Table 2.2 Effective Rainfall in Montong Krarak Project

Site : Montong Krarak
Meteorological Station : Pegondang Sakra

Month	Evapotrans-piration (ETo)	Average Rainfall		Annual-base Dependable Rainfall	Effective Rainfall	
					Paddy	Palawija
	[1] (mm)	[2] (mm)	[3] (%)	[4] (mm)	[5] (mm)	[6] (mm)
January	174	267	21.8%	190	133	135
February	157	211	17.2%	150	105	106
March	176	145	11.8%	103	72	80
April	165	48	3.9%	34	24	28
May	154	49	4.0%	35	24	27
June	145	35	2.9%	25	17	19
July	158	26	2.1%	19	13	15
August	178	10	0.8%	7	5	0
September	191	17	1.4%	12	8	0
October	210	53	4.3%	38	26	34
November	190	142	11.6%	101	71	80
December	173	221	18.1%	157	110	113
Total	2,071	1,224	100.0%	872	610	637

Note ;

[1] : Estimated by Modified Penman Method based on Selong station
[2] : Rainfall data in station compiled by DPU+Crippen (1951-1985)
[3] : Percentage of monthly rainfall to annual rainfall, calculated from column [2]
[4] : 872 mm (Calculated 80 % dependable annual rainfall) x [3]
[5] : [4] x 0.70
[6] : Derived by USDA SCS Method introduced by Design Criteria KP-01, where effective storage is assumed 75 mm

Source ; JICA Study Team estiamtin based on the rainfall data at the Pegondang Sakura station

Table 2.3 Irrigation Water Requirement in Montong Krarak Project (1/2)

Site : Montong Krarak
Crops : Wet Season Paddy

Item		Jan. 1	Jan. 2	Feb. 1	Feb. 2	Mar. 1	Mar. 2	Apr. 1	Apr. 2	May 1	May 2	Jun. 1	Jun. 2	Jul 1	Jul 2	Aug. 1	Aug. 2	Sep. 1	Sep. 2	Oct. 1	Oct. 2	Nov. 1	Nov. 2	Dec. 1	Dec. 2	Annual
	Month (days)	15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	
I. Evapotranspiration (Eto)	mm/day	5.60	5.60	5.61	5.61	5.69	5.69	5.50	5.50	4.98	4.98	4.84	4.84	5.11	5.11	5.75	5.75	6.38	6.38	6.79	6.79	6.33	6.33	5.58	5.58	
	mm	84	90	79	79	85	91	83	83	75	80	73	73	77	82	86	92	96	96	102	109	95	95	84	89	2,073
II. Wet Season Paddy																										
(1) Proposed cropping pattern / Crop coefficient																										
- WP-1		1.10	1.10	1.05	1.05	0.95	0.00																	LP	LP	
- WP-2		LP	1.10	1.10	1.05	1.05	0.95	0.00																	LP	
- WP-3		LP	LP	1.10	1.10	1.05	1.05	0.95	0.00																	
(2) Crop consumptive use (Etc)																										
- WP-1	mm	92	99	82	82	81	0																			437
- WP-2	mm		99	86	82	90	86	0																		444
- WP-3	mm			86	86	90	96	78	0																	436
(3) Land preparation (IR)																										
- WP-1	mm																							197	210	407
- WP-2	mm	197																							210	407
- WP-3	mm	197	210																							407
(4) Percolation																										
- WP-1	mm	30	32	28	28	30																				
- WP-2	mm		32	28	28	30	32																			
- WP-3	mm			28	28	30	32	30																		
(5) Water layer replacement (RW)																										
- WP-1	mm		50		50																					
- WP-2	mm			50		50																				
- WP-3	mm				50		50																			
(6) Effective rainfall (ER)	mm	64	69	53	52	35	37	12	12	12	12	9	8	6	7	2	3	4	4	13	13	35	36	53	57	608
(7) Field water requirement																										
- WP-1	mm	58	112	57	108	76	0																	144	153	709
- WP-2	mm	133	62	111	58	135	81	0																	153	734
- WP-3	mm	133	141	61	112	85	141	96	0																	769
(8) Diversion requirement	mm	166	161	118	143	151	114	49	0															74	157	1,134
	m3/ha	1,660	1,610	1,180	1,430	1,510	1,140	490	0															740	1,570	11,330

Source : JICA Study Team estimate based on the meteorological data at the Selong and the Pegondang station

Table 2.3 Irrigation Water Requirement in Montong Krarak Project (2/2)

Site : Montong Krarak
Crops : Palawija (1) & (2) : Tobacco and Soybeans

Item	Month (days)	Jan. 1 15	Jan. 2 16	Feb. 1 14	Feb. 2 14	Mar. 1 15	Mar. 2 16	Apr. 1 15	Apr. 2 15	May 1 15	May 2 16	Jun. 1 15	Jun. 2 15	Jul 1 15	Jul 2 16	Aug. 1 15	Aug. 2 16	Sep. 1 15	Sep. 2 15	Oct. 1 15	Oct. 2 16	Nov. 1 15	Nov. 2 15	Dec. 1 15	Dec. 2 16	Annual
I. Evapotranspiration (Eto)	mm/day	5.60	5.60	5.61	5.61	5.69	5.69	5.50	5.50	4.98	4.98	4.84	4.84	5.11	5.11	5.75	5.75	6.38	6.38	6.79	6.79	6.33	6.33	5.58	5.58	
	mm	84	90	79	79	85	91	83	83	75	80	73	73	77	82	86	92	96	96	102	109	95	95	84	89	2,073
II. Palawija(1) : Tobacco																										
(1) Proposed cropping pattern / Crop coefficient(Kc)								**Tobacco**																		
									0.45	0.70	1.00	1.00	0.65	0.30												
- Pwj(1)-1										0.45	0.70	1.00	1.00	0.65	0.30											
- Pwj(1)-2											0.45	0.70	1.00	1.00	0.65	0.30										
- Pwj(1)-3																										
(2) Crop consumptive use(Etc)																										
- Pwj(1)-1	mm								37	52	80	73	47	23												
- Pwj(1)-2	mm									34	56	73	73	50	25											
- Pwj(1)-3	mm										36	51	73	77	53	26										
(3) Effective rainfall (ER)	mm	65	70	53	53	39	41	14	14	13	14	10	9	7	8	0	0	0	0	16	18	40	40	55	58	637
(4) Field water requirement																										
- Pwj(1)-1	mm								23	39	66	63	38	16												245
- Pwj(1)-2	mm									21	42	63	64	43	17											248
- Pwj(1)-3	mm										22	41	64	70	45	26										267
(5) Diversion requirement	mm								15	40	86	111	110	86	41	17										507
	m3/ha								150	400	860	1,110	1,100	860	410	170										5,060
III. Palawija (2) : Soybeans																										
(1) Proposed cropping pattern / Crop coefficient(Kc)								**Soybeans**																		
									0.50	0.75	1.00	1.00	0.82	0.23												
- Pwj(2)-1										0.50	0.75	1.00	1.00	0.82	0.23											
- Pwj(2)-2											0.50	0.75	1.00	1.00	0.82	0.23										
- Pwj(2)-3																										
(2) Crop consumptive use(Etc)																										
- Pwj(2)-1	mm								41	56	80	73	60	18												
- Pwj(2)-2	mm									37	60	73	73	63	19											
- Pwj(2)-3	mm										40	54	73	77	67	20										
(3) Effective rainfall (ER)	mm	65	70	53	53	39	41	14	14	13	14	10	9	7	8	0	0	0	0	16	18	40	40	55	58	637
(4) Field water requirement																										
- Pwj(2)-1	mm								27	43	66	63	51	11												260
- Pwj(2)-2	mm									24	46	63	64	56	11											263
- Pwj(2)-3	mm										26	44	64	70	59	20										282
(5) Diversion requirement	mm								18	45	92	113	118	91	47	13										537
	m3/ha								180	450	920	1,130	1,180	910	470	130										5,370

Source : JICA Study Team estimate based on the meteorological data at the Selong and the Pegongang station

Table 3.1 Estimated Catchment Rainfall at Montong Krarak Embung Site

Unit : mm

	Jan		Feb		Mar.		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual
year	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
1960	131	131	95	95	30	30	31	31	73	73	0	0	0	0	0	0	0	0	0	0	56	56	61	61	954
1961	106	106	80	80	63	63	18	18	0	0	0	0	0	0	0	0	0	0	0	0	62	62	68	68	794
1962	74	74	244	244	37	37	44	44	0	0	0	0	59	59	2	2	0	0	38	38	38	38	309	309	1,690
1963	84	84	25	25	42	42	3	3	0	0	0	0	0	0	0	0	0	0	0	0	9	9	44	44	414
1964	157	157	137	137	147	147	0	0	116	116	13	13	0	0	0	0	0	0	117	117	195	195	80	80	1,924
1965	100	100	38	38	54	54	0	0	0	0	0	0	0	0	0	0	0	0	25	25	95	95	120	120	864
1966	186	186	99	99	88	88	4	4	0	0	0	0	0	0	0	0	0	0	13	13	38	38	127	127	1.110
1967	188	188	75	75	76	76	11	11	5	5	0	0	0	0	0	0	15	15	2	2	30	30	179	179	1.162
1968	190	190	109	109	6	6	67	67	66	66	8	8	82	82	0	0	0	0	11	11	18	18	76	76	1.266
1969	353	353	155	155	6	6	1	1	2	2	0	0	0	0	4	4	0	0	0	0	0	0	103	103	1.248
1970	218	218	75	75	71	71	89	89	82	82	23	23	0	0	0	0	16	16	5	5	84	84	124	124	1.574
1971	243	243	221	221	49	49	33	33	38	38	0	0	0	0	0	0	7	7	27	27	81	81	153	153	1.704
1972	72	72	37	37	87	87	0	0	13	13	0	0	0	0	0	0	0	0	0	0	15	15	73	73	594
1973	163	163	211	211	86	86	58	58	102	102	22	22	4	4	11	11	33	33	0	0	76	76	71	71	1.674
1974	78	78	129	129	91	91	30	30	1	1	0	0	0	0	13	13	9	9	97	97	117	117	74	74	1.278
1975	120	120	120	120	133	133	77	77	36	36	0	0	31	31	0	0	43	43	174	174	189	189	131	131	2.108
1976	96	96	128	128	71	71	0	0	13	13	0	0	0	0	0	0	0	0	14	14	0	0	46	46	736
1977	105	105	219	219	72	72	17	17	3	3	4	4	0	0	1	1	12	12	4	4	8	8	34	34	958
1978	176	176	93	93	117	117	14	14	33	33	183	183	74	74	26	26	20	20	57	57	115	115	116	116	2.048
1979	54	54	86	86	38	38	3	3	64	64	43	43	0	0	0	0	0	0	0	0	77	77	96	96	922
1980	108	108	54	54	8	8	47	47	1	1	0	0	0	0	0	0	0	0	0	0	66	66	155	155	878
1981	96	96	62	62	47	47	10	10	0	0	27	27	8	8	8	8	18	18	21	21	164	164	135	135	1.192
1982	123	123	88	88	122	122	8	8	0	0	0	0	0	0	0	0	0	0	0	0	7	7	125	125	946
1983	27	27	103	103	106	106	80	80	0	0	0	0	0	0	0	0	0	0	0	0	112	112	53	53	962
1984	147	147	89	89	172	172	47	47	41	41	3	3	1	1	8	8	39	39	43	43	33	33	108	108	1,462
1985	97	97	131	131	187	187	2	2	7	7	49	49	54	54	0	0	0	0	1	1	171	171	151	151	1,700
Mean	134	134	112	112	77	77	27	27	27	27	14	14	12	12	3	3	8	8	25	25	71	71	108	108	1,237

Table 3.2 Estimated Discharge at Montong Krarak Embung Site

Unit : 1000 m3

year	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
1960	248	248	180	180	57	57	59	59	138	138	0	0	0	0	0	0	0	0	0	0	106	106	115	115	1,806
1961	200	200	151	151	119	119	0	0	0	0	0	0	0	0	0	0	0	0	0	0	117	117	129	129	1,432
1962	140	140	461	461	70	70	83	83	0	0	0	0	112	112	0	0	0	0	72	72	72	72	584	584	3,188
1963	159	159	47	47	79	79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	83	83	736
1964	297	297	259	259	278	278	0	0	219	219	0	0	0	0	0	0	0	0	221	221	369	369	151	151	3,588
1965	189	189	72	72	102	102	0	0	0	0	0	0	0	0	0	0	0	0	47	47	180	180	227	227	1,634
1966	352	352	187	187	166	166	0	0	0	0	0	0	0	0	0	0	0	0	0	0	72	72	240	240	2,034
1967	355	355	142	142	144	144	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57	57	338	338	2,072
1968	359	359	206	206	0	0	127	127	125	125	0	0	155	155	0	0	0	0	0	0	0	0	144	144	2,232
1969	667	667	293	293	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	195	195	2,310
1970	412	412	142	142	134	134	168	168	155	155	43	43	0	0	0	0	0	0	0	0	159	159	234	234	2,894
1971	459	459	418	418	93	93	62	62	72	72	0	0	0	0	0	0	0	0	51	51	153	153	289	289	3,194
1972	136	136	70	70	164	164	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	138	138	1,016
1973	308	308	399	399	163	163	110	110	193	193	42	42	0	0	0	0	62	62	0	0	144	144	134	134	3,110
1974	147	147	244	244	172	172	57	57	0	0	0	0	0	0	0	0	0	0	183	183	221	221	140	140	2,328
1975	227	227	227	227	251	251	146	146	68	68	0	0	59	59	0	0	81	81	329	329	357	357	248	248	3,986
1976	181	181	242	242	134	134	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	87	87	1,288
1977	198	198	414	414	136	136	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	64	64	1,624
1978	333	333	176	176	221	221	0	0	62	62	346	346	140	140	49	49	0	0	108	108	217	217	219	219	3,742
1979	102	102	163	163	72	72	0	0	121	121	81	81	0	0	0	0	0	0	0	0	146	146	181	181	1,732
1980	204	204	102	102	0	0	89	89	0	0	0	0	0	0	0	0	0	0	0	0	125	125	293	293	1,626
1981	181	181	117	117	89	89	0	0	0	0	51	51	0	0	0	0	0	0	40	40	310	310	255	255	2,086
1982	232	232	166	166	231	231	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	236	236	1,730
1983	51	51	195	195	200	200	151	151	0	0	0	0	0	0	0	0	0	0	0	0	212	212	100	100	1,818
1984	278	278	168	168	325	325	89	89	77	77	0	0	0	0	0	0	74	74	81	81	62	62	204	204	2,716
1985	183	183	248	248	353	353	0	0	0	0	93	93	102	102	0	0	0	0	0	0	323	323	285	285	3,174
Mean	254	254	211	211	144	144	44	44	47	47	25	25	22	22	2	2	8	8	44	44	131	131	204	204	2,273
	508		422		289		88		95		50		44		4		17		87		262		409		

Table 3.3 Probable Flood Discharge at Montong Krarak Embung Site

Characteristics of the catchment area								
Catchment Area	(km2)	5.40						
Eelevation at Dam Site (1)	(m)	200						
Maximum elevation in the catchment area (2)	(m)	300						
Height (3)=(2)-(1)	(h)	100						
Length of Catchment Area (L	(m)	6,000						
Flow velocity	W2 (km/hr)	6.17						
Time of concentration	T2 (hrs)	0.97						
Probable Flood Discherge								
Return Period	(years)	2	5	10	20	50	100	200
Rainfall	(mm/day)	78	96	107	117	130	140	150
Rainfall intensity within the time of concentration	(mm)	16	20	22	24	27	29	31
Probable Flood Discharge	(m3/s)	19	24	27	29	32	35	37
Specific Discharge	(m3/s/km2)	4	4	5	5	6	6	7

To estimate design rainfall, the Log Pearson III method is adopted.
The rational method is adopted for estimation of the design flood discharge.
C = 0.8 is used to estimate designed flood discharge by the rational method.

Table 3.4 Result of Water Quality Test in Montong Krarak Embung Site

DESCRIPTION	UNIT	1 Upstream of proposed embung	2 Embung Site	3 Embung Site	4 downstream of proposed embung	Max. Limit of B Class by GR. NO. 20/1990
I. PHYSICS						
1 Temperature	C	24.00	25.00	24.50	25.00	Normal water temperature
2 Dissolved solid matter	mg/liter	290.00	181.00	177.00	187.00	1000
3 Electric Conductivety	umhos/cm	345.00	246.00	241.00	255.00	-
II. CHEMISTRY						
a. Unorganic chemistry						
1 Mercury	mg/liter	0.00	0.00	0.00	0.00	0.001
2 Ammonia	mg/liter	0.00	0.00	0.00	0.00	0.5
3 Arocnic	mg/liter	-	-	-	-	0.05
4 Barium	mg/liter	-	-	-	-	5
5 Ferro	mg/liter	0.00	0.00	0.00	0.00	1
6 Fluoride	mg/liter	0.80	0.82	0.82	0.80	1.5
7 Cadmium	mg/liter	0.00	0.00	0.00	0.00	0.005
8 Chloride	mg/liter	44.00	31.20	28.40	21.30	600
9 Chronium, valense-6	mg/liter	0.00	0.00	0.00	0.00	0.05
10 Manganese	mg/liter	0.00	0.00	0.00	0.00	0.5
11 Nitrate, N	mg/liter	0.72	0.86	0.97	0.95	10
12 Nitric, N	mg/liter	0.09	0.02	0.02	0.02	1
13 Dissolved Oxygen	mg/liter	6.39	7.02	6.96	6.14	*
14 pH	-	7.50	7.90	8.10	7.80	5-9
15 Selenium	mg/liter	-	-	-	-	0.01
16 Zinc	mg/liter	0.00	0.00	0.00	0.00	5
17 Cyanide	mg/liter	0.00	0.00	0.00	0.00	0.1
18 Sulphate	mg/liter	5.80	6.30	5.50	7.50	400
19 Sulfide, H2S	mg/liter	0.00	0.00	0.00	0.00	0.1
20 Copper	mg/liter	0.00	0.00	0.00	0.00	1
21 Lead	mg/liter	0.00	0.01	0.00	0.00	0.1
b. Organic Chemistry						
1 Aldrin and Dieldrin	mg/liter	0.00	0.00	0.00	0.00	0.017
2 Chlordane	mg/liter	0.00	0.00	0.00	0.00	0.003
3 DDT	mg/liter	0.00	0.00	0.00	0.00	0.042
4 Endrine	mg/liter	0.00	0.00	0.00	0.00	0.001
5 Fenol	mg/liter	0.00	0.00	0.00	0.00	0.001
6 Heptachlor and Heptachlor Epoxide	mg/liter	-	-	-	-	0.018
7 Carbon Cloroform Ektract	mg/liter	-	-	-	-	0.5
8 Lindane	mg/liter	0.00	0.00	0.00	0.00	0.056
9 Methoxychlor	mg/liter	-	-	-	-	0.035
10 Oil and Fat	mg/liter	0.00	0.00	0.00	0.00	Nil
11 Organofosphate and Carbomate	mg/liter	0.00	0.00	0.00	0.00	0.1
12 PCB	mg/liter	-	-	-	-	Nil
13 Senyawa alife biru (Sulfaktan)	mg/liter	0.05	0.04	0.04	0.05	0.5
14 Toxaphene	mg/liter	0.00	0.00	0.00	0.00	0.005
III MICRO BIOLOGY						
1 Coliform tinja	per 100 ml	12,000	18,000	21,000	14,000	2,000
2 Total Coliform	per 100 ml	16,000	35,000	54,000	24,000	10,000

NOTE:
* = The water level shall be more than or equal to 6.
mg = miligram
ml = Milimeter
Bq = Bequerel

Heavy metals are classified into dissolved matter.

Source : JICA's Water Quality Test

Table 7.1 Summary of Construction Cost in Montong Krarak Project

Item	Amount (Rp. million)
I. Direct Construction Cost	
1.1 Preparatory Works	70
1.2 Embung Construction	
1) Main dam	1,118
2) Spillway	0
3) Diversion Tunnel	0
4) Seepage protection works	0
5) Miscellaneous	112
Sub-total of 1.2	1,230
1.3 Irrigation Facilities	163
1.4 Domestic Water Supply	0
1.5 Embung Operation and Maintenance Road	9
Sub-total of I.	1,472
II. Administration Cost	74
III. Engineering Services	221
Sub-total of I, II & III	1,767
IV. Physical Contingency	265
Sub-total of I, II, II, & IV	2,031
V. Contract Tax	196
VI. Land Acquisition Cost	7
Sub-total I, II, III, IV, V & VI	2,235
VII. Price Contingency	447
GRAND TOTAL	2,682

Table 7.2 Direct Construction Cost in Montong Krarak Project (1/2)

Item	Unit	Unit Price Rp.	Quantity	Total 1000 Rp.
I. Dam				
1. Main Dam				
1.1 Earth/stone works				
1) Clearing	m2	400	4,600	1,840
2) Excavation, common	m3	3,500	1,100	3,850
, weathered rock	m3	7,500	9,500	71,250
, rock	m3	11,500	4,500	51,750
3) Stone masonry	m3	80,000	11,700	936,000
1.2 Grouting	m	71,000	0	0
1.3 Other miscellaneous works				53,235
Sub-total of 1.				1,117,925
2. Miscellaneous & Others				111,792
Total - I.				1,229,717
II. Irrigation Facilities				
1. Canal works (including the rehabilitation works)				
1.1 Earth works				
1) Clearing	m2	400	3,500	1,400
2) Excavation	m3	5,000	600	3,000
3) Embankment	m3	6,300	800	5,040
1.2 Stone masonry	m3	80,000	1,700	136,000
Sub-total of 1.				145,440
2. Related structures				
2.1 Turnout	nos.	2,600,000	1	2,600
2.2 Syphon	nos.	5,500,000		0
2.3 Aqueduct	nos.	6,000,000		0
2.3 Cross drain	nos.	4,700,000		0
2.4 Irrigation division box	nos.	900,000		0
2.5 Division box for livestock	nos.	1,200,000		
Sub-total of 2.				2,600
3. Miscellaneous & Others	L.S			14,804
Total - II				162,844

Table 7.2 Direct Construction Cost in Montong Krarak Project (2/2)

Item	Unit	Unit Price Rp.	Quantity	Total 1000 Rp.
III. Dam Operation and Maintenance Road				
1. Road Works				
1.1 Earth works				
1) Clearing	m2	400	1,400	560
2) Excavation	m3	5,000	200	1,000
3) Embankment	m3	6,300	600	3,780
4) Pavement (gravel / lime stone)	m3	15,000	200	3,000
2. Related structures				
2.1 Cross drain	nos.	4,700,000		0
3. Miscellaneous and others	L.S			834
Total - III				9,174
GRAND TOTAL				1,401,735

Table 8.1 Economic Construction Costs and Annual Disburement Schedule

Montong Krarak Project (Unit : Rp. million)

Item	SCF	Total cost	1st year	2nd year
1 Direct Construction Cost		968	26	942
1) Preparatory Works	0.71	52	26	26
2) Dam Construction				
- Main dam	0.71	794	0	794
- Spillway	0.71	0	0	0
- Diversion tunnel	0.71	0	0	0
- Seepage protection works	0.71	0	0	0
Sub-total		794	0	794
3) Irrigation Facilities	0.71	116	0	116
4) Domestic Water Supply System	0.71	0	0	0
5) Dam O & M Road	0.71	6	0	6
2 Administration Cost	0.90	68	34	34
3 Engineering Services	0.90	95	48	47
4 Physical Contingency		150	4	146
Total		1,281	112	1,169

Note : Standard Conversion Factors (SFC). Source ; Pedoman Pengamatan dan Evaluasi Proyek-Proyek Pengairan, Direktorato Jeneral Pengairan, 1985

Table 8.2 Financial and Economic Prices of Farm Inputs and Outputs in NTB

Item		Unit	Lombok		Sumbawa	
			Financial Price *1	Economic Price *2	Financial Price *1	Economic Price *2
1 Farm Products						
Paddy *3		kg	280	397	260	394
Maize *3		kg	200	220	200	215
Mungbeans *3		kg	1,000	906	1,000	901
Soybeans *3		kg	900	647	900	642
Red onion *4		kg	900	704	800	699
Tobacco *5		kg	900	522	900	521
2 Seeds						
Paddy	Certified	kg	605	605	605	605
	Own	kg	-	325	-	325
Maize	Certified	kg	922	922	922	922
	Own	kg	-	297	-	297
Mungbeans	Certified	kg	1,383	1,383	1,383	1,383
	Own	kg	-	893	-	893
Soybeans	Certified	kg	617	617	617	617
	Own	kg	-	606	-	606
Red onion		kg	850	850	850	850
Tobacco		kg	25,000	25,000	25,000	25,000
3 Fertilisers						
Urea		kg	350	414	350	419
TSP		kg	400	486	400	491
KCl		kg	400	416	400	421
4 Agro-chemicals						
Insecticides	Liquid type	lit	10,000	10,000	10,000	10,000
	Powder type	kg	3,000	3,000	3,000	3,000
Rodenticides		kg	5,500	5,500	5,500	5,500
5 Labour						
Hired labour *6		man-day	3,000	2,250	2,500	1,875
Family labour		man-day	-	2,250	-	1,875
6 Draft Animal						
Hired		head-day	6,000	6,000	5,000	5,000
Own		head-day	-	6,000	-	5,000
7 Farm Machinery						
Tractor		ha	250,000	250,000	200,000	200,000

Remarks : *1 ; As of 1994

*2 ; Projected prices in 2005 at 1994 constant prices

*3 ; Dry grain

*4 ; Fresh

*5 ; Fresh leaves

*6 ; Economic conversionfactor is 0.75.

Table 8.3 Economic Crop Budget per Ha

Montong Krarak Project

Item		Q'ty of Unit	Value (Rp.)	Without Project		With Project					
				Paddy (Rainfed)		Paddy (Irrigated)		Soybean (Rainfed)		Tobacco (Rainfed)	
				Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)
1 Gross Production Value											
Paddy		kg	397	2,000	794,000	4,500	1,786,500	0	0	0	0
Soybean		kg	647	0	0	0	0	1,100	711,700	0	0
Tobacco		kg	522	0	0	0	0	0	0	3,200	1,670,400
2 Production Cost											
Seed											
Paddy	Certified	kg	605	0	0	25	15,125	0	0	0	0
	Own	kg	325	50	16,250	0	0	0	0	0	0
Soybean	Certified	kg	617	0	0	0	0	20	12,340	0	0
	Own	kg	606	0	0	0	0	20	12,120	0	0
Tobacco	Certified	kg	25,000	0	0	0	0	0	0	0.1	2,500
Fertiliser											
Urea		kg	414	150	62,100	300	124,200	40	16,560	200	82,800
TSP		kg	486	50	24,300	100	48,600	80	38,880	160	77,760
KCl		kg	416	0	0	50	20,800	40	16,640	80	33,280
Agro-chemicals											
Insecticide	Lquid	lit	10,000	0.5	5,000	2.0	20,000	1.5	15,000	0.0	0
	Powder	kg	3,000	0.0	0	0.0	0	0.0	0	0.0	0
Rodenticide		kg	5,500	0.5	2,750	2.0	11,000	0.5	2,750	0.0	0
Labor											
Family		md	2,250	65	146,250	172	387,000	60	135,000	80	180,000
Hired		md	2,250	10	22,500	13	29,250	0	0	0	0
Draft Animal											
Family		ad	6,000	10	60,000	20	120,000	10	60,000	10	60,000
Hired		ad	6,000	0	0	0	0	0	0	0	0
Tractor		ha	250,000	0	0	0	0	0	0	0	0
Total production cost					339,150		775,975		309,290		436,340
3 Net Production Value					454,850		1,010,525		402,410		1,234,060

Table 8.4 Economic Costs and Benefits Flow

Montong Krarak Project Unit : Million Rp.

Year	Cost				Benefit			Increment
	Capital	Replace	O&M	Total	Irrigation	Negative	Total	
1.	112	0	0	112	0	0	0	-112
2.	1,169	0	0	1,169	0	0	0	-1,169
3.	0	0	5	5	37	0	37	32
4.	0	0	5	5	43	0	43	38
5.	0	0	5	5	49	0	49	44
6.	0	0	5	5	55	0	55	50
7.	0	0	5	5	61	0	61	56
8.	0	0	5	5	61	0	61	56
9.	0	0	5	5	61	0	61	56
10.	0	0	5	5	61	0	61	56
11.	0	0	5	5	61	0	61	56
12.	0	0	5	5	61	0	61	56
13.	0	0	5	5	61	0	61	56
14.	0	0	5	5	61	0	61	56
15.	0	0	5	5	61	0	61	56
16.	0	0	5	5	61	0	61	56
17.	0	0	5	5	61	0	61	56
18.	0	0	5	5	61	0	61	56
19.	0	0	5	5	61	0	61	56
20.	0	0	5	5	61	0	61	56
21.	0	0	5	5	61	0	61	56
22.	0	0	5	5	61	0	61	56
23.	0	0	5	5	61	0	61	56
24.	0	0	5	5	61	0	61	56
25.	0	0	5	5	61	0	61	56
26.	0	0	5	5	61	0	61	56
27.	0	0	5	5	61	0	61	56

EIRR = 0.3 %

Table 8.5 Financial Crop Budget per Ha

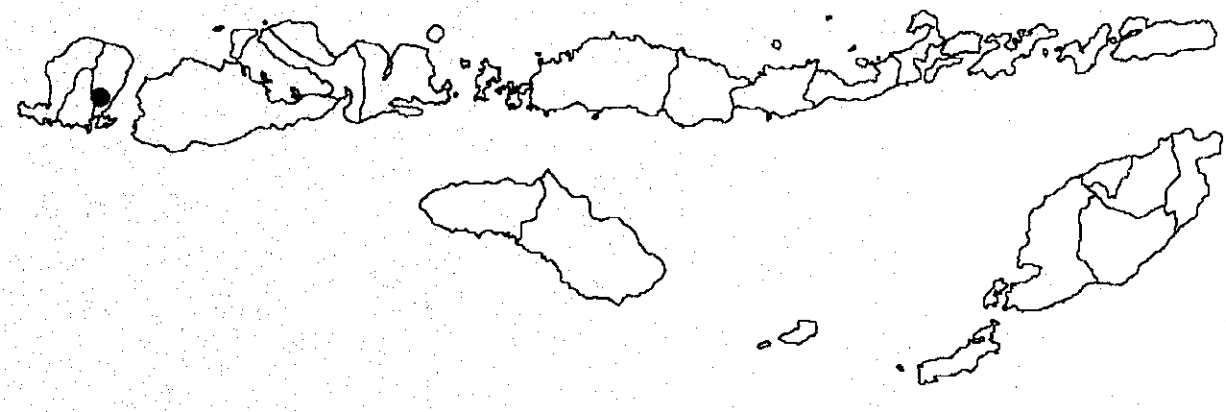
Montong Krarak Project

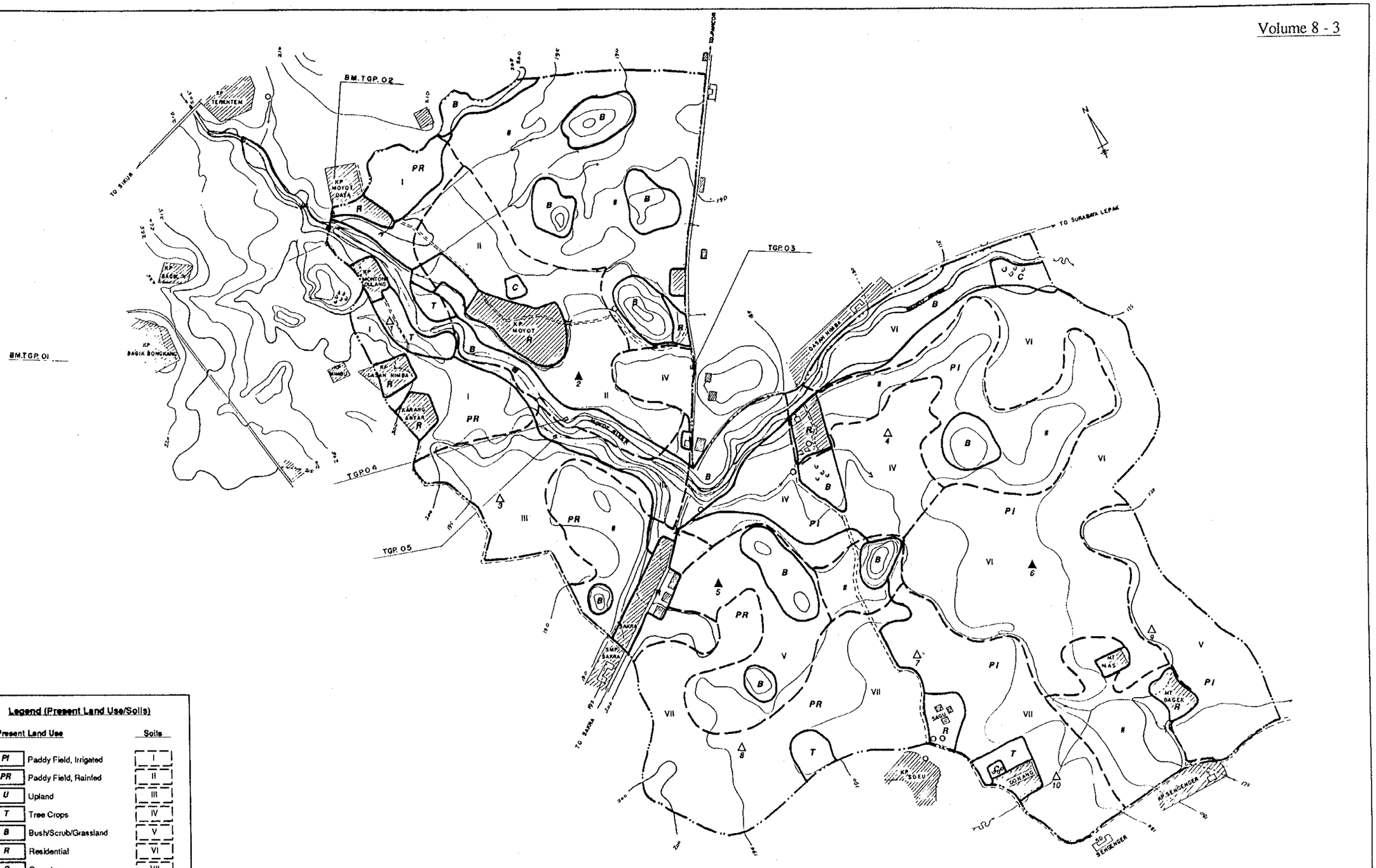
Item		Q'ty of Unit	Value (Rp.)	Without Project: Paddy (Rainfed) Q'ty	Without Project: Paddy (Rainfed) Am't (Rp.)	With Project: Paddy (Irrigated) Q'ty	With Project: Paddy (Irrigated) Am't (Rp.)	With Project: Soybean (Rainfed) Q'ty	With Project: Soybean (Rainfed) Am't (Rp.)	With Project: Tobacco (Rainfed) Q'ty	With Project: Tobacco (Rainfed) Am't (Rp.)
1 Gross Production Value											
Paddy		kg	280	2,000	560,000	4,500	1,260,000	0	0	0	0
Soybean		kg	900	0	0	0	0	1,100	990,000	0	0
Tobacco		kg	900	0	0	0	0	0	0	3,200	2,880,000
2 Production Cost											
Seed											
Paddy	Certified	kg	605	0	0	25	15,125	0	0	0	0
	Own	kg	0	50	0	0	0	0	0	0	0
Soybean	Certified	kg	617	0	0	0	0	20	12,340	0	0
	Own	kg	0	0	0	0	0	20	0	0	0
Tobacco	Certified	kg	25,000	0	0	0	0	0	0	0.1	2,500
Fertiliser											
Urea		kg	350	150	52,500	300	105,000	40	14,000	200	70,000
TSP		kg	400	50	20,000	100	40,000	80	32,000	160	64,000
KCl		kg	400	0	0	50	20,000	40	16,000	80	32,000
Agro-chemicals											
Insecticide	Lquid	lit	10,000	0.5	5,000	2.0	20,000	1.5	15,000	0.0	0
	Powder	kg	3,000	0.0	0	0.0	0	0.0	0	0.0	0
Rodenticide		kg	5,500	0.5	2,750	2.0	11,000	0.5	2,750	0.0	0
Labor											
Family		md	0	65	0	172	0	60	0	80	0
Hired		md	3,000	10	30,000	13	39,000	0	0	0	0
Draft Animal											
Family		ad	0	10	0	20	0	10	0	10	0
Hired		ad	6,000	0	0	0	0	0	0	0	0
Tractor		ha	250,000	0	0	0	0	0	0	0	0
Total production cost					110,250		250,125		92,090		168,500
3 Net Production Value					449,750		1,009,875		897,910		2,711,500

The Study on The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara

Feasibility Study on Montong Krarak Embung Development Project

Figures





Legend (Present Land Use/Soils)

Present Land Use		Soils
PI	Paddy Field, Irrigated	I
PR	Paddy Field, Rainfed	II
U	Upland	III
T	Tree Crops	IV
B	Bush/Scrub/Grassland	V
R	Residential	VI
C	Cemetery	VII
O	Others	#

▲ No — Soil Test Pit with Sampling
△ No — Soil Test Pit without Sampling
—·—·— Boundary of Beneficiary Area

Figure 1.1 Present Land Use and Soils (Montong Krarak)

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT, MINISTRY OF PUBLIC WORKS

The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara

MONTONG KRARAK

No. | Area

JAPAN INTERNATIONAL COOPERATION AGENCY

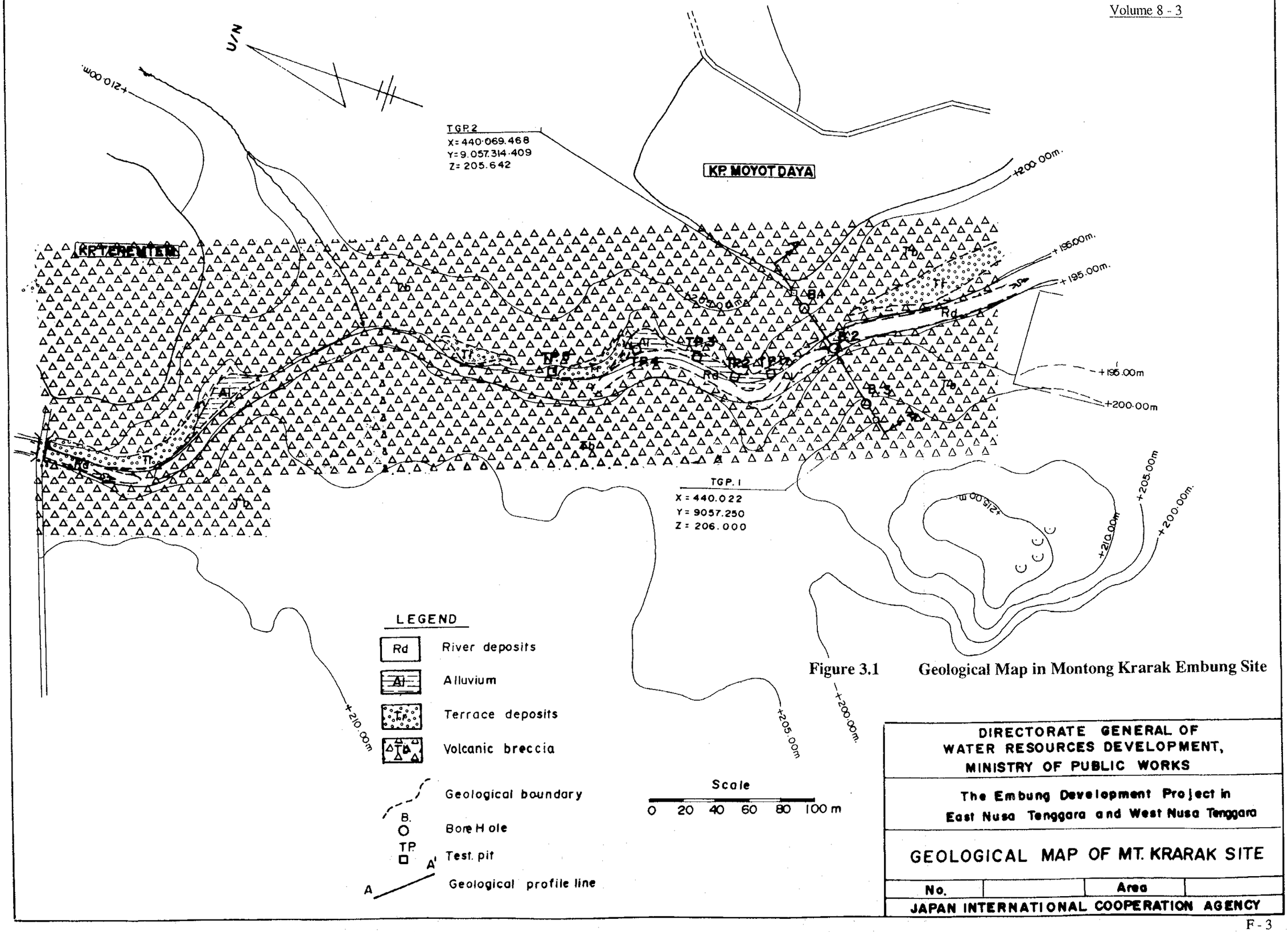
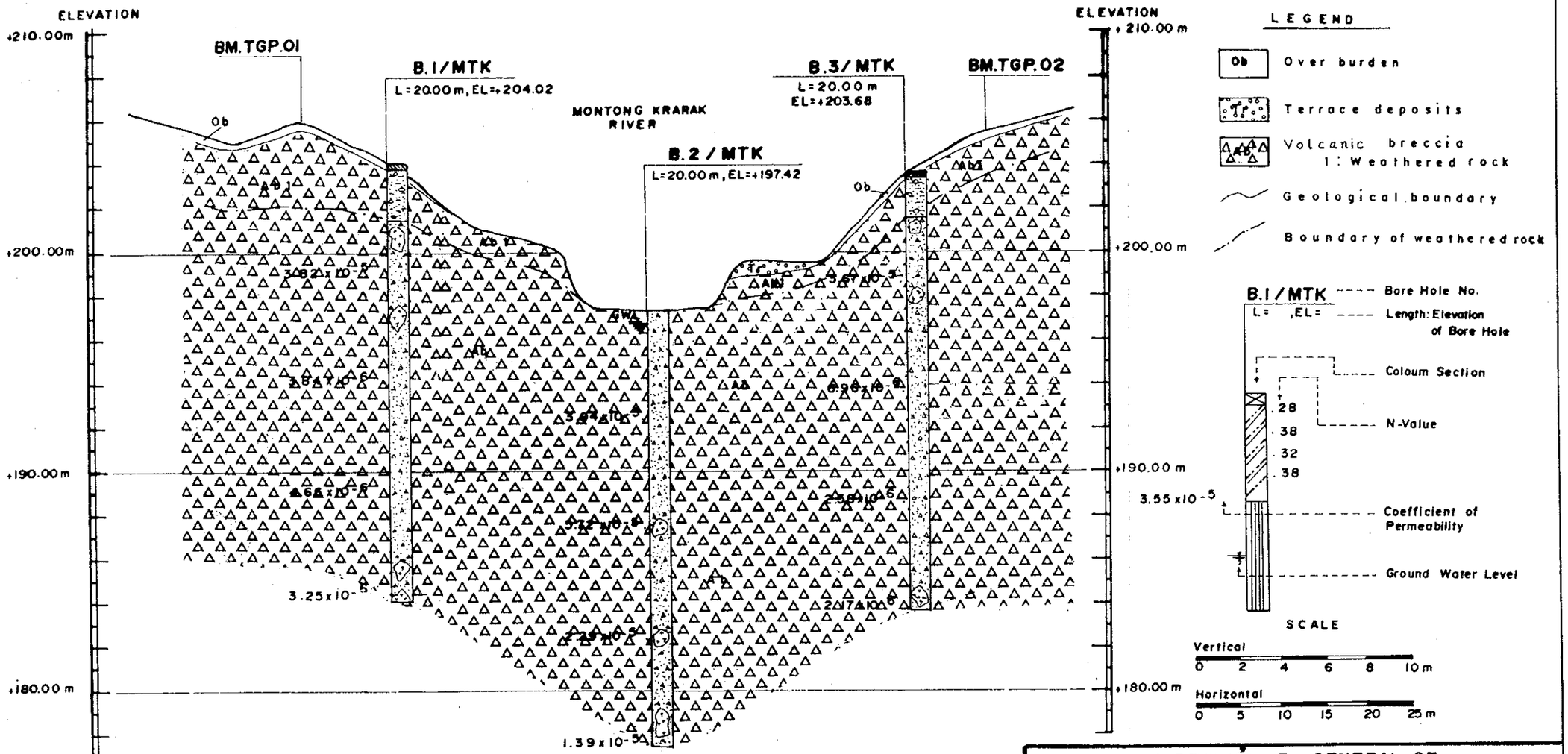


Figure 3.1 Geological Map in Montong Krarak Embung Site

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT, MINISTRY OF PUBLIC WORKS	
The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara	
GEOLOGICAL MAP OF MT. KRARAK SITE	
No.	Area
JAPAN INTERNATIONAL COOPERATION AGENCY	



DIRECTORATE GENERAL OF
WATER RESOURCES DEVELOPMENT,
MINISTRY OF PUBLIC WORKS

The Embung Development Project in
East Nusa Tenggara and West Nusa Tenggara

GEOLOGICAL PROFILE OF MT. KRARAK SITE

No.		Area	

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 3.2 Geological Profile in Montong Krarak Embung Site

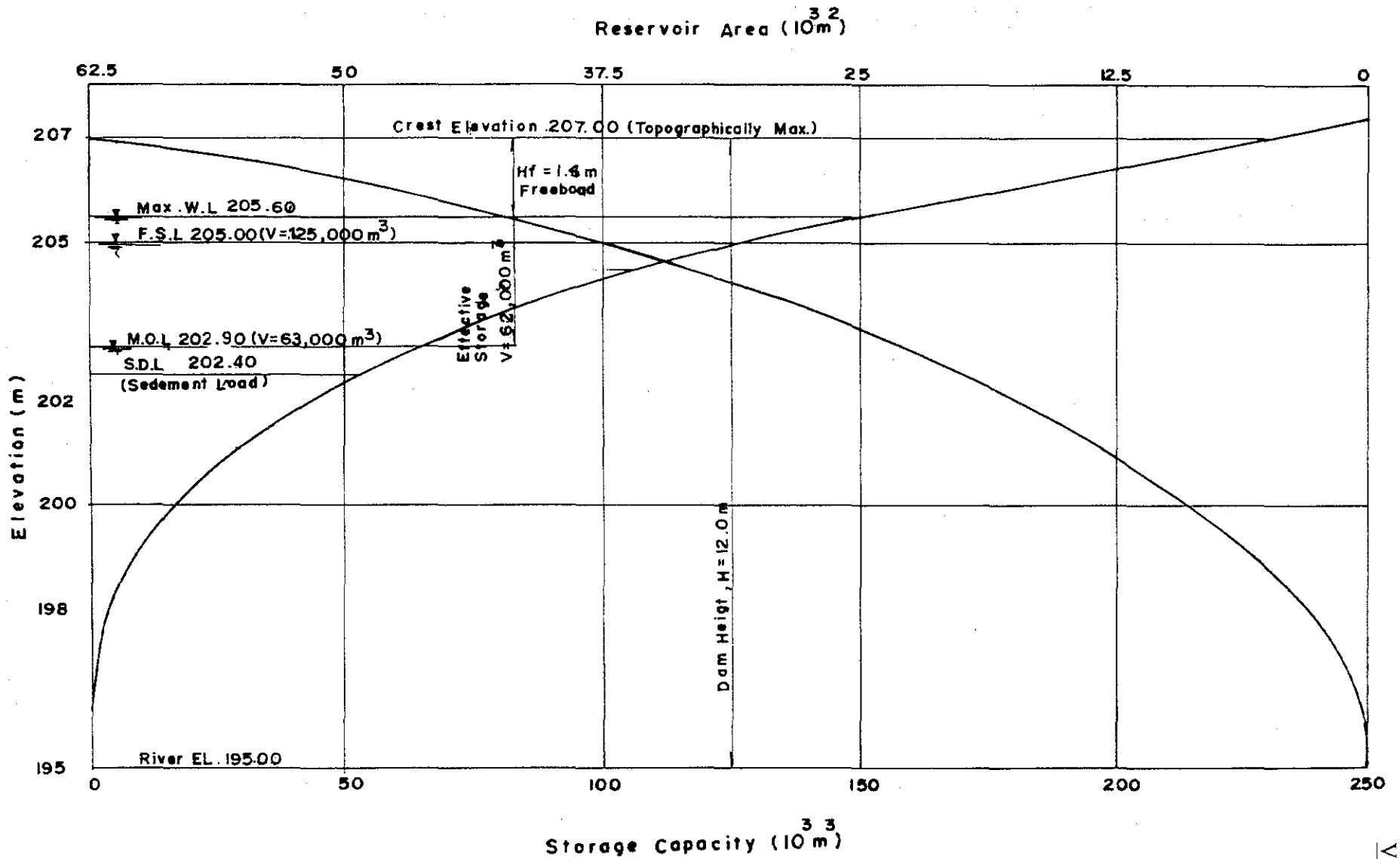


Figure 4.1 Reservoir Storage Curve in Montong Krarak Embung

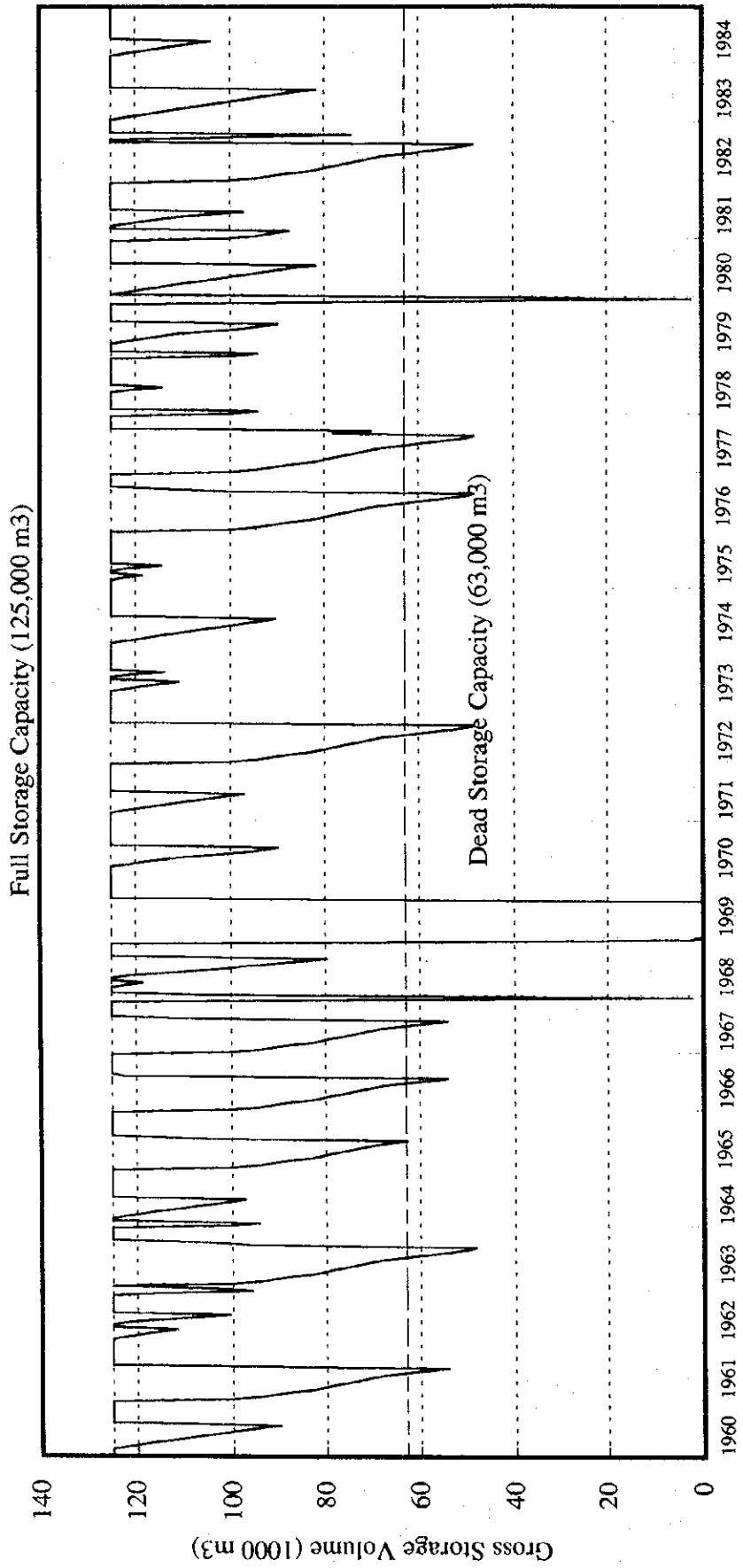


Figure 4.2 Result of Reservoir Operation in Montong Krarak Embung

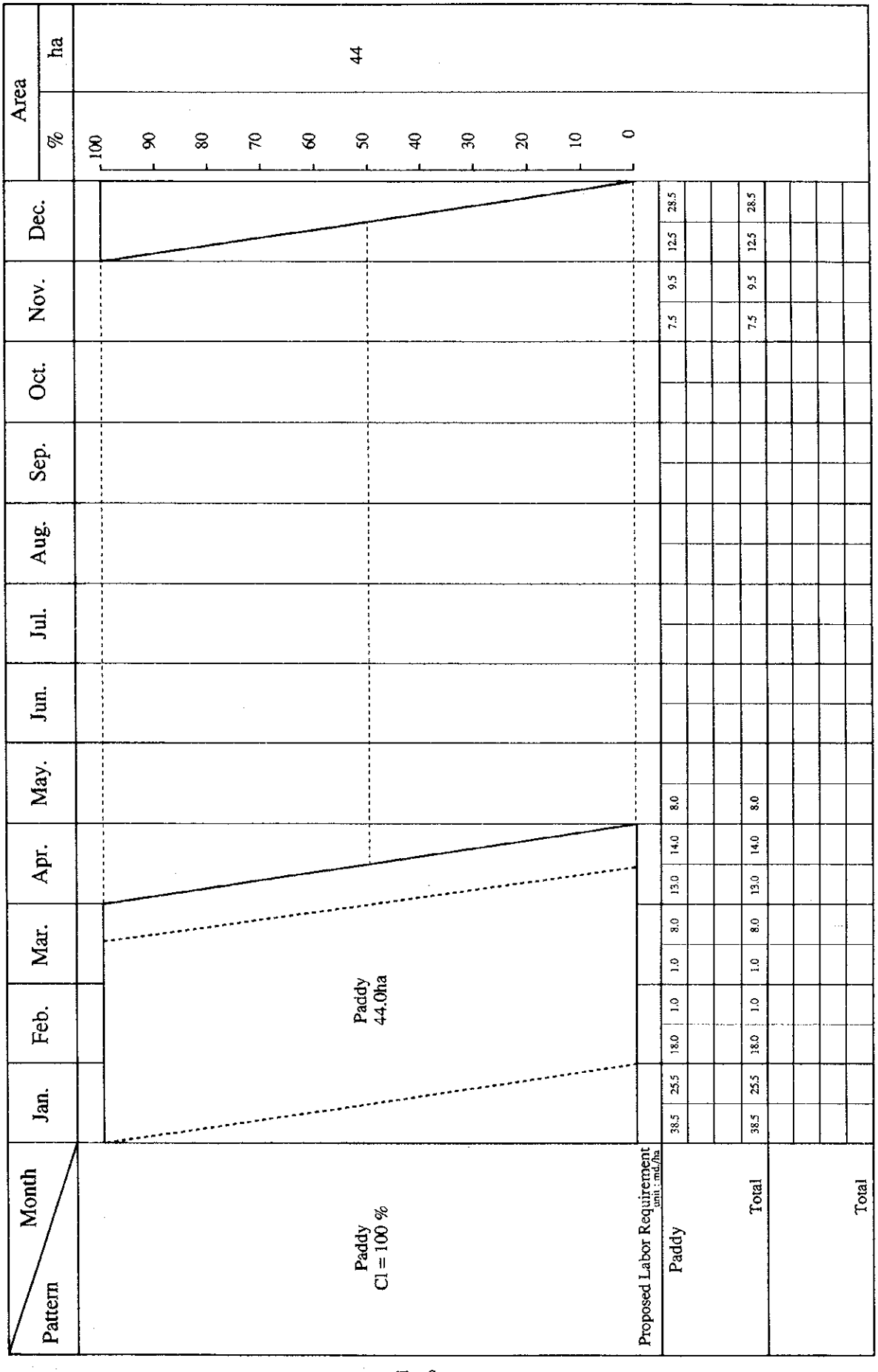
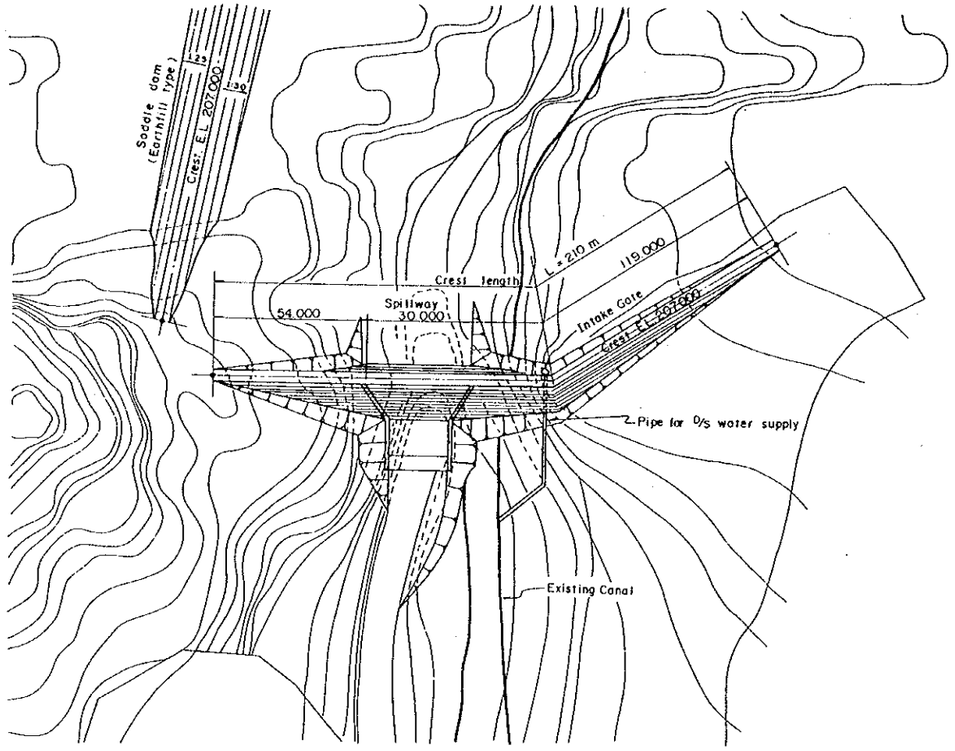
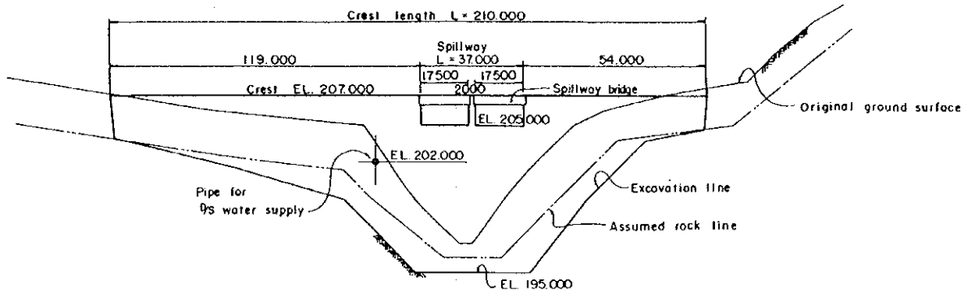


Figure 4.3 Proposed Cropping Pattern for Montong Krarak Project

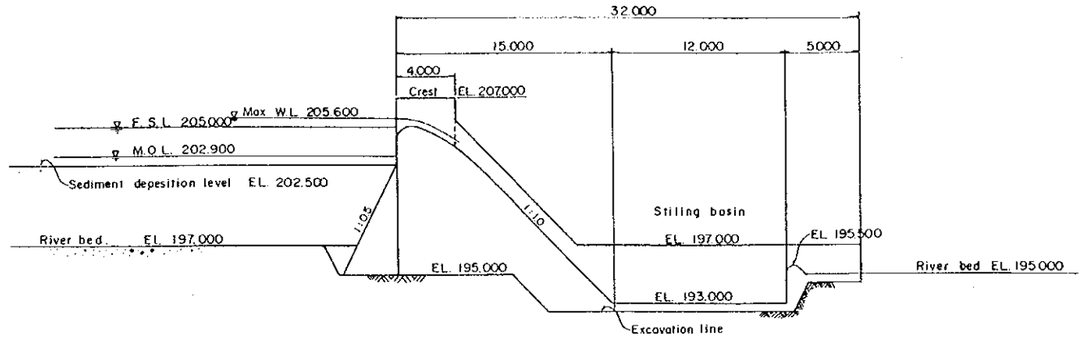


PLAN Scale A



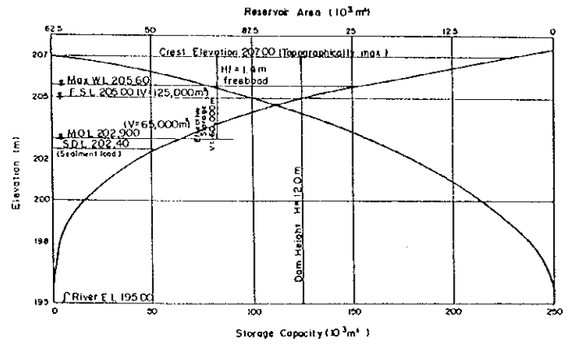
PROFILE OF MAIN DAM

Scale H = 1 : 1000
V = 1 : 200



OVERFLOW SECTION OF MAIN DAM

Scale B



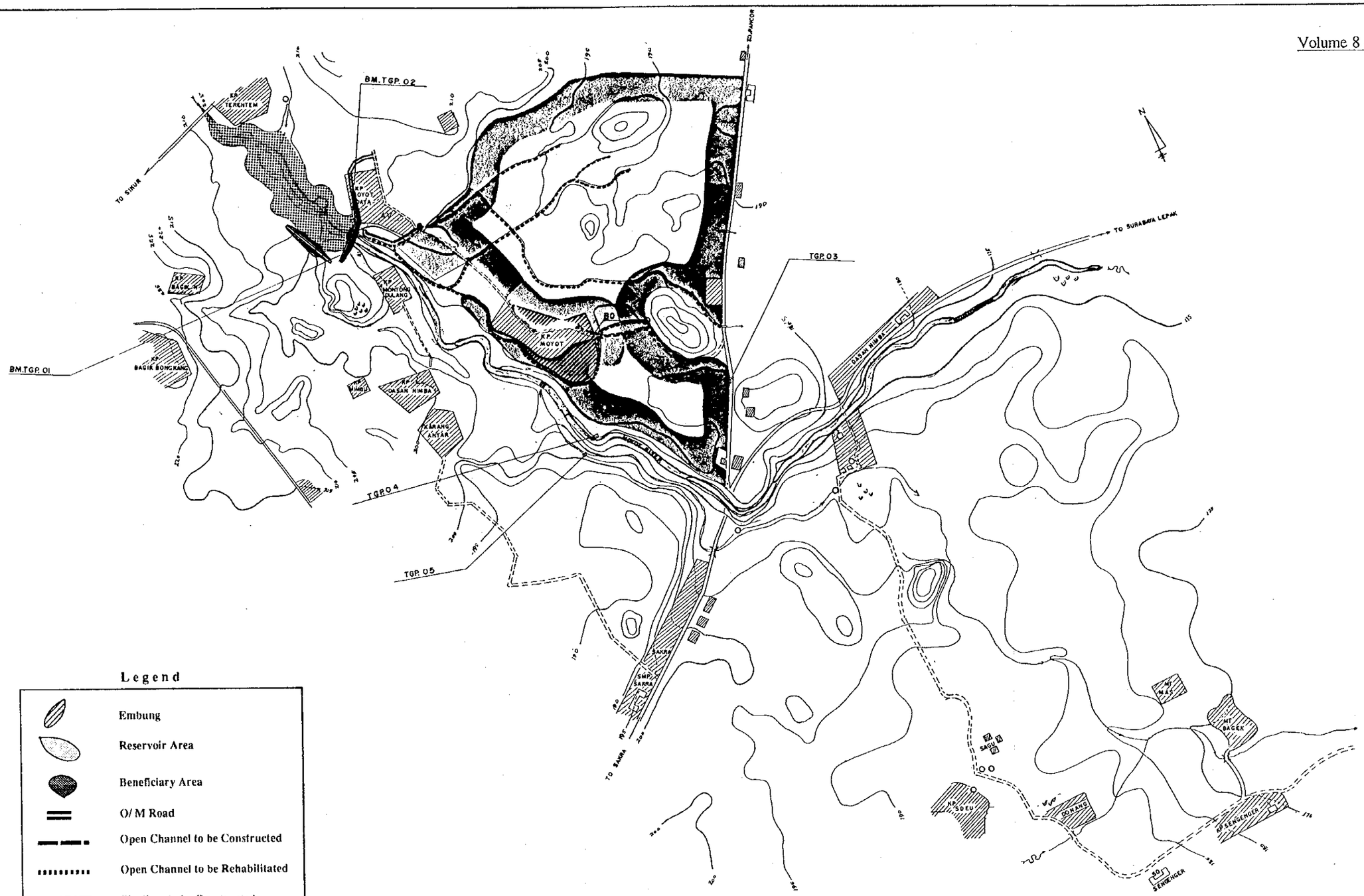
RESERVOIR STORAGE CAPACITY CURVE AT MONTONG KRARAK

Scale A 0 20 40 60 80 100m

Scale B 0 5 10 15 20m

Figure 4.4 General Plan of Montong Krarak Embung

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT, MINISTRY OF PUBLIC WORKS
The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara
GENERAL PLAN OF MONTONG KRARAK EMBUNG
No. | Area
JAPAN INTERNATIONAL COOPERATION AGENCY



Legend

- Embung
- Reservoir Area
- Beneficiary Area
- O/M Road
- Open Channel to be Constructed
- Open Channel to be Rehabilitated
- Pipelines to be Constructed
- Water Distribution Box

SCALE 1/5,000

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT, MINISTRY OF PUBLIC WORKS

The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara

EMBUNG MONTONG KRARAK

No. | Area

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 5.1 Genelal Layout of Montong Krarak Project

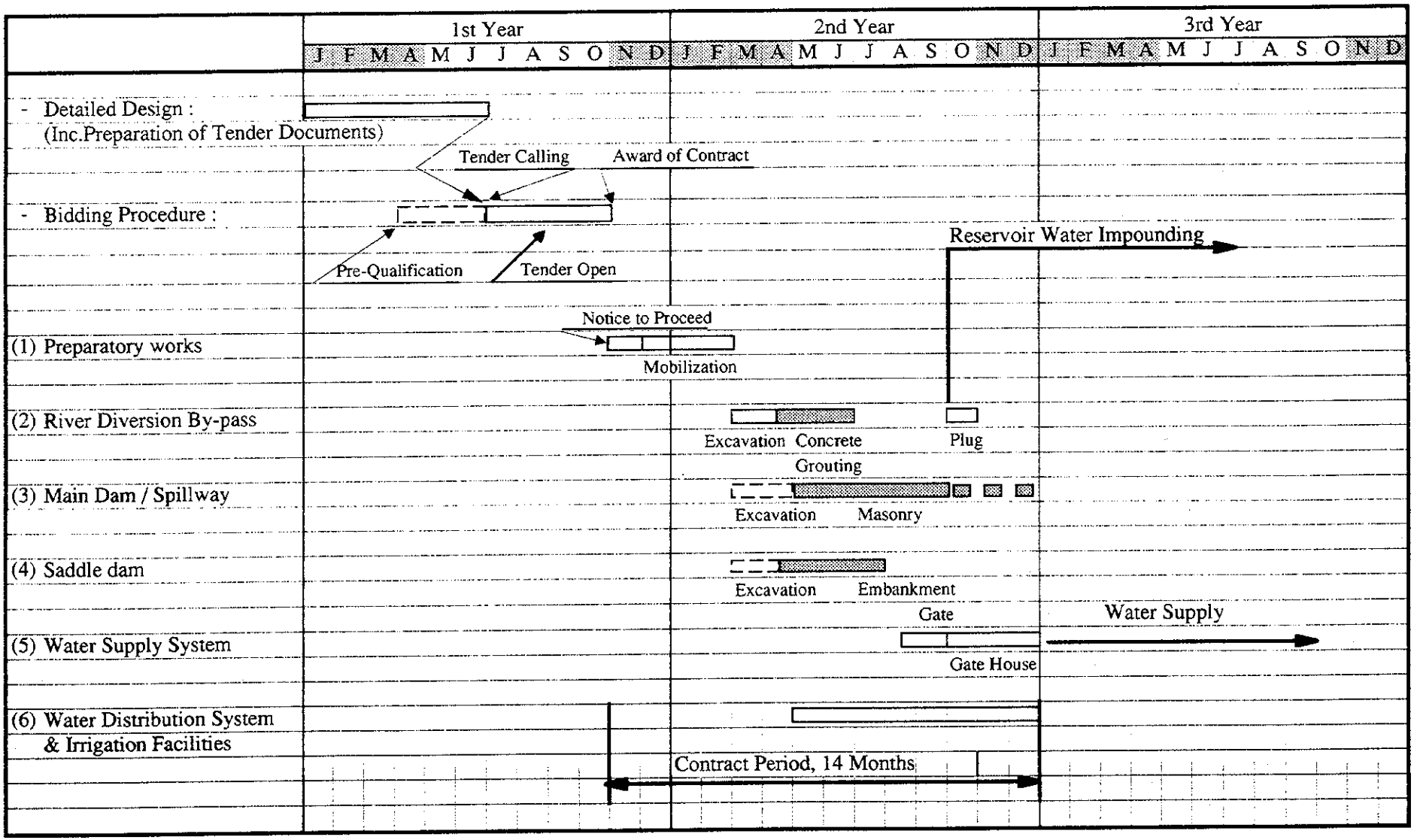


Figure 6.1 Construction Time Schedule for Montong Krarak Project

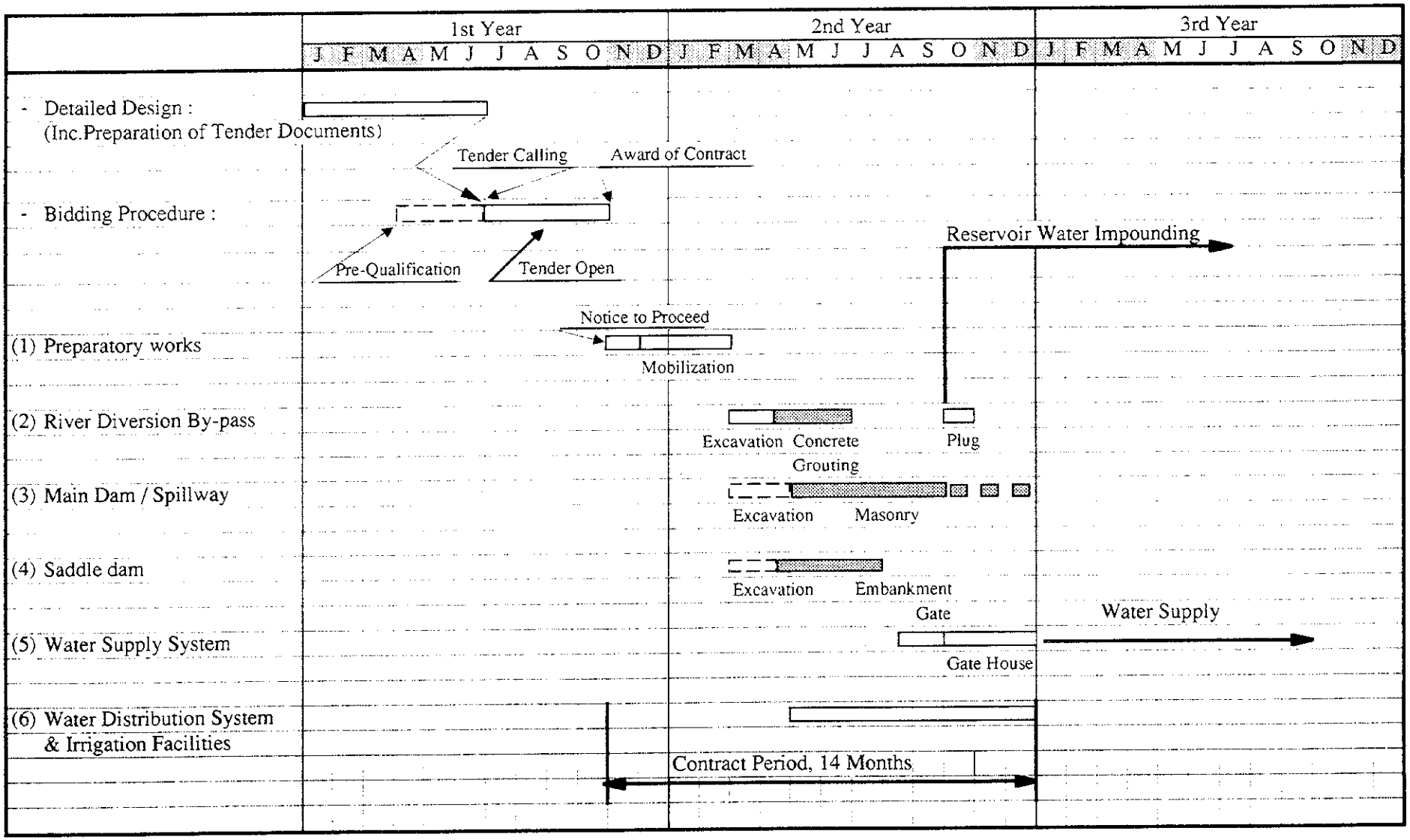


Figure 6.1 Construction Time Schedule for Montong Krarak Project

Japan International
Cooperation Agency
(JICA)

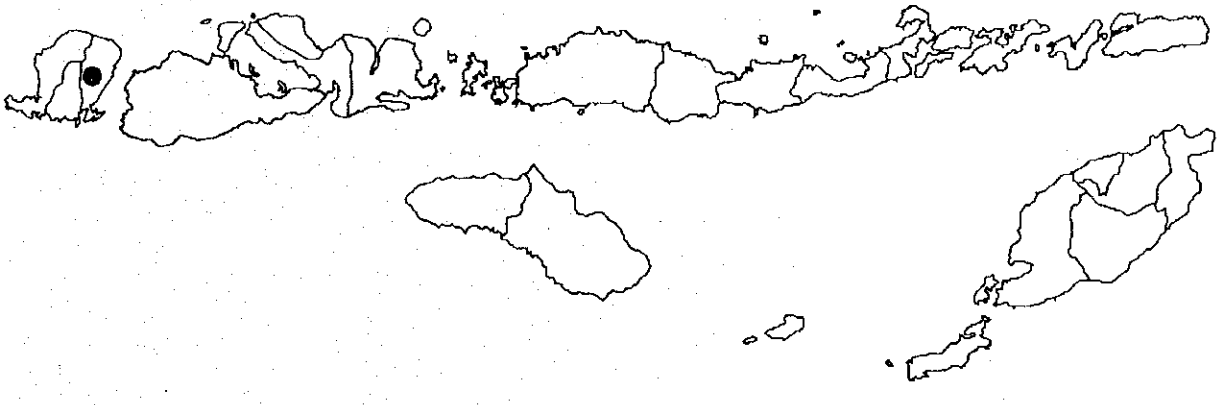
Directorate General of
Water Resources Development,
Ministry of Public Works

The Study
on
The Embung Development Project
(Small Scale Imponding Pond Development Project)
in
East Nusa Tenggara and West Nusa Tenggara
in
The Republic of Indonesia

Final Report

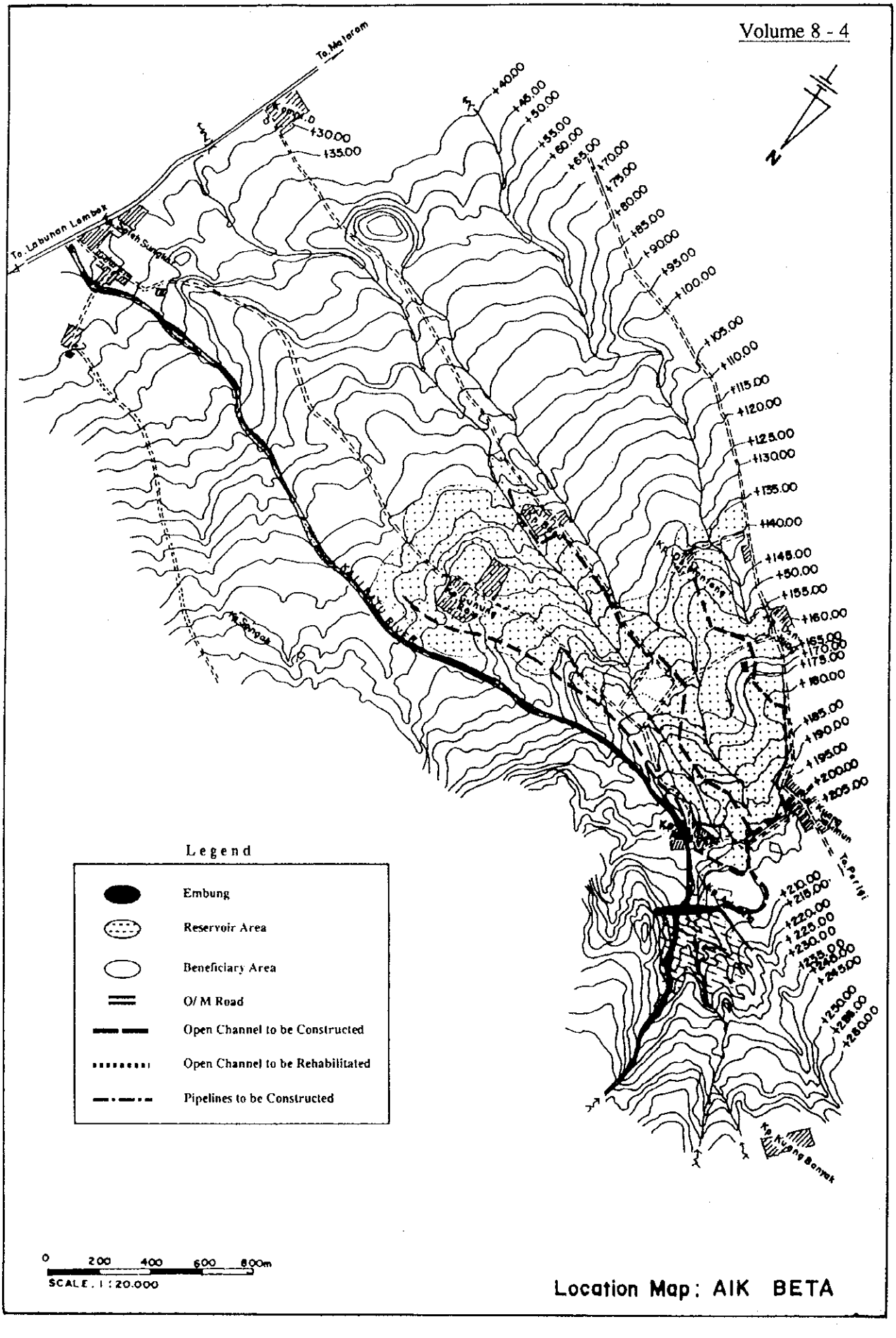
Volume 8-4

Feasibility Study
on
Aik Beta Embung Development Project



May 1995

Nippon Koei Co., Ltd.



Location Map : AIK BETA

THE STUDY
ON
THE EMBUNG DEVELOPMENT PROJECT
(SMALL SCALE IMPOUNDING POND DEVELOPMENT PROJECT)
IN
EAST NUSA TENGGARA AND WEST NUSA TENGGARA
IN
THE REPUBLIC OF INDONESIA

FINAL REPORT

VOLUME 8-4

FEASIBILITY STUDY
ON
AIK BETA EMBUNG DEVELOPMENT PROJECT

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1. PRESENT SITUATION OF THE PROJECT AREA

1.1 Location and Topography

The Project area is located in Aik Beta Village in Kecamatan Pringgabaya of Kabupaten Lombok Timur. The proposed Embung site is located on the Aik Beta river in Aik Beta Village and about 75 km from Mataram, the capital of Nusa Tenggara Barat (NTB) Province.

Topographical condition of the catchment area is rather steep slope on Mount Nangi (El. 2,330 m) covered by forest above El. 700 m. Below this elevation, there is developed agricultural land with upland crops due to rather dry weather condition.

The beneficiary area is located mainly on the right side of the Aik Beta river, which extends about 3 km downstream from the proposed Embung site.

1.2 Climate and Hydrology

The nearest climate station from the proposed Embung site is the Sambelia station while there are another two rainfall stations near the proposed Embung site; Sapit and Suela. The wet season usually starts from November and ends March in the Project area with the average annual rainfall of 1,150 mm in Suela. Mean annual temperature is 27.2 °C with the average maximum temperature of 31.7 °C and the average minimum temperature of 22.6 °C. Mean relative humidity is 81.0%. Average sunshine hours are 5 to 6 hr/day during the wet season and increase to 7 to 9 hr/day in the dry season. Winds are stronger from June to September and weaker from December to March with the average wind velocity of 7.0 km/hr. Tables 1.1 and 1.2 show monthly rainfall record at the Suela station and climate data at the Sambelia station, respectively.

The Aik Beta river drains the southeast side of Mount Rinjani. The river rises at hilly area where the altitude is approximately 2,000 m and follows a southeasterly course. It then discharges into the Alas Strait. The surface of the catchment area is mostly covered with forest. Only the valley bottoms up to about El. 600 m comprise the rainfed paddy field. The catchment area at the proposed Embung site is 22.4 km^2. There is no gauging station on this river.

1.3 Geology

The proposed Embung site is mainly underlain by new volcanic products of Mt. Pusuk, Holocene in the Quaternary age. This volcanic products are half consolidated rock and not homogeneous, named the Lekopiko Formation. The geological formation is: andesitic breccia composed of andesitic breccia, soft rock belonged to the Lekopiko Formation; terrace deposits composed of mainly sand and gravel, forming terrace with flat to gentle slope; alluvium composed of sand, silt and gravel, forming lowland; Detritus composed of soil with rock fragments, distributing at foot of slope or gentle valley; and, river deposits composed of sand, silt, gravel and boulder, distributing along the existing river bed.

1.4 Soils and Land Use

The Project area of Aik Beta lies on the hilly slope along the Kali Batu river. The land is undulating and rather steep, sloping from west to east at 5 to 10%. The farmland including wet paddy field and dry upland is formed of irregular terrace field.

Soils of the Project area lie on basaltic rocks or pumice as well as on alluvial materials. Soil drainage on farmland is generally well and soil permeability is moderate to rapid. Soil depth is deep to very deep ranging from 50 cm to more than 110 cm. Soil texture of surface soils is sandy clay to sandy loam. Stoniness on the field is very high, especially in the middle part of Project area.

The results of the soil survey are shown in Table 1.3 on a typical soil profile out of 18 soil test pits, Table 1.4 on soil laboratory tests for soil samples taken from three representative pits and Table 1.5 on the soil classification.

The predominant land use in the Project area is the terraced upland field as much as 365 ha in total because of the limited water availability. Some terraced field in upper and lower parts of the Project area is used as rainfed paddy field. There is no irrigated farmland in the Project area.

The present land use is classified on the 1/5,000 topographic map and it is summarized below.

Present Land Use on the Beneficiary Area of Aik Beta

Unit: ha

Land Use	Irrigated	Rainfed	Others	Total
Paddy field	0	64		64
Upland	0	365		365
Tree crops	0	0		0
Bush/Scrub/Grassland			97	97
Residential			14	14
Cemetery			1	1
Others			0	0
Total	0	429	112	541

Source : The JICA Study Team

The present land use and soil classification of the Project area is illustrated in Figure 1.1.

1.5 Demography

The demographic condition in the Project area as of 1993 is indicated by a total population of 1,660 and a total number of households of 262 including 202 farm households as shown below. The average family size is 6.3 persons. Ethnic condition is multiracial and the majority of inhabitants embrace Islam religion. Their education attainment is commonly primary school grade.

Present Demographic Condition

Village	Sub-Village	Total Population (person)	Total Household (No.)	Family Size (person)	Farm Household (No.)
Perigi	Aik Beta	1,016	160	6.4	121
	Gunung Rawi	644	102	6.3	81
Total		1,660	262	6.3	202

Source : JICA Water Use Survey

1.6 Domestic Water Use

Available water source facilities for domestic water use in the Project area comprise public water basin installed at spring and the Aik Beta river. At present, no inhabitants are confronted with water shortage in getting their drinking and livestock water. The present water use in each sub village clarified under the Study is summarized below:

- In Aik Beta Sub Village, all inhabitants depend their drinking water sources on five public water basins 100 to 500 m away and further carry water from the Aik Beta river at a distance of 200 to 500 m; and
- In Gunung Rawi Village, the whole households get their drinking water from the Aik Beta river 200 to 500 m away.

1.7 Social Infrastructures

The access from Mataram to the Project area is the Mataram-Labuhan Lombok road which is a two-lane paved road. The proposed Embung site is linked by an earth road with this main access. The on-going rural electrification network project is planned to be extended to the Project area soon.

Inhabitants are generally using private toilets outside their houses or an opened space of upland for defecating purposes. There are an auxiliary hospital and an integrated health service center within the Project area.

1.8 Agriculture and Livestock

(1) Present cropping pattern and intensity

The average annual planted areas of major crops are summarized below.

Present Cropping Pattern and Intensity

Cropping Pattern	Net Area (ha)	Planted Area (ha)	Proportion of Planted Area (%)	Cropping Intensity (%)
(1) Paddy - Palawija	46.0	58.0	19.5	126
(2) Upland crop - Fallow	239.0	239.0	80.5	100
Total / Average	285.0	297.0	100.0	105

Source : The JICA Land Use Survey and Inventory Survey

(2) Farming practice and farm inputs

As no irrigation facilities are available, the wet season paddy and the dry season tobacco are grown under the rainfed condition. Maize is cultivated on the upland field.

In terms of paddy, most farmers carry out land preparation with an animal-drawn plough and harrow their wet paddy field once or twice at the beginning of wet season, while this work by other marginal farmers depends on their own man power. High yielding rice varieties such as IR36, IR64, Krueng Aceh, Pelita and C4 are grown. Rice seed is sown on a nursery bed of which area is in the ratio of one twentieth against the main paddy field. Manual weeding is usually made one to three times for the rice growing period. Harvesting is carried out by using a sickle and hand threshing is done by means of beating rice plants against a frame.

Predominant cultivation methods of Palawija and upland crops are very primitive and local varieties are commonly used. Land preparation, planting, weeding and harvesting are done by hand.

Farm inputs and labor requirements currently used for growing these crops are given below.

Present Farm Inputs and Labor Requirements

Description	Unit	Wet Paddy	Maize	Tobacco
Farm Inputs				
Seed	kg/ha	50	25	0.1
Fertilizer				
Urea	kg/ha	300	50	250
TPS	kg/ha	100	50	200
KCl	kg/ha	50	0	100
Agro-chemicals	lit/ha	-	-	-
Labor Requirements				
Nursery	md/ha	3	-	-
Land preparation	md/ha	2	3	10
	ad/ha	5	-	-
Planting	md/ha	3	3	2
Transplanting	md/ha	15	-	5
Weeding	md/ha	10	3	8
Pest & disease control	md/ha	2	1	4
Farm management	md/ha	2	2	2
Harvesting	md/ha	15	12	5
Transportation	md/ha	5	6	5
Others	md/ha	4	2	2
Total	md/ha	61	32	43
	ad/ha	5	-	-

Source : The JICA Farm Economy Survey

(3) Crop yield and production

The present crop yield and production in the Project area are estimated as shown below. Unit yield of major crops remains extremely low due to lack of irrigation water, insufficient farm input supply and traditional farming practices.

Present Crop Yield and Production

Crops	Planted Area (ha)	Unit Yield (ton/ha)	Production (ton)
Wet Paddy Field			
Rainfed			
Wet season paddy	58	2.00	116
Dry season Palawija			
Tobacco	15	1.20	18
Upland Field			
Maize	239	1.30	311

Source: The JICA Inventory Survey

(4) Livestock population

Various kinds of livestock are raised in the Project area and their numbers are given below. Cows play important roles in land preparation and transportation as draft power. Other livestock are raised for self-consumption.

Current Population of Livestock

(Unit: head)

Breeding Household	Cow	Buffalo	Horse	Goat /Sheep	Pig	Chicken/ Duck
262	83	0	2	39	0	315

Source: The JICA Water Use Survey

1.9 Irrigation Facilities

In the Project area, there exists wet paddy field of 51 ha in gross on the right bank of Kali Batu river. All the wet paddy field are used under the rainfed condition. There are no irrigation facilities in the Project area.

1.10 Agro-economy

(1) Farmers group

Farmers are members of Agricultural Cooperative (KUD). From its branch shop called TPK, they commonly purchase fertilizers and use credit services. Some farmers are also members of Village Youth Association or Village Program of Women Education (PKK).

(2) Agricultural supporting services

Agricultural extension services are provided to farmers by field extension workers (PPL) attached to a rural extension center (BPP) in Pringgabaya. Usually, farmers receive PPL's visiting service very few because of limited budget for field operation in BPP. Some PPLs are livestock specialists to provide various services under the instructions of a specialized agricultural extension agent assigned to a district center for agricultural extension. Veterinary care services are given to breeding households through an animal health center of the Veterinary Service of the Department of Livestock. The present level of livestock extension services is similar to that of the agricultural extension services.

Credit services are available in KUD as well as in the service network of the Indonesian People's Bank (Bank Rakyat Indonesia) both handling "Credit for Farmer (KUT)" and "Income Generating Project for Marginal and Landless Farmers (P4K)". Financial sources of these credits are the Government for KUT and IFAD for P4K aiming at group financing.

Lombok Water Resources Development and Conservation Project Office (Proyek PKSA Lombok) under the NTB Provincial Public Works Service (DPUP) is responsible for new water resource development and watershed management. New development of irrigation system is the responsibility of Lombok Irrigation Project Office, while upgrading and rehabilitation works are the main task of Provincial Project Office for Rehabilitation and Upgrading of Irrigation. Operation and maintenance (O&M) works of all facilities are conducted by Provincial Project Office for Operation and Maintenance (PPO&M APBD). These project offices are under the direction of DPUP.

(3) Farmers' household economy

The results of agro-economy survey carried out in the Project area under the Study reveal that the average income and expenditure of 15 sample farmers amount to Rp. 1.32 million and Rp. 1.97 million, respectively. Sample farmers make up for deficit in their household economy by selling their livestock. Table 1.6 shows the summary of replies of 15 respondents.

2. DEVELOPMENT NEEDS AND CONCEPTS

2.1 Development Needs and Constraints

(1) Population increase

The future population in the Project area is anticipated by referring to "Projection of Population for Kabupaten/Kotamadya in Indonesia 1990-2000" prepared by National Statistic Bureau and the Second Long Term Development Plan (PJPT II). The total number of inhabitants living in the Project area will increase from 1,660 persons as at 1993 to 1,749 persons in 1998, 1,835 persons in 2003, 1,913 persons in 2008, 1,982 persons in 2013 and 2,044 persons in 2018.

(2) Basic human needs (BHN)

The inhabitants in the Project area are unsatisfied with the present condition of rural infrastructures because the existing domestic water supply sources are located in places 100 to 500 m away and no electricity is distributed to this area. However water distribution pipes and electric supply lines are planned to be extended to inhabitants' houses of the Project area. Thus, there is no pressing need in terms of BHN.

(3) Economic development needs

All of 202 farm households have principally consumed their farm products for their own use and then sold the remaining amount to local markets. There is not much possibilities of developing manufacturing and service sector industries in and around the Project area so as to offer new job opportunities to farmers. It is therefore indispensable for promoting public investment in economic infrastructures, especially for irrigation water source facilities, which encourage farmers to improve their farming system and enable them to increase their agricultural production. Increasing farm outputs could clue farmers themselves to upgrade their living standard and to catch up with faster economic growth of other sectors and places.

(4) Inhabitants' Intention to development pattern

Inhabitants in the Project area intend to use their farm land more intensive because no expansion of land holding size can be expected. To do so, they need all year-round water source facilities from which they will be able to get sufficient irrigation water for growing both the wet and dry season crops.

(5) Development constraints

The present constraints against economic development in the Project area are featured by no irrigation system to utilize water resources of the Aik Beta river. Such lack of water supply system has acted the barrier to improve agricultural development. Due to small size of the river basin and concentration of runoff into the wet season, the Aik Beta river is useless without construction of water regulating facilities.

2.2 Development Concepts and Approach

(1) Development concepts

The existing gap of economic status between NTB and other Provinces is caused by insufficient fulfillment of BHN, slow pace of poverty alleviation and less concerns about a balanced investment to regional development. In harmony with the national policy to correct this economic imbalance, the development concept is formed aiming at improvement of

social and economic infrastructures with the highest priority so as to meet BHN and increase agricultural outputs. Among others in the Project area, it is prerequisite to pay special attention to how to solve rainfed condition of crop cultivation caused by lack of irrigation system.

(2) Development strategies and approach

To overcome development constraints prevailing in the Project area, water resources seasonally available are to be regulated by means of constructing Embung as the water reservoir on the Aik Beta river. Approach to development planning of the potential Embung is as follows:

- To put the priority to supply irrigation water taking into account inhabitants' needs and intention;
- To project the future water demand for irrigation and domestic use at the target year of 2008 being the last year of Pelita VIII;
- To examine development potential of the Aik Beta Embung from the technical viewpoints;
- To determine the optimum development scale of the Embung;
- To make preliminary design and cost estimate; and
- To conduct investment justification from the viewpoints of economic soundness, social satisfaction and environmental impact.

2.3 Land Potential

The upper portion of terraced field is relatively suitable for irrigated paddy cultivation because of the low stoniness, while the middle portion with high stoniness has low productivity even irrigated. Therefore, the irrigation command area by the potential Embung should be planned on the upper terraced field being composed of rainfed paddy field and dry upland. The new irrigation potential area is expected at 66 ha, although there are hundreds hectare of terraced field under low suitability for irrigated paddy. If irrigation water is sufficient, some terraced field in the lower portion would be considered as irrigable area.

Rainfed paddy field	->	Irrigated paddy field	51 ha
Rainfed upland	->	Irrigated paddy field	33 ha

In conclusion, the future land use plan of the Project area is offered as shown below.

Future Land Use Plan in the Beneficiary Area of Aik Beta

Unit : ha

Land Use	Irrigated	Rainfed	Others	Total
Paddy field	84	13		101
Upland	0	332		332
Tree crops	0	0		0
Bush/Scrub/Grassland			97	97
Residential			14	14
Cemetery			1	1
Others			0	0
Total	84	345	112	541

Source : The JICA Study Team

The impounding area of the potential Embung includes small area of dry upland field. As the farmland to be submerged is estimated at about 0.5 ha only, much land acquisition cost is not necessary.

2.4 Agricultural and Livestock Development Plan

(1) Alternative cropping patterns

In formulating the future cropping patterns in the Project area, the following basic principles have been adopted:

- Higher benefit for farmers;
- Optimum use of irrigation water;
- Practical farming system for family labor; and,
- Crops and cropping patterns acceptable to farmers.

Wet paddy is the most predominant crop in the Project area and acceptable to farmers as they have long experience in rice cultivation. Therefore, they could easily master irrigated rice cultivation method to realize higher production and thereby large irrigation benefit under the condition of "With Project". Aiming to determine the optimum development scale of the proposed Embung, the following alternative cropping patterns are established.

Alternative Cropping Patterns

Pattern Code	Wet season		Dry season			
			First cropping		Second Cropping	
	Crop	Coverage (%)	Crop	Coverage (%)	Crop	Coverage (%)
With Project A-21	Paddy	100	Soybean	50	-	-
			Tobacco	50	-	-
With Project A-22	Paddy	100	Tobacco	100	Mungbean	100

(2) Farm Input and labor requirements

Under the "With Project" condition, farmers who are depending on unreliable rainfall, river flow or irrigation water can be expected to get stable irrigation water supply. They will be able to increase farm inputs to the optimal level with less risk. Proposed farm inputs are estimated in consideration of the present level in advanced irrigation areas as well as data collected from BPP. Labor requirements are also expected to increase substantially in cultivation under the technical irrigation system. On the other hand, farm input and labor requirements are expected to remain at present level under the "Without Project" condition.

Proposed Farm Input and Labor Requirements

Item	Unit	Wet Paddy	Soybean	Mungbean	Tobacco
Farm Inputs					
Seed	kg/ha	25	40	30	0.1
Fertilizer					
Urea	kg/ha	300	50	75	100
TPS	kg/ha	100	100	100	100
KCl	kg/ha	50	50	50	50
Agro-chemicals	lit/ha	2	2	2	1
Rodenticide	kg/ha	2	1	1	-
Labor	md/ha	185	70	80	200
Draft Animal	ad/ha	20	10	10	10

(3) Proposed farming practices

Proposed farming practices for wet paddy are as follows:

- High yielding rice varieties to be used under the With Project condition are IR64, Krueng Aceh, Pelita, C4 and IR36 with maturing periods of 110 to 135 days. These varieties are moderately resistant or resistant to several major rice pests and diseases. Land preparation on wet paddy field has to be done by animal ploughing and harrowing;

- Fertilizers need to be applied three times; the first application at the final stage of land preparation, and the second and third applications as top-dressing at the 20th and 37th day after transplanting, respectively. The top-dressing will be applied while water depth on wet paddy field is shallow. The phosphorous (TPS) and potassium (KCl) fertilizers have to be applied at the final stage of land preparation. The required amount of fertilizers is 60 kg/ha of N, 30 kg/ha of P and 30 kg/ha of K;

- Seed rates are 20 to 40 kg/ha for nursery. The best period for transplanting is 3 to 4 weeks after sowing, when the seedlings have 5 to 6 leaves. Ratio of the nursery bed to the main wet paddy field is about one twentieth. Planting density is about 2 to 3 plants per hill and spacing of hill is 20 cm x 20 cm;

- Weeding is required to be performed two to three times during the rice growing period according to weed growth. Irrigation water supply needs to be guaranteed during the most critical stages of the plant growth such as tillering, booting, flowering and germination stages. Timely control of insects, pest and diseases is necessitated on the basis of advice by PPLd and their assistants; and

- It is desirable to carry out harvesting when the ears are nearly ripened and are still in slight green. Harvesting is made by labors using a sickle. Harvested paddy plants need to be dried on the field for 3 to 4 days.

For growing Palawija crops under the irrigated condition, advanced farming practices similar to irrigated wet paddy cultivation and high yielding varieties are to be adopted. Land preparation will require animal-draft in order to enhance efficiency and accuracy of the work. Proper fertilization matching with soil conditions and timely insect/disease control are also indispensable. These farming practices need to be applied for, following technical instructions of PPLs.

(4) Anticipated crop yield

It is anticipated that the future yield of proposed crops under the "With Project" condition increases to 4.5 ton/ha for wet paddy, 1.4 ton/ha for soybean, 1.1 ton/ha for mungbean and 2.0 ton/ha for tobacco. These targets are estimated in due consideration of the present yield level in well established irrigation areas of Kabupaten Lombok Tengah as well as introduction of high yielding varieties and advanced farming practices, stable irrigation water supply and optimum use of farm inputs. As for build-up period to attain the anticipated yield, it is also prospected that crop yield level is 60% of the target in the first year, 70% in the second year, 80% in the third year, 90% in the fourth year and 100% from the fifth year and onward.

(5) Projected livestock population

The future livestock population in the Project area for the target year 2008/2009 is projected as shown below taking into account the actual growth rate of each livestock in Kabupaten Lombok Tengah during the Pelita V period.

Projected Population of Livestock

(Unit: head)

Cow	Buffalo	Horse	Goat /Sheep	Pig	Chicken/ Duck
99	0	11	35	0	1,792

2.5 Water Demand

(1) Domestic water demand

The future domestic water consumption level in rural areas of NTB is set to be 60 lit/day/capita up to 1998/99 for the Pelita VI period, 70 lit/day/capita up to 2003/04 for the Pelita VII period and 80 lit/day/capita from 2004/05 and onward. The public water demand is to be 30 lit/day for 10% of the projected population, while the unaccounted-for is to be equivalent to 20% of the total water demand.

Following the projected population, the future domestic water demand is estimated as shown below. The annual domestic water demand for 2008 is projected to be 69,600 m^3.

Projected Domestic Water Demand

Item	Unit	1998	2003	2008	2013	2018
Population	person	1,749	1,835	1,913	1,982	2,044
Domestic water	'000m^3/yr.	38.3	46.9	55.9	57.9	59.7
Public water	'000m^3/yr.	1.9	2.0	2.1	2.2	2.2
Un-accounted for	'000m^3/yr.	8.0	9.8	11.6	12.0	12.4
Total demand	'000m^3/yr.	48.2	58.7	69.6	72.1	74.3

(2) Irrigation water demand

In order to optimize the development scale and delineate the beneficiary area of the Project, irrigation water demand for each proposed crop is, estimated for unit irrigation area of 1 ha on the semi-monthly base taking into account crop consumptive use, evapotranspiration, crop coefficient, effective rainfall and irrigation efficiency both for wet paddy and Palawija crops as well as land preparation water, layer replacement and percolation loss only for wet paddy. As described in Attachment 1, irrigation water demand

in the Project area is calculated by referring to the standard quoted in "Irrigation Design Standard, KP-01" by DGWRD.

Tables 2.1 and 2.2 show the calculation results of evapotranspiration and effective rainfall, respectively, and Table 2.3 presents the unit irrigation water demands for each crop.

3. EXAMINATION OF EMBUNG DEVELOPMENT POTENTIAL

3.1 Topographic Condition

The Aik Beta Embung site was identified by PRIS of NTB through its identification study in 1993. Under the Study, the possibility of developing this Embung is firstly confirmed through the inventory survey. Then topographical survey with mapping for the proposed Embung site, reservoir area, and beneficiary area as well as geological investigations are carried out. The proposed Embung site is located at immediately downstream of a junction of two tributaries and the main stream, where U-shaped valley is formed. The elevation of river bed is 198.0 m and the width of valley shows rather wide about 450 m at elevation of 220.0 m. The gradient the main stream at the proposed site is very steep as 1/30.

3.2 Geological Condition

The proposed Embung site is underlain by volcanic breccia and alluvium of the Quaternary age. The foundation is mainly formed of volcanic breccia at the both banks, and alluvium at river bed. The drilling survey shows that the coefficient of permeability varies from 4.1×10^{-5} to 1.3×10^{-5} cm/sec for volcanic breccia. Ground water level varies from -4.8m to -9.0m in depth at three bore holes.

The reservoir is mainly underlain by volcanic breccia of the Quaternary age. No major fault and landslide are recognized in the reservoir area. No major problem for water leakage is assumed to occur in the reservoir area. Geological map and profile are shown in Figures 3.1 and 3.2.

3.3 Availability of Construction Materials

In and around the proposed Aik Beta Embung site, there are sufficient materials suitable for constructing a stone masonry type of dam. The coarse aggregate and sand for the stone masonry are investigated from the technical and economical view points. The following shows the summary of the materials available near the proposed site.

Availability of Construction Materials

Material	Location	Description
1. Coarse aggregate	Up/Downstream of the proposed site	River deposit Estimated to be more than 100,000m^3
2. Fine aggregate	(1)Embung site (2)Desa river, 5.5 km south from the proposed site	River deposit
3. Riprap (Rock)	(1)Embung site (2)Excavated rock from the dam foundation	Boulders around the dam site Estimated to be more than 30,000m^3

3.4 Availability of Water Resources

(1) Catchment yield

As for the Aik Beta river, there is no record of discharge. Accordingly, runoff at the proposed Embung site is estimated by use of the rainfall record near the proposed site. The Suela rainfall station which is located in the west of the Aik Beta Embung catchment has rainfall record of nearly consecutive 15 years and is considered to represent catchment rainfall. The climate is strongly influenced by altitude and the rainfall in the low elevated area is considerably low comparing to the high elevated area. Furthermore, most rainfall stations are located in the low elevated area. To convert the station rainfall to the catchment rainfall, thus, the adjustment coefficient of 1.2 is multiplied by use of isohyetal map. The generated catchment rainfall is given in Table 3.1. A runoff coefficient of 0.40 is adopted considering the characteristics of the catchment area and the previous hydrological analysis in the Lombok Island. Using this runoff coefficient and rainfall record at Suela, river flow of the Aik Beta at proposed site is estimated.

Following conditions are considered for estimation of the half monthly discharge:

- Catchment area of the proposed Embung site is 22.4 km^2; and,
- Less than 20 mm of half monthly rainfall is ignored for estimation.

This estimation is made based on the rainfall record from 1960 to 1974. The estimated half monthly discharge is given in Table 3.2 and monthly discharge is summarized below.

Mean Monthly Discharge

Unit: 1,000 m^3

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
2,811	2,322	1,497	612	229	27	182	78	0	558	1,142	2,560	12,019

(2) Floods

The flood analysis is made to determine the design discharge of the structures, such as spillway, diversion tunnel, and so on. Taking availability of the flood record and size of the catchment area into account, the rational formula is adopted to estimate the flood discharge in the Study. The formula is;

$$Q = 0.2778\ f\ r\ A$$

where, Q : Peak discharge (m^3/s)
f : Runoff coefficient
r : Average rainfall intensity within time of concentration (mm/hr)
A : Catchment area (km)

1) Design rainfall

Design rainfall is estimated by the Log Pearson Type III method, which is widely used in NTB. In this Study, 10 years rainfall data of the Sapit station from 1974 to 1993 are analyzed by the method. The result of probability analysis is summarized below.

Design Rainfall

Unit : mm

Return Period	Design Rainfall
1 in 2 year	100
1 in 5 year	127
1 in 10 year	146
1 in 20 year	166
1 in 50 year	194
1 in 100 year	217
1 in 200 year	241

2) Design flood

The following is the Ruziha's formula to estimate the flood travel time:

$$T = L/V$$
$$V = 72(H/L)^{0.6}$$

where, T : Flood travel time (hr)
L : Horizontally projected length of river course (km)
H : Difference of elevation (m)
V : Velocity of flood (km/hr)

The rainfall intensity within concentration time of the flood is estimated by an empirical formula prepared by Dr. Mononobe as follows:

$$r = (R_{24}/24) \times (24/T)^{2/3}$$

where; r : Maximum average rainfall intensity within concentration time (mm/hr)
R_{24} : Daily rainfall (mm)
T : Time of concentration (hr)

The runoff coefficient is estimated at 0.8 considering the condition of the catchment area.

Based on the above condition, the peak floods in various return period are estimated. The result is shown in Table 3.3 and summarizes below.

Probable Flood

Unit : m^3/s

Return Period	Probable Flood
1 in 2 year	151
1 in 5 year	192
1 in 10 year	221
1 in 20 year	251
1 in 50 year	293
1 in 100 year	328
1 in 200 year	364

(3) Sediment load

There is no available data on sediment load on the Aik Beta river. The Technical Report I (Embung Study Program) in the Sumbawa Water Resources Development Planning Study Extension Phase in 1982 indicates that the sedimentation rate is 0.5 mm/year/km ^{2}. Taking data availability and characteristics of the catchment area into account, 0.4 mm/year/km^2 is adopted in this Study.

(4) Water quality

On October 24, 1994, water samplings were carried out at the proposed Embung site and upstream and downstream of the site for the clarification of the water quality. The result of the test is shown in Table 3.4.

4. EMBUNG DEVELOPMENT PLAN

4.1 Optimization of Development Scale

The water balance study aims to clarify the relationship among the proposed Embung scale, irrigable area and cropping pattern. According to the water demand and procedure to be described below, the water balance study of the Aik Beta Embung Project is conducted.

(1) Methodology

The simulation equation is as follows:

$$W_2 = W_1 + I - L - S_P - O_D - O_L - O_I$$

where , I : inflow to reservoir at the half monthly period (m3)
L : water losses from the reservoir caused by evaporation during the half monthly period (m3)
SP : flow of water over the spillway during the half monthly period (m3)
OD : outflow needed for domestic water during the half monthly period (m3)
OL : outflow needed for livestock water during the half monthly period (m^3)
O_I : outflow needed for irrigation water during the half monthly period (m^3)
W_1 : volume of water in the reservoir at the beginning of the half monthly period (m^3)
W_2 : volume of water in the reservoir at the end of the half monthly period (m^3)

1) Inflow

Since there is no gauging station on the Aik Beta river, discharge is generated from rainfall of the Suela station.

2) Reservoir storage curve

Reservoir storage curve with surface area is shown in Figure 4.1 in relation to the elevation at the proposed Embung site.

3) Losses

Evaporation from inundation area can be estimated as "1.1 x ETo", indicating, "open water evaporation", which is employed in the Design Criteria KP-1.

4) Spill out discharge from reservoir

Spill out discharge is considered if there is any excess storage which exceeds the maximum storage capacity of dam.

5) Water Demand

The 100% dependability of the domestic water demand shall be secured by the proposed Aik Beta Embung.

To meet 80% dependability of irrigation water, reservoir capacity will be determined.

6) Water level of reservoir

Minimum water level is estimated at El. 213.9 m considering sedimentation volume for 25 years and 1.0 m allowance. Maximum water level for the

simulation is equal to the crest elevation of spillway. Probable maximum high water level according to topography is set at El. 219.0 m.

(2) Optimum development scale

With respect to the proposed Aik Beta Embung, the plan with the most sizable reservoir is selected within economically reasonable range in view of maximum exploitation of the endowed water resource. The optimum development scale of Aik Beta Embung is decided by the limitation of topography at the proposed site. The optimum development scale is thus in line with the maximum height of 25.0 m and effective storage capacity of 0.309 million cubic meters (MCM). The result of reservoir operation is shown in Figure 4.2.

4.2 Delineation of Beneficiary Area

(1) Delineation of beneficiary irrigation area

By developing available water resources of the Aik Beta river through construction of the proposed Aik Beta Embung at the maximum scale, irrigation water can be supplied to wet paddy field of 84 ha in net fully for the wet season and partly for the dry season. The beneficiary area of the proposed Embung comprises the newly converted field from the existing rainfed paddy field of 58 ha and dry upland of 26 ha. Taking such improved water supply condition into account, it is proposed that the future cropping pattern under the "With Project" condition is the full cropping of irrigated wet season paddy and the partial cropping of tobacco followed by mungbean under the irrigated condition coupled with rainfed tobacco and mungbean as the dry season Palawija crops as shown below and illustrated in Figure 4.3.

Under the "Without Project" condition, no new irrigation water source can be developed so that the future cropping pattern is to remain in the same condition of the present pattern.

Condition	Wet season			Dry Season		
	Crop	Water Supply	Area (ha)	Crop	Water Supply	Area (ha)
With Project	Paddy	Irrigated	84	Tobacco	Irrigated	11
				Mungbean	Irrigated	11
				Tobacco	Rainfed	31
				Mungbean	Rainfed	31
Without Project	Paddy	Rainfed	58	Tobacco	Rainfed	15
	Maize	Rainfed	26			

(2) Delineation of beneficiary area for domestic water supply

There is no water demand for domestic and livestock use in the Project area. It is therefore to utilize reservoir water of the proposed Embung for the irrigation purpose only.

4.3 Embung Development Plan

Following the results of the geological and material surveys as well as the optimization study, the proposed development plan of Aik Beta Embung is determined. In terms of dam type, masonry gravity type is applied in due consideration of the foundation strength and the availability of embankment materials.

The main components of Aik Beta Embung are the main dam, spillway, river diversion conduit and water supply facility as shown in Figure 4.4. In order to provide the reservoir with the optimum storage capacity of 0.309 MCM, the full supply level (F.S.L.) is

set at El. 219.0 m. Taking overflow depth of spillway and freeboard into account, the dam height of Aik Beta Embung becomes 25.0 m above the river bed. In order to release the flood discharge during the construction period, a by-pass conduit with a square size of 2.0 m x 2.0 m is provided in the dam body. The spillway is located on the middle portion of the main dam to release the flood discharge of 330.0 m^3 /sec from the catchment area of 22.4 km^2. For the purpose of supplying domestic water to the beneficiary area, such related facilities are provided as an intake structure in the reservoir, water supply pipe with a diameter of 250 mm below the dam body and valve house at the downstream of the main dam.

The principal features of Aik Beta Embung are summarized below.

(1)	Reservoir	
	- Catchment area	22.4 km^2
	- F.S.L.	El. 219.0 m
	- Minimum operating level	El. 213.9 m
	- Effective storage capacity	309,000 m^3
	- Dead storage capacity	261,000 m^3
	- Gross storage capacity	570,000 m^3
	- Sediment deposition level	El. 212.9 m
(2)	Main dam	
	- Type	Stone masonry dam (Gravity type)
	- Height	25.0m above river bed
	- Crest elevation	El. 223.0 m
	- Crest length	470 m
	- Crest width	5.0 m
	- Upstream slope	1 : 0.5
	- Downstream slope	1 : 1.0
	- Total masonry volume	86,000 m^3
(3)	Spillway	
	- Design flood (1/100 year)	330 m^3/sec
	- Type	Overflow weir
	- Crest elevation of overflow weir	El. 219.0 m
	- Width of overflow weir	53.0 m
	- Discharge capacity	330 m^3/sec
	- Overflow depth	2.0 m
(4)	River diversion	
	- Design flood (1/5 year)	192 m^3/sec
	- Type	By-pass in dam body
	- Diameter	2.0 x 2.0 m square
	- Length	-
(5)	Water supply system	
	- Inlet structure	Spindle gate with trashracks
	- Gate size	0.5 x 0.5 m square
	- Design discharge	110 lit/sec
	- Pipe diameter	250 mm
	- Outlet elevation	El. 213.0 m, Right abutment of dam site

5. PRELIMINARY DESIGN OF FACILITIES

5.1 Preliminary Design of Embung

(1) Main dam

Considering the geological condition and available construction materials around the dam site, stone masonry dam is applied for the Aik Beta Embung.

1) Dam height

Resulting from the optimization study based on irrigation benefit and construction cost, the dam height is decided to be 25.0 m in order to maximize the reservoir storage capacity. Actually, the dam height is limited to be El. 223.0 m as crest elevation due to topographic condition of the Embung site as seen in Figure 4.4.

2) Freeboard

The freeboard of main dam is designed taking into consideration the rise of reservoir water surface due to extraordinary flood discharge and wave uprush on the slope.

The following formula is applied for the design of the Aik Beta Embung.

$$Hf = 0.05h + 1.0 \text{ (m)}$$

where, Hf : freeboard
h : height from river bed to the designed flood level.

(2) River diversion during construction

During the construction period of main dam, river flow including flood discharge should be diverted to avoid inundation of the Embung construction site. For this purpose, the by-pass conduit with a closing gate is provided in the dam body. The dimension of by-pass conduit is 2.0 x 2.0 m square and the formation height set at El. 198.0m which is the same elevation of the river bed.

Before commencement of the reservoir water impounding, the by-pass conduit is closed by using closing gate and plugged by the concrete with contact grouting.

(3) Spillway

The spillway is located at the middle portion of main dam as overflow section as shown in Figure 4.4. The overflow weir is designed to cope with the design flood inflow with a flood surcharge space of 2.0m (overflow depth) provided above F.S.L. of El. 219.0 m The design flood is determined at 100 year probable flood having a peak discharge of 330 m^3/sec.

Based on comparative study on combination of overflow depth and width of the spillway, the overflow depth of 2.0 m and the width of 53.0 m are decided so as to minimize the cost of spillway and the main dam. A spillway bridge is provided over the overflow section in order to connect the crest road from the right to left abutments.

(4) Water supply system

In order to supply the water to the downstream irrigation area, the water supply system is provided to release the water of 110 lit/sec. The water supply system consists of inlet structure with trashracks, gate control house and water supply pipe with a diameter of 250 mm.

Inlet formation is set at above the sediment deposition level of El. 212.9 m and pipe outlet elevation is El. 213.0 m so as to connect the water supply pipe from the dam body to the existing irrigation canal.

5.2 Preliminary Design of Irrigation Facilities

(1) Basic concept

The following basic concepts are applied for the preliminary design of irrigation facilities in line with the development strategy:

- Irrigation water impounded by the Embung is supplied firstly to the existing cropped field, irrigated or rainfed, in the beneficiary area;
- Irrigation area is defined taking into consideration the available cropped field and the effective storage capacity of Embung;
- Irrigation canals from the outlet of Embung to the head of existing cropped field is constructed in the form of open channel as much as possible from the economic viewpoint;
- Irrigation system in the existing cropped field is be developed by farmers themselves, as the irrigation system commands around 50 ha only. No consideration is taken into in terms of new land reclamation;
- Proper design of canal alignment for gravity irrigation is considered paying special attention to avoid adverse effect on environment; and,
- Drainage improvement is not required for the existing cropped field since the beneficiary area is situated on well drained land.

(2) Irrigation plan

The water taken from the reservoir is led to the valve house through the cast iron pipe provided inside the dam body on the right abutment.

The irrigation water is discharged to the irrigation inlet box to make the open flow from the pipe pressure flow. From the irrigation inlet box, the irrigation water is led to the beneficiary wet paddy field by the newly constructed open channel with a distance of around 5,460 m and delivered to wet paddy field.

General layout is shown in Figure 5.1.

(3) Design discharge and initial water level

Design discharge for canal and related structures are decided based on the irrigation water requirement and proposed cropping pattern. Peak semi-monthly base diversion requirement for the unit irrigation area of 1.0 ha is defined as a design discharge after multiplying the irrigation area. Peak diversion requirement occurs in the first half month of

January for the wet season paddy and its design discharge is estimated at 110 lit/sec for the net irrigation area of 84 ha. This design discharge is enough to flow design discharge for the dry season Palawija crops at peak time.

Initial water level at the irrigation inlet box is decided taking the elevation at the box site into consideration. As a result, the initial water level is El. 213.0 m at the irrigation inlet box.

(4) Irrigation facilities

The proposed canal layout and design of irrigation facilities are made based on the 1/5,000 topographic map prepared under the Study and in accordance with the following considerations:

- Canal alignment is to be straight and short as much as possible;
- The alignment is to be planned to pass outside of villages and give no damages to public facilities;
- The types of canal related structures are to be minimized as much as possible; and,
- The structures are to be simplified as much as possible.

Irrigation canals to lead the water to wet paddy field from the Embung are constructed using concrete flumes taking into account the rather small design discharge of the canal, steep topographic condition, construction method and available construction materials in the Project area. Canal related structures required are irrigation inlet box, turnouts and irrigation division boxes. Required irrigation facilities are summarized below :

Irrigation Facilities Requirements

Facilities	Quantities
- Valve house (included in the facilities for Embung)	1 No.
- Irrigation inlet box	1 No.
- Concrete flume type canal to be constructed	5.5 km
- Turnout	2 Nos.
- Irrigation division box	43 Nos.

6. EMBUNG CONSTRUCTION PLAN

6.1 Construction Schedule

(1) Basic condition

All the construction works will be carried out by a local contractor selected by local competitive bidding.

The construction plan is based on the mode of construction and the target schedule of construction works as well as local conditions such as availability of construction labor, material and equipment as well as weather and topographic conditions of the construction site.

It is assumed that 200 working days per year are available for conducting the earthfill embankment works, 270 days per year for the filter and rock embankment works and 300 days per year for concreting works in view of the daily rainfall distribution in the Project area. For each working day, 8-hour shift is applied.

(2) Construction schedule

The overall construction schedule is determined as shown in Figure 6.1 taking into account the necessary time of detailed design, bidding procedure including the time of tender evaluation and award of the contract. The major points of construction schedule are described below.

1) Mobilization and preparation works

Immediately after received "Notice to Proceed", the contractor would commence the mobilization of the construction equipment and key staff to the Project site from the beginning of November in the first year. Following this, preparatory works would be commenced at the Project site.

2) Setting out and excavation works

During the mobilization, setting out of all the structures would be commenced by the contractor at the Project site. Construction of temporary access roads such as access to the borrow area and access to major structural sites shall be started by using equipment available at the Project site. The excavation works for the river diversion by-pass would be commenced at the beginning of March, in the second year.

3) Excavation and masonry works

After completion of the concrete placing into the river diversion by-pass culvert, excavation works for the main dam will be commenced followed by masonry works for the main dam and the spillway. These works shall be concentrated and completed before October in the third year.

4) Commencement of reservoir water impounding

Commencement of the reservoir water impounding will be done at the beginning of October, in the third year after completion of the main dam and spillway construction. Considering the rainfall in November and December, in the third year, the Aik Beta reservoir would be quite full, and the water could be supplied from the reservoir to the water users from January in the fourth year.

5) Water distribution system

Construction works for the water distribution system will be executed in parallel with the Embung construction works by using mainly manpower because those work quantities are not so much. The construction works shall be completed by the end of December in the third year before supplying the reservoir water to the beneficiary area.

6.2 Construction Plan of Embung

(1) Preparatory works

The preparatory works consist of preparation of temporary buildings, construction plant and repair shop, arrangement power and water supply systems as well as communication system, construction of access and haul roads, and so on. All of these works will be conducted from November in the first year to February in the second year.

1) Temporary buildings and yards

The temporary buildings required for the construction would include office, quarters, workshop, warehouse and storage yards. These temporary buildings will be built by the contractor.

2) Water and power supply

The water required for the construction works and the daily use in the construction camp is planned to be taken from the rivers or springs near the Embung site or the wells drilled in the contractor's yard.

The electric power for the construction camp is planned to be supplied by the contractor's diesel generators.

(2) River diversion works

The river flow will be released through the river diversion by-pass conduit during the both dry and wet seasons in the second and third year, and therefore the river diversion conduit would be provided in the dam body.

After completion of the main dam masonry works around the end of September in the third year, the river diversion conduit shall be plugged by the concrete using concrete pump.

(3) Main dam and spillway masonry works

Following the foundation excavation and completion of the river diversion conduit, the masonry works for the main dam and spillway will be commenced at the beginning of November in the second year and completed at the end of September in the third year.

6.3 Construction Plan of Irrigation Facilities

Since the irrigation facilities to be constructed are rather small in work quantities and scattering in the beneficiary area in comparison with the Embung construction works, almost all the works except earth works for irrigation canal will be basically executed by man power. Earth works for the irrigation canal such as clearing, stripping, excavation and embankment works will be executed by using heavy construction equipment including bulldozer,

excavator, compactor and so on. All of these works will be executed in parallel with the construction Embung works.

6.4 Institutional Arrangement for Project Implementation

(1) Responsible organization for Project implementation

In the course of Project implementation, DPUP of NTB, after getting approval from DGWRD, will direct the PKSA Lombok Project Office to commence undertaking of detailed investigation and design works of the Aik Beta Embung. These works will be done by the Survey and Investigation Section as well as the Technical Design Section of the said Project Office. Based on the cost estimate, DPUP of NTB will disburse budget for land acquisition and construction of Embung and related facilities to the Project Office using development budget allocated from the Central Government. Before starting construction work, land acquisition work will be carried out by the Land Acquisition Section of the Project Office. Supervision of construction works, being entrusted to a contractor through tendering, will be the responsibility of the Construction and Implementation Section of the Project Office.

(2) Technical resources input

In due consideration of the current availability of engineers and technical staff as well as the annual development target in the PKSA Lombok Project Office, it is necessary to utilize technical resources outside the Project Office to the maximum extent for enabling the Project Office to realize its target. In this connection, undertaking of detailed investigation and design works for the Aik Beta Embung need to be entrusted to consultants aiming to secure smooth implementation of the Project in accordance with the implementation program made by the Project Office.

(3) Organization for O&M

After completing all of the Project works for Aik Beta Embung, DPUP of NTB will submit its completion report to the Minister for Public Works through DGWRD and therefrom the notice of Project completion will be transferred to the Minister for Home Affairs. After receiving the Minister's direction, the Governor of NTB Province will order DPUP of NTB to take a necessary action for O&M of the said Project facilities. Following this, DPUP of NTB will direct its Provincial O&M Project Office for and arrange O&M works and disburse the Provincial Government's budget to DPUP Kabupaten Lombok Timur Office.

(4) Water User's Association (P3A)

In the Project area, no P3A has been established. It is therefore necessitated to organize the beneficiary farmers for establishing P3A and to train them by using training materials and modules prepared by the Water User Training Program under DGWRD.

7. COST ESTIMATE

7.1 Basic Assumption of Cost Estimate

Project cost of the proposed works for developing the Aik Beta Embung is estimated on the basis of assumptions as follows :

- All the civil works of the Project will be executed on the contract basis. Contractor(s) will be selected through the competitive bidding;
- Project cost includes the physical contingency of 15% of the construction costs in view of the preliminary nature of the estimate. The price contingency of 20% is also included in the cost estimate taking into account the recent price escalation of construction materials in Indonesia;
- The associated costs to be financed by the Government, such as the cost for strengthening the extension services, facilities of the Water Users' Association and improvement of the social infrastructures except for those included in the proposed Project works, are not included in the cost estimate;
- The direct construction cost is estimated based on the calculated work quantities of the Project works and unit prices of the works. The unit prices of the works are estimated based on the current prices in NTB as of October 1994 and the data collected from the on-going projects in NTT and NTB. The basic prices for construction works include delivery cost of construction materials to the Project site;
- The contract tax, which is a value added tax imposed by the government at a rate of 10% against the total contract cost, is included in the estimate of the Project cost;
- Engineering service cost for the consultants in conducting detailed design and construction supervision is estimated based on such assumption as 15% of direct construction cost;
- Administration cost consists of PRWS's staff salary for construction management, vehicle running cost and other related cost only for the Project implementation. Administration cost is estimated at around 5% of the direct construction cost with reference to the recent other project costs in NTT and NTB;
- Land acquisition cost including the purchase of the Embung site, reservoir area, borrow areas, and land of pipe line, irrigation canal and permanent structures and is estimated at 0.5 % of the direct construction cost taking into consideration the present condition of the Project area based on the survey results under the Study; and,
- The currency for cost estimate is expressed in Indonesian Rupiah (Rp.) since all construction materials are available in Indonesia and the payment for construction works will be executed with Indonesian Rupiah.

7.2 Construction Cost

The Project cost, as an initial investment by the Project, is composed of direct construction cost, administration cost, engineering service cost, physical contingency,

contract tax, land acquisition cost and price contingency. The total Project cost for constructing the Aik Beta Embung is estimated at Rp. 16,736 million as shown in Table 7.1. Detail of direct construction cost estimated based on the calculated work quantities of the proposed Project works and unit prices of the works is shown in Table 7.2 together with work quantities of the main work items and unit prices.

The total project cost for the Aik Beta scheme is summarized below :

Summary of Project Cost for Aik Beta Embung

Unit : Rp. Million

Item		Project cost
I.	Direct construction cost	9,188
1.1	Preparatory works	438
1.2	Embung construction	8,345
1.3	Irrigation facilities	405
1.4	Domestic water supply	0
1.5	Operation & maintenance road	0
II.	Administration cost	459
III.	Engineering services	1,378
IV.	Physical contingencies	1,654
V.	Contract tax	1,222
VI.	Land acquisition	46
VII.	Price contingency	2,789
	Grand Total	16,736

7.3 Operation and Maintenance Cost

The O&M costs consist of salaries of O&M staff, cost for maintaining the Project facilities, material and labor cost for repairing works, and running cost of Project facilities. The annual O&M costs are estimated at Rp. 83.7 million, which is equivalent to 0.5 % of the Project cost.

8. PROJECT JUSTIFICATION

8.1 Satisfaction of BHN

As there is no water demand for domestic and livestock use by the beneficiary inhabitants, no social impact can be expected in the Project area by developing the Aik Beta Embung at the proposed site on the Aik Beta river.

8.2 Economic Consideration

(1) Economic cost

The financial costs are to be converted into the economic costs by applying the economic conversion factor (ECF) established by DGWRD in 1985. The ECFs applied are: 0.71 for preparatory works and all civil works including Embung, irrigation facilities, domestic water supply system and road networks; 0.75 for unskilled on-farm labor and farm labor; 0.80 for land clearing, on-farm development and operation and maintenance cost; and tertiary irrigation system development, 0.90 for design and survey works and administration; and 1.00 for O&M equipment and replacement cost.

When the financial cost is converted to the economic cost, the contract tax, land acquisition cost and price contingency are fully excepted. In this Study, only the purchasing cost of consumable and goods appropriated in the administration cost is to be converted to the economic administration cost, as the normal payment to civil servants is principally appropriated in the operation budget of the Government. As the construction cost of dam and engineering cost estimated include some allowance to cover additional cost for expatriates, 50% of the engineering cost is to be converted to the economic cost in order to make the estimated cost equal to the level of local cost.

The economic cost converted and its annual disbursement schedule are shown in Table 8.1.

(2) Economic benefit

The irrigation benefits of the Project are principally derived from increased crop production attributable to stable irrigation water supply, full utilization of available farm land resources and optimum farm input supply. Table 8.2 gives financial and economic prices of farm inputs and outputs estimated for major islands. Based on the proposed quantity of farm inputs, anticipated crop yield and economic farm gate prices, the economic crop budget is estimated as shown in Table 8.3.

The annual net incremental benefit is thus estimated to be Rp. 124.4 million. This increment benefit will accure from the first year when irrigation water can be released from the Aik Beta Embung. Taking the present agricultural situation and farmers capability into account, it is assumed that five years are needed as the build-up period to attain the anticipated crop yield level. In the proposed reservoir area, there will be no production foregone by constructing the proposed Aik Beta Embung.

(3) Economic evaluation

The economic internal rate of return (EIRR) is examine as shown in Table 8.4 on costs and benefits as at August 1994. The result of economic analysis reveals that there is no economic merit in developing the proposed Aik Beta Embung because the economic benefit attributed to the Embung development is too small compared with the required capital cost as the topographic condition limits to enlarge the reservoir capacity of Embung resulting in new irrigation area of only 84 ha.

(4) Farm Budget Analysis

With the implementation of Aik Beta Embung Project, the net on-farm income of farmers holding a unit farm size of 1.0 ha can be expected to increase by Rp. 2,165,300/year from Rp. 560,500/year under the "Without Project" condition with the cropping intensity of 118% to Rp. 2,725,800/year under the "With Project" condition with the cropping intensity of 300% as shown in Table 8.5 and below. Such improvement of farm budget would give much incentive for farmers to make further investment in improvement of their living standard and also could increase their payment capacity enabling beneficiary farmers to pay irrigation water charge to some extent.

Farm Budget for Unit Farm Size of 1 Ha

Crop	Watering Condition	Without Project		With Project	
		Crop Intensity (%)	Income (Rp.)	Crop Intensity (%)	Income (Rp.)
Paddy	Wet/Rainfed	69.0	268,927	-	-
	Wet/Irrigated	-	-	100.0	889,875
Maize	Wet/Rainfed	31.0	58,246	-	-
Mungbean	Dry/Rainfed	-	-	36.9	288,436
	Dry/Irrigated	-	-	13.1	132,889
Tobacco	Dry/Rainfed	17.9	233,371	36.9	978,404
	Dry/Irrigated	-	-	13.1	436,230
Total		117.9	560,544	300.0	2,725,834

8.3 Environmental Impact Assessment

Environmental impact assessment is carried out in consideration of the development objectives of the Project.

(1) Environmental features of the Project area

The principal features of human and physical environment in the Aik Beta Project area are summarized as below.

Environmental Features in the Aik Beta Project Area

Item	Description
1. Human Environment	
Social intention	Insufficiency of reliable water sources and facilities for irrigation water
Human use	Use of water led by the pipeline from spring
Economic activities	Cultivation of rainfed paddy and Palawija, and livestock farming
Health and sanitation	Occurrence of waterborne intestinal diseases
2. Physical environment	
Geology/land	Volcanic products of the Quaternary
Surface/ground water	Surface water is not perennially observed
Endemic fauna and flora	None
3. Others	None

(2) Environmental impact assessment

Potential negative impact by Embung development in this Project area is only air pollution of atmosphere impact during the construction stage. It is assumed that the Embung construction works generate dust and the continuous operation of heavy equipment

simultaneously produces an exhaust gas. As a result, inhabitants and livestock in the vicinity area of the construction site will be considerably affected by atmosphere aspects of the dust and exhaust gas. It is recommended that the client of the construction works shall instruct the contractors to take countermeasures for inhabitants to cope with these environmental problems. An effective management such as stationing watchman aiming at daily safety control, proper transportation management of excavated materials and others is required.

(3) Primary information of environmental assessment

To support environmental analysis presentation for this project implementation by the Indonesian rule, primary information on environmental assessment is compiled in the Attachment to the Volume 4.

8.4 Contribution to Women in Development

Since housewives in the Project area manage their family budgets, an increase of the farmer's income would encourage women in investing surplus in improvement and diversification of their income sources.

9. CONCLUSION AND RECOMMENDATIONS

9.1 Conclusion

On the basis of categorization of 157 candidate schemes for the Study, the Aik Beta Embung scheme is selected representing a typical sample scheme of which potential beneficiary area has no irrigation facility, rainfed farming system and no demand for domestic and livestock water by the beneficiary inhabitants. The proposed Aik Beta Embung site has physically irrigable land resources of 84 ha in net and the annual discharge of 12.0 MCM from its catchment area of 22.4 km^2.

The topographic condition at the proposed Embung site is the determining factor in the optimization of development scale. The maximum dam height of Aik Beta Embung is thus set to be 25.0 m with the total and effective storage capacities of 0.570 and 0.309 MCM, respectively. Under such condition, the whole irrigable area of 84 ha will be provided with irrigation water fully for the wet season but about one-fourth for the dry season. It can be expected to grow the dry season Palawija crops under the rainfed condition depending on available soil moisture during the early dry season.

The structural components are main dam and irrigation water distribution system. The stone masonry dam is constructed with the crest length of 470 m, masonry volume of 86,000 m^3 and overflow weir of 53 m in width and 330 m^3/sec in design flood discharge. The required investment cost amounts to Rp. 16.7 billion of which direct construction cost is estimated to be 9.2 billion.

The results of feasibility study reveal that construction of the candidate Embung at the proposed site is technically sound but economically impossible because of a rather small reservoir capacity. Therefore, such type of Embung is worthless implementing from the economic viewpoint.

9.2 Recommendations

If irrigation development is required in the Aik Beta area, it is recommended to construct an intake weir on the Aik Beta river instead of the proposed Embung development from the viewpoint of investment cost saving.

The Study on The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara

Feasibility Study on Aik Beta Embung Development Project

Tables

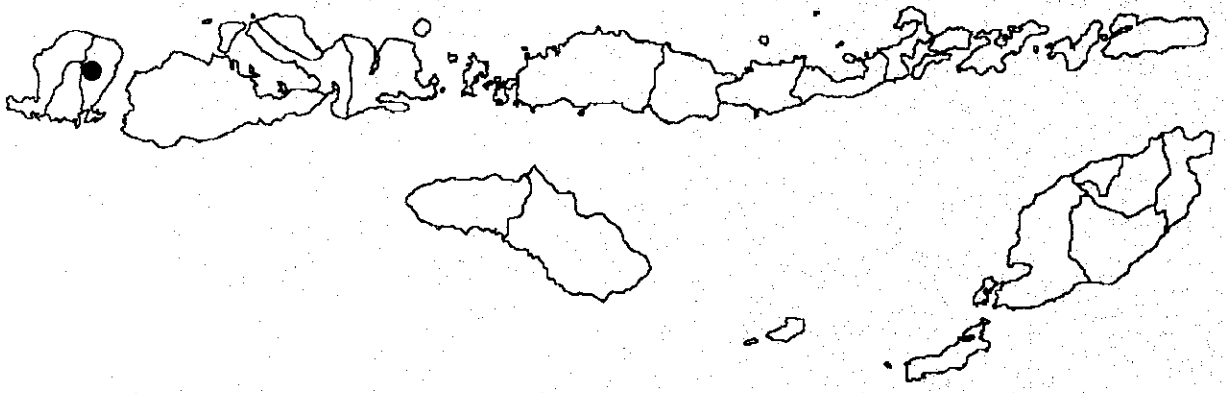


Table 1.1 Rainfall Record in Suela

SUELA (SOURCE CRIPPEN + DPU)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
1960	299	259	138	174	84	2	0	0	4	28	322	141	1451
1961	207	145	29	54	27	0	0	0	2	2	73	59	598
1962	496	340	58	169	47	10	122	0	0	31	101	378	1752
1963	398	304	408	161	54	0	0	0	0	42	40	324	1731
1964	237	149	168	46	93	15	9	0	0	442	278	73	1510
1965	342	184	159	15	0	0	0	0	0	0	0	221	921
1966	261	202	181	0	0	0	0	0	31	104	121	231	1131
1967	126	74	194	27	6	0	26	0	0	0	0	221	674
1968	336	0	126	119	23	38	132	60	21	129	198	219	1401
1969	139	508	139	66	0	0	0	0	0	0	9	238	1099
1970	70	218	0	0	0	0	0	3	23	9	250	314	887
1971	351	195	291	26	42	0	0	0	0	34	0	433	1372
1972	261	216	141	61	29	5	21	8	6	61	109	238	1156
1973	148	200	0	0	24	0	0	47	0	0	98	238	755
1974	242	242	79	0	0	0	0	0	6	30	30	238	867
Max.	496	508	408	174	93	38	132	60	31	442	322	433	1752
Mean	261	216	141	61	29	5	21	8	6	61	109	238	1154
Min.	70	0	0	0	0	0	0	0	0	0	0	59	598

Sum of monthly means

Table 1.2 Climate in Sambelia

Station: Sambelia
Island : Lombok
Kabupaten : Lombok Timur

Latitude : 08 23 S
Longitude : 116 43 E
Elevation : 132 m

Description	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Average	Year
Average daily maximum temperature	C	31.4	31.0	31.0	31.9	32.3	31.4	31.0	31.9	32.5	32.9	32.6	30.8	31.7	1981 - 1985
Average daily minimum temperature	C	22.5	22.3	22.5	23.5	23.2	22.6	21.7	21.5	22.4	23.0	23.3	22.6	22.6	1981 - 1985
Mean daily temperature	C	27.0	26.7	26.8	27.7	27.8	27.0	26.4	26.7	27.5	28.0	28.0	26.7	27.2	1981 - 1985
Mean daily relative humidity	%	89.0	87.0	86.0	83.0	82.0	76.0	77.0	74.0	75.0	77.0	80.0	80.0	81.0	1981 - 1985
Mean daily wind run over 24 hours	km/day	142.0	131.0	127.0	140.0	147.0	206.0	176.0	202.0	185.0	202.0	199.0	148.0	167.0	1981 - 1985
Wind speed at time of observation	m/s	1.6	1.5	1.5	1.6	1.7	2.4	2.0	2.3	2.1	2.3	2.3	1.7	1.9	1981 - 1985
Mean daily observed bright sunshine	hr/month	180.0	147.0	167.0	207.0	270.0	276.0	304.0	245.0	297.0	288.0	234.0	198.0	2,813.0	1981 - 1985
Mean daily observed bright sunshine	hr/day	5.8	5.2	5.4	6.9	8.7	9.2	9.8	7.9	9.9	9.3	7.8	6.4	7.7	1981 - 1985
Mean daily maximum possible sunshine	hr/day	12.5	12.4	12.2	12.0	11.8	11.7	11.8	11.9	12.0	12.2	12.5	12.6	12.1	1981 - 1985
Mean Solar Radiation	mm/day	16.2	16.5	15.8	14.5	13.2	12.5	12.8	13.8	15.0	16.0	16.1	16.3	14.9	1981 - 1985

Source : Repprot (Nusatenggara, Maluku, Timor Timur) Annex 3

Table 1.3 Typical Soil Profile in the Aik Beta Project Area

Profile No.:		1
Soil Classification:		Oxyaquic Ustropepts
Physiography:		Mountain middle slope
Topography:		Hilly (11 %)
Land Use/Vegetation:		Rainfed paddy field
Parent material:		Mixed, sandy-alluvium material
Drainage:		Moderately well
Groundwater Table:		3 - 5 m
Permeability:		Rapid (15.26 cm/hr)
Land Morphology:		
Horizon	**Depth (cm)**	**Description**
Ap	0 - 33	Very pole brown (10YR 7/3, dry); sandy clay; moderate, crumb, fine structure; sticky, plastic, friable, slightly hard consistency; many, fine root; clear, smooth horizon boundary
Bwq	33 - 62	Dark yellowish brown (10YR 4/4, dry); sandy clay; week crumb, fine structure; slightly sticky, slightly plastic, friable, slightly hard consistency; few, fine root; clear, smooth horizon boundary
Bw2	62 - 84	Dark brown-brown (10YR 4/3, dry); sandy clay; 20 % coarse material (gravel); week, granular, fine structure; slightly sticky, slightly plastic, friable, slightly hard consistency; diffuse, smooth horizon boundary
2A	84 - 100+	Dark brown-brown (10YR 4/3, dry); loam; weak, crumb, fine structure; slightly sticky, slightly olastic, friable, soft consistency

Source: Soil survey carried out by the local consultant under supervision of the JICA Study Team

Table 1.4 Results of Soil Laboratory Test in the Aik Beta Project Area

Soil Pit	Layer	Texture			Permeability	pH	pH	Organic	Total N	Ava. P	CEC	Ex. Na	Ex. Ca	Ex. K	Ex. Mg	Base	EC
		Sand (%)	Silt (%)	Clay (%)	(cm/hr)	(H2O)	(KCl)	matter	(%)	(ppm)	(me/100g)	(me/100g)	(me/100g)	(me/100g)	(me/100g)	Saturation (%)	(mS/cm)
4	Ap	53.4	13.6	33.0	15.9	6.6	5.6	1.13	0.05	2.08	14.55	0.79	6.62	2.10	1.40	75	0.14
	C	58.8	12.2	29.0	6.0	6.8	5.6	0.98	0.04	1.99	19.69	0.25	4.83	0.99	1.08	36	0.06
	2A	56.7	14.3	29.0		7.1	5.4	1.15	0.04	2.17	20.31	0.82	7.39	1.13	1.19	52	0.04
8	Ap	58.7	14.3	27.0	6.1	7.0	6.2	1.13	0.06	2.30	35.94	0.55	8.79	1.05	5.55	44	0.20
	AC	60.8	8.2	29.0	4.3	7.5	6.2	1.17	0.04	2.44	37.24	1.19	9.81	0.78	5.62	47	0.06
	C	53.8	18.2	28.0		7.9	6.2	0.67	0.03	2.05	36.75	0.87	10.82	0.64	5.65	49	0.20
13	A	43.7	31.3	25.0	14.7	6.8	5.7	1.17	0.05	9.12	13.02	0.32	6.49	1.77	1.10	74	0.06
	Bw1	77.2	4.8	18.0	18.0	7.0	5.7	1.35	0.03	6.16	17.81	0.21	7.90	1.36	2.16	65	0.02
	C	76.8	5.4	17.9		6.5	5.7	0.55	0.03	3.19	20.78	0.62	9.00	1.27	2.44	64	0.06

Source: Soil survey carried out by the local contractor under supervision of the JICA Team

Table 1.5 Soil Classification in the Aik Beta Project Area

Land Unit	Description	Physiography	Topography	Potential Suitability			Area	
				Paddy	Soybean	Maize	(ha)	(%)
I	Oxyaquic Ustropepts deep; fine clay; neutral; low-high CEC; rapid permeability; moderate-well drainage	Mountain middle slope	Hilly (11%)	N	S2	S2	15	3%
II	Typic Ustifluvents shallow-deep; fine clay-coase loamy; neutral; moderate CEC; rapid-very rapid permeability; well drainage	Alluvial fan-mountain foot slope	Flat-hilly (0-13%)	S1/S2/N	S1/S3	S2/S3	155	29%
III	Typic Argiustolls deep; fine clay; neutral; moderate CEC; slightly rapid permeability; moderate-well drainage	Mountain foot slope	Undulating (4-6%)	N	S3	S3	14	3%
IV	Typic Ustarents deep; coarse loamy; neutral; moderate CEC; rapid permeability; well drainage	Mountain slope	Rolling (8-15%)	N	S3	S3	48	9%
V	Typic Haplustalfs deep; coarse loamy; neutral; high CEC; moderate-rapid permeability; well drainage	Mountain foot slope	Undulating-rolling (4-15%)	S2/S3/N	S1/S2	S2	55	10%
VI	Typic Ustrothents shallow-deep; fine loamy; neutral; high CEC; moderate-rapid permeability; well drainage	Mountain foot slope	Undulating-rolling (5-18%)	S3/N	S2	S2	33	6%
VII	Fluventic Ustropepts deep; fine loamy-coase loamy; neutral; moderate CEC; rapid permeability; well drainage	Alluvial fan-mountain foot slope	Undulating (4%)	S2	S1/S3	S2	131	24%
VIII	Fluventic Haplustalfs deep; coase loamy; neutral; moderate CEC; slightly rapid-rapid permeability; well drainage	Mountain foot slope	Undulating (5-6%)	S2/S3	S1/S3	S2	57	11%
IX	Typic Ustropepts deep; loamy; neutral; moderate CEC; very rapid permeability; somewhat excessive drainage	Mountain foot slope	Undulating (2-4%)	S2	S1	S2	23	4%
#	Unclassified						10	2%
	Total						541	100%

Source: Soil survey carried out by the local consultant under supervision of the JICA Team

Table 1.6 Summary ofFarm Household Economic Survey inthe Aik Beta Project Area

	Item	Unit	Respond't No. 1	Respond't No. 2	Respond't No. 3	Respond't No. 4	Respond't No. 5	Respond't No. 6	Respond't No. 7	Respond't No. 8	Respond't No. 9	Respond't No. 10	Respond't No. 11	Respond't No. 12	Respond't No. 13	Respond't No. 14	Respond't No. 15	Average
1	Sex and Age		Male 30	Male 45	Male 35	Male 35	Male 45	Male 35	Male 40	Male 45	Male 40	Male 45	Male 60	Male 37	Male 52	Male 45	Male 60	Male 43
2	No. of Family Member		M-2/F-4	M-5/F-2	M-1/F-2	M-1/F-2	M-2/F-3	M-4/F-2	M-1/F-4	M-0/F-2	M-3/F-3	M-1/F-4	M-2/F-5	M-2/F-3	M-1/F-5	M-3/F-3	M-5/F-1	M-2/F-3
3	Type of Side Job		Worker	Desa Ser.	Worker	Worker	Worker	None	Worker	None	Worker	None	None	Worker	Entrepren.	Worker	Worker	
4	Own Farmland	ha	0.27	2.87	1.02	1.02	1.53	0.62	1.20	1.80	2.52	1.03	4.03	0.52	4.32	1.20	1.20	1.68
	Rented Farmland	ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Yield Division	ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	(Paddy field)	ha	0.00	2.50	0.00	0.00	1.00	0.00	0.00	0.64	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.41
5	Cropped Area	ha	0.50	2.35	1.00	1.00	1.50	2.20	1.00	1.51	2.50	2.00	4.00	0.50	4.75	2.50	1.75	1.94
	(Paddy)	ha	0.25	2.00	0.00	0.00	1.00	0.00	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25
	(Palawija)	ha	0.25	0.35	1.00	1.00	0.50	2.20	1.00	0.96	2.50	2.00	4.00	0.50	4.75	2.50	1.75	1.68
	(Others)	ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	Cow/Buffalo	head	0	1	0	0	0	0	0	0	0	4	0	0	2	0	0	0
	Horse	head	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Goat/Sheep	head	0	0	3	0	0	0	0	0	0	0	0	2	0	8	10	2
	Pig	head	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Chicken/Duck	head	0	0	8	0	0	0	0	3	0	14	0	0	0	0	0	2
7	Gross Income	Rp.'000/yr	1,310.0	8,320.0	870.0	550.0	11,715.0	492.5	312.5	2,185.0	1,055.0	537.5	4,875.0	835.0	3,000.0	1,820.0	1,287.5	2,611.0
	(Crop)	Rp.'000/yr	410.0	3,820.0	450.0	400.0	11,505.0	492.5	212.5	2,185.0	875.0	537.5	4,875.0	475.0	2,000.0	1,770.0	597.5	2,040.3
	(Livestock)	Rp.'000/yr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	150.0	13.3
	(Side job)	Rp.'000/yr	900.0	4,500.0	420.0	150.0	210.0	0.0	100.0	0.0	180.0	0.0	0.0	360.0	1,000.0	0.0	540.0	557.3
	(Miscellaneous)	Rp.'000/yr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	Expenditure	Rp.'000/yr	977.2	12,642.8	1,097.6	839.5	2,299.0	1,626.4	2,295.2	3,056.2	1,982.4	1,676.7	2,415.2	1,051.0	2,663.0	3,243.6	1,799.7	2,644.4
	(Food/drink)	Rp.'000/yr	667.2	1,356.0	747.6	552.0	1,470.0	1,130.4	1,891.2	1,063.2	1,304.4	1,147.2	1,084.8	636.0	1,302.0	1,485.6	1,327.2	1,144.3
	(Living)	Rp.'000/yr	212.0	483.0	182.5	158.5	262.0	265.0	264.0	171.0	319.0	327.0	374.4	314.0	805.0	1,216.0	176.0	368.6
	(Education)	Rp.'000/yr	36.0	10,000.0	0.0	0.0	0.0	24.0	30.0	54.0	60.0	36.0	0.0	36.0	0.0	180.0	72.0	701.9
	(Production)	Rp.'000/yr	62.0	803.8	167.5	129.0	567.0	207.0	110.0	1,768.0	299.0	166.5	956.0	65.0	556.0	362.0	224.5	429.6
9	Surplus/Deficit	Rp.'000/yr	332.8	-4,322.8	-227.6	-289.5	9,416.0	-1,133.9	-1,982.7	-871.2	-927.4	-1,139.2	2,459.8	-216.0	337.0	-1,423.6	-512.2	-33.4
10	Saving	Rp.'000/yr	0.0	0.0	0.0	0.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8

Source : JICA Agro-economy Survey

Table 2.1 Estimated Evapotranspiration in Aik Beta Project

Site : Aik Beta
Mteorological Station : Sambelia

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
T mean	C	27.00	26.70	26.80	27.70	27.80	27.00	26.40	26.70	27.50	28.00	28.00	26.70
RH mean	%	89.00	87.00	86.00	83.00	82.00	76.00	77.00	74.00	75.00	77.00	80.00	80.00
U km/day	km/day	142.00	131.00	127.00	140.00	147.00	206.00	176.00	202.00	185.00	202.00	199.00	148.00
ea	mbar	35.49	34.86	35.07	36.96	37.17	35.49	34.23	34.86	36.54	37.59	37.59	34.86
RH/100		0.89	0.87	0.86	0.83	0.82	0.76	0.77	0.74	0.75	0.77	0.80	0.80
ed	mbar	31.59	30.33	30.16	30.68	30.48	26.97	26.36	25.80	27.41	28.94	30.07	27.89
(ea-ed)	mbar	3.90	4.53	4.91	6.28	6.69	8.52	7.87	9.06	9.14	8.65	7.52	6.97
f(u)		0.65	0.62	0.61	0.65	0.67	0.83	0.75	0.82	0.77	0.82	0.81	0.67
(1-W)		0.24	0.24	0.24	0.23	0.23	0.24	0.25	0.24	0.24	0.23	0.23	0.24
(1-W)f(u)(ea-ed)	mm/day	0.61	0.69	0.73	0.95	1.04	1.70	1.45	1.80	1.66	1.63	1.40	1.14
Ra	mm/day	16.40	16.30	15.50	14.20	12.80	12.00	12.40	13.50	14.80	15.90	16.20	16.20
n	hr/day	5.80	5.20	5.40	6.90	8.70	9.20	9.80	7.90	9.90	9.30	7.80	6.40
N	hr/day	12.60	12.40	12.10	11.80	11.60	11.50	11.60	11.80	12.00	12.30	12.60	12.70
(0.25+0.50n/N)		0.48	0.46	0.47	0.54	0.63	0.65	0.67	0.58	0.66	0.63	0.56	0.50
Rs	mm/day	7.87	7.49	7.33	7.70	8.00	7.80	8.34	7.89	9.81	9.99	9.06	8.13
Rns	mm/day	6.30	5.99	5.87	6.16	6.40	6.24	6.67	6.32	7.84	7.99	7.25	6.51
f(T)		16.10	16.02	16.06	16.22	16.26	16.10	15.98	16.02	16.18	16.30	16.30	16.02
f(ed)		0.09	0.09	0.09	0.09	0.09	0.11	0.11	0.11	0.11	0.10	0.09	0.10
f(n/N)		0.51	0.48	0.50	0.63	0.78	0.82	0.86	0.70	0.84	0.78	0.66	0.55
Rnl=f(T)f(ed)f(n/N)	mm/day	0.73	0.71	0.76	0.93	1.17	1.42	1.51	1.27	1.44	1.26	1.01	0.92
Rn =Rns-Rnl		5.57	5.28	5.11	5.23	5.23	4.82	5.16	5.05	6.41	6.73	6.24	5.59
W		0.76	0.76	0.76	0.77	0.77	0.76	0.75	0.76	0.76	0.77	0.77	0.76
W Rn		4.23	3.99	3.87	4.00	4.01	3.66	3.88	3.82	4.89	5.18	4.80	4.22
c		1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Eto	mm/day	5.33	5.15	5.06	5.45	5.56	5.89	5.87	6.18	7.21	7.48	6.82	5.90

Source : JICA Study Team estimation by Modified Penman method based on the meteorological data at the Sambelia station.

Table 2.2 Effective Rainfall in Aik Beta Project

Site : Aik Beta
Meteorological Station : Suela

Month	Evapotrans-piration (ETo)	Average Rainfall		Annual-base Dependable Rainfall	Effective Rainfall	
					Paddy	Palawija
	[1] (mm)	[2] (mm)	[3] (%)	[4] (mm)	[5] (mm)	[6] (mm)
January	165	261	22.6%	192	135	133
February	144	216	18.7%	159	111	108
March	157	141	12.2%	104	73	77
April	164	61	5.3%	45	31	35
May	172	29	2.5%	21	15	18
June	177	5	0.4%	4	3	0
July	182	21	1.8%	15	11	13
August	192	8	0.7%	6	4	0
September	216	6	0.5%	4	3	0
October	232	61	5.3%	45	31	40
November	205	109	9.4%	80	56	68
December	183	238	20.6%	175	123	129
Total	2,189	1,156	100.0%	852	596	620

Note ;

[1] : Estimated by Modified Penman Method based on Sambelia station
[2] : Rainfall data in station compiled by DPU+Crippen (1960-1974)
[3] : Percentage of monthly rainfall to annual rainfall, calculated from column [2]
[4] : 852 mm (Calculated 80 % dependable annual rainfall) x [3]
[5] : [4] x 0.70
[6] : Derived by USDA SCS Method introduced by Design Criteria KP-01, where effective storage is assumed 75 mm

Source : JICA Study Team estimation based on the rainfall data at the Suela station

Table 2.3 Irrigation Water Requirement in Aik Beta Project (1/2)

Site : Aik Beta
Crops : Wet Season Paddy

Item		Jan. 1	Jan. 2	Feb. 1	Feb. 2	Mar. 1	Mar. 2	Apr. 1	Apr. 2	May 1	May 2	Jun. 1	Jun. 2	Jul 1	Jul 2	Aug. 1	Aug. 2	Sep. 1	Sep. 2	Oct. 1	Oct. 2	Nov. 1	Nov. 2	Dec. 1	Dec. 2	Annual
	Month (days)	15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	
I. Evapotranspiration (Eto)	mm/day	5.33	5.33	5.15	5.15	5.06	5.06	5.45	5.45	5.56	5.56	5.89	5.89	5.87	5.87	6.18	6.18	7.21	7.21	7.48	7.48	6.82	6.82	5.90	5.90	
	mm	80	85	72	72	76	81	82	82	83	89	88	88	88	94	93	99	108	108	112	120	102	102	89	94	2,188
II. Wet Season Paddy																										
(1) Proposed cropping pattern / Crop coefficient																										
- WP-1		1.10	1.10	1.05	1.05	0.95	0.00																	LP	LP	
- WP-2		LP	1.10	1.10	1.05	1.05	0.95	0.00																	LP	
- WP-3		LP	LP	1.10	1.10	1.05	1.05	0.95	0.00																	
(2) Crop consumptive use (Etc)																										
- WP-1	mm	88	94	76	76	72	0																			405
- WP-2	mm		94	79	76	80	77	0																		405
- WP-3	mm			79	79	80	85	78	0																	401
(3) Land preparation (IR)																										
- WP-1	mm																							200	213	413
- WP-2	mm	194																							213	407
- WP-3	mm	194	206																							400
(4) Percolation																										
- WP-1	mm	30	32	28	28	30																				
- WP-2	mm		32	28	28	30	32																			
- WP-3	mm			28	28	30	32	30																		
(5) Water layer replacement (RW)																										
- WP-1	mm		50		50																					
- WP-2	mm			50		50																				
- WP-3	mm				50		50																			
(6) Effective rainfall (ER)	mm	65	70	56	55	35	38	16	15	8	7	2	1	5	6	2	2	1	2	15	16	28	28	60	63	596
(7) Field water requirement																										
- WP-1	mm	53	106	48	99	67	0																	140	150	662
- WP-2	mm	129	56	101	49	125	71	0																	150	680
- WP-3	mm	129	136	51	102	75	129	92	0																	714
(8) Diversion requirement	mm	159	153	103	128	137	103	47	0															72	154	1,055
	m3/ha	1,590	1,530	1,030	1,280	1,370	1,030	470	0															720	1,540	10.560

Source : JICA Study Team estimate based on the meteorological data at the Sambelia and the Sucla station

Table 2.3 Irrigation Water Requirement in Aik Beta Project (2/2)

Site : Aik Beta
Crops : Palawija (1), (2) &(3) : Tobacco, Soybeans and Mungbeans

Item		Month	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul		Aug.		Sep.		Oct.		Nov.		Dec.		Annual
		(days)	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
			15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	
I. Evapotranspiration (Eto)		mm/day	5.33	5.33	5.15	5.15	5.06	5.06	5.45	5.45	5.56	5.56	5.89	5.89	5.87	5.87	6.18	6.18	7.21	7.21	7.48	7.48	6.82	6.82	5.90	5.90	
		mm	80	85	72	72	76	81	82	82	83	89	88	88	88	94	93	99	108	108	112	120	102	102	89	94	2,188
II. Palawija(1) : Tobacco																											
(1) Proposed cropping pattern / Crop coefficient(Kc)									Tobacco																		
- Pwj(1)-1										0.45	0.70	1.00	1.00	0.65	0.30												
- Pwj(1)-2											0.45	0.70	1.00	1.00	0.65	0.30											
- Pwj(1)-3												0.45	0.70	1.00	1.00	0.65	0.30										
(2) Crop consumptive use(Etc)																											
- Pwj(1)-1		mm								37	58	89	88	57	26												
- Pwj(1)-2		mm									38	62	88	88	57	28											
- Pwj(1)-3		mm										40	62	88	88	61	28										
(3) Effective rainfall (ER)		mm	64	69	54	54	37	40	18	17	9	9	0	0	6	7	0	0	0	0	19	21	34	34	62	67	621
(4) Field water requirement																											
- Pwj(1)-1		mm								20	49	80	88	57	20												315
- Pwj(1)-2		mm									29	53	88	88	51	21											331
- Pwj(1)-3		mm										31	62	88	82	54	28										345
(5) Diversion requirement		mm								13	52	110	159	156	102	50	19										661
		m3/ha								130	520	1,100	1,590	1,560	1,020	500	190										6,610
III. Palawija (2),(3) : Soybeans and Mungbeans																											
(1) Proposed cropping pattern / Crop coefficient(Kc)									Soybeans										Mungbeans								
- Pwj(2),(3)-1										0.50	0.75	1.00	1.00	0.82	0.23				0.45	0.75	1.05	0.30					
- Pwj(2),(3)-2											0.50	0.75	1.00	1.00	0.82	0.23				0.45	0.75	1.05	0.30				
- Pwj(2),(3)-3												0.50	0.75	1.00	1.00	0.82	0.23				0.45	0.75	1.05	0.30			
(2) Crop consumptive use(Etc)																											
- Pwj(2),(3)-1		mm								41	63	89	88	72	20					49	84	126	31				
- Pwj(2),(3)-2		mm									42	67	88	88	72	22					50	90	107	31			
- Pwj(2),(3)-3		mm										44	66	88	88	77	21					54	77	107	27		
(3) Effective rainfall (ER)		mm	64	69	54	54	37	40	18	17	9	9	0	0	6	7	0	0	0	0	19	21	34	34	62	67	621
(4) Field water requirement																											
- Pwj(2),(3)-1		mm								24	54	80	88	72	14					49	65	105	0				551
- Pwj(2),(3)-2		mm									33	58	88	88	66	15					31	69	73	0			522
- Pwj(2),(3)-3		mm										35	66	88	82	70	21					33	43	73	0		512
(5) Diversion requirement		mm								16	58	115	162	166	108	56	14			32	64	138	77	49	0		1,057
		m3/ha								160	580	1,150	1,620	1,660	1,080	560	140			320	640	1,380	770	490	0		10,550

Source : JICA Study Team estimate based on the meteorological data at the Sambelia and the Suela station

Table 3.1 Estimated catchment Rainfall in Aik Beta Embung Site

Unit : mm

	Jan		Feb		Mar.		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual
year	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
1960	180	180	156	156	83	83	104	104	50	50	1	1	0	0	0	0	2	2	17	17	193	193	85	85	1,742
1961	125	125	88	88	18	18	32	32	17	17	0	0	0	0	0	0	1	1	1	1	44	44	36	36	724
1962	298	298	204	204	35	35	102	102	29	29	6	6	73	73	0	0	0	0	19	19	61	61	227	227	2,108
1963	239	239	182	182	245	245	97	97	32	32	0	0	0	0	0	0	0	0	25	25	24	24	194	194	2,076
1964	143	143	90	90	101	101	28	28	56	56	10	10	6	6	0	0	0	0	265	265	167	167	44	44	1,820
1965	205	205	110	110	96	96	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	133	133	1,108
1966	157	157	121	121	109	109	0	0	0	0	0	0	0	0	0	0	19	19	62	62	73	73	139	139	1,360
1967	76	76	44	44	116	116	17	17	4	4	0	0	16	16	0	0	0	0	0	0	0	0	133	133	812
1968	202	202	0	0	76	76	72	72	14	14	23	23	79	79	36	36	13	13	78	78	119	119	132	132	1,688
1969	84	84	305	305	84	84	40	40	0	0	0	0	0	0	0	0	0	0	0	0	6	6	143	143	1,324
1970	42	42	131	131	0	0	0	0	0	0	0	0	0	0	2	2	14	14	6	6	150	150	188	188	1,066
1971	211	211	118	118	175	175	16	16	25	25	0	0	0	0	0	0	0	0	20	20	0	0	260	260	1,650
1972	157	157	130	130	85	85	37	37	18	18	4	4	13	13	5	5	4	4	37	37	66	66	143	143	1,398
1973	89	89	120	120	0	0	0	0	14	14	0	0	0	0	29	29	0	0	0	0	59	59	143	143	908
1974	145	145	145	145	48	48	0	0	0	0	0	0	0	0	0	0	4	4	18	18	18	18	143	143	1,042
Mean	157	157	130	130	85	85	37	37	17	17	3	3	12	12	5	5	4	4	37	37	65	65	143	143	1,388

Table 3.2 Estimated Discharge at Aik Beta Embung Site

Unit : 1000 m3

	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual
year	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
1960	1,613	1,613	1,398	1,398	744	744	932	932	448	448	0	0	0	0	0	0	0	0	0	0	1,729	1,729	762	762	15,252
1961	1,120	1,120	788	788	0	0	287	287	0	0	0	0	0	0	0	0	0	0	0	0	394	394	323	323	5,824
1962	2,670	2,670	1,828	1,828	314	314	914	914	260	260	0	0	654	654	0	0	0	0	0	0	547	547	2,034	2,034	18,442
1963	2,141	2,141	1,631	1,631	2,195	2,195	869	869	287	287	0	0	0	0	0	0	0	0	224	224	215	215	1,738	1,738	18,600
1964	1,281	1,281	806	806	905	905	251	251	502	502	0	0	0	0	0	0	0	0	2,374	2,374	1,496	1,496	394	394	16,018
1965	1,837	1,837	986	986	860	860	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,192	1,192	9,750
1966	1,407	1,407	1,084	1,084	977	977	0	0	0	0	0	0	0	0	0	0	0	0	556	556	654	654	1,245	1,245	11,846
1967	681	681	394	394	1,039	1,039	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,192	1,192	6,612
1968	1,810	1,810	0	0	681	681	645	645	0	0	206	206	708	708	323	323	0	0	699	699	1,066	1,066	1,183	1,183	14,642
1969	753	753	2,733	2,733	753	753	358	358	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,281	1,281	11,756
1970	376	376	1,174	1,174	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,344	1,344	1,684	1,684	9,156
1971	1,891	1,891	1,057	1,057	1,568	1,568	0	0	224	224	0	0	0	0	0	0	0	0	0	0	0	0	2,330	2,330	14,140
1972	1,407	1,407	1,165	1,165	762	762	332	332	0	0	0	0	0	0	0	0	0	0	332	332	591	591	1,281	1,281	11,740
1973	797	797	1,075	1,075	0	0	0	0	0	0	0	0	0	0	260	260	0	0	0	0	529	529	1,281	1,281	7,884
1974	1,299	1,299	1,299	1,299	430	430	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,281	1,281	8,618
Mean	1,406	1,406	1,161	1,161	749	749	306	306	115	115	14	14	91	91	39	39	0	0	279	279	571	571	1,280	1,280	12,019
	2,811		2,322		1,497		612		229		27		182		78		0		558		1,142		2,560		

Table 3.3 Probable Flood Discharge at Aik Beta Embung Site

Characteristics of the catchment area								
Catchment Area	(km2)	22.40						
Eelevation at Dam Site (1)	(m)	200						
Maximum elevation in the catchment area (2)	(m)	2000						
Height (3)=(2)-(1)	(h)	1800						
Length of Catchment Area (L	(m)	11,000						
Flow velocity	W2 (km/hr)	24.30						
Time of concentration	T2 (hrs)	0.45						
Probable Flood Discherge								
Return Period	(years)	2	5	10	20	50	100	200
Rainfall	(mm/day)	100	127	146	166	194	217	241
Rainfall intensity within the time of concentration	(mm)	30	39	44	50	59	66	73
Probable Flood Discharge	(m3/s)	151	192	221	251	293	328	364
Specific Discharge	(m3/s/km2)	7	9	10	11	13	15	16

To estimate design rainfall, the Log Pearson III method is adopted.
The rational method is adopted for estimation of the design flood discharge.
C = 0.8 is used to estimate designed flood discharge by the rational method.

Table 3.4 Result of Water Quality Test in Aik Beta Embung Site

DESCRIPTION	UNIT	1 Upstream of proposed embung	2 Embung Site	3 Embung Site	4 downstream of proposed embung	Max. Limit of B Class by GR. NO. 20/1990
I. PHYSICS						
1 Temperature	C	28.00	27.00	24.00	28.00	Normal water temperature
2 Dissolved solid matter	mg/liter	219.00	185.00	129.00	141.00	1000
3 Electric Conductivety	umhos/cm	298.00	251.00	176.00	191.00	-
II. CHEMISTRY						
a. Unorganic chemistry						
1 Mercury	mg/liter	0.00	0.00	0.00	0.00	0.001
2 Ammonia	mg/liter	0.00	0.00	0.00	0.00	0.5
3 Arsenic	mg/liter	-	-	-	-	0.05
4 Barium	mg/liter	-	-	-	-	5
5 Ferro	mg/liter	0.00	0.00	0.00	0.00	1
6 Fluoride	mg/liter	0.76	0.76	0.78	0.70	1.5
7 Cadmium	mg/liter	0.00	0.00	0.00	0.00	0.005
8 Chloride	mg/liter	17.80	30.00	26.30	21.30	600
9 Chronium, valense-6	mg/liter	0.00	0.00	0.00	0.00	0.05
10 Manganese	mg/liter	0.00	0.00	0.37	0.00	0.5
11 Nitrate, N	mg/liter	0.72	1.90	0.00	0.74	10
12 Nitric, N	mg/liter	0.00	0.00	0.00	0.00	1
13 Dissolved Oxygen	mg/liter	7.03	8.95	7.63	5.17	*
14 pH	-	7.50	8.10	6.70	7.00	5-9
15 Selenium	mg/liter	-	-	-	-	0.01
16 Zinc	mg/liter	0.00	0.00	0.00	0.00	5
17 Cyanide	mg/liter	0.00	0.00	0.00	0.00	0.1
18 Sulphate	mg/liter	2.60	6.00	6.60	3.00	400
19 Sulfide, H2S	mg/liter	0.00	0.00	0.00	0.00	0.1
20 Copper	mg/liter	0.00	0.00	0.00	0.00	1
21 Lead	mg/liter	0.00	0.01	0.01	0.01	0.1
b. Organic Chemistry						
1 Aldrin and Dieldrin	mg/liter	0.00	0.00	0.00	0.00	0.017
2 Chlordane	mg/liter	0.00	0.00	0.00	0.00	0.003
3 DDT	mg/liter	0.00	0.00	0.00	0.00	0.042
4 Endrine	mg/liter	0.00	0.00	0.00	0.00	0.001
5 Fenol	mg/liter	0.00	0.00	0.00	0.00	0.001
6 Heptachlor and Heptachlor Epoxide	mg/liter	-	-	-	-	0.018
7 Carbon Cloroform Ektract	mg/liter	-	-	-	-	0.5
8 Lindane	mg/liter	0.00	0.00	0.00	0.00	0.056
9 Methoxychlor	mg/liter	-	-	-	-	0.035
10 Oil and Fat	mg/liter	0.00	0.00	0.00	0.00	Nil
11 Organofosphate and Carbomate	mg/liter	0.00	0.00	0.00	0.00	0.1
12 PCB	mg/liter	-	-	-	-	Nil
13 Senyawa atife biru (Sulfaktan)	mg/liter	0.05	0.05	0.05	0.04	0.5
14 Toxaphene	mg/liter	0.00	0.00	0.00	0.00	0.005
III MICRO BIOLOGY						
1 Coliform tinja	per 100 ml	18,000	11,000	18,000	14,000	2,000
2 Total Coliform	per 100 ml	24,000	28,000	28,000	28,000	10,000

NOTE:
* = The water level shall be more than or equal to 6.
mg = miligram
ml = Milimeter
Bq = Bequerel

Heavy metals are classified into dissolved matter.

Source : JICA's Water Quality Test

Table 7.1 Summary of Construction Cost in Aik Beta Project

Item	Amount (Rp. million)
I. Direct Construction Cost	
1.1 Preparatory Works	438
1.2 Embung Construction	
1) Main dam	7,586
2) Spillway	0
3) Diversion Tunnel	0
4) Seepage protection works	0
5) Miscellaneous	759
Sub-total of 1.2	8,345
1.3 Irrigation Facilities	405
1.4 Domestic Water Supply	0
1.5 Embung Operation and Maintenance Road	0
Sub-total of I.	9,188
II. Administration Cost	459
III. Engineering Services	1,378
Sub-total of I, II & III	11,025
IV. Physical Contingency	1,654
Sub-total of I, II, II, & IV	12,679
V. Contract Tax	1,222
VI. Land Acquisition Cost	46
Sub-total I, II, III, IV, V & VI	13,947
VII. Price Contingency	2,789
GRAND TOTAL	16,736

Table 7.2 Direct Construction Cost in Aik Beta Project

Item	Unit	Unit Price Rp.	Quantity	Total 1000 Rp.
I. Dam				
1. Main Dam				
1.1 Earth/stone works				
1) Clearing	m2	400	8,900	3,560
2) Excavation, common	m3	3,500	500	1,750
, weathered rock	m3	7,500	8,800	66,000
, rock	m3	11,500	21,700	249,550
3) Stone masonry	m3	80,000	86,300	6,904,000
4) Rip-rap protection	m3	15,000		0
1.2 Grouting	m	71,000		0
1.3 Other miscellaneous works				361,243
Sub-total of 1.				7,586,103
2. Miscellaneous & Others				758,610
Total - I.				8,344,713
II. Irrigation Facilities				
1. Canal works (including the rehabilitation works)				
1.1 Earth works				
1) Clearing	m2	400	25,400	10,160
2) Excavation	m3	5,000	4,400	22,000
3) Embankment	m3	6,300	5,700	35,910
1.2 Stone masonry	m3	80,000	3,200	256,000
Sub-total of 1.				324,070
2. Related structures				
2.1 Turnout	nos.	2,600,000	2	5,200
2.2 Syphon	nos.	5,500,000		0
2.3 Aqueduct	nos.	6,000,000		0
2.3 Cross drain	nos.	4,700,000		0
2.4 Irrigation division box	nos.	900,000	43	38,700
2.5 Division box for livestock	nos.	1,200,000		0
Sub-total of 2.				43,900
3. Miscellaneous & Others	L.S			36,797
Total - II				404,767
GRAND TOTAL				8,749,480

Table 8.1 Economic Construction Costs and Annual Disburement Schedule

Aik Beta Project (Unit : Rp. million)

Item	SCF	Total cost	1st year	2nd year	3rd year
1 Direct Construction Cost		5,985	156	2,992	2,837
1) Preparatory Works	0.71	311	156	155	0
2) Dam Construction					
- Main dam	0.71	5,386	0	2,693	2,693
- Spillway	0.71	0	0	0	0
- Diversion tunnel	0.71	0	0	0	0
- Seepage protection works	0.71	0	0	0	0
Sub-total		5,386	0	2,693	2,693
3) Irrigation Facilities	0.71	288	0	144	144
4) Domestic Water Supply System	0.71	0	0	0	0
5) Dam O & M Road	0.71	0	0	0	0
2 Administration Cost	0.90	413	11	206	196
3 Engineering Services	0.90	569	227	171	171
4 Physical Contingency		898	23	449	426
Total		7,865	417	3,818	3,630

Note : Standard Conversion Factors (SFC). Source ; Pedoman Pengamatan dan Evaluasi Proyek-Proyek Pengairan, Direktorato Jeneral Pengairan, 1985

Table 8.2 Financial and Economic Prices of Farm Inputs and Outputs in NTB

	Item		Unit	Lombok		Sumbawa	
				Financial Price *1	Economic Price *2	Financial Price *1	Economic Price *2
1	Farm Products						
	Paddy *3		kg	280	397	260	394
	Maize *3		kg	200	220	200	215
	Mungbeans *3		kg	1,000	906	1,000	901
	Soybeans *3		kg	900	647	900	642
	Red onion *4		kg	900	704	800	699
	Tobacco *5		kg	900	522	900	521
2	Seeds						
	Paddy	Certified	kg	605	605	605	605
		Own	kg	-	325	-	325
	Maize	Certified	kg	922	922	922	922
		Own	kg	-	297	-	297
	Mungbeans	Certified	kg	1,383	1,383	1,383	1,383
		Own	kg	-	893	-	893
	Soybeans	Certified	kg	617	617	617	617
		Own	kg	-	606	-	606
	Red onion		kg	850	850	850	850
	Tobacco		kg	25,000	25,000	25,000	25,000
3	Fertilisers						
	Urea		kg	350	414	350	419
	TSP		kg	400	486	400	491
	KCl		kg	400	416	400	421
4	Agro-chemicals						
	Insecticides	Liquid type	lit	10,000	10,000	10,000	10,000
		Powder type	kg	3,000	3,000	3,000	3,000
	Rodenticides		kg	5,500	5,500	5,500	5,500
5	Labour						
	Hired labour *6		man-day	3,000	2,250	2,500	1,875
	Family labour		man-day	-	2,250	-	1,875
6	Draft Animal						
	Hired		head-day	6,000	6,000	5,000	5,000
	Own		head-day	-	6,000	-	5,000
7	Farm Machinery						
	Tractor		ha	250,000	250,000	200,000	200,000

Remarks : *1 : As of 1994

*2 : Projected prices in 2005 at 1994 constant prices

*3 : Dry grain

*4 : Fresh

*5 : Fresh leaves

*6 : Economic conversionfactor is 0.75.

Table 8.3 Economic Crop Budget per Ha

Aik Beta Project

Item		Q'ty of Unit	Value (Rp.)	Without Project						With Project									
				Paddy (Rainfed)		Maize (Rainfed)		Tobacco (Rainfed)		Paddy (Irrigated)		Mungbean (Irrigated)		Tobacco (Irrigated)		Mungbean (Rainfed)		Tobacco (Rainfed)	
				Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)
1 Gross Production Value																			
Paddy		kg	397	2,000	794,000	0	0	0	0	4,500	1,786,500	0	0	0	0	0	0	0	0
Maize		kg	220	0	0	1,300	286,000	0	0	0	0	0	0	0	0	0	0		0
Mungbean		kg	906	0	0	0	0	0	0	0	0	1,200	1,087,200	0	0	950	860,700	0	0
Tobacco		kg	522	0	0	0	0	1,600	835,200	0	0	0	0	4,000	2,088,000	0	0	3,200	1,670,400
2 Production Cost																			
Seed																			
Paddy	Certified	kg	605	0	0	0	0	0	0	25	15,125	0	0	0	0	0	0	0	0
	Own	kg	325	50	16,250	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maize	Certified	kg	922	0	0	5	4,610	0	0	0	0	0	0	0	0	0	0	0	0
	Own	kg	297	0	0	20	5,940	0	0	0	0	0	0	0	0	0	0	0	0
Mungbean	Certified	kg	1,383	0	0	0	0	0	0	0	0	10	13,830	0	0	10	13,830	0	0
	Own	kg	893	0	0	0	0	0	0	0	0	20	17,860	0	0	20	17,860	0	0
Tobacco	Certified	kg	25,000	0	0	0	0	0.1	2,500	0	0	0	0	0.1	2,500	0	0	0.1	2,500
Fertiliser																			
Urea		kg	414	150	62,100	50	20,700	125	51,750	300	124,200	75	31,050	250	103,500	60	24,840	200	82,800
TSP		kg	486	50	24,300	50	24,300	100	48,600	100	48,600	100	48,600	200	97,200	80	38,880	160	77,760
KCl		kg	416	0	0	0	0	50	20,800	50	20,800	50	20,800	100	41,600	40	16,640	80	33,280
Agro-chemicals																			
Insecticide	Lquid	lit	10,000	0.5	5,000	0.0	0	0.0	0	2.0	20,000	2.0	20,000	0.0	0	2.0	20,000	0.0	0
	Powder	kg	3,000	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Rodenticide		kg	5,500	0.5	2,750	0.0	0	0.0	0	2.0	11,000	1.0	5,500	0.0	0	1.0	5,500	0.0	0
Labor																			
Family		md	2,250	65	146,250	32	72,000	43	96,750	172	387,000	80	180,000	100	225,000	80	180,000	80	180,000
Hired		md	2,250	10	22,500	0	0	0	0	13	29,250	0	0	0	0	0	0	0	0
Draft Animal																			
Family		ad	6,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hired		ad	6,000	10	60,000	5	30,000	5	30,000	20	120,000	10	60,000	10	60,000	10	60,000	10	60,000
Tractor		ha	250,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total production cost					339,150		157,550		250,400		775,975		397,640		529,800		377,550		436,340
3 Net Production Value					454,850		128,450		584,800		1,010,525		689,560		1,558,200		483,150		1,234,060

Table 8.4 Economic Costs and Benefits Flow

Aik Beta Project Unit : Rp. '000

Year	Cost				Benefit			Increment
	Capital	Replace	O&M	Total	Irrigation	Negative	Total	
1.	417	0	0	417	0	0	0	-417
2.	3,818	0	0	3,818	0	0	0	-3,818
3.	3,630	0	0	3,630	0	0	0	-3,630
4.	0	0	32	32	75	0	75	43
5.	0	0	32	32	88	0	88	56
6.	0	0	32	32	100	0	100	68
7.	0	0	32	32	113	0	113	81
8.	0	0	32	32	125	0	125	93
9.	0	0	32	32	125	0	125	93
10.	0	0	32	32	125	0	125	93
11.	0	0	32	32	125	0	125	93
12.	0	0	32	32	125	0	125	93
13.	0	0	32	32	125	0	125	93
14.	0	0	32	32	125	0	125	93
15.	0	0	32	32	125	0	125	93
16.	0	0	32	32	125	0	125	93
17.	0	0	32	32	125	0	125	93
18.	0	0	32	32	125	0	125	93
19.	0	0	32	32	125	0	125	93
20.	0	0	32	32	125	0	125	93
21.	0	0	32	32	125	0	125	93
22.	0	0	32	32	125	0	125	93
23.	0	0	32	32	125	0	125	93
24.	0	0	32	32	125	0	125	93
25.	0	0	32	32	125	0	125	93
26.	0	0	32	32	125	0	125	93
27.	0	0	32	32	125	0	125	93
28.	0	0	32	32	125	0	125	93

EIRR = #DIV/0! %

Table 8.5 Financial Crop Budget per Ha

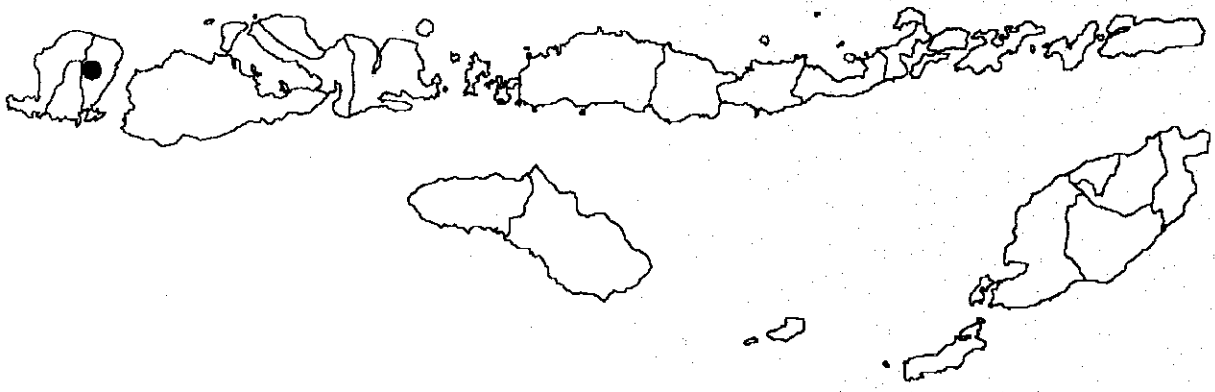
Aik Beta Project

Item		Q'ty of Unit	Value (Rp.)	Without Project						With Project									
				Paddy (Rainfed)		Maize (Rainfed)		Tobacco (Rainfed)		Paddy (Irrigated)		Mungbean (Irrigated)		Tobacco (Irrigated)		Mungbean (Rainfed)		Tobacco (Rainfed)	
				Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)	Q'ty	Am't (Rp.)
1 Gross Production Value																			
Paddy		kg	280	2,000	560,000	0	0	0	0	4,500	1,260,000	0	0	0	0	0	0	0	0
Maize		kg	200	0	0	1,300	260,000	0	0	0	0	0	0	0	0	0	0		0
Mungbean		kg	1,000	0	0	0	0	0	0	0	0	1,200	1,200,000	0	0	950	950,000	0	0
Tobacco		kg	900	0	0	0	0	1,600	1,440,000	0	0	0	0	4,000	3,600,000	0	0	3,200	2,880,000
2 Production Cost																			
Seed																			
Paddy	Certified	kg	605	0	0	0	0	0	0	25	15,125	0	0	0	0	0	0	0	0
	Own	kg	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maize	Certified	kg	922	0	0	5	4,610	0	0	0	0	0	0	0	0	0	0	0	0
	Own	kg	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
Mungbean	Certified	kg	1,383	0	0	0	0	0	0	0	0	10	13,830	0	0	10	13,830	0	0
	Own	kg	0	0	0	0	0	0	0	0	0	20	0	0	0	20	0	0	0
Tobacco	Certified	kg	25,000	0	0	0	0	0.1	2,500	0	0	0	0	0.1	2,500	0	0	0.1	2,500
Fertiliser																			
Urea		kg	350	150	52,500	50	17,500	125	43,750	300	105,000	75	26,250	250	87,500	60	21,000	200	70,000
TSP		kg	400	50	20,000	50	20,000	100	40,000	100	40,000	100	40,000	200	80,000	80	32,000	160	64,000
KCl		kg	400	0	0	0	0	50	20,000	50	20,000	50	20,000	100	40,000	40	16,000	80	32,000
Agro-chemicals																			
Insecticide	Lquid	lit	10,000	0.5	5,000	0.0	0	0.0	0	2.0	20,000	2.0	20,000	0.0	0	2.0	20,000	0.0	0
	Powder	kg	3,000	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Rodenticide		kg	5,500	0.5	2,750	0.0	0	0.0	0	2.0	11,000	1.0	5,500	0.0	0	1.0	5,500	0.0	0
Labor																			
Family		md	0	65	0	32	0	43	0	172	0	80	0	100	0	80	0	80	0
Hired		md	3,000	10	30,000	0	0	0	0	13	39,000	0	0	0	0	0	0	0	0
Draft Animal																			
Family		ad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hired		ad	6,000	10	60,000	5	30,000	5	30,000	20	120,000	10	60,000	10	60,000	10	60,000	10	60,000
Tractor		ha	250,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total production cost					170,250		72,110		136,250		370,125		185,580		270,000		168,330		228,500
3 Net Production Value					389,750		187,890		1,303,750		889,875		1,014,420		3,330,000		781,670		2,651,500

The Study on The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara

Feasibility Study on Aik Beta Embung Development Project

Figures



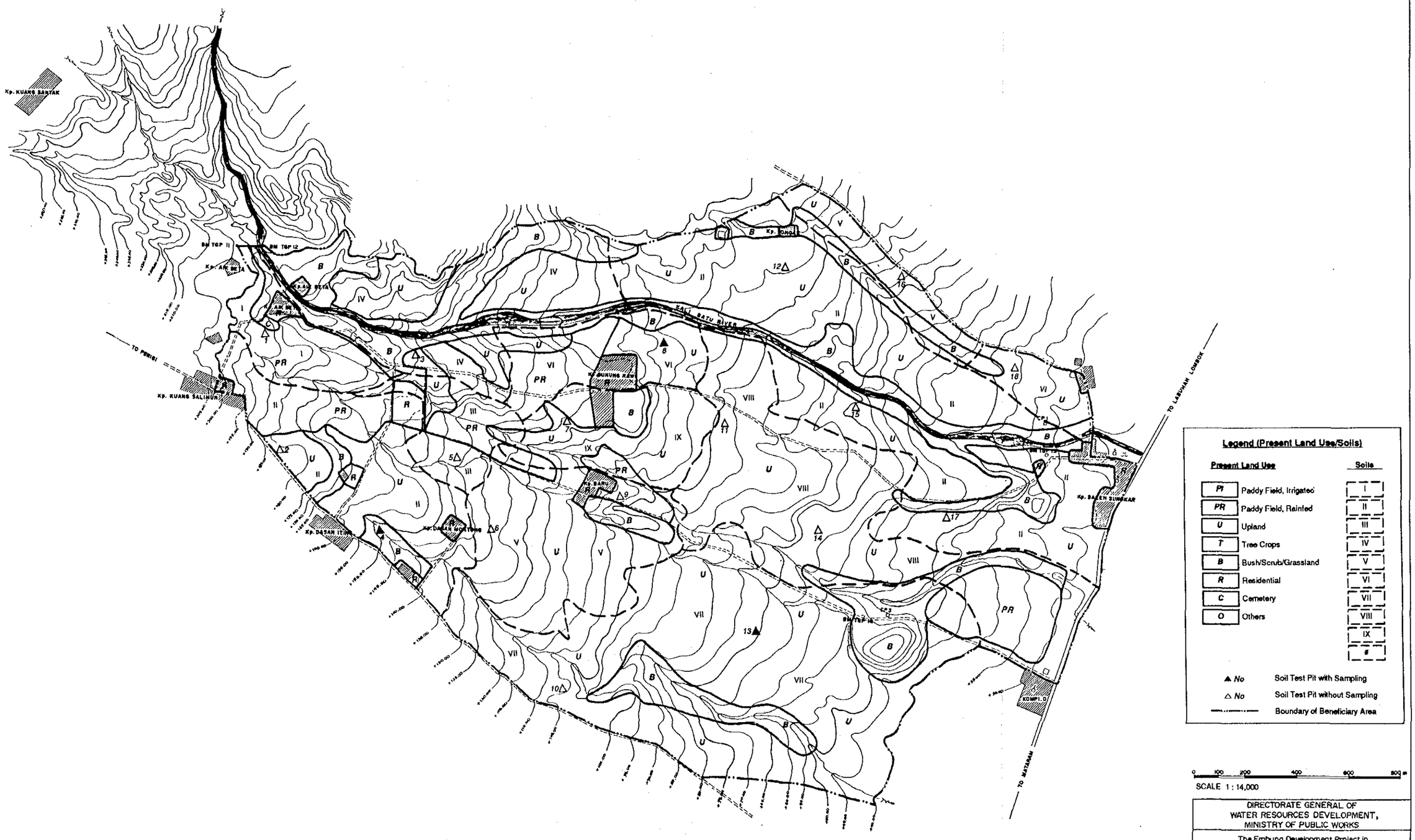


Figure 1.1 Present Land Use and Soils (Aik Beta)

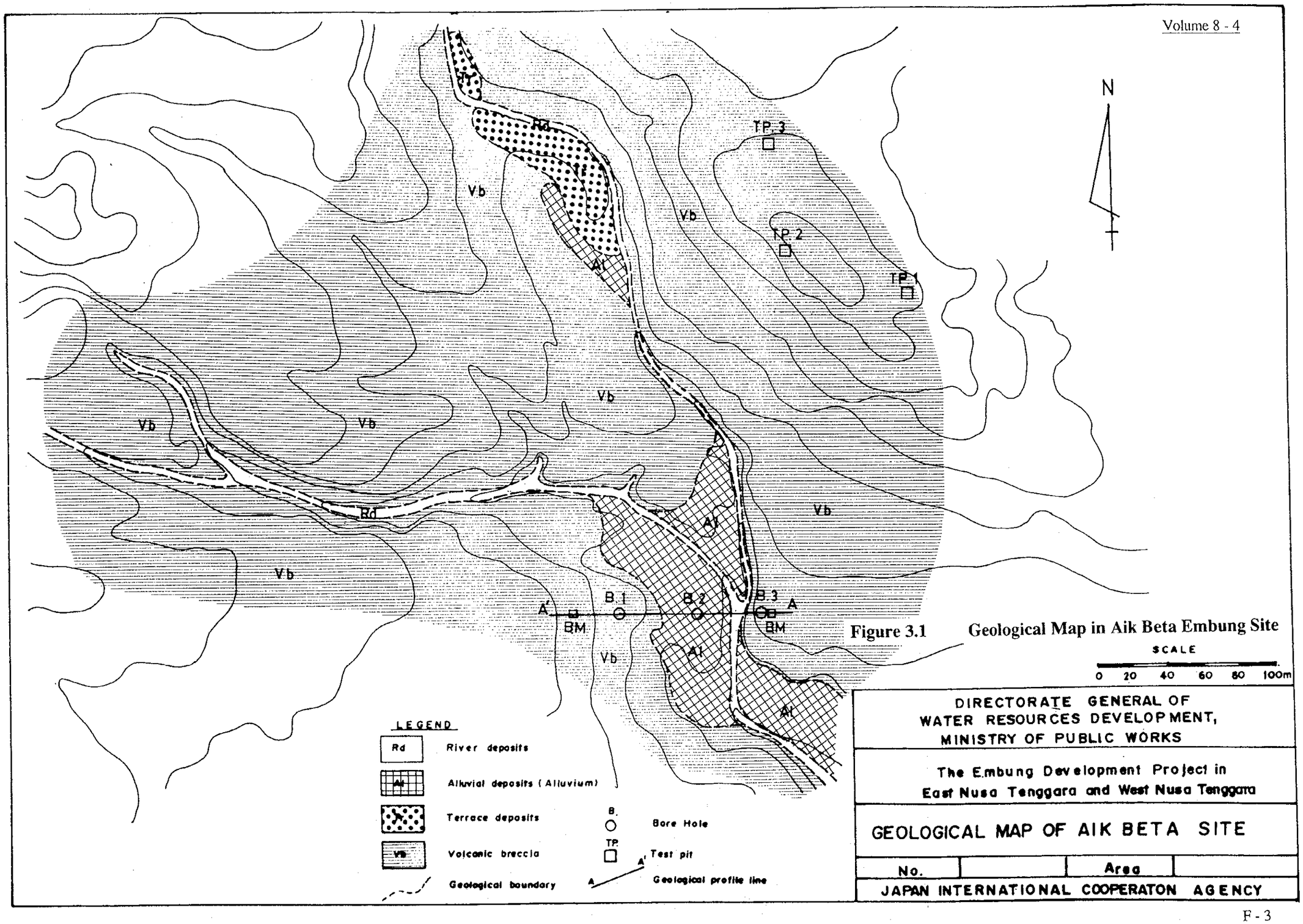


Figure 3.1 Geological Map in Aik Beta Embung Site

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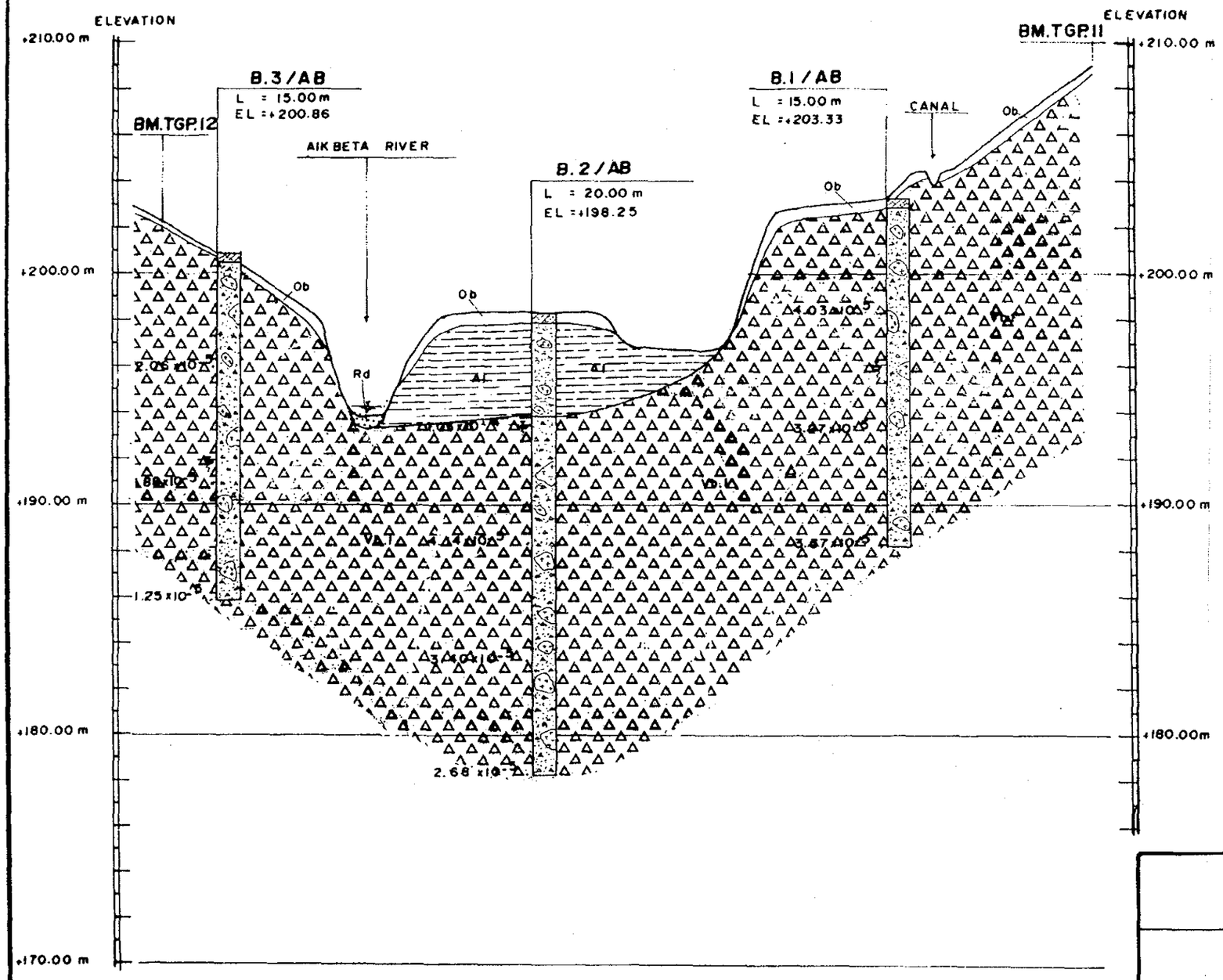
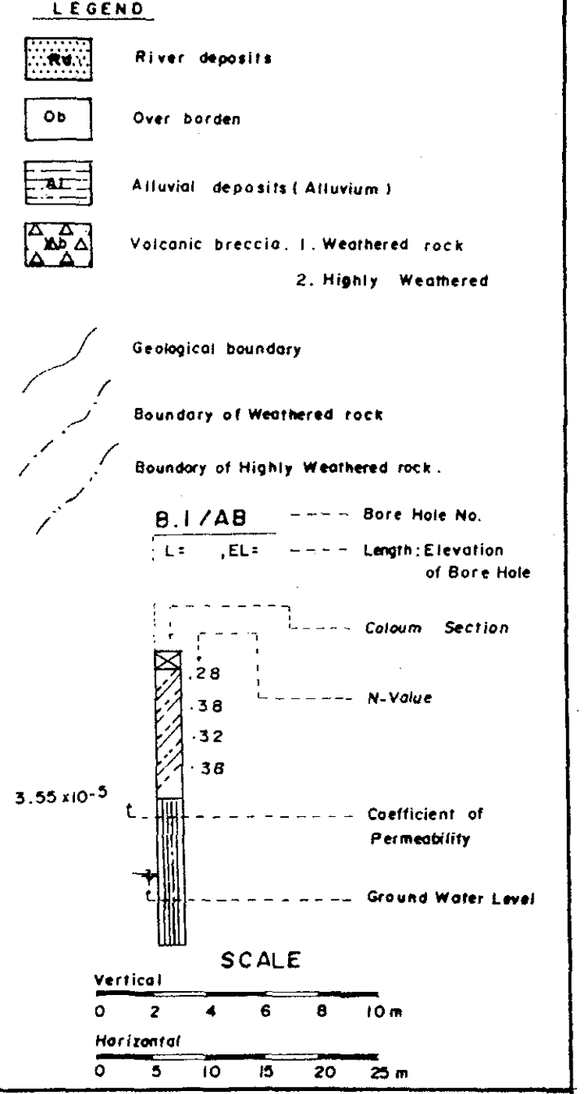
GEOLOGICAL MAP OF AIK BETA SITE

No.		Area	

JAPAN INTERNATIONAL COOPERATON AGENCY





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GEOLOGICAL PROFILE OF AIK BETA SITE

No.		Area	

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 3.2 Geological Profile in Aik Beta Embung Site

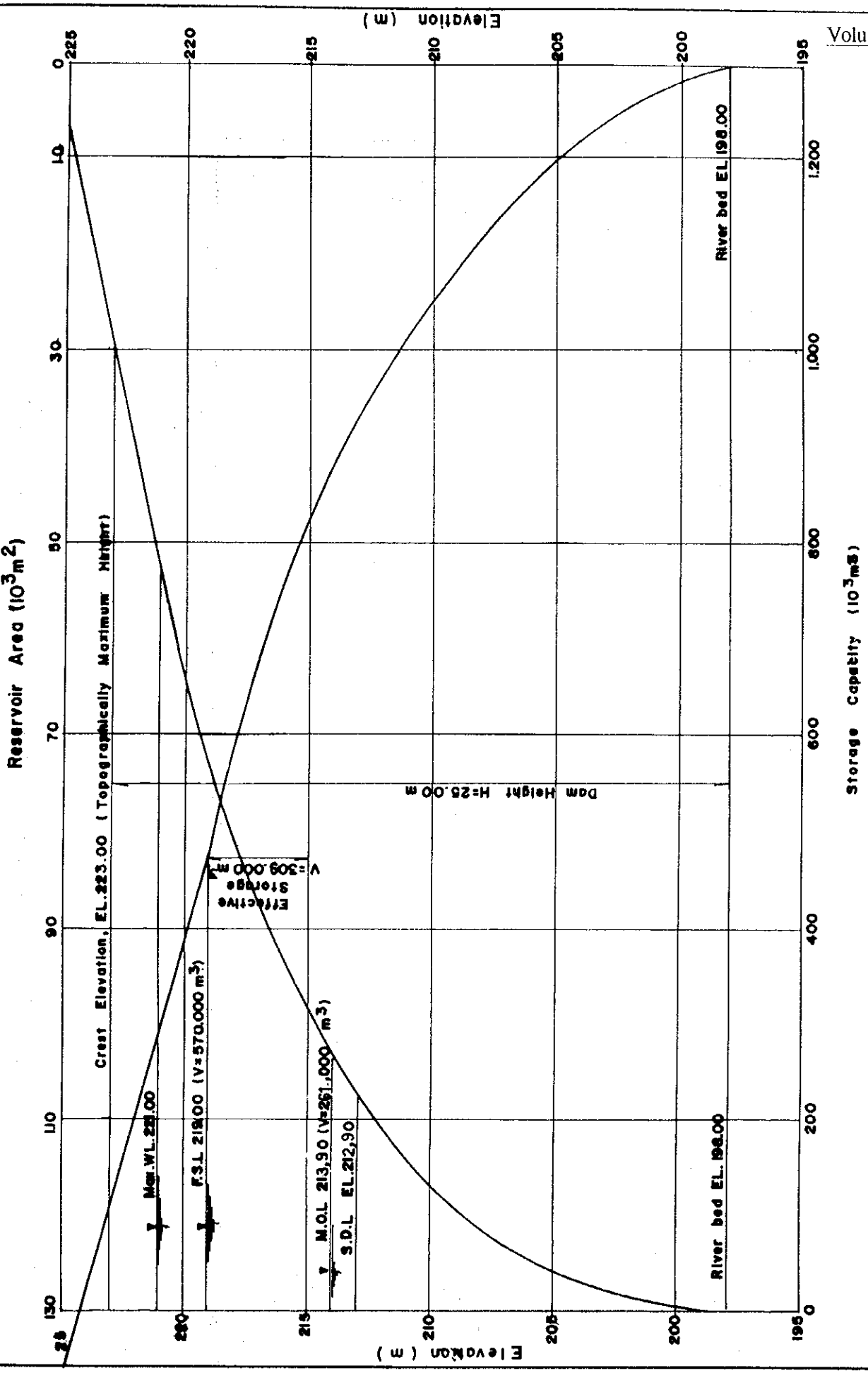


Figure 4.1 Reservoir Storage Curve in Aik Beta Embung

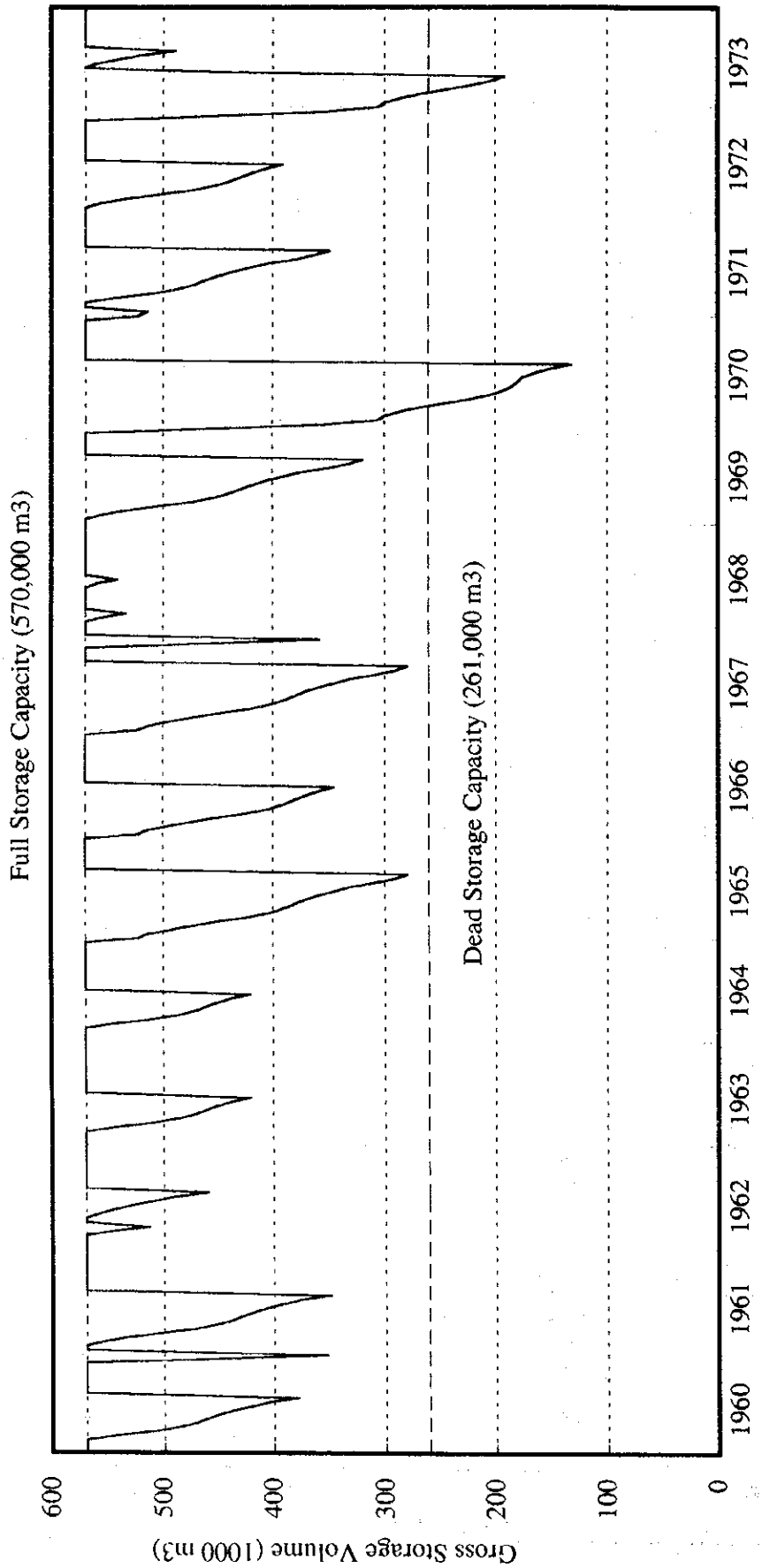


Figure 4.2 Result of Reservoir Operation in Aik Beta Embung

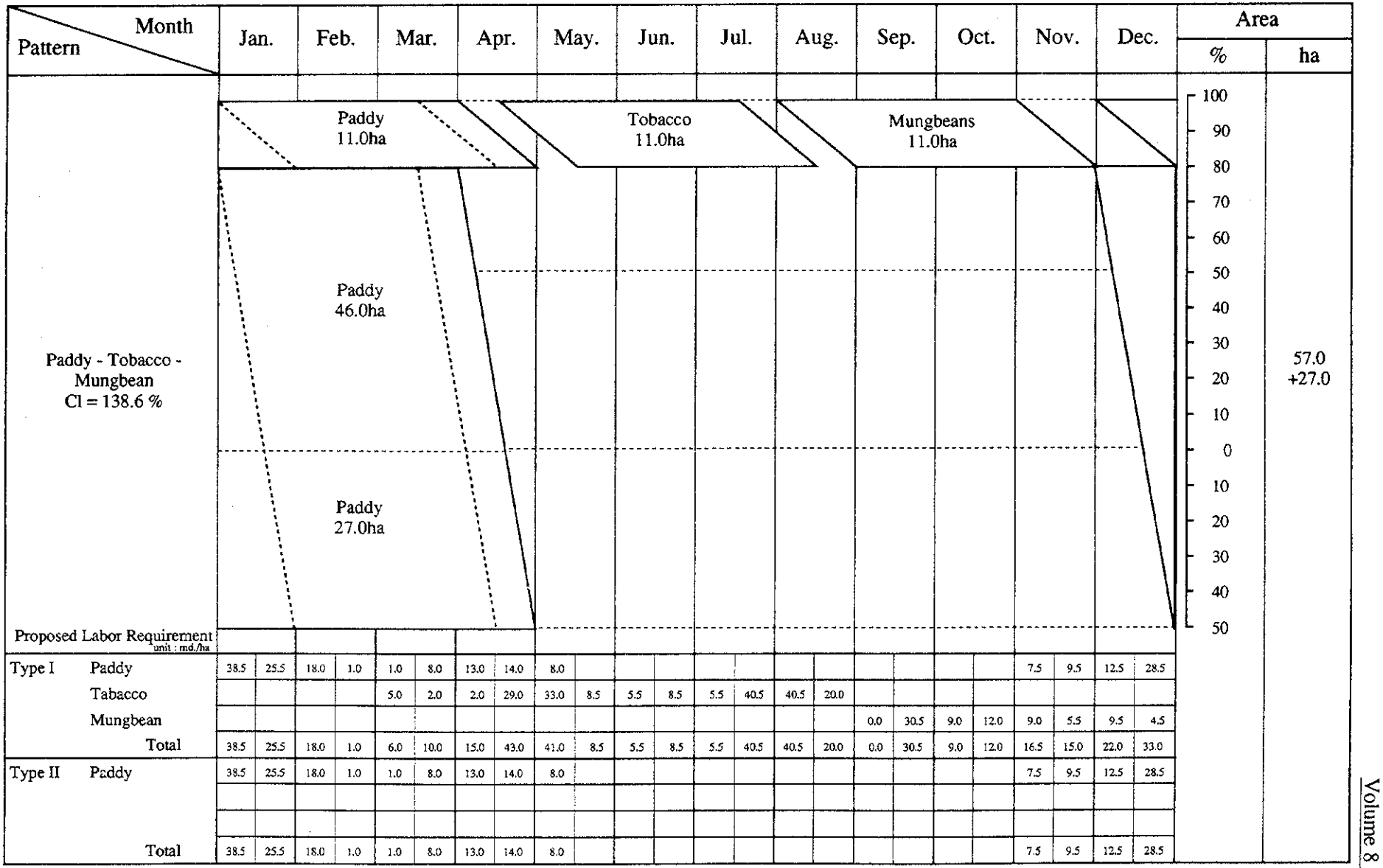
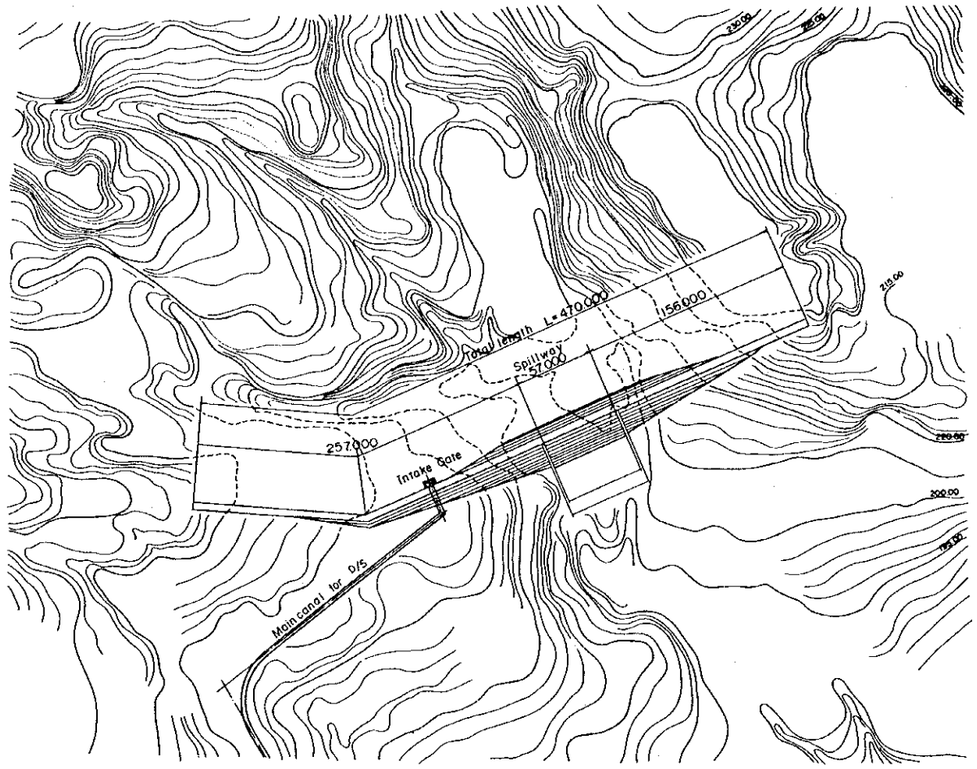
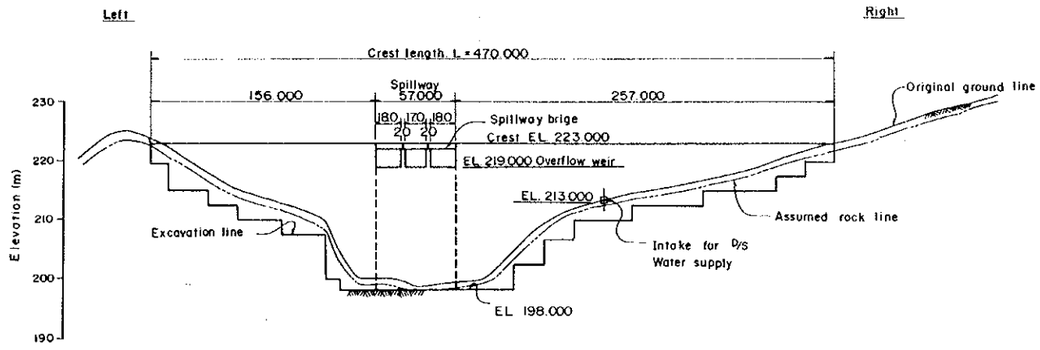


Figure 4.3 Proposed Cropping Pattern for Aik Beta Project

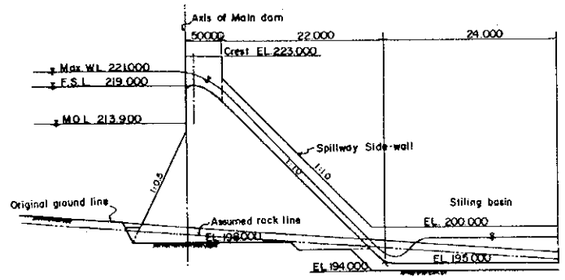


PLAN Scale A



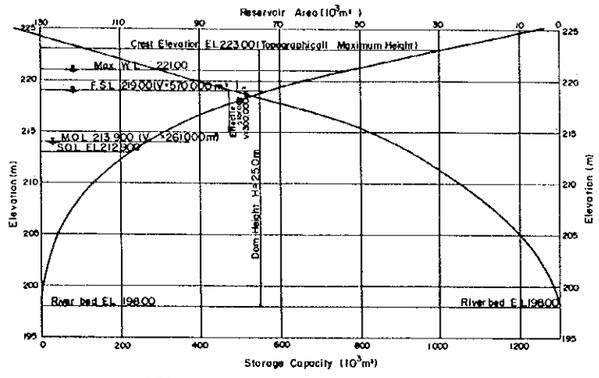
PROFILE OF MAIN DAM

Scale : H = 1 : 2000
V = 1 : 500



OVERFIOW SECTION OF MAIN DAM

Scale B



RESERVOIR STORAGE AT AIK BETA

Scale A 0 50 100 150 200m

Scale B 0 10 20 30 40m

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GENERAL PLAN OF AIK BETA EMBUNG

No. | Area

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 4.4 General Plan of Aik Beta Embung

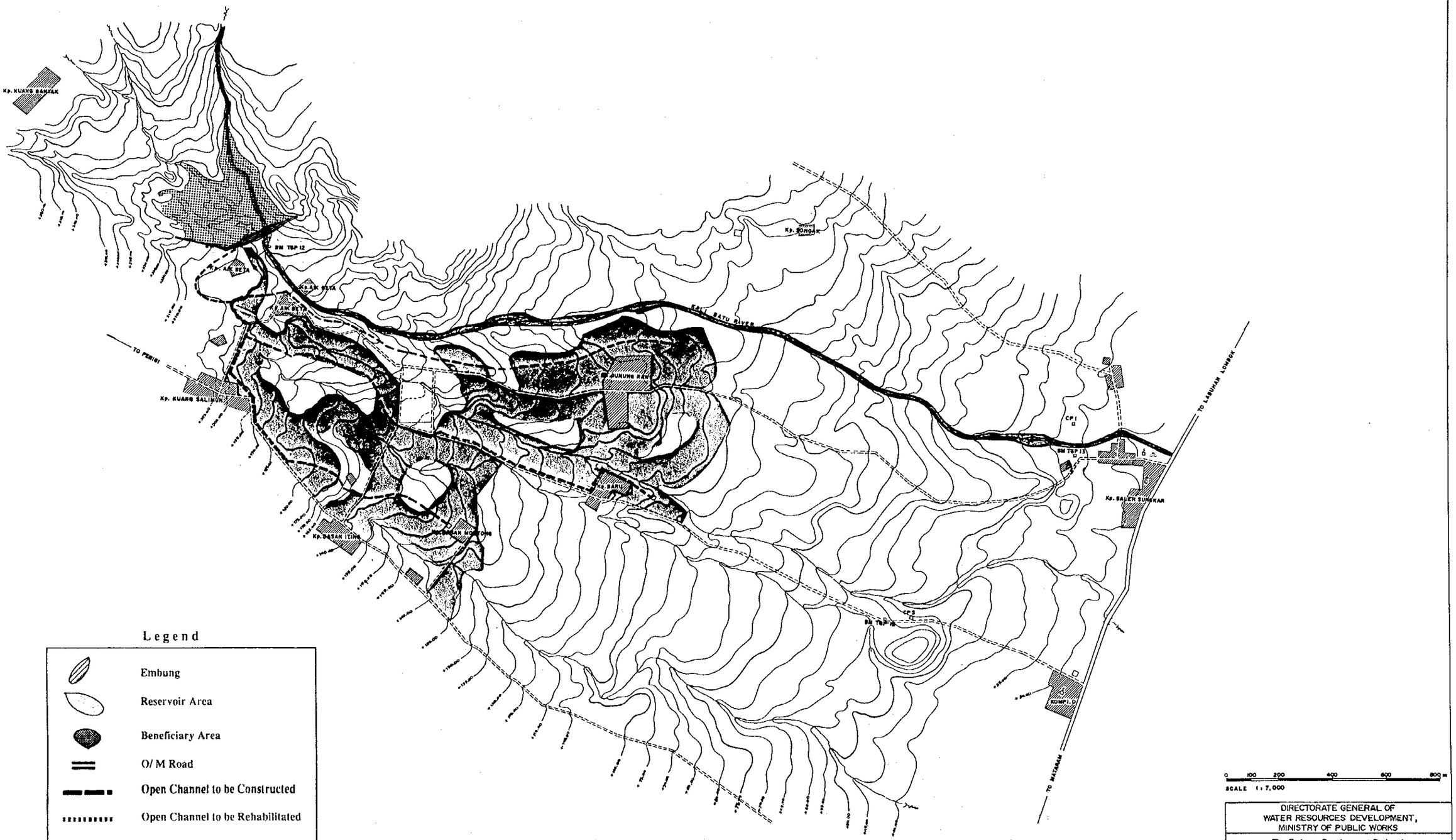

Figure 5.1 Genelal Layout of Aik Beta Project

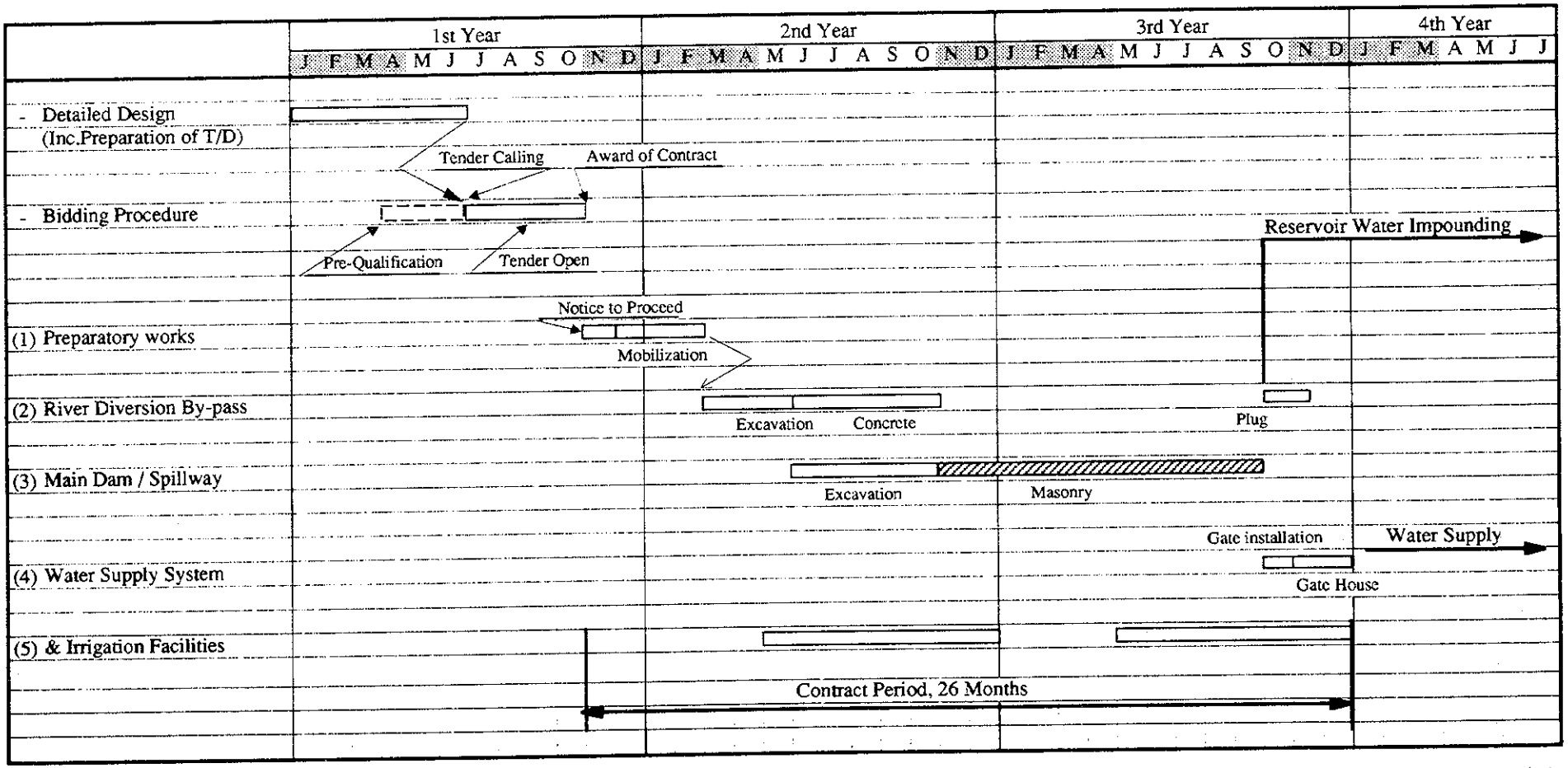

Figure 6.1 Construction Time Schedule for Aik Beta Project