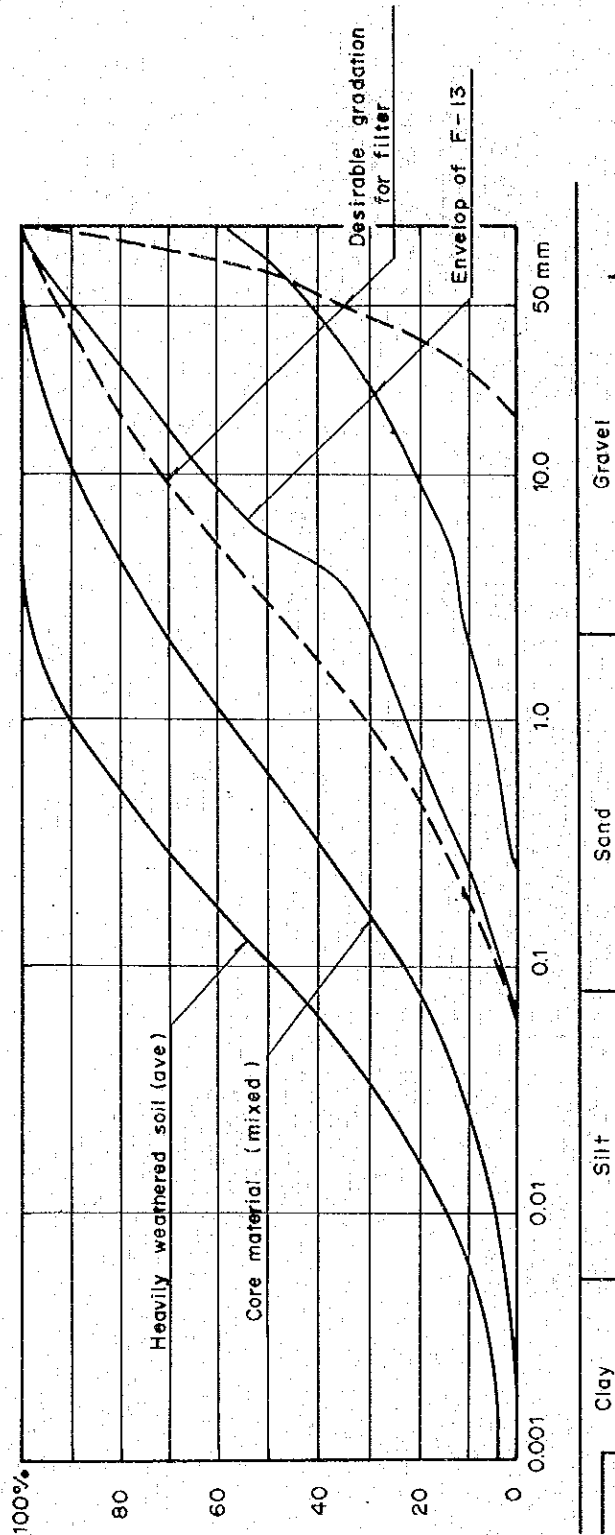
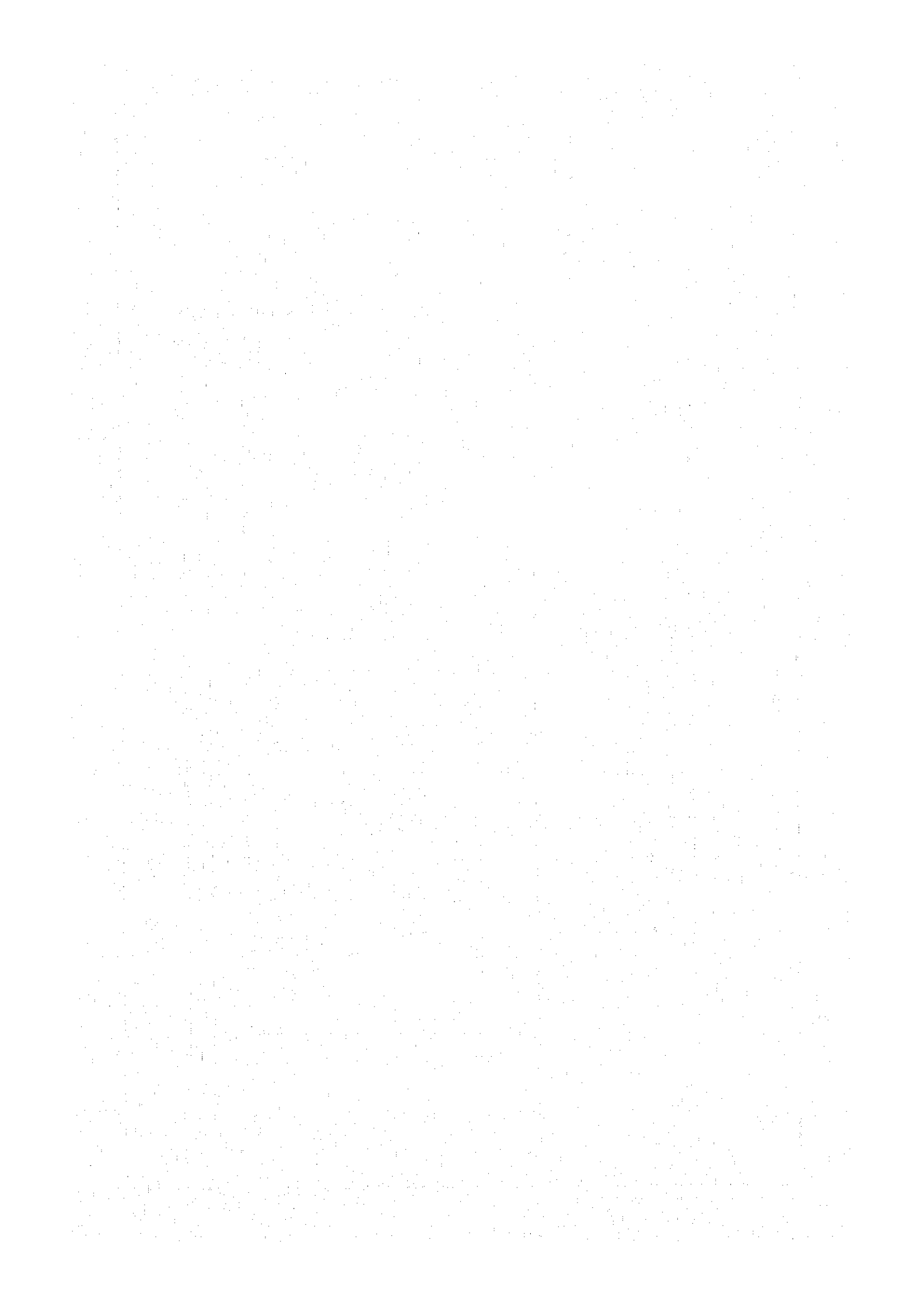
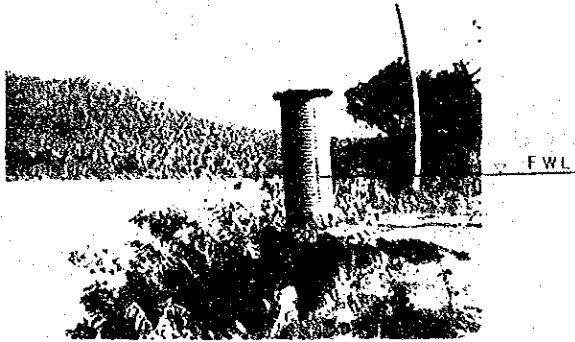
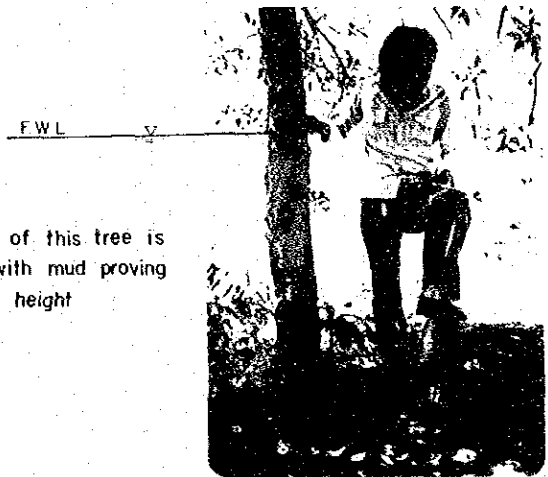


Fig. 4-8 Gradation Curves of Embankment Materials





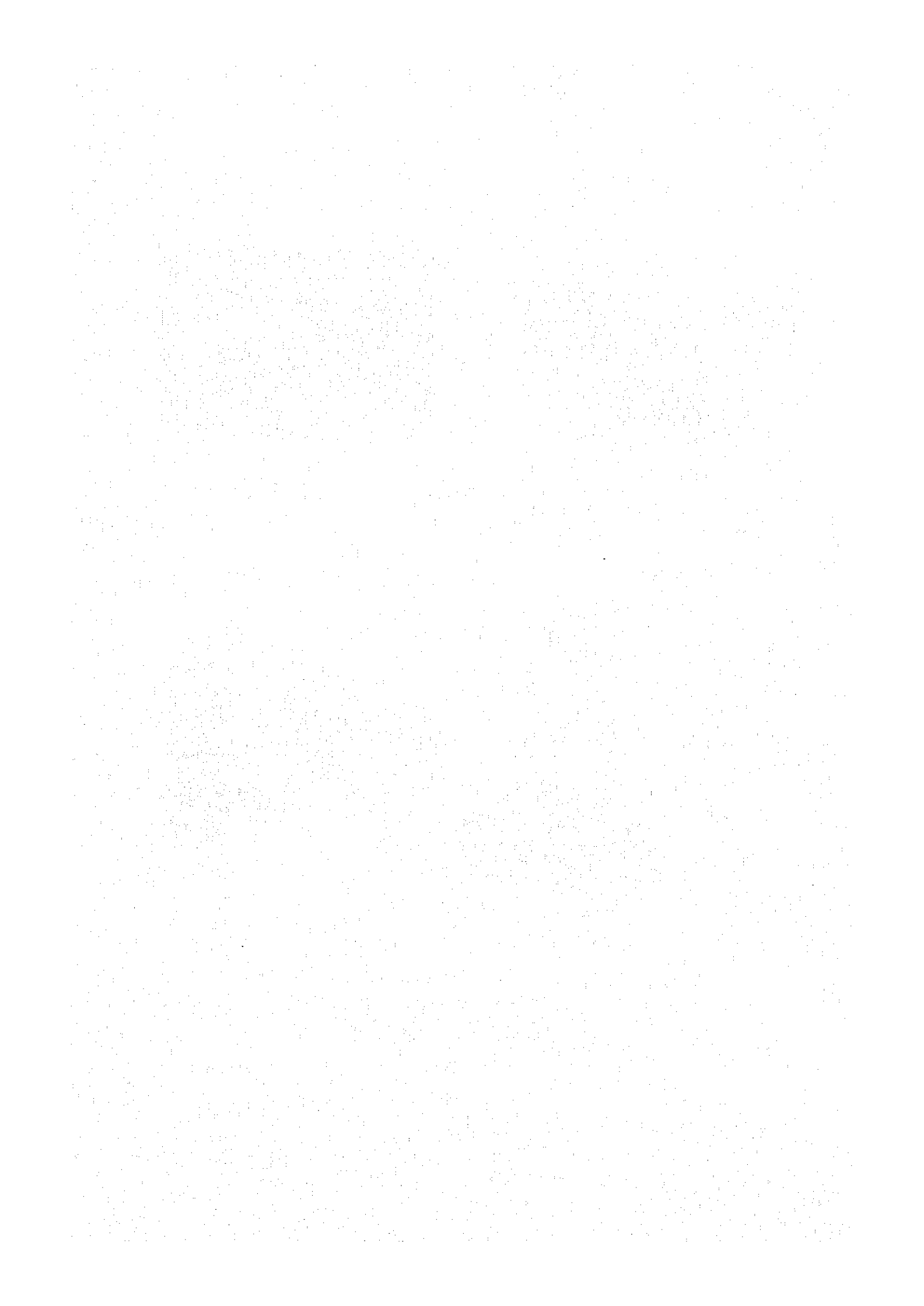
Eroded bank around the Banugao Stream Gauging Station during the flood on Oct. 26, 1978



The trunk of this tree is stained with mud proving the flood height



Fig.5-1 Flood Marks at Banugao on Agos River caused by the Typhoon Kading Oct. 26, 1978  
( Photographs taken on March 9, 1979 )



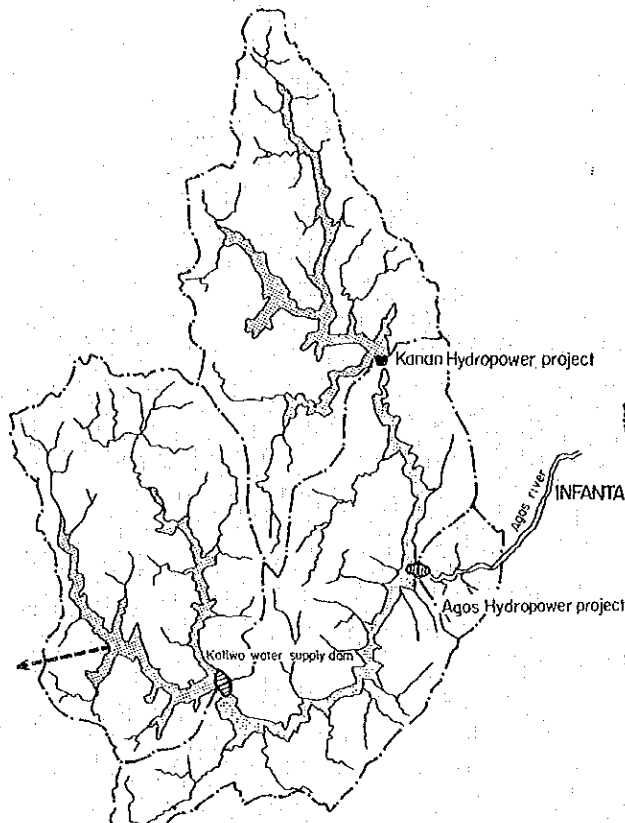


Fig5-2 Alternative Development Plan A-1

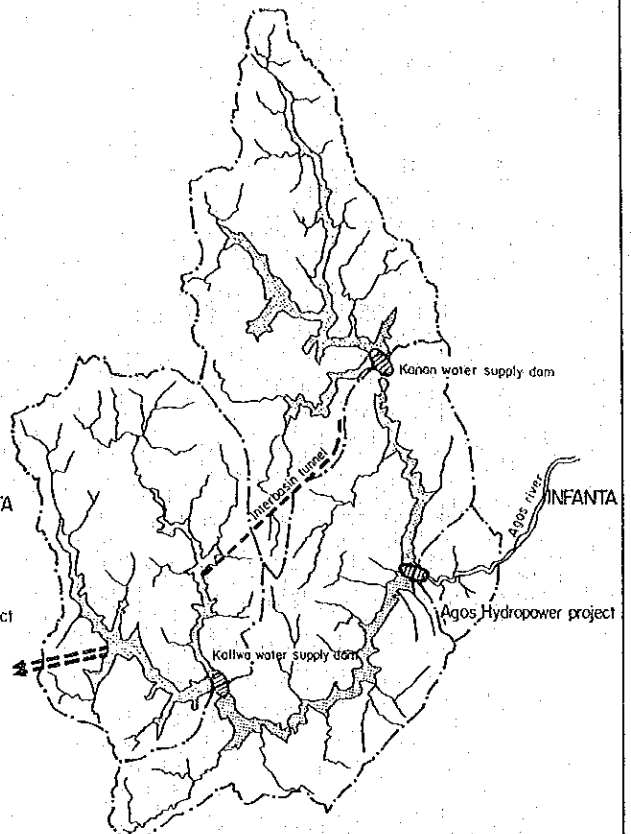


Fig.5-3 Alternative Development Plan A-2

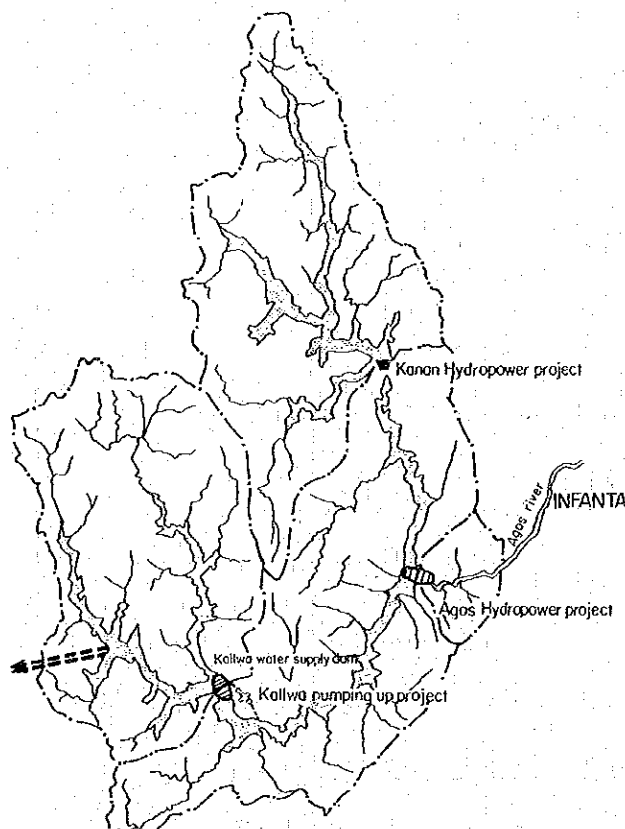


Fig5-4 Alternative Development Plan A-3

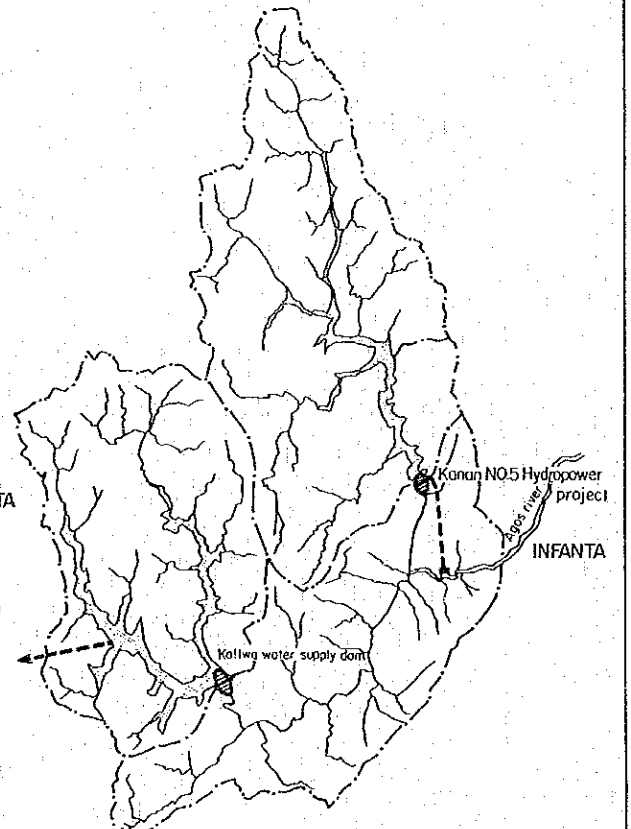


Fig.5-5 Alternative Development Plan B

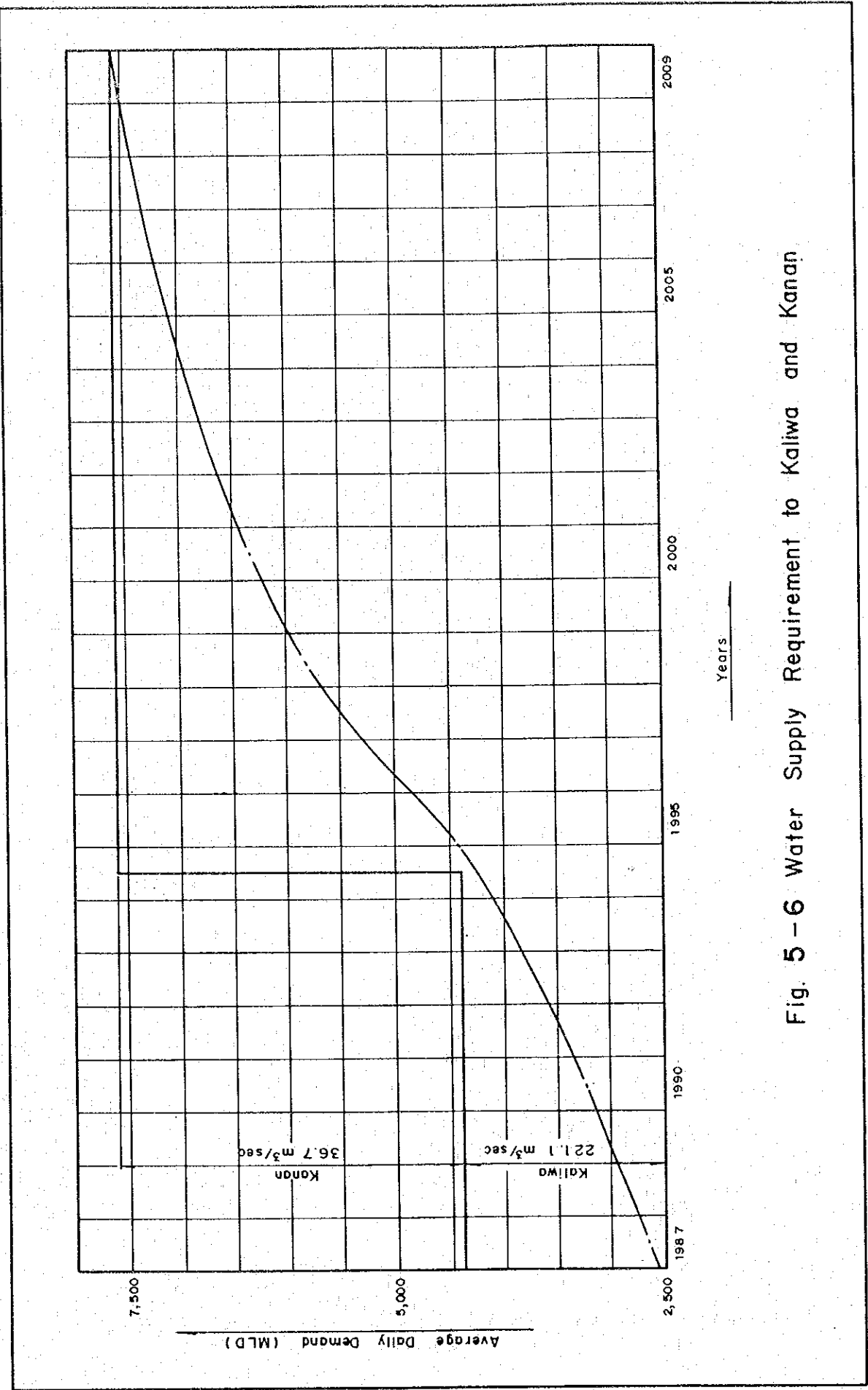


Fig. 5 - 6 Water Supply Requirement to Kaliwa and Kanan



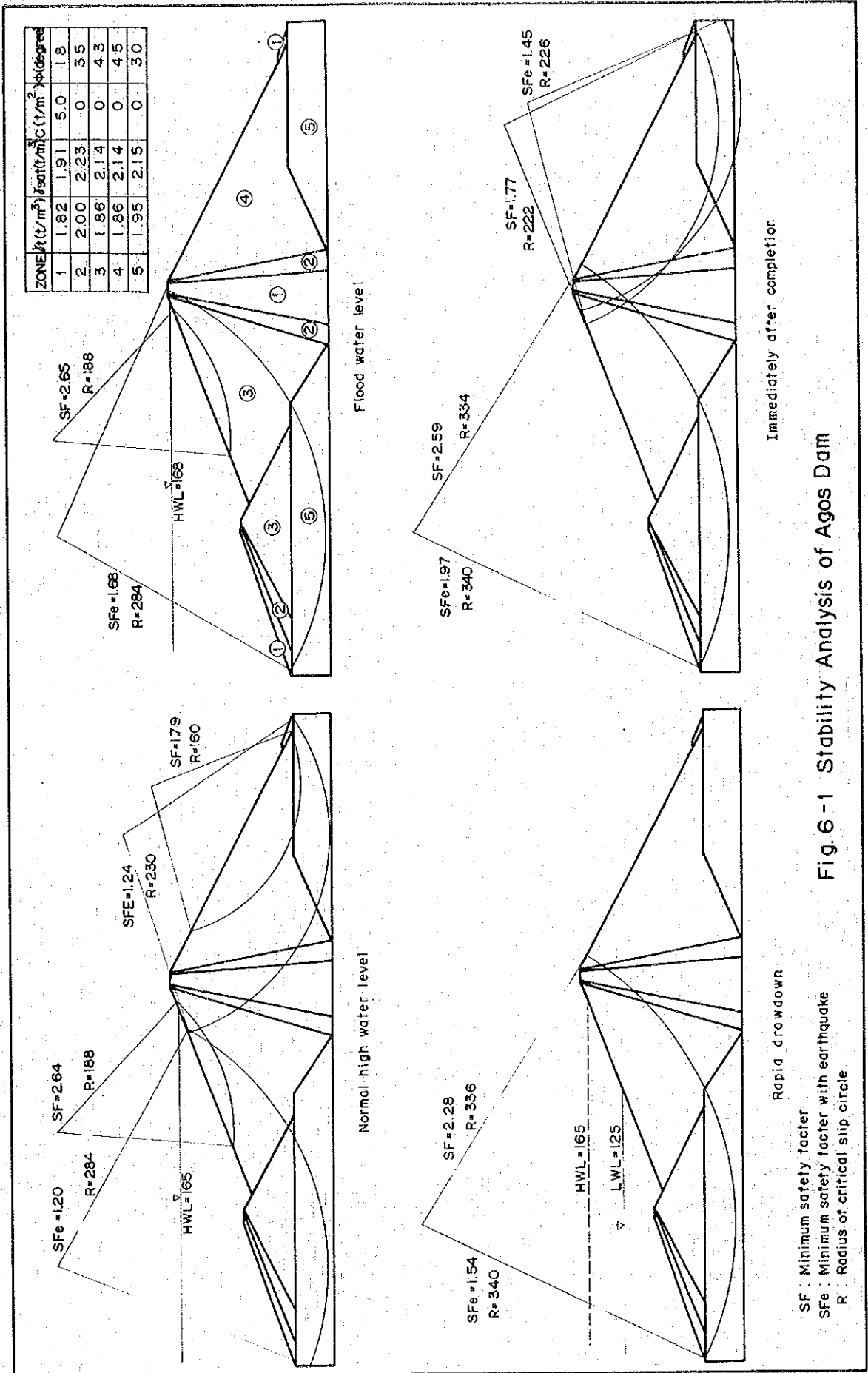


Fig. 6-1 Stability Analysis of Agos Dam



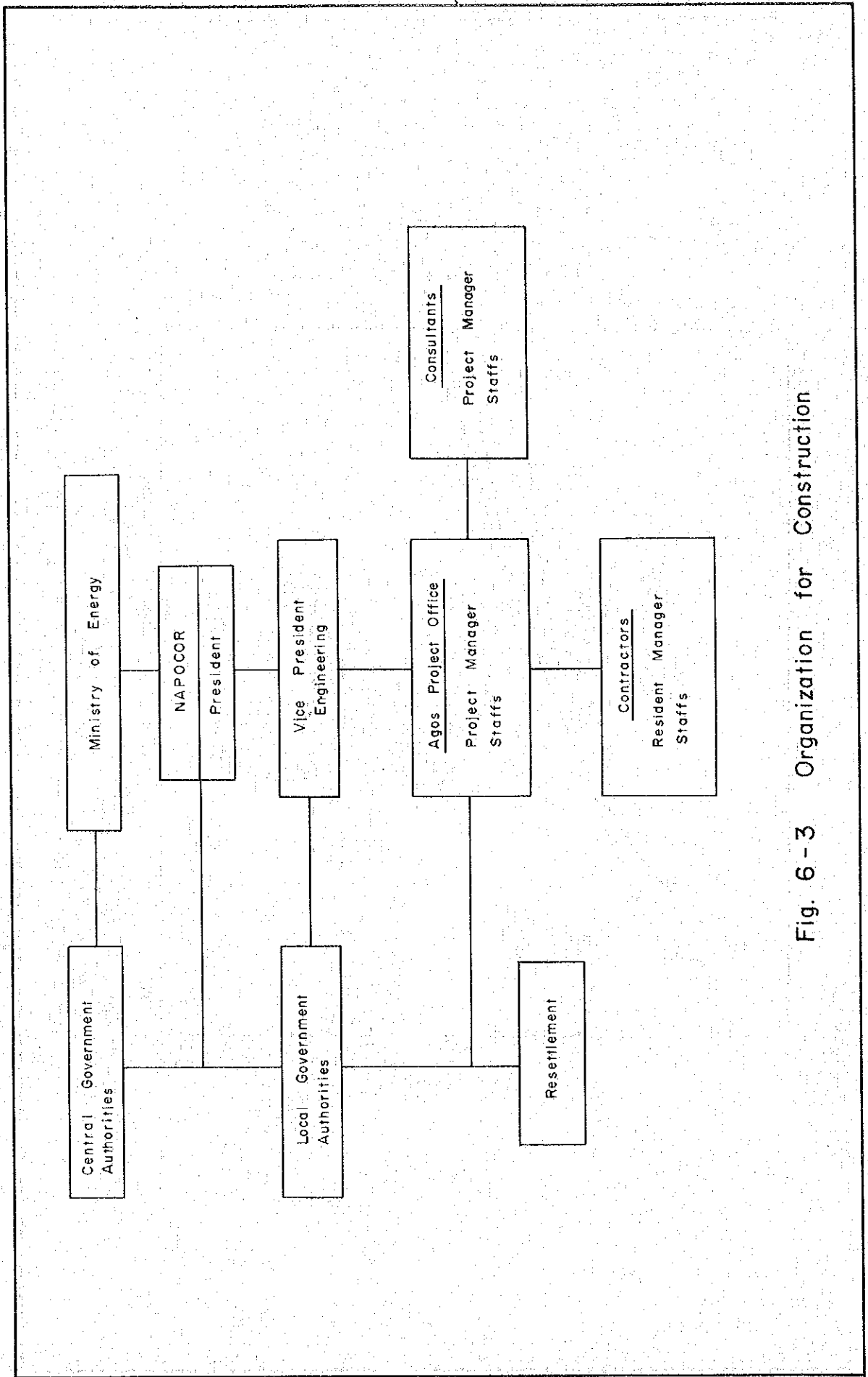


Fig. 6-3 Organization for Construction

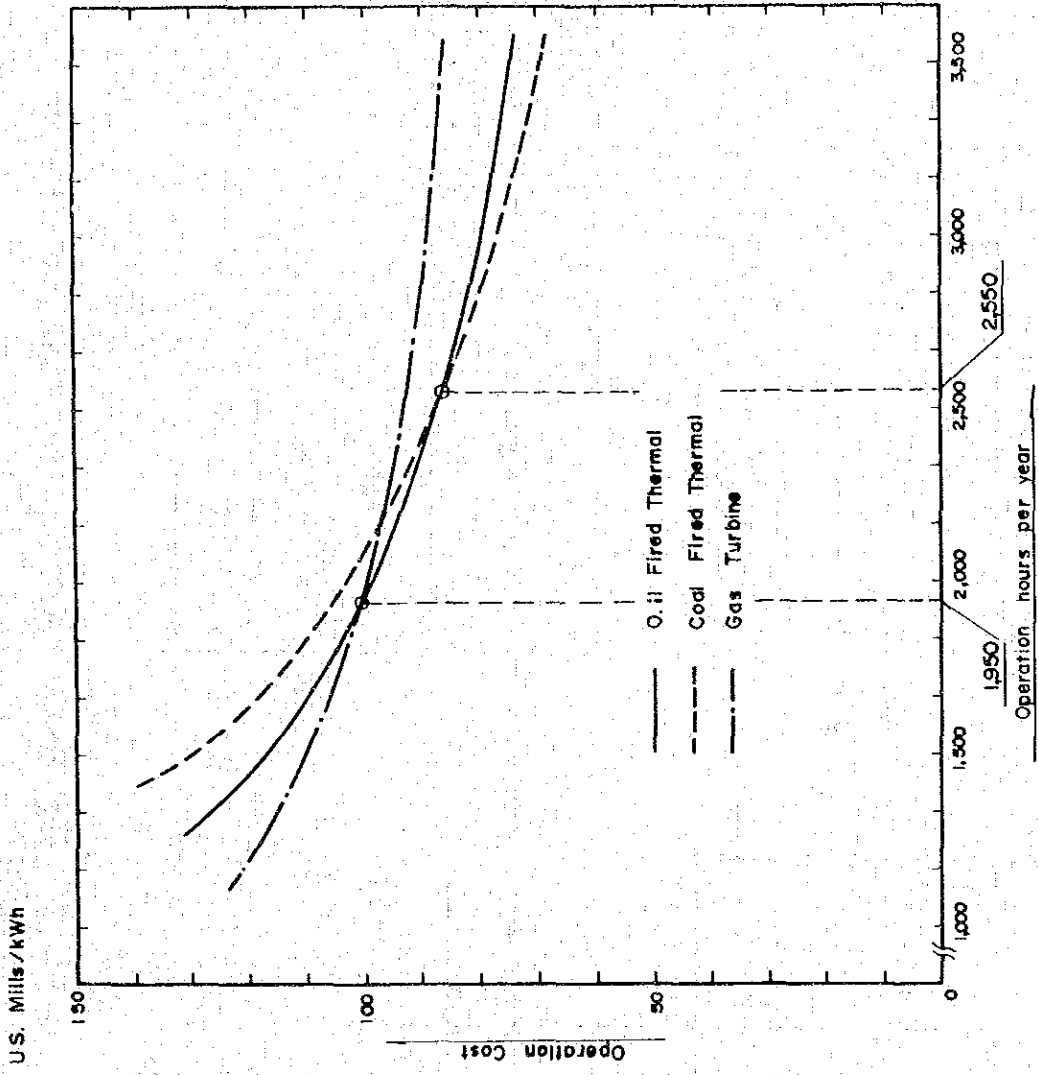


Fig. 7-1 Comparison of Power Cost by Alternative Plants

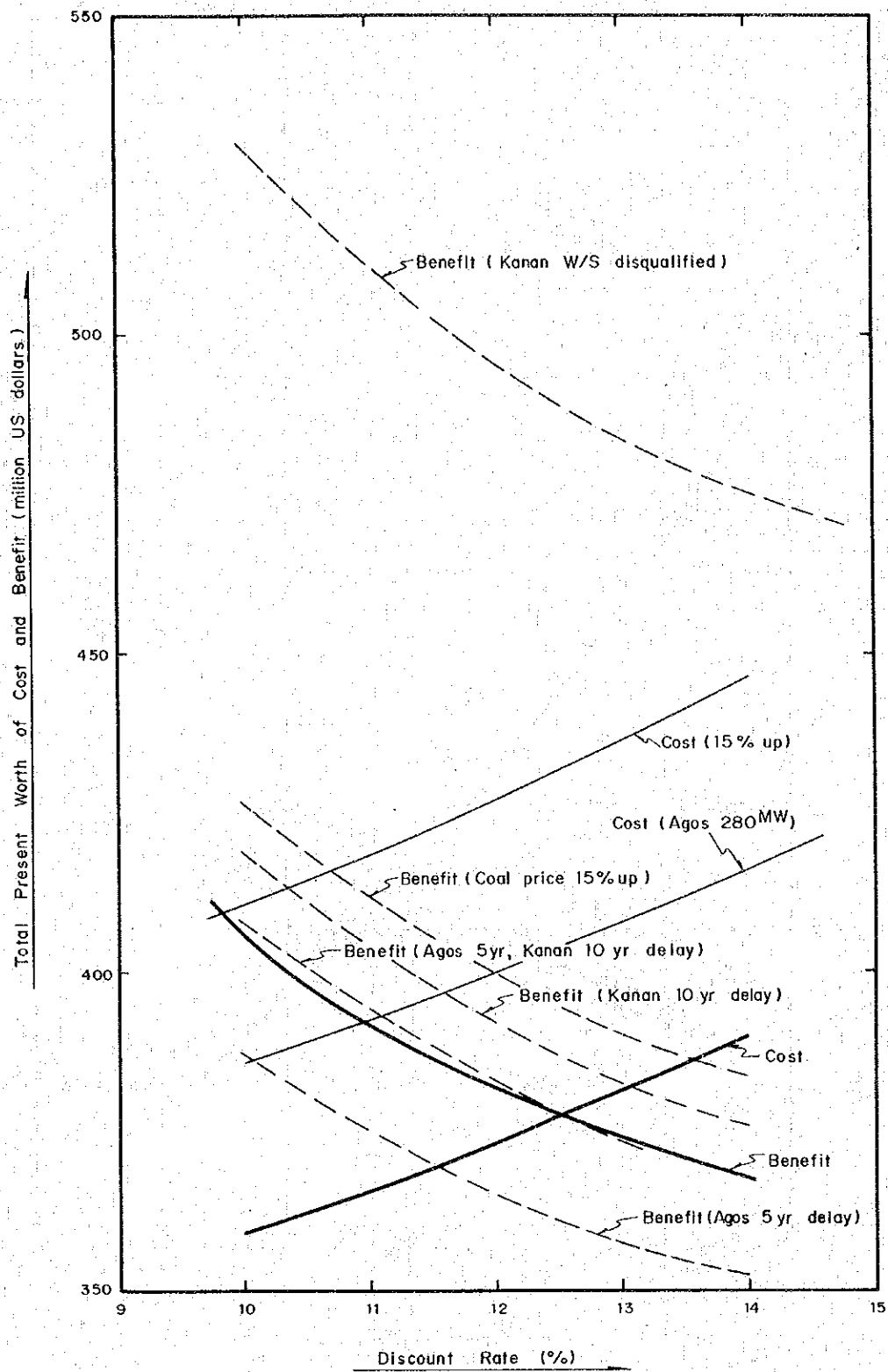


Fig. 7-2 Economic Internal Rate of Return

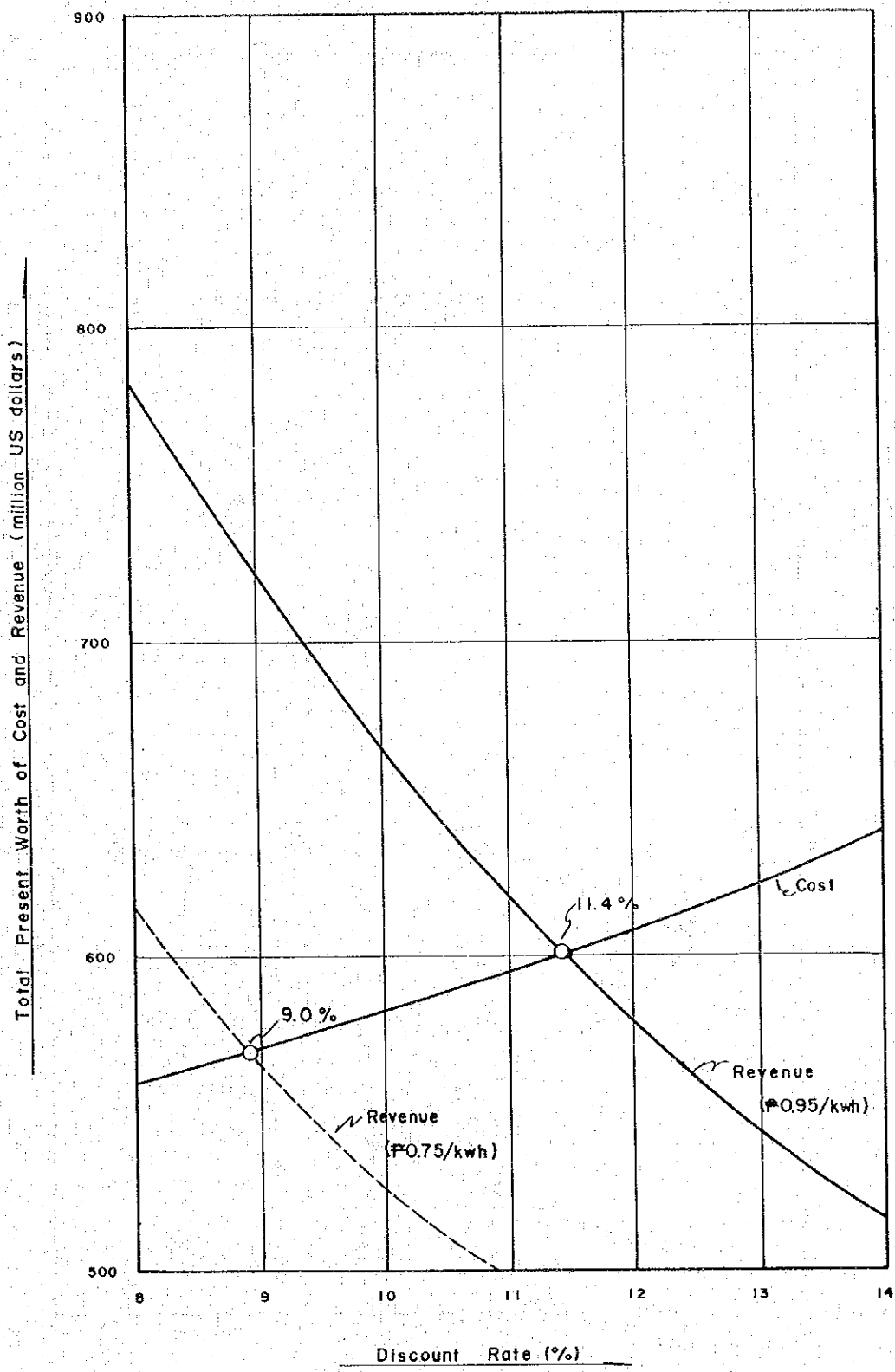
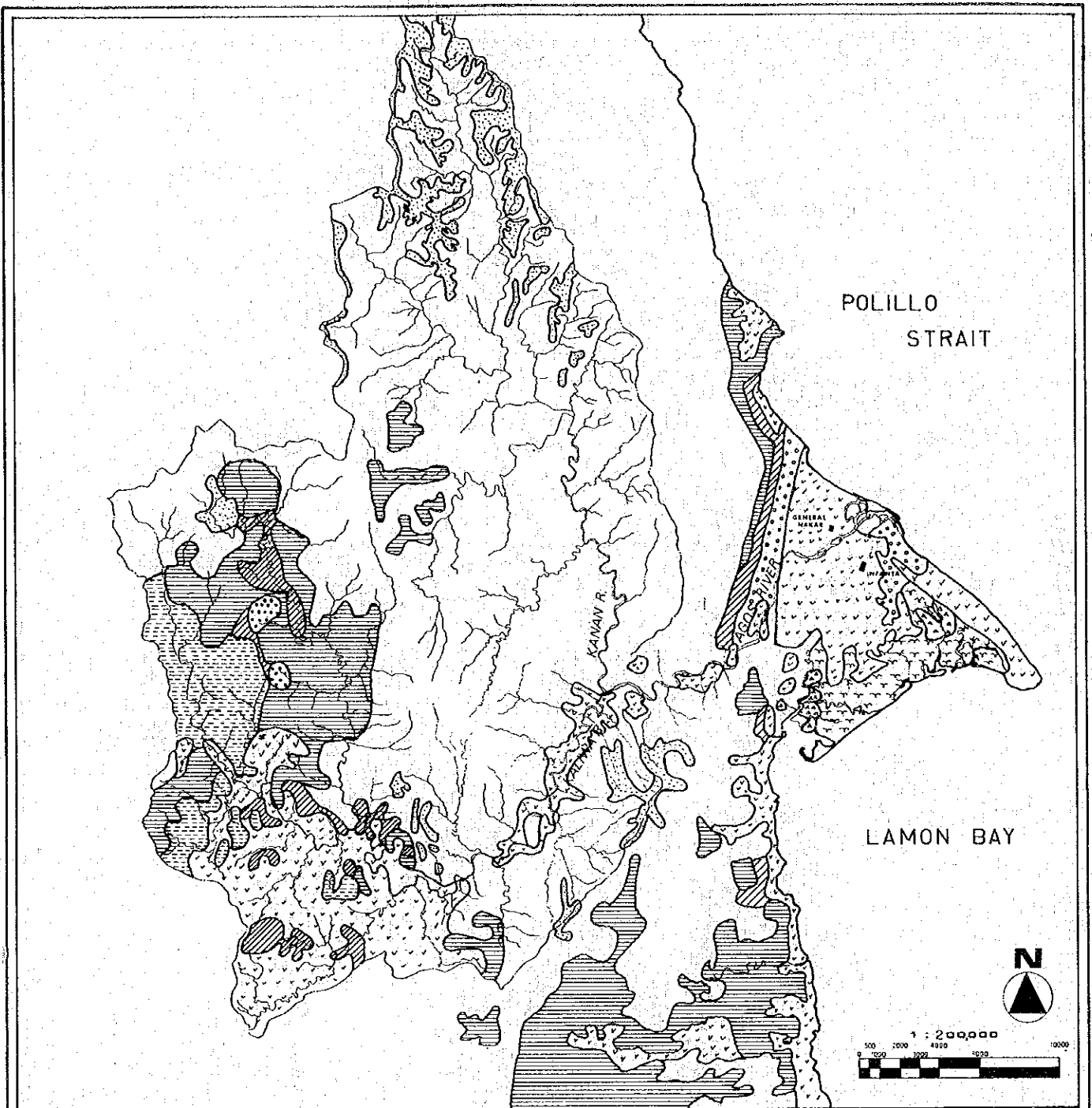


Fig. 7-3 Financial Internal Rate of Return



**LEGEND**











- |   |                      |   |                  |
|---|----------------------|---|------------------|
|  | Old Growth Forest    |  | Open & Grassland |
|  | Young Growth Forest  |  | Pines            |
|  | Reproduction - Brush |  | Fish Pond        |
|  | Mossy Forest         |  | Mangrove         |
|  | Cultivated Land      |  | Plantation       |

Fig.8-1 General Land Use

SOURCE: FOREST RESOURCES CONDITION MAP OF 1969

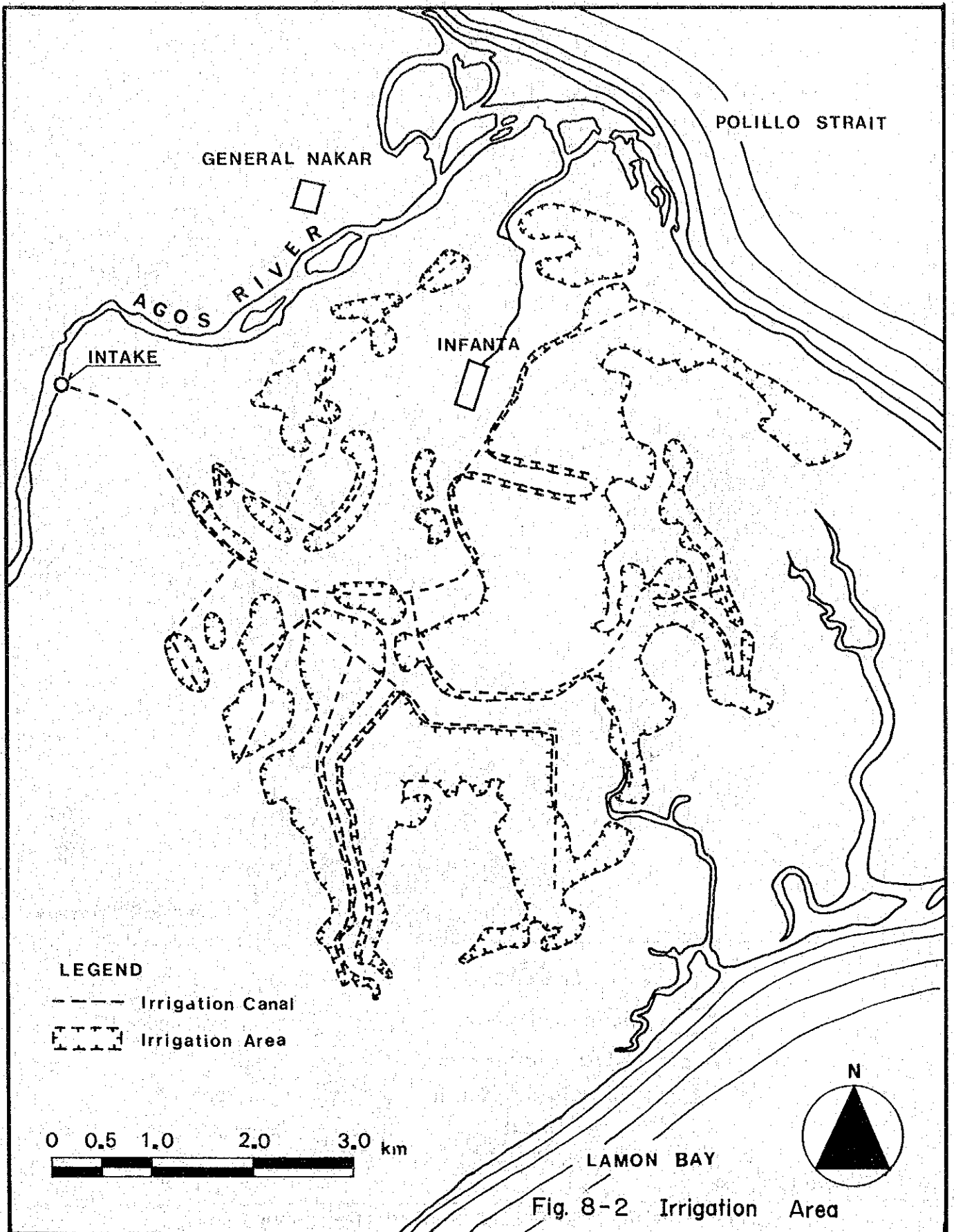
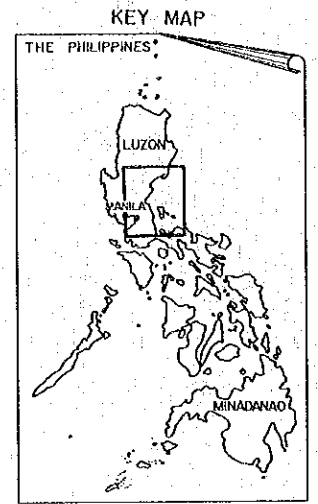
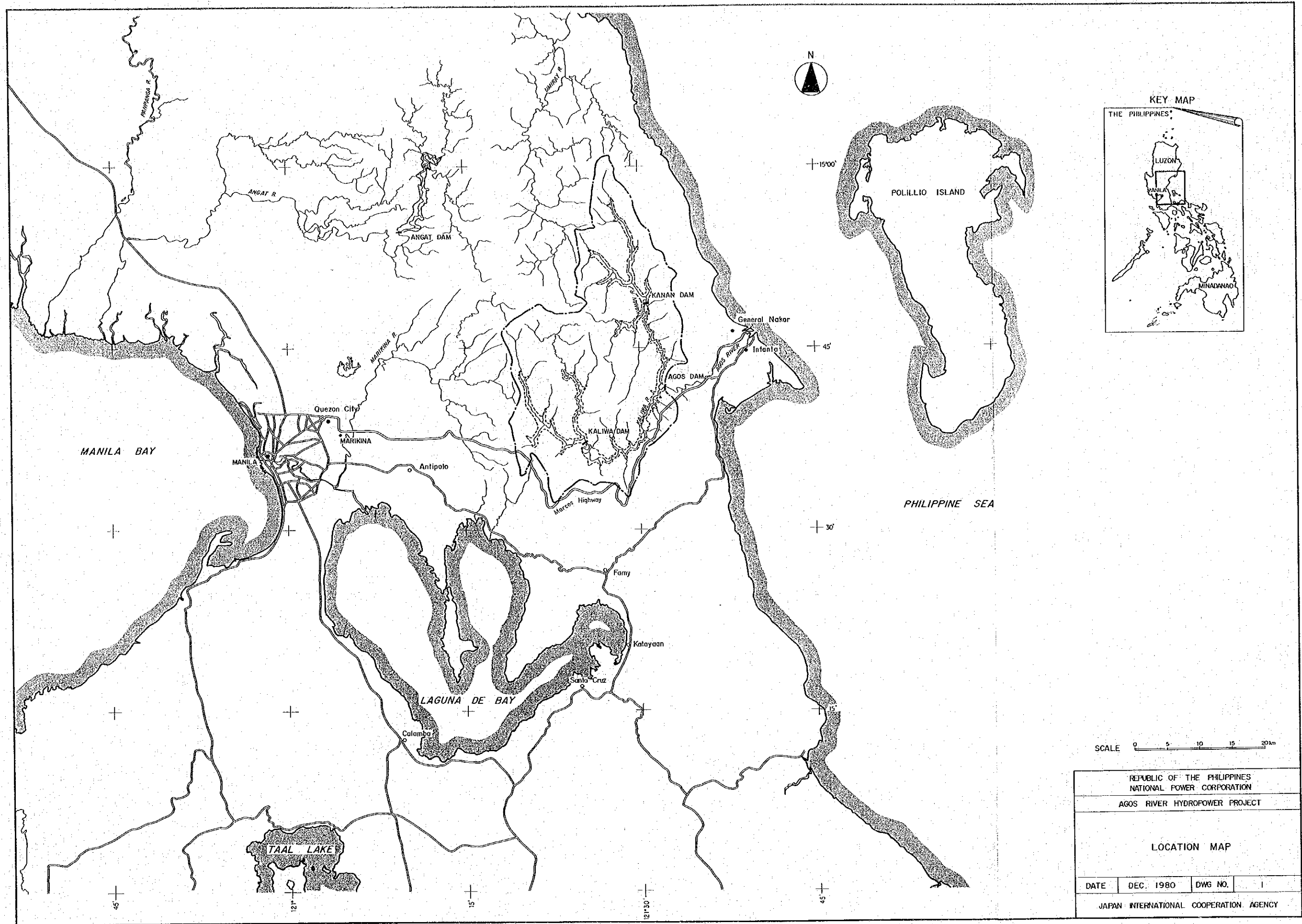


Fig. 8-2 Irrigation Area

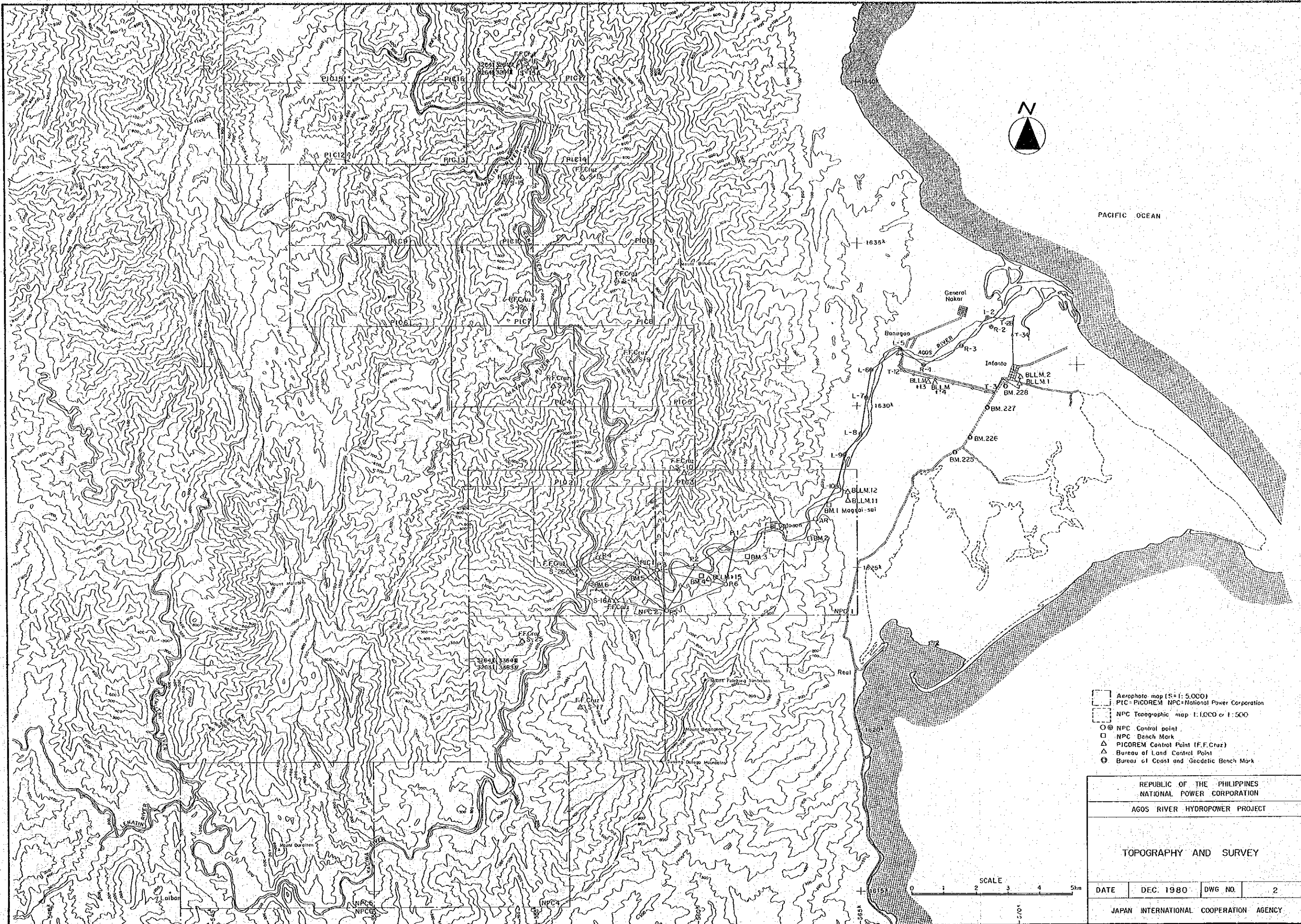


DRAWINGS



SCALE 0 5 10 15 20km

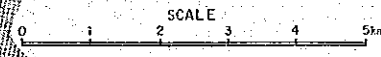
REPUBLIC OF THE PHILIPPINES NATIONAL POWER CORPORATION			
AGOS RIVER HYDROPOWER PROJECT			
LOCATION MAP			
DATE	DEC. 1980	DWG NO.	1
JAPAN INTERNATIONAL COOPERATION AGENCY			



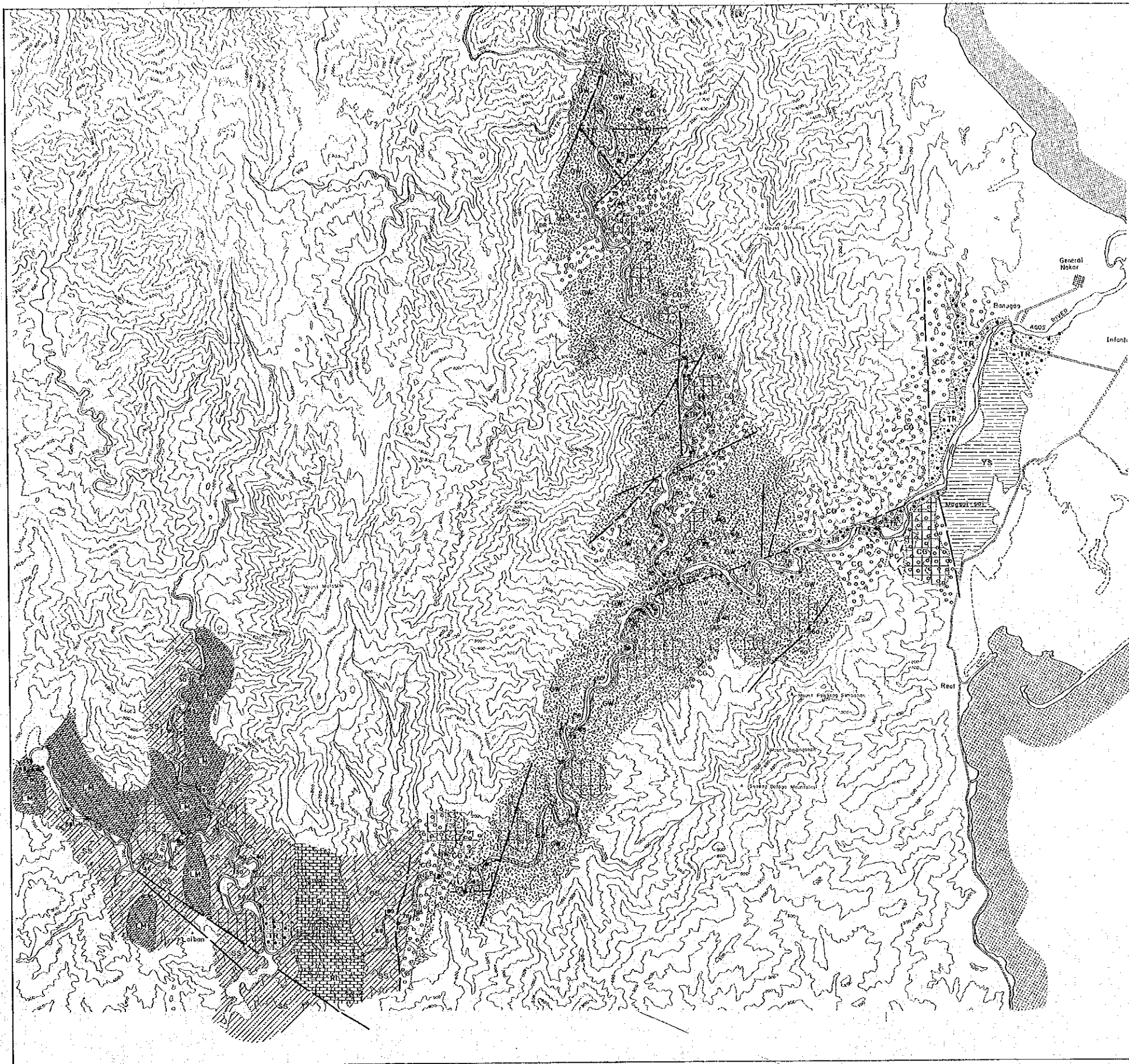
PACIFIC OCEAN

- Aerial photo map (S+ 1:5,000)
- PIC - PICOREM NPC - National Power Corporation
- NPC Topographic map 1:1,000 or 1:500
- NPC Control point
- NPC Bench Mark
- △ PICOREM Control Point (F.F.Cruz)
- △ Bureau of Land Control Point
- ⊙ Bureau of Coast and Geodetic Bench Mark

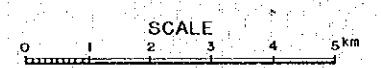
REPUBLIC OF THE PHILIPPINES NATIONAL POWER CORPORATION			
AGOS RIVER HYDROPOWER PROJECT			
TOPOGRAPHY AND SURVEY			
DATE	DEC. 1980	DWG NO.	2
JAPAN INTERNATIONAL COOPERATION AGENCY			



2/7



- LEGEND**
- QUATERNARY
    - [Symbol] RIVERBED DEPOSIT
    - [Symbol] RESIDUAL SOIL
    - [Symbol] TERRACE DEPOSIT
    - [Symbol] YOUNG SEDIMENTARY ROCKS
  - OLIGOCENE - MIOCENE
    - [Symbol] MASSIVE REEF LIMSTONE
  - UNDIFFERENTIATED
    - [Symbol] PYROCLASTIC ROCK
    - [Symbol] GREYWACKE, CALCAREOUS BRECCIA
    - [Symbol] FINE SANDSTONE
    - [Symbol] CONGLOMERATE
    - [Symbol] ALTERNATING SANDSTONE, SHALE
    - [Symbol] FOLDED LIMSTONE
  - CRETACEOUS - TERTIARY
    - [Symbol] ANDESITE, BASALT
    - [Symbol] DIORITE
  - [Symbol] Strike and dip of bedding plane
  - [Symbol] Strike and dip of fault
  - [Symbol] Fault



REPUBLIC OF THE PHILIPPINES  
 NATIONAL POWER CORPORATION  
 AGOS RIVER HYDROPOWER PROJECT

**REGIONAL GEOLOGICAL MAP**

DATE	DEC. 1980	DWG. NO.	3
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JAPAN INTERNATIONAL COOPERATION AGENCY